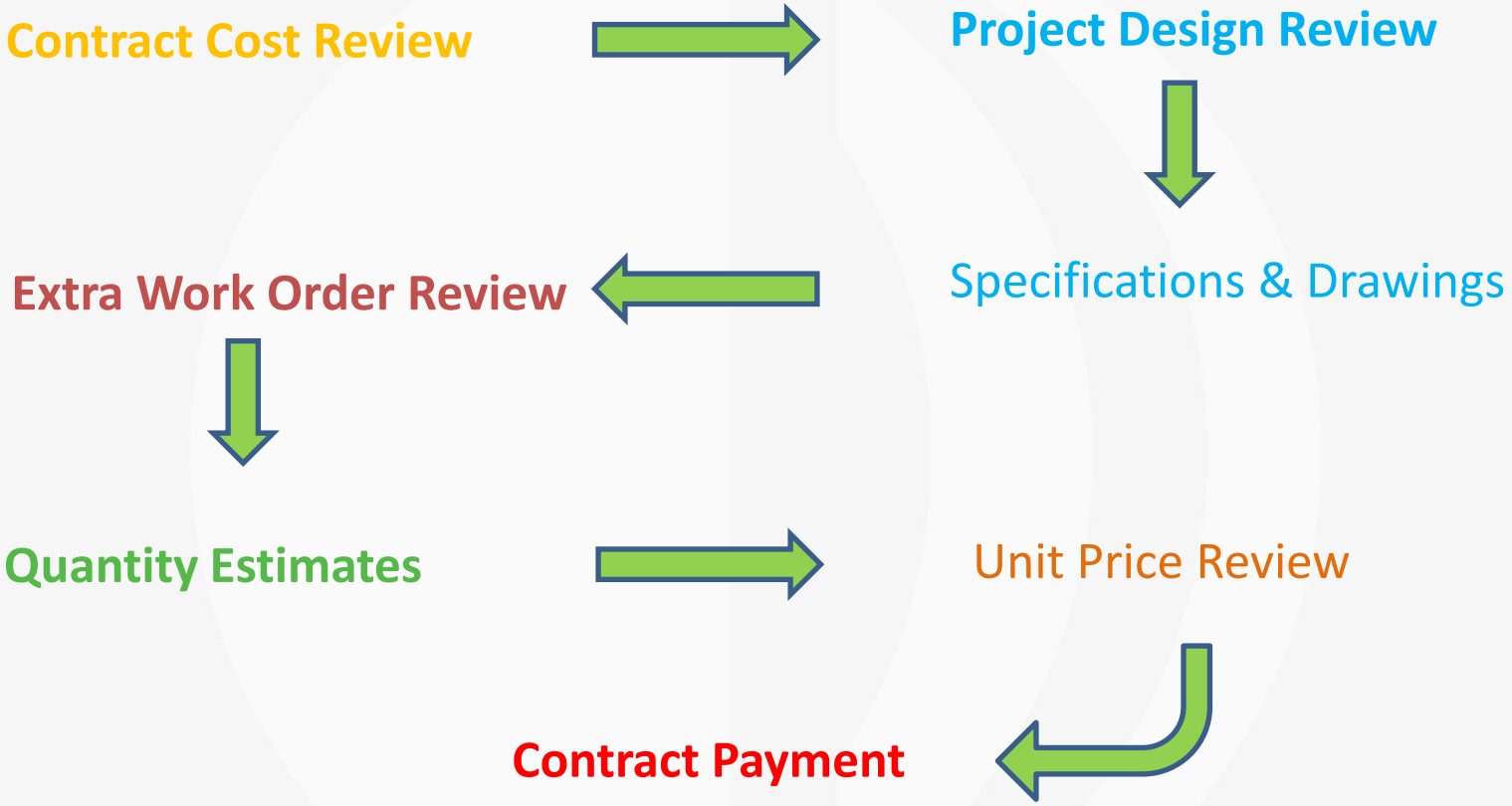
Keeyask Engineering Review
Jan 30 2017



Overview – KCB Review Scope

- Project Costs– 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?
- Extra Work Orders – what were they, were they reasonable and how did they impact the project costs?
- Unit Prices – were they reasonable compared with other projects?
- Contracting Methodology – is the contract format reasonable and appropriate for the project?

Overview - Methodology

- Review the cost overruns to identify the areas of concern,
- Review the engineering design and drawings associated with each area of concern,
- Review extra work orders, quantity changes, unit prices and their potential impact on the cost overruns
- Review the contract format, specifically the measurement and payment sections

Contract Cost Review

- Contract summary table shows 247 contracts awarded with a current forecasted value of $4.644 Billion
- The total of the original contract values was $2.722 Billion
- The increase in the project cost is therefore $1.922 Billion

What are the important contract increases?

- KCB initially sorted all the contracts by contract value.
- Then we calculated the percentage increase for each contract.
- Then we sorted the percentage increase of each contract as percentage of the total project cost, to understand which contract changes are important to the overall project.

Contract Cost Review – Table 2 Extract

1a - All numbers in this slide are CSI. Not all increases have been negotiated with the contractors. Forecasted values also include contingency on the contract

Table 2 Extract - 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				

Contract Cost Review - Conclusions

- The General Civil Contract with BBE is the critical contract for the project [redacted] of project overrun).
- If BBE was on budget and schedule the total project would only be over budget by $628M or 23%.
- Much of that 23% is also directly related to civil delays. Camp costs, turbine supply costs, etc. all would be significantly reduced.
- Therefore, the majority of our review examined the General Civil Contract.

Design – Specification Review

Were design changes a major driver of cost increases?

- Design changes typically appear as revisions to the Issued for Construction Drawings or the Technical Specifications. Consequently KCB reviewed the drawings and specifications looking at the revision history.
- 12 versions of the Technical Specifications were produced between March 2014 and July 2017. The amended agreement includes a version from 1 May 2015.
- KCB reviewed the GCC specification sections at three dates, the amended contract version March 2014, Version 3 in May 2015 and Version 12 from July 2017.
- Table 3 in the report summarized the significant changes.

Design – Specification Review - Table 3 Extract

Legend: 1 Revision from previous 2 or more Revisions from previous

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

Design – Specification Review Comments

- 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.
- There were approximately 20 sections with noticeable changes.
- All the changes had some impact on the costs. Together they show that the mechanical and electrical design was not as well advanced as the civil design back in 2014 (not unsurprising).
- 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.

Design - Geotechnical Data

Were unforeseen geotechnical issues a major cost impact?

- The investigations appear to have been reasonably comprehensive, both for construction materials and, in general, for the structures
- The following small issues were noted:
  - The regional bedrock geology drawing in the contract, which covers the vicinity of the major structures, does not include the locations of drill holes and test pit
  - There is a brittle deformation zone which crosses the axis of principal structures beneath the central dam and cofferdam which was only investigated with one drill hole.
  - The ductile deformation zone (shear or fault) shown on the geology plan beneath the central dam mainly in the water was not investigated, even though it is shown to continue onto the island near Gull Rapids.

Design – Geotechnical Materials

Was there enough material for construction?

- The material balance was reviewed. The engineer's material balance represents one plan that could be followed which showed that identified material volumes are adequate.
- The required rock excavations are shown as being 100% utilized. Abundant additional rock is available in nearby quarries.
- The sum of the impervious borrow material in the three identified locations greatly exceed the requirements.

Design – Geotechnical Design

Were the earthfill structures easy to construct?

- On the earthfill dam sections, some material zones are relatively thin, and materials will be slow to place and (where required) to compact. 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. This narrow placement area is limited to a 2 m vertical height in the dams.

- In summary, there are a few areas where more investigation might have helped, but overall the geotechnical information is sufficient and there is plenty of borrow materials available to build the project.

Design – Drawing Review

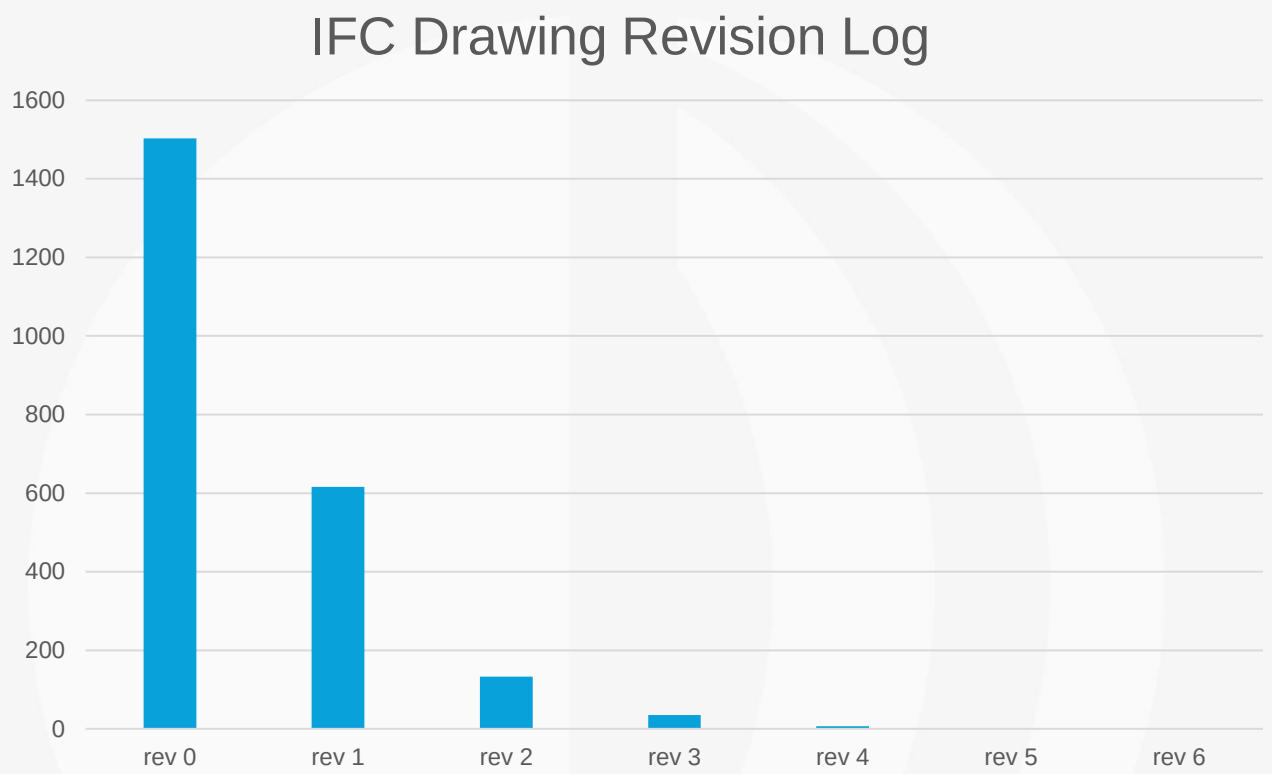
Were the drawings sufficient for construction?

- KCB reviewed drawing register list of 2300 IFC drawings with some emphasis on 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.
- 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.

Were the drawings revised multiple times?

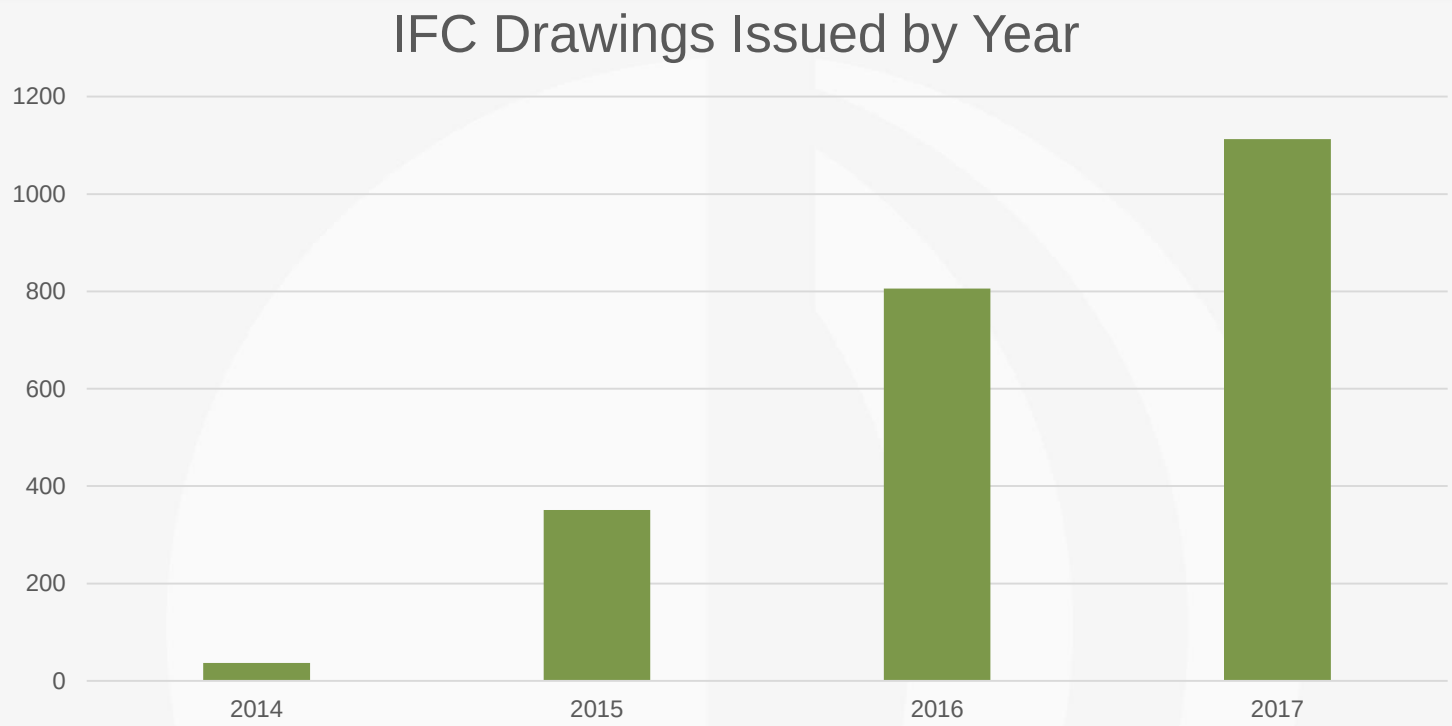
- We looked at the revision history for the IFC drawings, if the drawings had undergone multiple revisions that would likely indicate changes to the scope or inadequate drawings to start.

Design – Drawing Review



- The vast majority of the drawings have not been revised after issued IFC.
- 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.

Design – Drawing Review



- 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 could impact the costs:
  - The contractor missed or did not allow for the complexity of the project – i.e. underbid
  - The engineer could have added more detail and work after the contract was signed.

Design – Summary

- 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;
- There are a few areas where more geotechnical investigation might have helped, but overall the geotechnical information is sufficient and there is plenty of borrow materials available to build the project.
- The drawing 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 only potential issue may be the timing of the drawing production, which may have created some delays in construction.
- In summary, “design changes” do not account for the major cost increase.

Extra Work Order - Review

Do the EWO's show where the cost increase came from?

- We reviewed the EWO's for the GCC as extracted from the Keeyask Contract Revision Register for Allocated Contingency - August 2017.
- Review shows the total additional for all the "Approved GP" EWO's, which is where the technically driven changes are recorded, adds up to [redacted] million which includes [redacted] million in MH directed work.

Extra Work Order - Review

Year	EWO Value
2014	[redacted]
2015	
2016	
2017	
Total	

1a

- But the profit reductions add up to [redacted] 1a
- So there is actually a net savings of approximately [redacted] between the profit reductions and the approved technical EWO's.

Extra Work Order – Summary

- 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. 1a

Quantity Review

Were the quantity estimates grossly wrong, impacting the original Target Price?

- 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. Therefore, KCB concentrated our review on the earthworks and concrete quantities and their changes

Quantity Review – Table 8 Extract

Work Class	Work Type	UoM	Stage IV Hatch Report	Original Budget (OC) A	Current Budget (AA7) B	% C	Variance D=B-A
Concrete Works							
	Formwork	*$m^{=2}$*		*199,794.00*	*209,304.81*	*4.76%*	*9,510.81*
	Embedded Anchors	*kg*		*323,592.16*	*408,285.07*	*26.17%*	*84,692.91*
	Reinforcing Steel	*kg*		*23,448,787.00*	*23,413,316.00*	*-0.15%*	*-35,471.00*
	Cast-In-Place Concrete	*m^3*	*356,800*	*329,713.00*	*322,194.07*	*-2.28%*	*-7,518.93*
Structural Steel		**kg**		**1,684,784.00**	**2,081,500.00**	**23.55%**	**396,716.00**
Earthwork							
	Unclassified Excavations	*m^3*	*3,078,700*	*3,226,490.00*	*3,937,244.49*	*22.03%*	*710,754.49*
	Rock Excavations	*m^3*	*1,976,400*	*1,937,975.00*	*2,079,870.40*	*7.32%*	*141,895.40*
	Impervious Fill (Class 1)	*m^3*	*1,567,100*	*1,006,300.00*	*714,084.00*	*-29.04%*	*-292,216.00*
	Granular Fill	*m^3*	*1,437,550*	*3,800,135.00*	*2,248,242.00*	*-40.84%*	*-1,551,893.00*
	Rockfill	*m^3*		*1,567,750.00*	*2,917,677.00*	*86.11%*	*1,349,927.00*
	Riprap	*m^3*		*469,550.00*	*486,248.00*	*3.56%*	*16,698.00*

Quantity Review

- 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.

Summary to this point

1. The design is reasonable
2. The drawings and specifications have very few revisions
3. The geotechnical investigations were reasonable
4. The technical EWO's have not been excessive
5. The quantity estimates are, in total, reasonably close

Unit Price Review

Were the Unit Prices changed at AA#7, if so what might the impact be?

- The Bill of Quantities, Prices and Target Price Estimate unit prices are very detailed.
- Comparison between the unit prices of the original contract and later agreement amendments is difficult.
- For our review similar items in the Bill of Quantities have been grouped together and “consolidated unit prices” were calculated by dividing the total cost of the grouped items by the total quantity.

Unit Price Review – Consolidated Prices

- The following consolidated items were reviewed.
  - Cast-in-Place Concrete - formwork area to concrete volume
    - » Intake = 0.7 m^2/m^3.
    - » Powerhouse and service bay = 0.52 m2/m3.
    - » Tailrace = 1.08 m2/m3.
    - » Spillway = 0.32 m2/m3.
  - Reinforcing Steel.
  - Structural Steel. The consolidated unit price included all main structural steelwork.
  - Unclassified Excavation for concrete structures, dams and dykes and for dykes in winter.
  - Rock excavation.
  - Impervious fill.
  - Granular fill, all classes.
  - Rockfill.

Unit Price Review - Consolidated Prices

- KCB compared the consolidated unit prices between the original contract, in AA3 (March 2014) and AA7 (February 2017).

Unit Prices – Table 9 Extract

Description	Unit	Amending Agreement 3		Amending Agreement 7		Consolidated Unit Price Increase
		Quantity	Consolidated Unit Price	Quantity	Consolidated Unit Price	
Cast-in-Place Concrete			1a		1a	1a
Intake	m^3	72,210	[redacted]	71,530	[redacted]	[redacted]
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	kg	23,448,787		23,218,582		
Structural Steel	kg	1,684,784		2,081,500		
Unclassified Excavation						
For concrete structures	m^3	1,226,700		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	m^3	1,937,975		2,079,869		
Compacted Fill						
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		

Unit Price Review – Consolidated Prices

- The percentage increase in the consolidated unit prices from Amending Agreement 3 to Amending Agreement 7 in the Table vary between 67% to 366%.
- Reviewing the entire Bill of Quantities, Prices and Target Price Estimate in the two respective Amending Agreements, virtually all the unit prices show similar increases.
- The substantial increases in the unit prices appear to be largely responsible for the substantial increase in the Target Price Estimate in AA 7.

Unit Price Review – Comparison with Others

Are the Keeyask unit prices comparable to other similar projects?

- 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.

Unit Price Review – Table 10 Comparison with Others

Description	Unit	Consolidated Unit Price		
		Amending Agreement 3	Amending Agreement 7	Historical Information
Cast-in-Place Concrete		1a	1a	
Intake	m^3	[redacted]		$1,000
Powerhouse and service bay	m^3			$1,000
Tailrace	m^3			$1,200
Spillway	m^3			$600
Reinforcing Steel	kg			$4.00
Structural Steel	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	m^3			$20.00
Compacted Fill				
Impervious fill	m^3			$25.00
Granular fill	m^3			$10.00
Rockfill	m^3			$80.00

Unit Price Review – Comparison with Others

- The unit prices in the initial contract appear to be generally lower compared with the KCB unit price data,
- The unit prices in Amending Agreement 7 appear to be generally significantly higher compared with the KCB unit price data

Unit Price Review – Cost Comparison

- KCB then calculated approximate costs using the consolidated prices for AA3, AA7 and the KCB data and the associated subset of Keeyask quantities. The results were:
  - AA3 - [redacted](baseline)
  - AA7 - [redacted]x baseline)
  - KCB – [redacted]x baseline)
- KCB concluded that the original target price was optimistically low
- The contractor would therefore likely not have been able to do the work for the original Target Price.

Contract - Terms of Payment - Section 5

"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."

"….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…."

- All very reasonable……certainly for a contract with unit prices and measured quantities leading to the Final Target Price.

Contract - Basis for Payment – Section 9

"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."

- 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.
- The Section 9 payment wording discussion of Actual Costs does not seem to include any exclusions or amendment possibility and does not mention Actual Costs being equal to quantities x unit prices.

Thus the definition of *Actual Costs* is critically important.

Contract - Section 11

""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……, all costs incurred for all labour……, 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)and (c) discuss extra work and termination

There is no connection between Actual Costs and the quantities and unit prices

Conclusions

1. The design is reasonable
2. The drawings and specifications have very few revisions
3. The geotechnical investigations were reasonable
4. The technical EWO's have not been excessive
5. The quantity estimates are, in total, reasonably close
6. The original unit prices were optimistically low, thus the original Target Price was optimistically low
7. The contractor would probably not have been able to do the work for the original Target Price.
8. The Actual Costs are not based on the quantities and unit prices