ONTARIO POWER GENERATION

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OPG-FORM-0076-R005*

Type 3 Business Case Summary

To be used for investments/projects meeting Type 3 criteria in OPG-STD-0076.

Executive Summary and Recommendations

Project Information			
Project #:	COR80581 (HDEV 0024)	**Document #:**	QC10-22260-0001
Project Title:	Ranney Falls G3 Project		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Business Development Initiative
Phase:	Execution	**Release:**	Full
Facility:	Ranney Falls Generating Station (GS)	**Target In-Service or Completion Date:**	December 31, 2019

Project Overview

We recommend the release of $71.2M, including $7.4M of contingency.
This approval brings the total released for the Project to $77.3M, including definition phase of $6.1M plus execution phase of $71.2M.

The estimated cost of the Execution Phase of the Ranney Falls G3 Project is $74.2M. The Definition Phase cost to date is $3.1M and the Definition Phase release was for $6.1M. We recommend the approval of an incremental release of $71.2M for project execution. The cost estimate is an AACE (Association for the Advancement of Cost Engineering) Class 2 quality estimate, with a 94% confidence level. It includes fixed price contracts with the civil contractor, gates contractor, and Water-to-Wire (W2W) contractor and other costs estimated on the basis of experience with previous OPG hydroelectric development projects.

This release will fund the following scope of work:

- Construction, testing and turnover to Central Operations (CO) of the new 10 MW G3 single unit generating station (GS)
- Transmission connection with Hydro One - point of connection is at site
- Owner's Engineer and other OPG direct costs
- Interest during Construction (IDC)

Problem Statement/Business Need:

The Ranney Falls G3 Project is being undertaken to construct, test and turnover to CO a new 10 MW single unit hydroelectric generating station at OPG's Ranney Falls G3 site. Key drivers of the Project include:
:

- Replaces the existing G3 unit (0.8 MW) that reached end of life in June 2014 and preserves the site for an additional 90 years.
- Offers the opportunity for a reasonable financial return. Project costs are lower than recent renewable procurement price offers on a ¢/kWh basis.
- Utilizes excess water running through existing OPG and Parks Canada water control infrastructure on the Trent River.
- Installing a new spillway integrated with the new G3 powerhouse provides asset protection at the Ranney Falls Generating Station (GS) site and enhances public safety in Campbellford.
- Distribution system connection has been secured and no new distribution line is needed.
- Addition of a clean, renewable source of generation to OPG's capacity and revenue base.
- OPG and area Indigenous communities have discussed capacity building and contracting and construction employment opportunities.
- Project is specifically noted in the Province's proposed Long Term Energy Plan (LTEP); highlights hydroelectric expansions at existing sites as a cost-effective and green way of leveraging provincial assets while avoiding the need for new near-term procurement in Southern and Central Ontario.
- Consistent with OPG's strategic plan and is included in OPG's 2017-19 business plan.
- Provides an opportunity to enhance OPG's long-term relationship with Parks Canada and the Trent Hills Municipality.

*Associated with OPG-STD-0076, Developing and Documenting Business Cases

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Project Overview

Summary of Preferred Alternative:

The Ranney Falls G3 Project is being undertaken to construct a new 10 MW single G3 unit in a new powerhouse adjacent to the existing G1 and G2 powerhouse at the Ranney Falls GS site, with an expected in-service date of December 31, 2019. The proposed new G3 unit is replacing the existing 0.8 MW G3 unit that reached end of life in June 2014. The design life of the new asset will be 90 years and the forecast annual incremental generation is 33.1 GWh for an average year, based upon the available 61 years of hydraulic data.

The Project takes advantage of available flows in the Trent River to generate green power. Water is diverted down the Trent Canal from the Trent River by the Parks Canada Dam #10, located 1.4 km upstream of the existing Ranney Falls GS, which was acquired by Ontario Hydro in 1922. The Project is one of the few opportunities in Ontario that has reserved capacity on the Hydro One distribution system. It also has the least environmental impact, as no inundation is required to build the new unit. This Project will result in investment, contracting, employment and training opportunities for the local Trent Hills Municipality economy. Currently, the Project is expected to provide an economic injection of about $25M to the local Campbellford area.

Financial evaluation determined that the Ranney Falls G3 Project compares favourably to other waterpower developments being procured in the province considering enhanced asset protection and public safety at the site. The Power Purchase Agreement (PPA) equivalent price for the Project is 15.9¢/kWh. The Independent Electricity System Operator's Large Renewable Procurement (LRP) I program in March 2016 resulted in a weighted average price of 17.6¢/kWh for the four successful hydroelectric proponents. The Levelized Unit Energy Cost (LUEC) for the Project is 11.7¢/kWh, which is close to the regulated rate that OPG receives for its CO regulated hydroelectric assets.

A Design Bid Build (DBB) contracting approach was selected for the Ranney Falls G3 Project to create more competition between contractors for the relatively small sized project and to avoid mark ups by a general contractor when hiring subcontractors. The detailed design was completed during the Definition Phase to enable OPG to request fixed prices from prequalified suppliers and contractors. In addition, the design was optimized through physical model testing by a Ryerson University team. After a competitive Request for Proposals (RFP) process, GDB Constructeurs was chosen as the contractor to construct the project civil works during Phase One of the execution of the Project. Andritz Hydro Canada Inc. was chosen as the contractor to supply, install, and commission the W2W equipment in Phase Two of the execution of the Project. Gates for the Project are being supplied by Canmec Industriel Inc. OPG is "Owner-only" in both phases of the Project, with GDB and Andritz acting as the "Constructor" in Phases One and Two, respectively. Each of the contracts is based on OPG's Engineering, Procurement and Construction (EPC) template, with a fixed price to limit the risk of cost overruns on the Project.

History of BCS releases and project cost estimates:

In December 2011, the partial release of $6.1M was approved to initiate key Definition Phase activities and ready the Project for execution. Work included detailed engineering, design of critical long-lead time equipment (i.e. turbine/generator), project construction planning and permit application activities.

Key activities completed during the Definition Phase of the project included:

- negotiating the EPC agreements with the civil contractor (GDB), gates contractor (Canmec) and W2W contractor (Andritz)
- Completing an extensive geotechnical investigation at the site
- Completing engineering design (approximately 100%)
- Obtaining the federal environmental assessment approval and key permits, including extensive communication with several Federal and Provincial agencies and area First Nations
- Obtaining the Transport Canada approval and key permits
- Completing the Permit To Take Water exemption process
- Securing the 10 MW capacity on the distribution grid and executing the Hydro One Cost Connection Recovery Agreement (CCRA)

Key Assumptions and Risks:

The Project faces execution risks common to new hydroelectric projects, including discovery of unknown adverse geotechnical conditions, resourcing and contractor interface management.

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Project Cash Flows, NPV, and OAR Approval Amount

M$	LTD	2016	2017	2018	2019	2020	Future	Total
Currently Released	6.1							6.1
Requested Now	-		39.2	22.5	9.1	0.4		71.2
Future Required	-							
Total Project Cost	6.1		39.2	22.5	9.1	0.4		77.3
Ongoing Costs	-							
Grand Total	6.1		39.2	22.5	9.1	0.4		77.3

Estimate Class:	Class 2	**Estimate at Completion:**	$77.3M
NPV:	N/A	**OAR Approval Amount:**	$77.3M

Additional Information on Project Cash Flows (optional):

Approvals

	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Carlo Crozzoli SVP, Corporate Business Development & Strategy	Carlo Crozzoli		Feb 3/17.
Mike Martelli President, Renewable Generation & Power Marketing	Mike Martelli		6 Feb 17
I concur with the business decision as documented in this BCS.			
Finance Approval: Ken Hartwick SVP Finance, Strategy, Risk & CFO per OPG-STD-0076	K Hartwick		March 14, 2017
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Jeffrey Lyash President & Chief Executive Officer per OAR 1.3	J Lyash		March 14, 2017

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Business Case Summary

Part A: Business Need

The Ranney Falls G3 Project is being undertaken to construct, test and turnover to CO a new 10 MW single G3 unit at the Ranney GS site. The new hydroelectric unit replaces the existing 0.8 MW G3 unit that reached end of life in June 2014. The expected in-service date is December 31, 2019. The asset life will be 90 years and the forecast annual incremental energy production of the generation station is 33.1 GWh. The Project takes advantage of flows diverted down the Ranney canal from the Trent River by the Parks Canada Control Dam #10, which was constructed by the crown in 1882. The head (approximately 14.37 m) and flow available at the proposed site provide an opportunity to develop a renewable energy resource and meet OPG's objective of maintaining and expanding its hydroelectric asset base, while utilizing the existing infrastructure of OPG and Parks Canada. The existing Ranney Falls G1 and G2 that were built in 1922 are approaching end of life within the next 15 to 20 years. Execution of the Ranney Falls G3 Project preserves the Ranney Falls GS site for an additional 90 years.

The Trent Canal is sensitive to Ranney GS operations because it is a run-of-the-river station with a very small storage capacity (3 m^3/s-day), with no spilling capacity. The Trent-Severn Waterway (TSW) owned and operated control dam is 1.4 km upstream of the station. Therefore, timely diversion of the flow away from Ranney GS is important in emergency shutdown situations. However, there are inevitable delays associated with mobilizing the TSW staff to manually operate TSW Dam #10 to divert the flow. A major issue with the status quo is that CO will continue to be exposed to the risk of flooding the residential areas along the Trent Canal leading to Ranney GS. This risk is credible as an overtopping event occurred in the past. Although TSW is responsible for operating the control dam when the station is down for any reason, including the outages imposed by Hydro One, the reputation of OPG is associated with any delay or failure to perform this critical operation in a timely manner. Including the new spillway as an integrated part of the new powerhouse is a major enhancement to asset protection and public safety for the newly developed Ranney GS site. The new spillway will allow for passing the flow from the new unit and also from any of the two existing units (G1 and G2) at the site.

The Ranney Falls Generating Station is included in OPG's regulated hydroelectric assets and the Ranney Falls G3 Project is expected to receive a regulated rate that reflects cost recovery and a return on capital. OPG will prepare comprehensive evidence to demonstrate that project costs were prudently incurred and their recovery is consistent with applicable regulatory principles. The Ranney Falls G3 Project measures up well against other hydroelectric developments being procured in the province. When evaluated at a 70% debt ratio (higher leverage than the deemed debt ratio allows for a more accurate comparison with LRP I hydroelectric projects), the PPA equivalent price is 15.9¢/kWh, well below the 17.6¢/kWh weighted average price of the successful LRP I proponents. The LUEC for the Project is 11.7¢/kWh, which is close to the regulated rate of 10.7¢/kWh that OPG receives for its CO regulated hydroelectric assets.

Part B: Preferred Alternative: Construct the Ranney Falls G3 Generating Station

Description of Preferred Alternative

Proceed with the Execution Phase of the Ranney Falls G3 Project to have the selected DBB contractors construct, test and turnover to CO, the new G3 10 MW unit. In this alternative, a 10 MW unit is recommended to be installed in a new, smaller powerhouse, next to the existing main powerhouse. The existing forebay structure will also need to be expanded. This alternative does not require a penstock because the expanded forebay will feed the flow directly to the new unit. In addition, the existing tailrace must be expanded to handle the additional discharge from the new unit and spillway as illustrated in the figure below.

The end of life 0.8 MW unit in the "Pup" powerhouse will be mothballed and its penstock will be partially removed and capped to make space for the new powerhouse. The superstructure of the "Pup" powerhouse itself will be left in place for heritage and cultural purposes. A new spillway will be integrated with the new powerhouse to provide asset protection for the existing and new facilities and mitigates the current public safety and reputational risks. The spillway can pass 172 m^3/s outside the navigation season and 120 m^3/s during navigation season, which is the combined flow of all (existing and new) generating units.

Pros:

- The new station takes advantage of unused flows diverted down the Trent River by the Trent Canal.
- Extensive geotechnical investigation completed to help alleviate the geotechnical risk at the site.
- The development meets OPG's stated objective of maintaining assets by replacing the G3 unit that reached end of life, and expanding its hydroelectric asset base utilizing the existing infrastructure.
- The Project preserves the Ranney Falls GS site for an additional 90 years.
- The Project is also identified in the of the proposed Province's Long Term Energy Plan.
- The new station will provide an additional source of income for OPG.

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Part B: Preferred Alternative: Construct the Ranney Falls G3 Generating Station

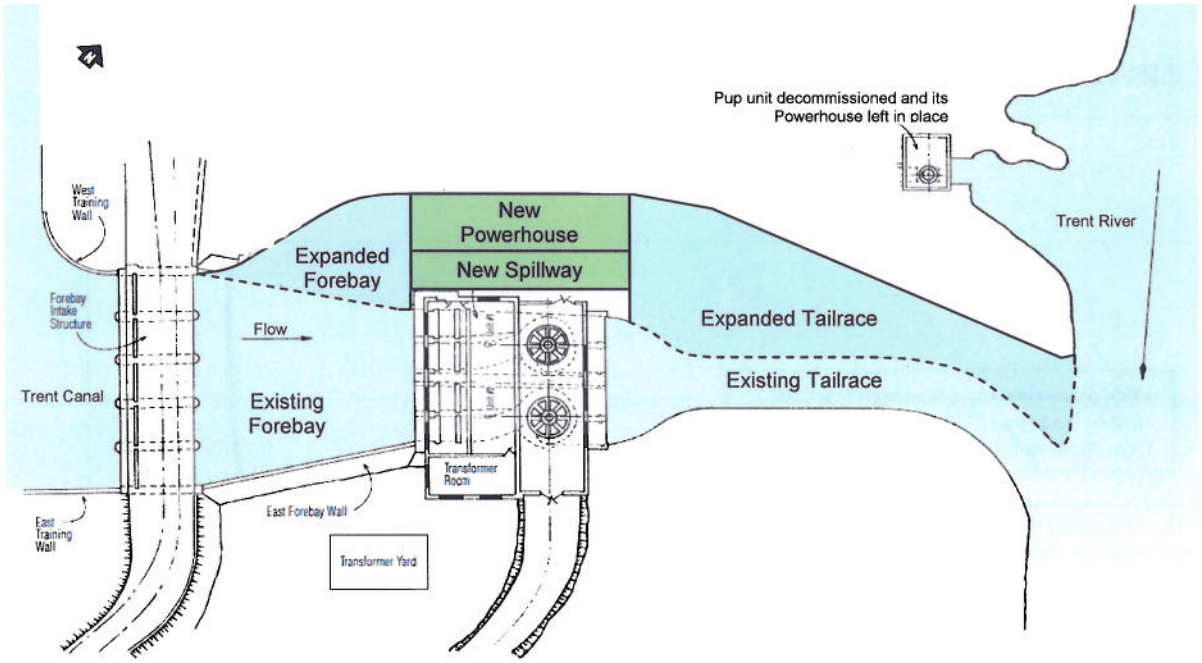
Description of Preferred Alternative

- The Project will result in investment, contracting, employment and training opportunities for Trent Hills Municipality communities. The Project will build on and strengthen OPG's relationship with these communities and Parks Canada.

Cons:

- Like other new construction projects in Ontario, the Ranney Falls G3 Project will face several risks to meeting cost and schedule targets, particularly the labour productivity, potential discovery of adverse geotechnical issues, and contractor interface management. Although extensive geotechnical investigation was completed at this site, the risk is still possible.

Proposed Ranney Falls G3 Project Layout



Deliverables:	Associated Milestones (if any):	Target Date:
Mobilize to site	• Ready the site to start excavation activities	April 2017
Excavate for expanded forebay, spillway, intake, powerhouse and the expanded tailrace canal		October 2017
Concrete work for the forebay wall, intake, spillway, and powerhouse and gate installations		April 2018
Civil work complete		October 2018
Install mechanical and electrical equipment	• Turbine/Generator installed	August 2019
Commission the new Ranney Falls G3 10 MW unit	• Unit In-service	December 31, 2019

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

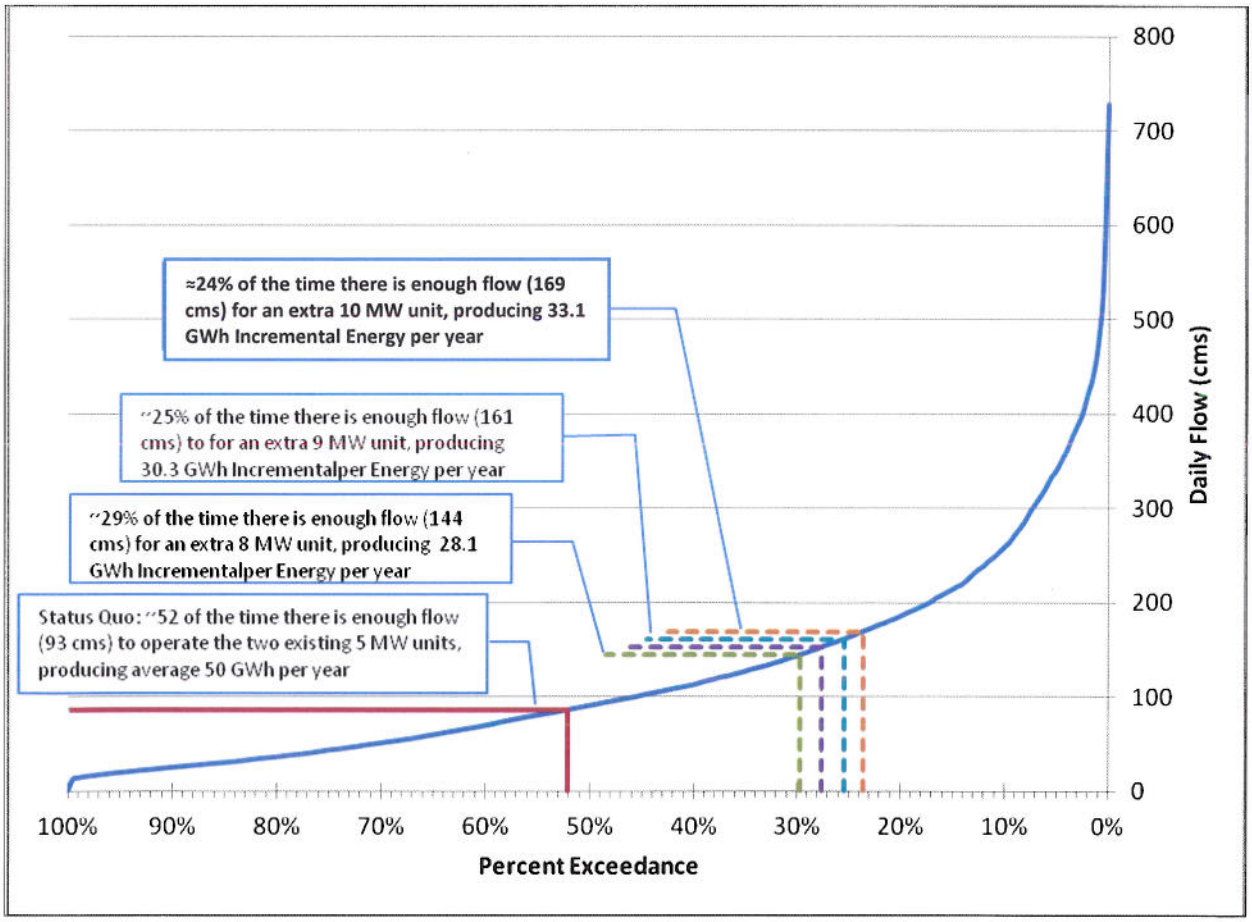
Alternative 2: Base Case – Cancel the Project

Alternative 2: Base Case – Cancel the Project

The "status quo" alternative is not recommended because it represents a lost opportunity in expanding OPG's hydroelectric generation portfolio. It continues to expose OPG to the risk of damage to the site assets and flooding the residential areas along the Trent Canal leading to Ranney GS. With this "status quo" alternative, the Ranney GS is left with a reduced total station capacity of 10.3 MW and average annual energy production by G1 and G2 combined is about 50 GWh. This "status quo" alternative underutilizes the available flow during the non-navigation period (between the long weekends of Thanksgiving in October to Victoria Day in May), which if economically utilized could produce on average an additional 33.1 GWh of electricity in a typical water year. The figure below shows the percentage of available flow spilling at the site for different new unit sizes.

[Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Text Box Tools tab to change the formatting of the pull quote text box.]

Comparison of Unit Size and Incremental Energy



Pros:

- None.

Cons:

- Lost revenue opportunity with unused flows diverted down the Trent River.
- Continued exposure to flooding risk as the new spillway would not be constructed.
- OPG's relationship with the Municipality of Trent Hills and the community at large will be negatively impacted, as there will be lost project employment and business opportunities.
- The Ranney Falls GS site may not be preserved for OPG generation beyond the expected end of life for the G1 and G2 units (estimated to be within the next 15 to 20 years).

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Part D: Project Cash Flows, NPV, and OAR Approval Amount

M$	LTD	2016	2017	2018	2019	2020	Future	Total
Currently Released	6.1							6.1
Requested Now	-		39.2	22.5	9.1	0.4		71.2
Future Required	-							
Total Project Cost	6.1		39.2	22.5	9.1	0.4		77.3
Ongoing Costs	-							
Grand Total	6.1		39.2	22.5	9.1	0.4		77.3

Estimate Class:	Class 2	**Estimate at Completion:**	$77.3M
NPV:	N/A	**OAR Approval Amount:**	$77.3M

Additional Information on Project Cash Flows (optional):
See Appendices A and C for further information on Project Cash Flows and Financial Assumptions.

Part E: Financial Evaluation

M$	Execute Project	Cancel Project			
Project Cost	77.3	3.1			
NPV	N/A	-3.1			
Equivalent PPA (¢/kWh)	15.9	N/A			
LUEC (¢/kWh)	11.7	N/A			

Summary of Financial Model Key Assumptions or Key Findings:

Once in service, the Ranney Falls G3 Project is expected to receive a regulated rate that reflects cost recovery of all prudent and reasonable costs, plus a return on capital based on a deemed 55/45 debt/equity capital structure. The Ranney Falls G3 Project measures up well against other hydroelectric developments being procured in the province. When evaluated at a 70% debt ratio (higher leverage than the deemed debt ratio allows for a more accurate comparison with LRP I hydroelectric projects), the PPA equivalent price is 15.9¢/kWh, well below the 17.6¢/kWh weighted average price of the successful LRP I proponents. The LUEC for the Project is 11.7¢/kWh, which is close to the regulated rate that OPG receives for its CO Operations regulated hydroelectric assets.

See Appendix C for additional detail on the financial evaluation and results.

Part F: Qualitative Factors

1. Sustainable Energy Development

The Project meets OPG's stated objective of expanding its hydroelectric asset by constructing 10 MW of emission-free generation. Given the increase in intermittent generation in Ontario, such as wind, additional emission-free generation is extremely valuable. Hydroelectric generation is the most environmentally sustainable form of generation that accomplishes this task. The Project is also identified as a key component to the Province's hydroelectric strategy in the proposed LTEP.

2. Stakeholder Relations

There is broad support for the Project among the Municipality of Trent Hills, Parks Canada, local First Nations and the community at large. The Project will provide employment, training and business opportunities to local stakeholders in the region. Approval of the Project ensures the continued engagement and support of Parks Canada and Trent Hills municipality.

3. Economic Benefits to Central Ontario

A significant portion of the total project expenditure will occur in Central Ontario, resulting in benefits to the local and regional economy. These benefits will include, but not be limited to, contracting opportunities for local businesses, along with training and employment opportunities. The Project will also result in indirect benefits to local businesses due to the increased activity in the area.

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Part F: Qualitative Factors

4. Health and Safety Performance

Safety program/performance was a significant factor in the contractor evaluation process. GDB and Andritz will develop and implement comprehensive site specific safety plans for construction safety, public safety and security. GDB, Canmec and Andritz have demonstrated its commitment and ability to work safely through their participation in previous OPG projects.

5. Project Management Reputation

Successful completion of the Project within budget and on time will enhance OPG's project management reputation with the Provincial Government and regulators and enhance the probability of obtaining future development opportunities.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that the actual project cost exceeds the approved budget.	The project budget was reviewed and updated with confirmed fixed prices from DBB Contractors. Contingency is included in the cost estimate.	Medium	Low
Scope	There is a risk that the project scope increases in the Execution Phase leading to unexpected costs and schedule delays	The Project completed 100% of the design during the Definition Phase and WSP (the project designer) is a leading hydroelectric engineering firm. Contingency is included in the cost estimate for any residual risk.	Low	Low
Schedule	There is a risk that abnormal weather (in excess of 1 in 20 years), Force Majeure events or critical equipment delivery delays will impact the project schedule.	The Project is carrying contingency to address this risk should it occur. The DBB Contractors have experience working on hydro projects in Ontario and managing adverse weather conditions. The project schedule also has some flexibility built into it and it is possible to recover schedule by increasing the amount of winter work conducted. The fixed price contracts include milestone related payments and liquidated damages for schedule delay.	Low	Low
Resources	There is a risk of a shortage of skilled construction labour for the project.	The construction site is close to a number of centers that are able to supply construction labour.	Low	Low
Quality/ Performance	There is a risk that execution productivity is impacted by interface coordination between the DBB contractors.	The DBB contractors are experienced in performing similar work. The DBB contracts identify interfaces and the contractors are preparing an integrated schedule for the Project. OPG has included contingency in its estimate to cover any residual risk.	Medium	Medium
Technical	There is a risk that unexpected subsurface conditions are discovered during construction, leading to additional costs and/or schedule delays.	A comprehensive geotechnical site investigation was undertaken as part of the Conceptual and Definition phases and led to the creation of a Geotechnical Baseline Report (GBR). The GBR was used to inform engineering/design decisions and the Civil Work contract negotiations. OPG will retain ownership of the risk of unknown adverse geotechnical conditions discovered during construction and hold contingency to address it, if required. The Civil Work	Medium	Medium

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Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
		contractor will retain ownership of risks related to the design/construction assumptions and dewatering. The Civil Work contractor will conduct the remediation for any geotechnical issues encountered.		

Project Risks will be managed as follows:

1. Risk management will be an agenda item at regular project meetings.
2. New or emerging risks will be identified and included along with the status of existing risks in monthly reports.
3. The project risk register will be maintained throughout the course of the Project.
4. The Project Director will report project risk status through the project reporting processes.
5. Project contingency will be managed through the change control process and supported by a contingency log. A re-assessment of the adequacy of the contingency will be part of the risk monitoring and control processes.

Additional Risk Analysis:

See Appendix E for a summary of the additional risk analysis and results.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Comprehensive PIR	December 31, 2019	December 2020

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Target In-Service Dates	December 31, 2019	December 31, 2019	Compared with contract completion date and approved changes	RG&PM Project Execution
Actual turbine/ generator output	Output guaranteed in contract	Output guaranteed in contract	Actual turbine/ generator output will be compared to the output guaranteed in the contract	External performance testing consultant
Actual Cost	$77.3M	$77.3M	Cost compared with approved release	OPG Finance

Part I: Definitions and Acronyms

AACE – Association for the Advancement of Cost Engineering
ACF – Annual Capacity Factor
CCA – Capital Cost Allowance
CCRA – Connection Cost Recovery Agreement
CO – Central Operations
DBB – Design Bid Build
EPC – Engineering, Procurement and Construction
GBR – Geotechnical Baseline Report
GS – Generating Station
GWh – Gigawatt hour
IDC – Interest during Construction
kWh – kilowatt-hour
LRP – Large Renewable Procurement
LTEP – Long Term Energy Plan
LUEC – Levelized Energy Cost

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Part I: Definitions and Acronyms
m^3/s – cubic meters per second
m^3/s – cubic meters per second-day
MW – Megawatt
OM&A – Operating, Maintenance and Administration
PIR - Post Implementation Review
PPA - Power Purchase Agreement
RFP – Request for Proposal
TSW – Trent-Severn Waterway
W2W – Water-to-Wire
WACC – Weighted Average Cost of Capital

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For Internal Project Cost Control

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Appendix A: Summary of Estimate									
Project Number:	COR80581 (HDEV 0024)								
Project Title:	Ranney Falls G3 Project								
M$	**LTD**	**2016**	**2017**	**2018**	**2019**	**2020**	**Future**	**Total**	**%**
Definition Phase (not including IDC)	3.0			-	-	-		3.0	3.9%
OPG Project Management	-		0.7	0.7	0.6	0.3		2.3	3.0%
Commercial	-		0.15	0.31	-	-		0.5	0.7%
Engineering & Contract Management (Owner's Engineer)	-		0.3	0.4	0.5	0.1		1.3	1.7%
Operations Interface	-		0.12	0.07	0.11	-		0.3	0.4%
Environment	-		0.17	0.07	0.08	-		0.3	0.4%
DBB Allowance	-		0.5	-	-	-		0.5	0.7%
Civil Work Contract (GDB)	-		22.0	12.1	-	-		34.1	44.1%
Gates Contract (Canmec)	-		5.7	1.6	-	-		7.3	9.4%
Water-to-Wire Contract (Andritz)	-		6.0	2.0	5.5	-		13.5	17.4%
Hydro One Connection	-		0.8	-	-	-		0.8	1.0%
EPSCA	-		0.2	0.2	-	-		0.4	0.5%
Interest during Construction	0.1		0.9	2.9	1.7	-		5.6	7.2%
Subtotal	3.1		37.6	20.3	8.5	0.4		69.9	90.4%
Contingency	-		4.6	2.2	0.6	-		7.4	9.6%
Total	3.1		42.2	22.5	9.1	0.4		77.3	100%

Notes			
Project Start Date	Mar-2017	**Total Definition cost** (excludes unspent contingency for Nuclear)	$3.1M
Target In-Service (or AFS) Date	Dec-2019	**Contingency included in this BCS** (Nuclear only)	N/A
Target Completion Date	Dec-2019	**Total contingency released plus contingency in this BCS** (Nuclear only)	N/A
Escalation Rate	2.00%; 0.00% on fixed price contracts	**Total released plus this BCS without contingency** (Nuclear only)	N/A
Interest Rate	4.83%	**Total released plus this BCS with contingency** (Nuclear only)	N/A
Removal Costs	N/A	**Estimate at Completion** (includes only spent contingency for Nuclear)	$77.3M

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Prepared by:		Approved by:	
Iskander Boulos		Paul Burroughs	
Iskander Boulos	Date	Paul Burroughs	Date
Project Manager	2017-01-~~XX~~	Director	2017-01-~~XX~~
Project Execution		Project Execution	
Renewable Generation & Power Marketing		Renewable Generation & Power Marketing	

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Appendix B: Comparison of Total Project Estimates and Project Variance Analysis

Comparison of Total Project Estimates

Phase	Release In M$	Approval Date	Total Project Estimate in M$ (by year including contingency)						Future	Total Project Estimate
			LTD	2016	2017	2018	2019	2020		
Definition Phase	$6.1	Dec-2011	3.1							$48.7
Full Release Execution Phase	$71.2	Mar-2017	3.1		42.2	22.5	9.1	0.4		$77.3

Project Variance Analysis

Choose an item.	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management					
OPG Engineering (including Design)					
OPG Procured Materials					
OPG Other					
Design Contract(s)					
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total					

Type 3 Business Case Summary

Project #: COR80581 (HDEV 0024) Document #: QC10-22260-0001
Project Title: Ranney Falls G3 Project, <Full> <Execution> Release

Appendix C: Financial Evaluation Assumptions

Key assumptions used in the financial model of the Project are:

Once in service, the Project is expected to receive a regulated rate that reflects OPG's revenue requirements at that time according to O. Reg. 53/05, as it refurbishes and expands capacity.

Key assumptions used in the financial model of the Project are:

Project Cost:

1. The total project cost is $77.3M.
2. The project cost includes $0.2M of cost escalation, $7.4M of contingency, and $5.6M of interest during construction (IDC).
3. $54.9M of the project cost consists of fixed price construction contracts (Civil Work, W2W, and Gates) which do not receive annual escalation.

Financial:

1. Weighted Average Cost of Capital (WACC) used for LRP I PPA price comparison based on 70/30 debt/equity capital structure, 4.83% cost of debt, 9.33% return on equity, and a tax rate of 25%.
2. PPA equivalent price is based on a 40-year contract term, with 20% of the price escalating at 2.00%/year once the unit goes into service.
3. WACC used for LUEC price is based on a 55/45 deemed debt/equity capital structure, 4.83% cost of debt, 9.33% return on equity, and a tax rate of 25%.
4. LUEC price is based on a 90-year asset life, with 100% of the price escalating at 2.00%/year once the unit goes into service.
5. The IDC rate is 4.83%.
6. General cost escalation during the construction and operating periods is 2.00%/year. Fixed price construction contracts do not escalate.
7. The tax rate is 25% and taxes have been calculated on a stand-alone basis.

Project Life:

1. The asset life is 90 years from the expected in-service date of December 31, 2019.

Energy Production:

1. The 10MW unit is expected to generate an incremental 33.1GWh annually (37.8% Annual Capacity Factor (ACF)) for an average year based upon the available 61 years of hydraulic data.

Operating Cost:

1. The incremental annual OM&A cost associated with the new unit is $50k/year (2016$).
2. The financial forecast includes $300k (2016$) in project specific OM&A, occurring on a 25-year cycle.
3. The Gross Revenue Charge (GRC) is $40/MWh, with escalation beginning in 2020. There is no 10-year GRC holiday on the TSW system.
4. The financial forecast includes $3.3M (2016$) in sustaining capital for turbine-generator overhauls, occurring on a 25-year cycle.

Other:

1. The full project cost is allocated to Capital Cost Allowance (CCA) class 43.2 (50%).

Appendix D: References

1. Ranney Falls G3 Project – Project Charter (Document Number QC10-00120-0003 R000, July 2010)
2. Ranney Falls G3 Project – Project Execution Plan, Definition Phase (Document Number QC10-COR80581-PEP-0000 R000, August 2015)
3. Ranney Falls G3 Project – Project Execution Plan, Execution Phase (Document Number QC10-PLAN-00121.1-0001

Type 3 Business Case Summary

Project #: COR80581 (HDEV 0024) Document #: QC10-22260-0001
Project Title: Ranney Falls G3 Project, <Full> <Execution> Release

R000, February 2017)
4. Ranney Falls G3 Project – Project Definition Rating Index Report, Stage 3 (December 12, 2016)
5. Ranney Falls G3 Project – Business Case Summary, Definition Phase (Document Number QC10-HDEV0024-BCS R000, December 2011)

Type 3 Business Case Summary

Project #: COR80581 (HDEV 0024)
Project Title: Ranney Falls G3 Project, <Full> <Execution> Release

Document #: QC10-22260-0001

Appendix E: Quantitative Risk Assessment Results

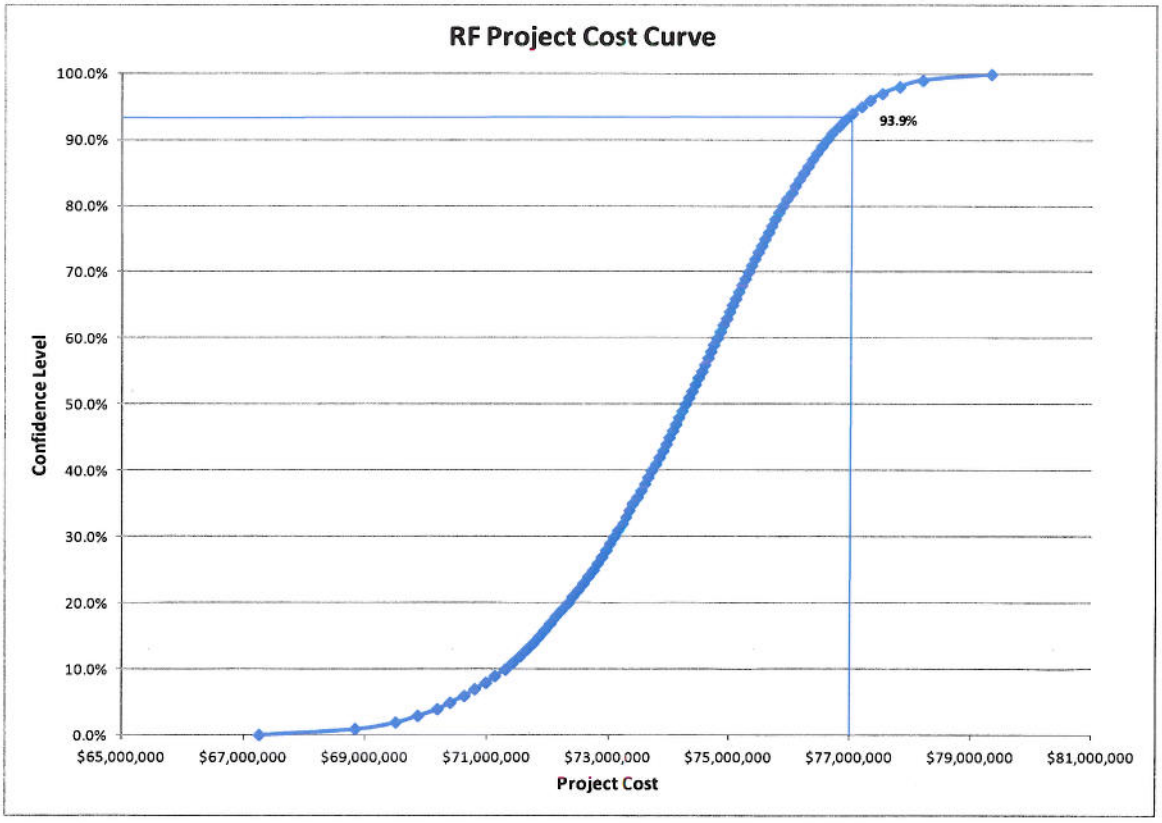
The Ranney Falls G3 Project overall cost estimate includes a Project contingency of $7.4M, which is held by OPG.

The Project completed a quantitative risk assessment to calculate this contingency. The overall cost estimate, including contingency, is expected to be sufficient to cover project costs and risks at a 94% confidence level. The following areas of uncertainty and risk were included in the assessment:

1. Cost Estimate Uncertainty – The Project team provided best case, worst case and most likely estimates for the Owner's, construction work packages, and construction management and engineering consultant costs. This analysis took into account any estimate uncertainty and the likely range that each cost item would fall in.
2. Discrete Project Risks – The Project team developed a detailed register of Execution phase risks through a series of meetings. Likelihood of occurrence and three point estimates for Financial and Schedule Impact were estimated for each of these risks. The Financial Impact of each risk was included in the contingency calculation, while the Schedule Impact was used to conduct a Monte Carlo analysis of the schedule.
3. Schedule Uncertainty – A high-level critical path schedule was created for the purposes of the schedule analysis. The Project team estimated the best case, worst case and most likely durations for each of the high-level schedule tasks. The Schedule Impacts of the discrete risks were then mapped directly to the schedule tasks. A simulation of the project schedule was then conducted using Primavera Pertmaster software to develop probability curves for likely in-service dates for the Project. Potential delays were input into the project cost model using a project run rate calculated by the Project Manager.

   A project cost model was developed in Microsoft Excel 2007, based on the model developed for the Lower Mattagami River Project, New Post Creek Project and Mattagami Lake Generating Station Project. The software @Risk 6 was used to conduct the Monte Carlo Simulation used to develop the project cost distribution curve. The model also takes into account variability related to Interest during Construction and Escalation. The cost probability curve is illustrated below:

Ranney Falls G3 Project – Quantitative Risk Assessment Results



Appendix F

RANNEY FALLS G3 PROJECT RESOLUTION

RESOLUTION OF THE BOARD OF DIRECTORS
OF
ONTARIO POWER GENERATION INC.

Re: Approval of Ranney Falls G3 Generating Station Project

WHEREAS:

A. Ontario Power Generation Inc. ("**OPG**") is finalizing its plans to construct and operate a new 10 MW hydroelectric generating station in Campbellford, in the Municipality of Trent Hills, Northumberland County. The new station is an expansion to OPG's existing hydroelectric station ("**Ranney Falls GS**") and a new unit (the "**G3 Unit**") will replace the former G3 unit, which reached end of life. The new station will also include construction of an integrated spillway to bypass the flow of the existing two units (G1 and G2) and the G3 Unit during emergency situations to protect OPG assets and ensure protection of public safety (the "**Ranney Falls G3 Project**").

B. OPG and Her Majesty the Queen, in right of Canada, represented by the Minister of the Environment for the purposes of Parks Canada Agency ("**Her Majesty**") have entered into an interim licence agreement for the construction of the Ranney Falls G3 Project.

C. Upon completion of construction, OPG and Her Majesty intend to enter into a final licence, which will govern the operation of Ranney Falls GS and the G3 Unit (the "**Final Licence**"). It is anticipated that the Final Licence will have a term of thirty (30) years, with renewals at Her Majesty's discretion. The scheduled in-service date of the G3 Unit is December 31, 2019 and it is estimated to have a useful life of ninety (90) years.

D. The total cost estimate for the Ranney Falls G3 Project is $77.3 million (the "**Estimated Cost**"), including the $6.1 million previously approved on December 2011. OPG intends to finance the Estimated Cost through its cash flow.

E. The Ranney Falls GS is a regulated hydroelectric asset pursuant to O. Reg. 53/05 under the *Ontario Energy Board Act, 1998* and OPG expects to recover the Estimated Cost through the rate regulation process.

F. The project design has been completed and the environmental assessment for the project has been approved.

G. OPG intends to enter into certain project construction agreements, including agreements with the civil contractor and the water-to-wire contractor. Subject to Board approval, the agreements will be executed and Ranney Falls G3 Project construction activities will commence by March 12, 2017.

H. Further particulars about the Ranney Falls G3 Project are set out in the Ranney Falls G3 Project Approval memo and accompanying materials dated March 10, 2017 (the "**Board Memo**").

RESOLVED THAT:

Ranney Falls G3 Project

1. The Ranney Falls G3 Project, as described in the Board Memo, is approved and OPG is authorized to proceed with construction activities.

Project Costs

2. OPG hereby approves and authorizes OPG to finance the Estimated Cost in accordance with the project economic analysis detailed in the Board Memo.

Execution of Project Agreements

3. OPG hereby approves and authorizes any one of the President of Renewable Generation & Power Marketing or an officer of OPG to take such action, and sign and deliver such documents, as may be necessary or desirable in respect of the construction of the Ranney Falls G3 Project.

ONTARIO POWER GENERATION

Records File Information:
Records SCI/USI Retention
- See Guidance Section

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OPG-FORM-0076-R005*

Type 3 Business Case Summary

To be used for investments/projects meeting Type 3 criteria in OPG-STD-0076.

Executive Summary and Recommendations

Project Information			
Project #:	HDEV0028	**Document #:**	Facility-BCS-SCI-Sequence# R00X
Project Title:	Sir Adam Beck Pump Generating Station Reservoir Refurbishment		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Sustaining
Phase:	Execution	**Release:**	Full
Facility:	Sir Adam Beck Pump Generating Station	**Target In-Service or Completion Date:**	April 1, 2017

Project Overview

The estimated cost of the Execution Phase of the Sir Adam Beck Pump Generating Station Reservoir Refurbishment Project is $47.4M. Since the Definition Phase was underspent by $2M (i.e., the release was for $9.3M and the actual is $7.3M) we recommend approval for the release of $45.4M for the project execution. This release value is based on Class 2 quality estimate, with a 95% confidence level. The estimated $47.4M includes $10.2M contingency. Combined with the costs of the Concept and Definition Phases, the total project cost will be $58.2M.

This release will fund the following scope of work:

- Refurbishment of the Sir Adam Beck (SAB) Pump Generating Station (PGS) reservoir by the Contractor,
- Owner's Representative and other OPG direct costs, and
- Interest during Construction.

Problem Statement/Business Need:

The Sir Adam Beck (SAB) Pump Generating Station (PGS) and its storage reservoir are integral parts of the SAB hydroelectric complex and the Ontario electricity system. Along with ability to store water in off-peak hours and generate during higher priced on-peak hours, the PGS also helps to control the diversion flow to the SAB complex, and enables the SAB1 and SAB2 generating stations to provide additional peaking power and services such as Automated Generation Control (AGC) and Operating Reserve.

The SAB PGS reservoir is enclosed by a 7.4km long rock-filled ring dyke that employs a natural clay material in its core and the extension of the core towards the reservoir bottom (referred to as the dyke tongue) to prevent water seepage. Although the containment dyke is stable, the underlying bedrock may contain open, continuous joints below the dyke, which could result in water seepage from the reservoir and cause migration of fine grained soils into the open joints. The northeast corner of the reservoir is the main area of concern, as this is where the water depth is the highest and a strong downward seepage gradient exists. Such bedrock characteristics could make the foundation, and potentially the dyke itself, susceptible to sinkhole formation, which could lead to a dyke breach. A dyke breach would result in significant financial impacts to OPG; these impacts would include both dyke repair costs and lost revenues from the PGS and the entire SAB Complex while the dyke is out-of-service for repairs. If a significant amount of water is released from the PGS as a result of a dyke breach, there could also be significant safety and environmental impacts to the surrounding community.

The Project will ensure that the PGS can continue to operate safely for the next 50 years. The project will also help to ensure that OPG can maintain its reputation as a safe dam operator and a trusted community partner.

Summary of Preferred Alternative:

The preferred alternative is to conduct the PGS reservoir refurbishment activities to reduce the risk of seepage from the reservoir that can lead to a dam safety event. The PGS reservoir refurbishment was identified as the preferred alternative in the facility's Life Cycle Plan (LCP), approved in 2014. The project has also been included in the 2014-2016 HTO Business Plan. The project is in line with the OPG's mandate to maintain and develop hydroelectric resources.

Financial evaluation in the LCP estimated that the PGS would yield a net present value (NPV) of $508M (2014$) of benefits to

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Project Overview

the system, with this reservoir refurbishment project in the plan. Alternatively, if there is no project, the PGS would be harvested and decommissioned by 2017/2018 due to the anticipated poor condition of the reservoir then. The NPV would be negative $23M. The financial evaluation has been updated to 2015$ with updated System Economic Values (SEVs) and project cost. This reservoir refurbishment along with a number of capex projects identified in the LCP would enable the continued operations of the PGS, which would provide a NPV of $528M to the Ontario electricity system over the next 30 years.

The work will be executed between April 1, 2016 and March 31, 2017 and includes:

- Dewatering of the PGS reservoir and fish removal.
- Installation of engineered liners over the critical areas of the reservoir floor. This is referred to as the "partial liner," as opposed to the full liner option that would have covered the entire bottom of the reservoir.
- Construction of a bedrock grout curtain through the upstream slope of the dyke in the northeast corner of the reservoir.
- Re-grading of the reservoir floor within 30m of the upstream toe of the dyke in specified locations at the southeast corner to remove any depressions
- Covering the reservoir bottom areas remediated in 1958 with additional sediment blanket;
- Watering-up the reservoir and returning it to service.

A design-bid-build contracting approach was selected for the project to minimize costs while maintaining a high level of control over the design and technical aspects of the project. Golder Associates completed the comprehensive geotechnical investigation and design work during the Definition Phase, and will provide Owner's Representative services during the Execution Phase. Rankin Construction Inc. was selected amongst four qualified proponent as the construction contractor through a rigorous prequalification, evaluation and request for proposals process. Rankin has selected the liner installation and grouting subcontractors from a previously prequalified list of companies.

History of BCS releases and project cost estimates/ History of scope and schedule changes:

In April 2011, $2.0M of OM&A funds were released to complete the Concept Phase of the project, bringing the total released at that time to $3.5M of OM&A funds. Concept Phase work included documentation reviews and site exploration, preliminary geotechnical investigation, and preliminary scoping, design, costing and scheduling.

In September 2011, $9.3M of Definition Phase capital funds were released to finalize the design of the reservoir liner system and study the possibility of expanding the reservoir capacity. At the time, the expected total project cost was $287.3M with work being completed in 2014 and 2015. After completing the comprehensive geotechnical investigation in 2011, it was determined that complete lining of the entire PGS reservoir was not required and that a partial liner solution was appropriate. Furthermore, it was concluded that expanding the reservoir was not financially viable under current market conditions. The current scope of the PGS refurbishment was developed thereafter and refined over the Definition Phase. In the 2014 SAB PGS Lifecycle Plan, a project cost of $100M was estimated. The current estimated project cost of $58.2M was finalized upon completion of the Definition Phase design, procurement and estimating processes.

Key Assumptions and Risks:

Given that the PGS reservoir refurbishment is largely a civil work project with significant geotechnical risks (excavation over the dyke tongue, grouting into the bedrock through the dyke core and overburden interface, and lining installation connected to the dyke tongue), the project contingency might be higher than typical for OPG projects. A three-month contingency has also been included in the project schedule. The project used both qualitative and quantitative risk assessments, along with past lessons learned and industry knowledge, to develop the project contingency estimates. The areas of significant risk for the project are:

1) Uncertainty regarding subsurface and dyke conditions.
2) Liner supply, installation, quality and costs risks.
3) Technical issues with the grouting process and its impact on the dyke, as well as grouting material quantity risk.

A detailed risk register was created during the Definition Phase to capture all identified discrete risks and risk response plans.

Type 3 Business Case Summary

Project #: HDEV0028
Document #: Facility-BCS-SCI-Sequence# R00X
Project Title: Sir Adam Beck Pump Generating Station Reservoir Refurbishment, <Full> <Execution> Release

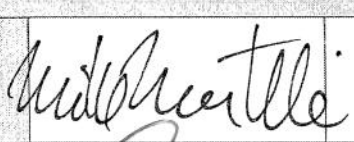
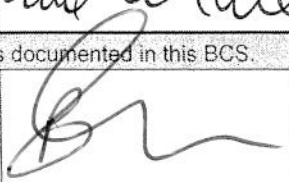
Project Cash Flows, NPV, and OAR Approval Amount

M$	LTD	2015	2016	2017	2018	2019	Future	Total
Currently Released – Concept Phase OM&A	3.5							3.5
Currently Released – Definition Phase Capital	6.5	2.8						9.3
Actual Spent – Definition Phase Capital	6.5	0.8						7.3
Requested Now	-	2.0	38.9	6.5				47.4
Future Required	-							
Total Project Cost	10.0	2.8	38.9	6.5				58.2
Incremental Ongoing Costs	-							0.0
Grand Total	10.0	2.8	38.9	6.5				58.2

Estimate Class:	Class 2	**Estimate at Completion:**	$58.2M
NPV:	$528M	**OAR Approval Amount:**	$58.2M

Additional Information on Project Cash Flows (optional):
See Appendix A for further information on Project Cash Flows.
The NPV of $528M refers to the NPV of the PGS's benefits to the system if the PGS is to continue to operate for the next 30 years.

Approvals

	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Mike Martelli, SVP Hydro-Thermal Operations			17 Aug 15.
I concur with the business decision as documented in this BCS.			
Finance Approval: Beth Summers, SVP & Chief Financial Officer, per OPG-STD-0076			18 Aug 15
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell, President & Chief Executive Officer, per OAR 1.1			18 AUG 15

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Type 3 Business Case Summary

Project #: HDEV0028
Document #: Facility-BCS-SCI-Sequence# R00X
Project Title: Sir Adam Beck Pump Generating Station Reservoir Refurbishment, <Full> <Execution> Release

Business Case Summary

Part A: Business Need

The Sir Adam Beck (SAB) Pump Generating Station (PGS) and its storage reservoir are integral parts of the SAB hydroelectric complex, which, along with the PGS, includes the Sir Adam Beck 1 (SAB1) and Sir Adam Beck 2 (SAB 2) generating stations, and the three water conveyance tunnels and the power canal that deliver water from the Grass Island Pool. The SAB PGS was constructed between 1953 and 1957, and is the only pump generating station in Canada. The six-unit reversible pump-turbine plant is capable of pumping water from the outlet of the tunnels and canals into its reservoir, and then generating 174 MW from that reservoir by discharging the stored water back into the SAB complex headpond. The PGS supports the peaking operation of the SAB complex by storing water in off-peak hours and generating during higher priced on-peak hours. The SAB PGS's operation is integrated with SAB1 and SAB2 as stored water is used to generate peaking power at all three stations. The PGS is also used for: 1) Improving the overall efficiency of operations at the SAB Complex, 2) Assisting SAB1 and SAB2 in the provision of Automated Generation Control (AGC) and Operating Reserve services to the Ontario Electricity System, and 3) Providing relief for the electricity system during periods of Surplus Baseload Generation (SBG) by providing a load which prevents other generators from spilling water or shutting down units.

The SAB PGS reservoir is enclosed by a 7.4km long rock-filled ring dyke, varying in height from 4.6 meters in the west to 20.5 meters in the east. The dyke employs a natural clay material in its core and at the connection point with the reservoir floor (referred to as the clay "tongue") to prevent water seepage. The PGS reservoir has operated satisfactorily since 1958 when it was returned to service after an outage to repair areas of leakage. Although the containment dyke is stable, the underlying bedrock may contain open, continuous joints below the dyke, which could result in water seepage from the reservoir and cause migration of fine grained soils into the open joints. The northeast corner of the reservoir is the main area of concern as that is the area where the water depth is the highest and a strong downward seepage gradient exists. Such bedrock characteristics could make the foundation, and potentially the dyke itself, susceptible to sinkhole formation, which in turn could lead to a dyke breach. A dyke breach would result in significant financial impacts to OPG; those impacts would include both dyke repair costs and lost revenues from the PGS and the entire SAB Complex while the PGS is out-of-service for repairs. If a significant amount of water is released from the PGS as a result of a dyke breach, there could also be significant safety and environmental impacts to the surrounding community, including the residential development west of the reservoir, Highway 405 north of the reservoir and the Canada-US Customs Office east of the reservoir.

Part B: Preferred Alternative: Refurbishment of the SAB PGS Reservoir

Description of Preferred Alternative

Proceed with the execution of the SAB PGS Reservoir Refurbishment Project to ensure that the station can continue to safely provide value to the Ontario electricity system. The Project will take remedial measures to protect against potential bedrock piping mechanisms under the dyke that may currently exist or develop over time. It was concluded that these remedial measures were required as a result of the studies completed during the Definition Phase, including a review of historical data, the comprehensive geotechnical investigations carried out in 2011 and seepage analysis. The Project will allow OPG to continue to operate the PGS for 50 years and maintain its reputation as a safe dam operator. The scope of work for the project, which will be executed between April 1, 2016 and March 31, 2017, includes:

- Dewatering of the PGS reservoir and fish removal.
- Installation of geomembrane and geosynthetic clay liners over the critical areas of the reservoir floor. This is referred to as the "partial liner," as opposed to the full liner option that would have covered the entire bottom of the reservoir. The full liner option was studied during the Concept Phase of the project and dismissed during the Definition Phase after review of the available information and the results of the 2011 geotechnical investigations.
- Construction of a bedrock grout curtain through the upstream slope of the dyke in the northeast corner of the reservoir.
- Re-grading of the reservoir floor within 30m of the upstream toe of the dyke in specified locations at the southeast corner to remove any depressions and cover the area with a 1m thick sediment blanket obtained from within the reservoir.

A diagram of the exact location of these remedial activities is provided in Appendix E. This approach was deemed to be the most appropriate to address potential seepage issues as a result of the analysis and geotechnical investigation completed during the Definition Phase by OPG and its Owner's Representative, Golder. In addition, OPG engaged an independent Dam Safety Review Panel comprised of three international geotechnical experts to review, contribute to and validate the agreed upon approach.

The expected cost of the project execution phase is $47.4M, which includes construction costs, Owner's Representative costs, OPG direct costs, interest during construction and contingency. Part E and Appendix A provide a detailed breakdown of the project cost flows along with the financial assumptions made. The SAB PGS is a regulated hydroelectric asset and as such will

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Part B: Preferred Alternative: Refurbishment of the SAB PGS Reservoir

Description of Preferred Alternative

receive the regulated rate for energy. The PGS Reservoir Refurbishment was identified as the preferred alternative in the facility's Life Cycle Plan, approved in 2014. The project has also been included in the 2014-2016 HTO Business Plan. The project is in line with the OPG's mandate to maintain and develop hydroelectric resources.

A design-bid-build contracting approach was selected for the project to minimize costs while maintaining a high level of control over the design and technical aspects of the project. The design, including technical specifications and associated drawings, was finalized by Golder Associates based on the work conducted during the Definition Phase. Rankin Construction Inc. was selected as the construction contractor through a rigorous prequalification, evaluation and request for proposals process. Rankin was evaluated as the technically most competent proponent and its cost estimate was competitive. The contractor has selected the liner installation and grouting subcontractors from a previously prequalified list of companies. Rankin is a large and reputable construction firm with proven hydroelectric experience. Its liner subcontractor's Layfield Environmental Containment is a leading supplier and installer of engineered liners in Canada. Rankin's grouting subcontractor, Advanced Construction Techniques, is a well-known grouting company operating in Canada and the U.S. Golder will be the Owner's Representative during project execution and will provide oversight of the construction activities.

Pros:

- Refurbishment of the reservoir will allow the PGS to continue to operate safely for the next 50 years. The PGS is a valuable asset for the Ontario electricity system; it facilitates optimization of the entire SAB complex and assists in the provision of AGC and peaking at the SAB generating stations. An economic assessment shows that continued operation of the PGS would provide approximately $528M of NPV to the Ontario electricity system based on the capacity value and the peaking energy value, compared to an NPV of negative $25M if the PGS has to shutdown in a few years due to no reservoir refurbishment.
- By completing the project, OPG will reduce the likelihood of a dam safety event at the PGS, particularly a failure of the dyke. This will protect OPG's neighbours in the Niagara and Niagara-on-the-Lake area and enhance OPG's reputation as a safe hydroelectric operator.
- The partial liner solution is significantly less expensive than the full liner solution first thought necessary during the Concept Phase.
- Energy storage, include pumped storage, is becoming increasingly valuable due to its potential to assist in integrating intermittent renewable energy, such as wind and solar.
- The project will have minimal environmental impacts because all construction activities will be contained within the reservoir. An environmental assessment is not required.
- The project has obtained support from the IESO regarding the April 2016 to March 2017 construction outage window.

Cons:

- Upfront capital will be required to complete the Project.

Deliverables:	Associated Milestones (if any):	Target Date:
Finalization of construction and liner fabrication/ installation contracts and site preparation activities	• Construction contract signed • Mobilization on site begins	September 2015
PGS is taken out of service and construction outage begins	• Start of reservoir dewatering	April 2016
Construction activities, including liner installation, grouting and grading of the reservoir floor.	• Liner installation complete • Grouting complete	April 2016 – March 2017
PGS returns to service (Schedule contingency: Jan-Mar, 2017)	• Reservoir is watered up	March 2017

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Alternative 2: Base Case – SAB PGS Reservoir is not Refurbished

This alternative is not recommended. Not proceeding with the refurbishment of the PGS Reservoir would result in the shutdown and removal of the SAB PGS from operations in 2016 because of dam safety concerns. There is considerable cost, estimated at greater than $50M, associated with shutting down the PGS and putting it in a safe state. The economic analysis presented in Section E of this BCS shows that this option has a NPV of negative $25M.

Alternative 2: Base Case – SAB PGS Reservoir is not Refurbished

Pros:

- In absolute terms, not refurbishing the SAB PGS Reservoir and eventually shutting it down is a lower cost solution than the preferred alternative. Operating, maintenance and administration costs to continue to run the PGS would also be eliminated.

Cons:

- Until the PGS is shut down, the station will continue to run with a higher risk of a dam safety event occurring. Seepage associated with the potential bedrock piping will continue to be a major risk concern for OPG while the plant is operational.
- Once the PGS is shut down, OPG and the Ontario electricity system will lose a valuable asset. The ability of the SAB complex to provide peaking and AGC services for Ontario will be greatly impacted. This will make it more difficult to integrate and manage renewable energy in Ontario.
- OPG will lose generation from the PGS units and the corresponding improvement in output from SAB1 and SAB2 as a result of PGS operations.
- The project to shutdown and decommission the PGS is estimated to cost over $50M and will provide no value to OPG.

Alternative 3: Delay the SAB PGS Reservoir Refurbishment

This alternative is not recommended. Deferring the refurbishment of the PGS Reservoir will expose OPG to a greater risk of seepage and bedrock piping under the dyke, which can lead to potential sinkhole formation or dyke failure in certain areas. Given the analysis and site investigation completed during the Definition Phase, it is prudent for OPG to implement remedial measures to address the issues discovered as soon as possible. If a dam safety event were to occur during the time that the reservoir refurbishment is deferred, it would have severe impacts on OPG's reputation as a safe dam operator and its standing in the community.

Pros:

- The capital required to complete the project will not be needed in the immediate future.

Cons:

- The station will continue to run with a higher risk of a dam safety event occurring. Annual PGS maintenance costs may increase in order to prevent any potential seepage from the reservoir.
- Seepage and potential bedrock piping under the dyke may occur or worsen during the time that the reservoir refurbishment is deferred. This may lead to a larger scope of work or a more difficult refurbishment when the execution moves forward. Further site investigation and project definition will likely be required.
- A dam safety event during the time that the refurbishment is deferred will likely lead to intense regulatory and public scrutiny of OPG's dam safety practices. OPG's reputation is likely to be severely damaged.
- Obtaining buy-in from the IESO and other stakeholders on a new outage window for the project may be difficult given the other projects expected in the Ontario electricity system, particularly the Darlington Refurbishment, Bruce B Refurbishment and Pickering shutdown.

Alternative 4: Complete the Refurbishment and Expansion of the PGS Reservoir

This alternative is not recommended. In the SAB PGS Reservoir Refurbishment Definition Phase BCS, the project committed to investigating the feasibility of expanding the storage capacity of the PGS reservoir while refurbishing it. The project studied three options to expand the reservoir volume: 1) expanding the footprint of the reservoir, 2) raising the height of the PGS dyke perimeter, and 3) deepening the reservoir in the west end. Of the three options, increasing the height of the dyke perimeter appeared to be the lowest cost per volume increase. However, simulations of the value of the reservoir volume expansion showed that even this expansion option was unlikely to be economical under a wide range of circumstances (i.e., various combinations of forecasts for natural gas prices, CO2 prices and load growth were considered in the simulations). The base case estimates place the value of the reservoir volume expansion at 10% to 20% of what would likely be needed to justify the investment.

Pros:

- Refurbishment and expansion of the reservoir will allow the PGS to continue to operate safely for the next 50 years.
- The additional volume capacity of the reservoir will increase the station's value to the SAB Complex and the Province. In particular, the station will be able to shift supply from off-peak to on-peak times, which is important for its potential to assist in integrating intermittent renewable energy, such as wind and solar.
- By completing the project, OPG will reduce the likelihood of a dam safety event at the PGS, particularly a failure of the dyke. This will protect OPG's neighbours in the Niagara and Niagara-on-the-Lake areas and enhance OPG's reputation as a safe hydroelectric operator.

Type 3 Business Case Summary

Project #: HDEV0028 Document #: Facility-BCS-SCI-Sequence# R00X
Project Title: Sir Adam Beck Pump Generating Station Reservoir Refurbishment, <Full> <Execution> Release

Alternative 4: Complete the Refurbishment and Expansion of the PGS Reservoir

Cons:

- The expansion portion of the work is prohibitively expensive and uneconomical. The base case estimates place the value of the reservoir volume expansion at 10% to 20% of what would likely be needed to justify the investment.
- The complexity of the reservoir expansion may expose OPG to greater construction risks than just refurbishment of the reservoir, such as the possibility of damaging the existing dyke, disturbing the local community and interfering with the remediation work.

Part D: Project Cash Flows, NPV, and OAR Approval Amount

M$	LTD	2015	2016	2017	2018	2019	Future	Total
Currently Released – Concept Phase OM&A	3.5							3.5
Currently Released – Definition Phase Capital	6.5	2.8						9.3
Actual Spent – Definition Phase Capital	6.5	0.8						7.3
Requested Now	-	2.0	38.9	6.5				47.4
Future Required	-							
Total Project Cost	10.0	2.8	38.9	6.5				58.2
Incremental Ongoing Costs	-							0.0
Grand Total	10.0	2.8	38.9	6.5				58.2

Estimate Class:	Class 2	**Estimate at Completion:**	$58.2M
NPV:	$528M	**OAR Approval Amount:**	$58.2M

Additional Information on Project Cash Flows (optional):

See Appendices A and C for further information on Project Cash Flows and Financial Assumptions.

The NPV of $528M refers to the NPV of the PGS's benefits to the system if the PGS is to continue to operate for the next 30 years.

Part E: Financial Evaluation

M$	Reservoir Refurbishment	No Project & Decommission Reservoir	Delay Refurbishment Work	Refurbishment & Expansion	
Project Cost	$58.2M	$56.2M	N/A	$287.3M	
NPV	$528M	$-25M	N/A	N/A	
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

Reservoir Refurbishment:

The economic assessment of proceeding with the preferred alternative has a Net Present Value of $528M over the 30-year assessment period. This analysis is based on OPG's evaluation of the capacity value and the peaking energy value of the PGS. Net present value calculations have used forecasts for System Economic Values as the basis for estimating the capacity and on-peak generation benefits. The analysis demonstrates that the capital investment to refurbish the reservoir is worthwhile, as the PGS provides substantial long-term value to the Ontario Electricity System. The analysis was included in the 2014 PGS Lifecycle Plan and updated during the preparation of this BCS.

The PGS is a regulated hydroelectric asset and as such will receive the regulated rate for energy. The impact on regulated Hydro rates to recover the cost of this project is estimated to be less than $0.2/MWh in 2016 based on current assumptions.

Type 3 Business Case Summary

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Summary of Financial Model Key Assumptions or Key Findings:

No Project & Decommission Reservoir:

It is estimated that the cost to remove the PGS from service in 2016, and then dewater and decommission it, would be approximately $56.2M. This option would also remove future economic benefits from the PGS and limit the operational flexibility of the entire SAB complex. Overall, this option has an NPV of negative $25M over the 30-year evaluation period.

Delay Refurbishment Work:

The cost and net present value of this alternative was not assessed. Given the dam safety and reputational risks related with this alternative, it was ruled out prior to being financially evaluated.

Refurbishment & Expansion:

Preliminary evaluation of this alternative during the Concept Phase valued the project to refurbish and expand the PGS reservoir at $287.3M. Simulations of the value of the reservoir volume expansion showed that even the cheapest expansion option was unlikely to be economical under a wide range of circumstances (i.e., various combinations of forecasts for natural gas prices, CO2 prices and load growth were considered in the simulations).

A summary of the financial model assumptions is provided in Appendix C.

Part F: Qualitative Factors

1) **Dam Safety:** OPG's main focus is on the safety of its employees and the general public. The PGS Reservoir Refurbishment will allow OPG to maintain its strong reputation as a safe dam operator by greatly reducing the probability of a PGS dyke failure. By reducing the likelihood of a dyke failure, the Project is also protecting the surrounding areas from the potentially devastating environmental and safety risks of a dyke failure.

2) **Community Reputation:** OPG has a positive reputation in the Niagara region and a strong working relationship with all major stakeholders, including the city of Niagara Falls and town of Niagara-on-the-Lake. A dam safety event at the PGS would negatively impact OPG's reputation in the area, particularly if it damages Highway 405 along the north side of the reservoir and the Canada-US Customs Office east of the reservoir.

3) **Wind and Solar Integration:** Energy storage, including pumped storage, has been widely discussed in recent years due to its potential to assist in integrating intermittent renewable energy, such as wind and solar, into the electricity system and maximize their contribution. There is potential for additional value, including new sources of value to the electricity system for pumped storage in the future as the share of wind and solar increases in Ontario's electricity system.

4) **Value to SAB Complex:** The PGS is extremely valuable to the operation of the SAB complex and the Ontario electricity system. Along with improving the overall efficiency of the SAB complex, it also assists providing Operating Reserve services to the Ontario electricity system and the provision of AGC at SAB2. Furthermore, there are opportunities to increase the output of the entire SAB Complex by 1) Improving the unit efficiencies and removing operation limits of PGS units, and 2) Refurbishing SAB1 Units 1 and 2. A key component to the business cases for these upgrades is the availability of the PGS to optimize SAB Complex operations.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost/ Schedule	There is a risk that inclement weather occurs and impacts various construction activities, resulting in schedule delays and safety concerns. Extended periods of rain are the biggest threats, as they impact dewatering, sediment removal and relocation, and liner installation. Windy weather may also result in safety concerns during liner installation.	1) Clear specifications will be in place to ensure that work is conducted in the appropriate weather conditions. 2) Work will be scheduled with consideration of the seasonal weather conditions and weather forecasts. 3) A 3-month schedule contingency has been included to accommodate for poor weather and other delays. 4) Golder will monitor construction	High	High

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
		activities to ensure work is not being conducted in unsafe weather conditions.		
Cost/ Schedule	There is a risk that the grouting work may be extended due to potential damage to the dyke core and filters during drilling and grouting, unexpected conditions of the core and excessive grout take in bedrock.	1) Grouting specifications developed by Golder have been reviewed and commented by OPG, Dam Safety Panel and the grouting companies. 2) Golder will provide QA services during grouting and will provide quick responses if issues are identified.	Medium	High
Scope	There is a risk that new discoveries (such as the liquefaction issue observed at Ch. 56+00) appearing during the construction may require changes in the scope of work.	1) Contingencies are included in the project cost, schedule and resources. 2) Golder will maintain ability to respond to changing site conditions during construction.	Medium	High
Cost/ Schedule	There is a risk that excessive sediment (higher volume and slow drying time) is observed at the bottom of reservoir and this may delay the construction activities.	1) Contingencies are included in the project cost and schedule. 2) The issue was discussed with Rankin Construction for possible solutions for better sediment management.	Medium	High
Cost/ Schedule	There is a risk that the liner is not properly connected to the dyke tongue in the key trench, especially if the tongue could not be identified clearly or it does not exist.	1) The key trench design has been extensively studied and discussed among OPG, Golder and Panel. 2) Golder will provide QA services during liner installation and provide quick response if any tongue issues appear.	Medium	Medium
Quality/ Performance	There is a risk that the liner requires excessive rework or repairs during construction. Poor quality manufacturing or damage during installation could result in the need for rework/ repairs.	3) Liner manufacturing quality assurance practices was assessed by Golder during the procurement process. 4) Specifications are in place to ensure proper handling, placement and monitoring of liner. 5) Proper foundation/ bedding preparation criteria will be established. 6) Golder will provide quality assurance services during liner installation.	Medium	Medium

Additional Risk Analysis:

The Project completed a Qualitative Risk Assessment process during the Definition Phase to create its risk register. The risk register is a living document and will be used to record and track risk information throughout the Execution Phase. Among the list of risks described above, some other key risks being managed by the Project include:

1) Stakeholders oppose the project and take action to delay or halt it.
2) Fluctuating oil and energy prices impact the plastic resin and liner prices.
3) Bedrock formations underneath the dyke require more grout material than anticipated.
4) New discoveries or unexpected geological features are encountered during construction.
5) Aquatic species relocation during dewatering takes longer than expected.
6) Unanticipated environmental permits are required.

A Quantitative Risk Assessment was also completed to develop the Project contingency, further details are provided in Appendix F.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Comprehensive PIR	2017-03-31	2018-07-31

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Target In-Service Date	March 31, 2017	March 31, 2017	Compared with contract completion date	HTO Project Execution
Actual Cost	$58.2M	$58.2M	Compared with approved release	OPG Finance
Reservoir Performance (total leakage and piezometer responses)	To be determined in February 2016 Testing	To be determined in February 2016 Testing	A 48-hour Static Head Test and piezometer readings will be completed in February 2016 to set baseline levels. The measurements will be repeated in April 2017 to determine the effectiveness of the remedial activities.	HTO Plant Engineering Services, Niagara Plant Group, Golder Associates

Part I: Definitions and Acronyms

Definitions:

Automated Generation Control (AGC) – The ability to adjust the power output of a generator in response to changes in electricity demand.

dyke – The water-retaining structure that surrounds the PGS reservoir. The PGS dyke is composed of a rock-full embankment with an impervious clay core.

dyke tongue – The extension of the clay core material from the dyke to the reservoir floor at the dyke toe. The tongue ensures water retention and reduces water seepage under the dyke.

geomembrane – A 2mm thick liner material made of High Density Polyethylene. The geomembrane will be used to line the bottom of the reservoir in select areas.

geosynthetic clay liner – A synthetic material that performs in a similar manner to clay. The membrane uses a bentonite material in its core. This liner will be used as a single layer to remediate some areas of the PGS reservoir, or will surround the geomembrane in other areas to protect it.

grout curtain – An underground barrier that protects the foundation of a dam from seepage. A grout curtain usually consists of a row of vertically drilled holes filled with pressurized grout. The holes are drilled in intervals and in such a way that they cross each other, creating a solid curtain.

key-trench – The area on the upstream side of the dyke where the geomembrane and geosynthetic clay liner will be tied into the dyke tongue.

operating reserve – Additional supply of energy available on request should an unanticipated event take place in the real-time energy market.

piezometer – A device used to measure the pressure of groundwater at a specific point.

static head test – A test where the reservoir is filled to maximum level and held for 48-hours to determine if changes in water level are occurring from sources other than the operation of the PGS units (i.e. seepage, evaporation, etc.).

Acronyms:

CO2 – Carbon Dioxide
IESO – Independent Electricity System Operator
MWh – Megawatt Hour
NPV – Net Present Value
OPG – Ontario Power Generation
PGS – Pump Generating Station
SAB – Sir Adam Beck
SAB1 – Sir Adam Beck 1 Generating Station
SAB2 – Sir Adam Beck 2 Generating Station

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Type 3 Business Case Summary

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Project Title: Sir Adam Beck Pump Generating Station Reservoir Refurbishment, <Full> <Execution> Release

For Internal Project Cost Control

Type 3 Business Case Summary

Project #: HDEV0028
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Project Title: Sir Adam Beck Pump Generating Station Reservoir Refurbishment, <Full> <Execution> Release

Appendix A: Summary of Estimate									
Project Number:	HDEV0028								
Project Title:	Sir Adam Beck Pump Generating Station Reservoir Refurbishment								
M$	LTD	2015	2016	2017	2018	2019	Future	Total	%
Concept Phase – OM&A	3.5							3.5	6.0
Definition Phase – Capital including Interest	6.5	0.8						7.3	12.5
Project Management & Administration		0.1	0.7	0.3				1.1	2.0
Owner's Representative		0.2	3.4	0.1				3.7	6.4
Construction		1.6	28.8	0.0				30.4	52.2
Interest during Construction		0.1	1.1	0.8				2.0	3.5
Subtotal	**10.0**	**2.8**	**34.0**	**1.2**				**48.0**	**82.5**
Contingency			4.9	5.3				10.2	17.5
Total	**10.0**	**2.8**	**38.9**	**6.5**				**58.2**	**100**

Notes			
Project Start Date	2016-04-01	**Total Definition cost** (excludes unspent contingency for Nuclear)	$7.3M
Target In-Service (or AFS) Date	2017-03-31	**Contingency included in this BCS** (Nuclear only)	N/A
Target Completion Date	2017-03-31	**Total contingency released plus contingency in this BCS** (Nuclear only)	N/A
Escalation Rate	2.0%	**Total released plus this BCS without contingency** (Nuclear only)	N/A
Interest Rate	4.89%	**Total released plus this BCS with contingency** (Nuclear only)	N/A
Removal Costs	N/A	**Estimate at Completion** (includes only spent contingency for Nuclear)	$58.2M

Prepared by:	Approved by:
Clara Greco Project Manager Hydro-Thermal Project Execution Date 2015-07-23	Dick Jessop Director Hydro-Thermal Project Execution Date 23-Jul 2015

Type 3 Business Case Summary

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Appendix B: Comparison of Total Project Estimates and Project Variance Analysis

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in M$ (by year including contingency)						Future	Total Project Estimate
			Pre-2013	2013	2014	2015	2016	2017		
Concept Phase	3.5	15-Apr-11								N/A
Full Definition Phase	9.3	19-Sep-11	10.5	2.3	131.5	143.0				287.3
Full Execution Phase	45.4	21-Aug-15	6.8	2.5	0.7	2.8	38.9	6.5		58.2

Project Variance Analysis

Choose an item.	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management					
OPG Engineering (including Design)					
OPG Procured Materials					
OPG Other					
Design Contract(s)					
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total					

Appendix C: Financial Evaluation Assumptions

Key assumptions used in the financial model of the Project are (complete relevant assumptions only):

Project Cost:

1. Definition Phase total costs of $7.3M, of which only $800k is included in the 2015$ NPV calculation because the remainder was sunk cost.
2. Execution Phase costs of $47.4M, which included $10.2M of contingency. Only $45.4M is included in the 2015$ NPV calculation because the IDC cost for execution phase of $1.98M shall not be included in the cash flows to avoid double-counting, as the effect of IDC has already been accounted for in the discount rate.
3. $3.5M OM&A spent during the Concept Phase was considered a sunk cost for the analysis.

Financial Assumption:

1. For NPV calculations, a Weighted Average Cost of Capital (WACC) of 7.0% was used to discount future cash flows to the base year of 2015.

Project Life:

1. Project is expected to occur from April 1, 2016, to March 31, 2017.
2. The financial analysis covers the 2015-2043 period.

Revenue/System Benefits:

1. Revenue/benefit from generation: Average 50 years of production from the SAB PGS will be 100 GWh's.
2. Revenue/benefit from capacity: Peaking capacity / MCR is 700MW during years when all 6 units are operating. Eleven of the years within the forecast period will have a capacity of 583MW due to planned overhaul programs when only 5 of 6 units are operational.

Operating Cost:

1. Average 50 years of uplift charges of $1.4M (2011$) which include rural rate assistance, debt retirement charge and charging energy.
2. Average standard and non standard OM&A of $10.3 M/yr, including unit overhaul programs.
3. Average sustaining capital expenditures of $1.57 M/yr.

Appendix D: References

1) Sir Adam Beck Pump Generating Station Reservoir Refurbishment – Project Charter
2) Sir Adam Beck Pump Generating Station Reservoir Refurbishment – Execution Phase Project Execution Plan
3) Life Cycle Plan: Sir Adam Beck Pump Generating Station
4) Sir Adam Beck Pump Generating Station Reservoir Refurbishment – Concept Phase Report

Type 3 Business Case Summary

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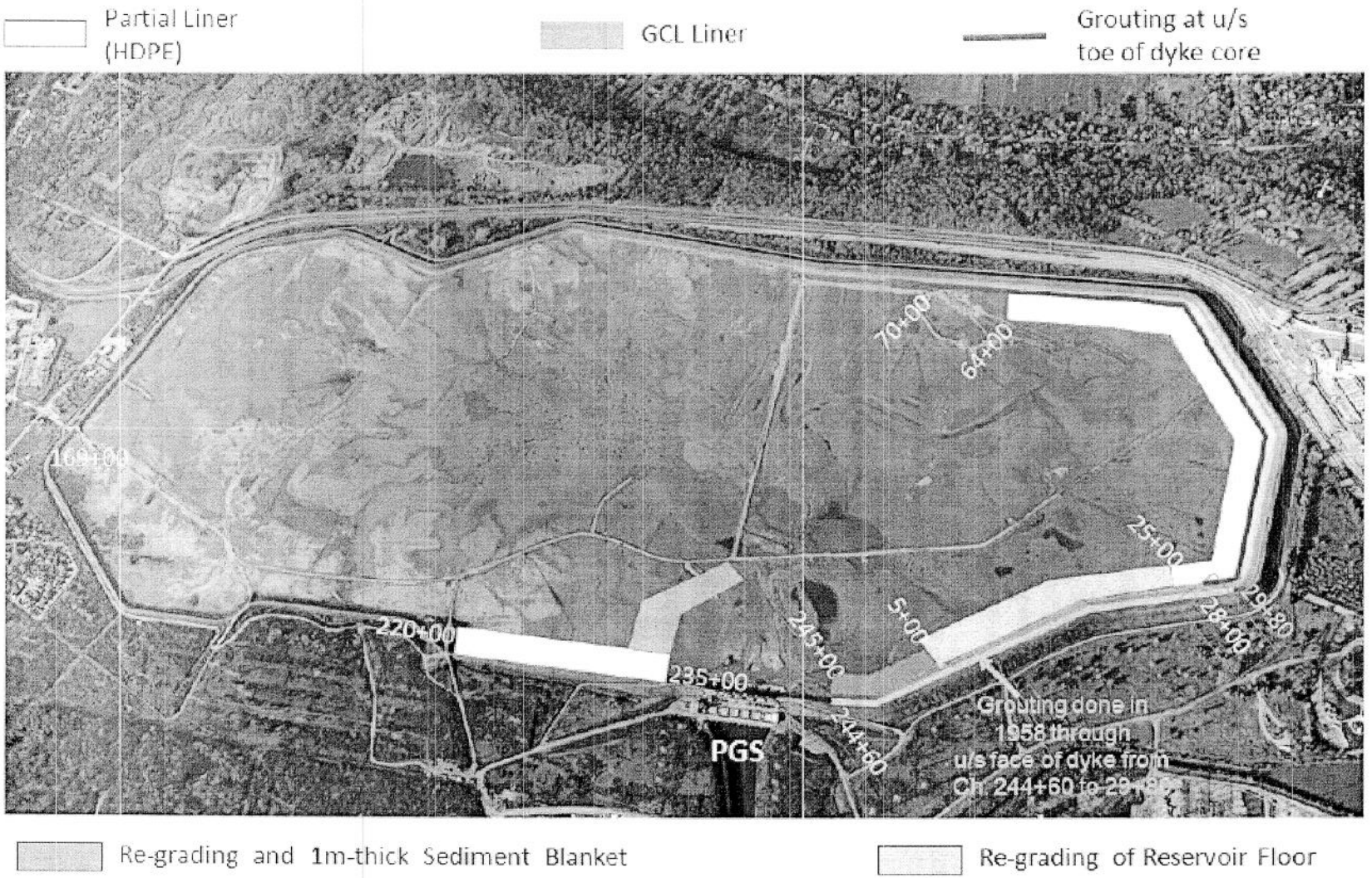
Appendix E: Diagram of SAB PGS Reservoir Refurbishment Activities



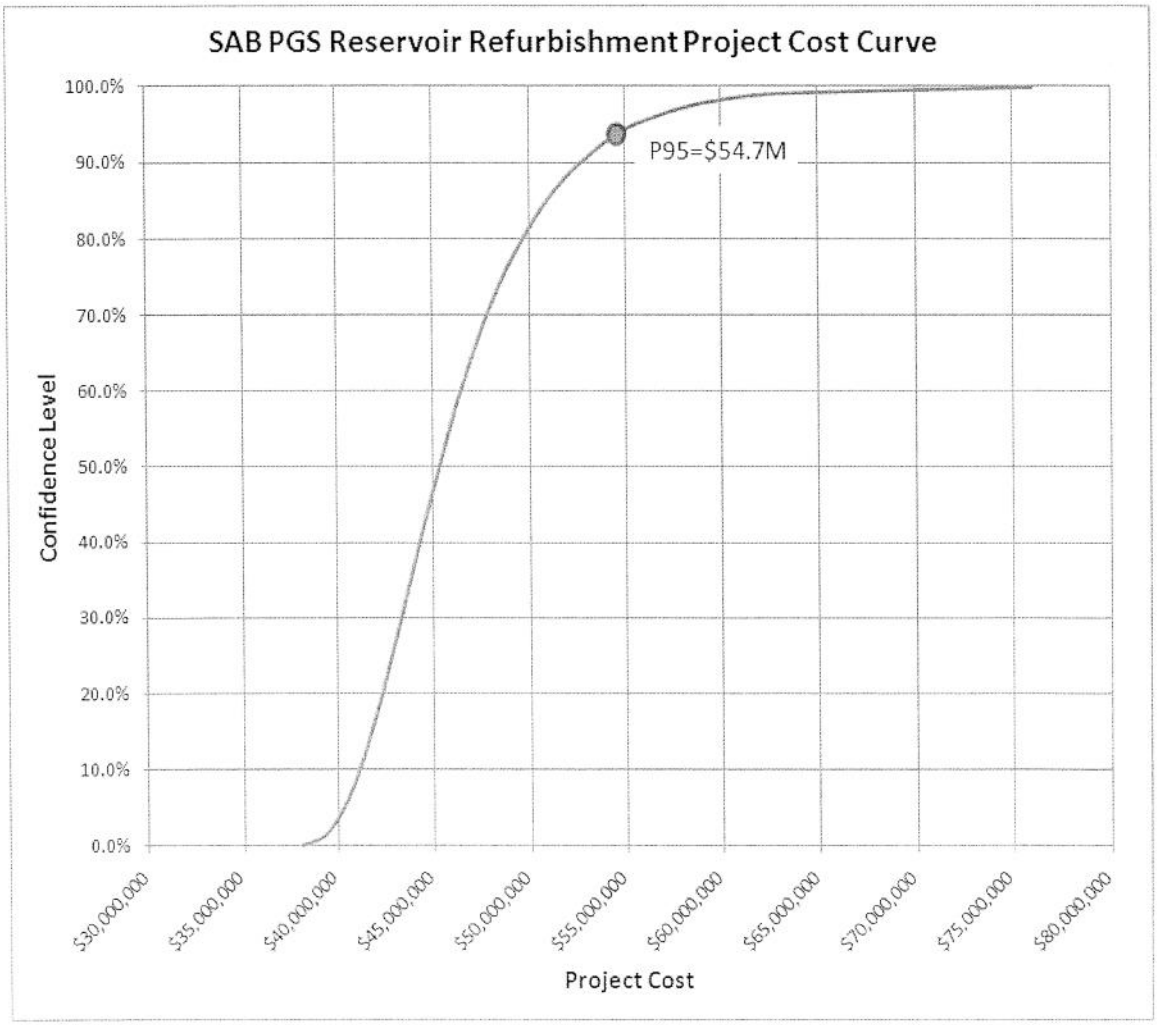
Appendix F: Risk Management and Contingency Development

The SAB PGS Reservoir Refurbishment Project overall cost estimate includes a Project Contingency of $10.2M.

Excluding the Concept Phase, the estimated project capital cost is $54.7M. The project completed a simple quantitative risk assessment to calculate these contingencies. The overall cost estimate, including contingency, is expected to be sufficient to cover project costs and risks at a 95% confidence level. The following areas of uncertainty and risk were included in the assessment:

1. Cost Estimate Uncertainty – The Owner's Representative provided best case, worst case and most likely estimates for each cost item. This analysis took into account the discrete project risks that were identified during the Definition Phase through a series of qualitative risk assessment workshops.
2. Schedule Uncertainty – The Owner's Representative and OPG Project Manager estimated the best case, worst case and most likely scenario for the project in-service date.

A project cost model was developed in Microsoft Excel 2007, based on the models developed for the Lower Mattagami River Project and New Post Creek Project. A Monte Carlo Simulation was used to develop the project cost distribution curve. The model also takes into account potential variability in interest rates and escalation rates. The cost probability curve is illustrated below:



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Appendix F: Risk Management and Contingency Development

The Owner's Project Contingency ($10.2M) is equal to approximately 27% of the execution phase cost estimate, without contingency ($47.4-10.2=$37.2M). Given that the reservoir refurbishment is largely a geotechnical and civil based project, this amount of contingency is appropriate to cover the large amount of uncertainty and risk inherent in these types of projects. Past history with OPG projects has also confirmed that civil work with high levels of geotechnical risk is typically over estimates, as indicated in the following table:

Project	BCS Cost Estimate	Actual Cost	Percentage that Actual Cost was Above Estimate
Niagara Tunnel Project	$900 million	$1.5 billion	66.7%
Lower Mattagami River Project – Design Build Civil Work Only	$1.03 billion	$1.46 billion	41.7%

ONTARIO POWER GENERATION

Records File Information:
For all projects, file in accordance with local project management governance
For capital projects, send a copy to Shared Financial Services/Asset Accounting
For PIRs, refer to OPG-PROC-0056; Retention: P

Internal Use Only

FIN-FORM-PA-005-R005*

Project Closure Report

This Project Closure Report (PCR) form is used for documenting relevant project closure information and approving the project closure decision in accordance with FIN-PROC-0030. It may also be used as a Post Implementation Review (PIR) report in accordance with OPG-PROC-0056, Post Implementation Review.

Part 1: Project Account Closure – Complete for all projects	
Is this PCR also used as a PIR report? No	**Records Document Number** (required only when the PCR is also used as a PIR report) NF20-REP-00190-0021
Project Executing Organization NPG-Projects	**Date** December 21, 2018
Project Number BK180649	**Site / Location Name** SAB1
Project Title G10 Major Overhaul and Upgrade	
Project and Asset (if any) Description	
Company Code / Business Area (Controller) 9817	**Asset Class (Controller)** 10501000
Super Asset Number (Controller) 04094	**Super Asset Description (Controller)** Sir Adam Beck - Niagara GS 1

Part 2: Final In-Service Transfer – Complete for CAPITAL projects
Final In-Service Transfer Credit Account (Controller) N80649H8103 $34,924.44 N80649H8108 $(198,366.94), N80649H8112 $1,268.77 Total ($162,173.73)

Part 3: Project Cost and Schedule Variance – Complete for all projects

	(1) Original Approved Estimate	(2) Current Approved Estimate	(3) Final / Actuals	(4) Variance (= 3 – 2)
Cost ($K)	27,000	33,140	30,810	(2,330)
Schedule (In-service date)	2016-July	2017-Feb	2017-Jun-9	21# weeks behind schedule

Deliverables (Completed? Intended Functionality Achieved? Target vs. Actual?)

Total Project Cost $30,809,995.27
Final Actuals FRA $30,165,019.27 include Removal Costs of $644,976

References or attached pages for:

- Listing in chronological order of all corresponding BCSs and of variance approvals – date and approval authority; and what approved – cost, schedule, and deliverables
- Reference the “lessons learned report”
- Discussion and analysis – cost, schedule, deliverables, and key lessons learned

*Associated with FIN-PROC-0030, Property, Plant and Equipment

ONTARIO POWER GENERATION

Records File Information:
For all projects, file in accordance with local project management governance
For capital projects, send a copy to Shared Financial Services/Asset Accounting
For PIRs, refer to OPG-PROC-0056; Retention: P

Internal Use Only

FIN-FORM-PA-005-R005*

Project Closure Report

Display Actual Cost Line Items for Orders

Document | Master Record

Layout	/NTGS	Order Actual Debits with sub totals
Order	N80649H8008.	G10 Upgrade Generator, Runner,
Report currency	CAD	Canad.dollars

Order	CO object name	Cost Element	Val.in rep.cur.	P
N80649H8008	G10 Upgrade Generator, Runner, Trans		0.00	
N80649H8014	G10 Upgrade Generator, Runner, Trans		0.00	
N80649H8103	G10 Upgrade Generator, Runner, Trans		34,924.44	
N80649H8104	G10 Upgrade Generator, Runner, Trans		0.00	
N80649H8105	G10 Upgrade Generator, Runner, Trans		0.00	
N80649H8106	G10 Upgrade Generator, Runner, Trans		0.00	
N80649H8108	G10 Upgrade Generator, Runner, Trans		198,366.94-	
N80649H8112	G10 Upgrade Generator, Runner, Trans		1,268.77	
N80649H8113	G10 Upgrade Generator, Runner, Trans		0.00	
N80649H8166	G10 Upgrade Generator, Runner, Trans		0.00	
			162,173.73-	

Display Actual Cost Line Items for Ord

Document | Master Record

Layout	/NTGS	Order A
Order	N80649H8008.	G10 Upg
Report currency	CAD	Canad.d

Cost Element		Val.in rep.cur.	Posting Date
8980000000	C	926,997.77	
8980001000	C	1,785,178.17	
8980001300	C	30,210.48	
8980001600	C	302,998.19	
8980001700	C	13,403.81	
8980012500	C	396,949.96	
8980020000	C	5,183.99	
8980031000	C	25,583,321.82	
8980032000	C	310,081.87	
8980050000	C	10.91	
8980057000	C	4,297.78	
8980057200	C	452.93	
8980059000	C	351.82	
8980070000	C	1,450,555.77	
8980081000	C	30,327,193.00-	
8980100000	C	644,976.00-	
		162,173.73-	

Project (All In) Cost by Project Facility (LTD including % Spent) (FRA_PRJ_005)

Fiscal Year/Period
Period 12 2018
Last Data Update
2018/12/15 06:36:35
Project
UPGRADE

Project Facility		Cost Category	Project		Status		Month Actual	YTD Actual	LTD Actual	LTD Release Amount	LTD % Spent
							* 1,000	* 1,000	* 1,000	* 1,000	
NIOP	Niagara Operations	Capital Projects	80649	G10 UPGRADE GENERATO	26	REIS	0	1	30,165.019270	33,140	91.02
NIOP	Niagara Operations	Result					0	1	30,165.019270	33,140	91.02
Overall Result							0	1	30,165.019270	33,140	91.02

Total Project Cost(Includes Removals)	$ 30,165,019.27
In Service REIS	$ 30,327,193.00
In Service Required as part of the PCR	$ 162,173.73

Total Project Cost(Includes Removals)	$ 30,165,019.27
Removals	$ 644,976.00
Total Project Cost Removals added back	$ 30,809,995.27

*Associated with FIN-PROC-0030, Property, Plant and Equipment

Project Closure Report

Part 4: PCR Approval Signatures – Complete for all projects	
Project Manager: The project is declared closed. I confirm that all remaining materials (if applicable) of the project are appropriately dispositioned as spare parts to accepting business areas or are declared surplus. No costs shall be charged to this project at this point forward. **Controller for Project Organization (if applicable, i.e., the BU/Function has a Project Organization Controller):** I confirm the information documented in this PCR is correct.	
PCR Submitted by: Project Manager Alison Bradley (208547) Senior Manager, Production Support (Acting) **Date**	**PCR Reviewed by: Controller for Project Executing Organization** (if applicable) Bryan Shaddock (209675) Site Controller, Finance, Niagara Plant Group **Date**
Station / Plant Group / Function Controller: I confirm the information documented in this PCR is correct. **Asset Owner:** I authorize the decision to declare project closure for this project.	
PCR Reviewed by: Controller for Sponsoring Organization Bryan Shaddock (209675) Site Controller, Finance, Niagara Plant Group **Date**	**PCR Approved by: Asset Owner or Sponsoring Organization Authority** Jessica Polak (209918) VP Operations, Niagara Plant Group **Date**

Part 5: PIR Signature – Required only when the PCR is also used as a PIR report		
	Signature	**Date**
I have reviewed and accept the PIR results in this report.		
Reviewed by: Project Sponsor Not Required Title, Department, BU/Function		

Part 6: Distribution – Required only when the PCR is also used as a PIR report
Distribution: When this PCR is also used as a PIR report, the Project Sponsor shall ensure distribution (cc) to the following personnel if they have not already signed off above: • Finance Approver in the BCS: Name, Title, Department, BU/Function • Line Approver in the BCS: Name, Title, Department, BU/Function • Other key stakeholders: Name, Title, Department, BU/Function

Part 7: PCR Checklist – Complete for all projects by Project CSA or Project Manager	
Checklist Item	**Checkbox**
All Tempus Work Events have been closed, including: • Assigned Tempus Work Events • AS7 Work Order Task created work events	☒ ☒
All PO/WO/MRs/CRs have been closed, including: • Request sent to AS7 buyer to close PO/COs after closing related MRs/CRs • Request sent to Planner to close any AS7 Work Order Tasks • Request sent to ONCORE to close all tasks and associated PO's	☒ ☒ ☒
All Accruals have been cleared.	☒
Any purchases through purchasing cards (VISA) or Ariba Web Catalogue have been reconciled in Concur or shipped by Ariba Vendor.	☒
All default Business Expense or VISA default accounts have been changed.	☒
All spare parts have been set up in AS7, including: • Inventory by Cat ID with ROP/TMAX values • Capital Spares are set up in the appropriate Asset Class and account	☒ ☒
All obsolete or surplus inventory or components have been identified and Surplus Declarations routed to ensure that all retired assets have been properly removed from the fixed asset ledger and inventory accounts.	☒
The Super Asset Class, the Company Code, Super Asset Numbers agree with previous REIS.	☒
The Final Actual Costs and Current Approved Estimate agree with FRA and/or SAP.	☒
If this is combined PCR/PIR, it was defined in the approved BCS.	☒
If the Actuals are greater than the Approved amount, the overspend has been approved in accordance with the appropriate OAR Element specified in the BCS standard (OPG-STD-0076, Developing and Documenting Business Cases), with an approved OPG-FORM-0077, Project Over-Variance Approval or a Superseding BCS.	☒
A copy of the FRA and/or SAP Report is attached.	☒

Project CSA / Project Manager (Sign-Off): I confirmed the completion of all the checklist items.		
Project CSA or Project Manager Debby DaCosta CSA, Niagara	**Signature**	**Date**

Tasks

This workflow created the following tasks. You can also view them in Tasks.

Assigned To	Title	Due Date	Status	Link	Outcome
BRADLEY Alison -EASTERNOPS	Please approve PCR BK180649 G10 Major Overhaul and Upgrade R0	12/22/2018	Completed	PCR BK180649 G10 Major Overhaul and Upgrade R0	Approved
SHADDOCK Bryan -FIN & C CTRL	Please approve PCR BK180649 G10 Major Overhaul and Upgrade R0	12/22/2018	Completed	PCR BK180649 G10 Major Overhaul and Upgrade R0	Approved
POLAK Jessica -OPERATIONS	Please approve PCR BK180649 G10 Major Overhaul and Upgrade R0	12/22/2018	Completed	PCR BK180649 G10 Major Overhaul and Upgrade R0	Approved

Workflow History

The workflow recorded these events.

Date Occurred	Event Type	User ID	Description	Outcome
12/21/2018 2:04 PM	Workflow Initiated	AITCHISON Chris -OPERATIONS	Approval was started. Participants: BRADLEY Alison -EASTERNOPS;SHADDOCK Bryan -FIN & C CTRL;POLAK Jessica -OPERATIONS	
12/21/2018 2:04 PM	Task Created	AITCHISON Chris -OPERATIONS	Task created for BRADLEY Alison -EASTERNOPS. Due by: 12/22/2018 2:04:46 PM	
12/21/2018 2:04 PM	Task Created	AITCHISON Chris -OPERATIONS	Task created for SHADDOCK Bryan -FIN & C CTRL. Due by: 12/22/2018 2:04:46 PM	
12/21/2018 2:04 PM	Task Created	AITCHISON Chris -OPERATIONS	Task created for POLAK Jessica -OPERATIONS. Due by: 12/22/2018 2:04:46 PM	
12/21/2018 2:21 PM	Task Completed	BRADLEY Alison -EASTERNOPS	Task assigned to BRADLEY Alison -EASTERNOPS was approved by BRADLEY Alison -EASTERNOPS. Comments:	Approved by BRADLEY Alison -EASTERNOPS
12/21/2018 3:23 PM	Task Completed	SHADDOCK Bryan -FIN & C CTRL	Task assigned to SHADDOCK Bryan -FIN & C CTRL was approved by SHADDOCK Bryan -FIN & C CTRL. Comments:	Approved by SHADDOCK Bryan -FIN & C CTRL
12/22/2018 1:35 PM	Task Completed	POLAK Jessica -OPERATIONS	Task assigned to POLAK Jessica -OPERATIONS was approved by POLAK Jessica -OPERATIONS. Comments:	Approved by POLAK Jessica -OPERATIONS
12/22/2018 1:35 PM	Workflow Completed	AITCHISON Chris -OPERATIONS	Approval was completed.	Approval on PCR BK180649 G10 Major Overhaul and Upgrade R0 has successfully completed. All participants have completed their tasks.