CCC Interrogatory #8

Interrogatory

Reference: Ex. H1/T1/S1 pp. 38-39

Question:

Over the 2020-2022 period OPG recorded debit additions of $105.2 million to the Nuclear Development Business Account in relation to non-capital preliminary planning and preparation costs for a Darlington SMR (small modular reactor):

a) Is OPG seeking recovery of this amount through the Application?
b) Please provide detailed budgets for each of the 4 activities identified in Chart 4 for 2020, 2021 and 2022;
c) Please provide detailed budgets for the years 2023-2026 regarding SMRs;
d) Please provide the due diligence assessment referred to in the evidence;
e) Please provide all materials provide to OPG's Board of Directors regarding the selection of the SMR technology;
f) Please provide all materials provided to the Province regarding the selection of the SMR technology;
g) Please provide a list of all technologies considered.
h) Please provide all reports produced internally regarding the selection of the SMR supplier and technology.

Response

a) Yes.

b) OPG managed the costs of preliminary planning and preparation activities for a small modular reactor ("SMR") at the Darlington New Nuclear site as identified in Ex. H1-1-1, Chart 4, within the budget envelope of $270M. As discussed in part e) below, this budget envelope was approved by OPG's Board of Directors (See Attachment 2).[1] A breakdown of the projected amounts for the anticipated activities can be found in Appendix 4 of Attachment 2, DNNP Project & Scope Breakdown. The OPG Board of Directors' approval required that actual expenditures be substantially consistent with Appendix 4, which they were.

c) OPG declines to provide the requested information on the basis of relevance. OPG's Application addresses only the amounts OPG proposes to clear from the previously authorized deferral and variance accounts and certain specific

[1] OPG's plans for these activities were also discussed in EB-2020-0290, Ex. F2-8-1.

approvals sought in connection with the implementation of the IESO's Market Renewal Program. As such, the information sought is not relevant to any issue before the OEB in this Application.

d) See Attachment 1 (confidential) for OPG's assessment process in respect of the three identified developers and their respective SMR technologies. This assessment was undertaken with the goal of selecting a single technology developer to deploy an SMR at the Darlington New Nuclear site.

e) See Attachment 2 (confidential) for the OPG Board of Directors' approval of OPG's preliminary planning and preparation budget for a SMR at the Darlington New Nuclear site, including the selection of a SMR technology. OPG is providing this document as this approval underpins OPG's request for recovery of amounts recorded in the Nuclear Development Variance Account in this Application. OPG declines to provide any additional "materials provided to the Board of Directors" that mention the selection of SMR technology on the basis of relevance.

f) OPG declines to provide the requested information on the basis of relevance. This interrogatory seeks information on communications with the Province of Ontario that is not relevant to deciding any issue on the approved Issues List in this application. The activities and resulting costs related to SMR technology selection were undertaken by OPG and are fully explained in evidence with additional detail provided in the document produced in response to part d) of this interrogatory.

g) OPG considered a total of 11 different SMR technologies (in no particular order):

- Terrestrial IMSR-400
- GE-Hitachi BWRX-300
- X-Energy XE-100
- [redacted]

h) OPG declines to answer on the basis that this is not an appropriate question. The question ignores the principle of proportionality, which underlies the interrogatory process, in that it is overly broad and all encompassing. Contrary to the OEB Rules of Practice and Procedure (Section 26.02 (d)), the question

does not "contain specific requests for clarification of a party's evidence, documents or other information in the possession of the party and relevant to the proceeding. The question seeks without limit all reports produced internally regarding the selection of the SMR supplier and technology.

Furthermore, OPG notes that much of the documentation captured by this request would not be relevant to any issue before the OEB in this proceeding. OPG is seeking approval of the costs associated with the technology selection process, and not approval of the technology that was selected, and has provided, in response to part d) of this interrogatory, a detailed internal document outlining the process. OPG's assessment and evaluation of particular technologies and their characteristics and potential vulnerabilities are, as such, irrelevant, and moreover, contain highly confidential information proprietary to third parties and OPG, disclosure of which could lead to significant commercial harm.

Ex. L-H-CCC-08 ATTACHMENT 1 IS CONFIDENTIAL IN ITS ENTIRETY

OPG's due diligence process in respect of the three identified developers and their respective SMR technologies.

ONTARIO POWER GENERATION

OPG Confidential Exclusive

FOR APPROVAL by the Board of Directors

August 13, 2020

SMALL MODULAR REACTORS – APPROVAL OF FUNDS AND UPDATE OF SMR PROJECTS

DECISION REQUIRED

The purpose of this memo is to request Board approval to release $270 Million (consistent with the business plan) for the planning and design of a Small Modular Reactor (SMR) at Darlington, and to renew and maintain the Power Reactor Site Preparation Licence (PRSL).

ISSUE

The Darlington New Nuclear Project (DNNP) is part of OPG's Strategic Objectives including Energy Industry Leader (which our climate strategy contributes to). OPG has selected four developers to proceed to the next phase of our process, which includes planning and design work, plus activities to maintain the PRSL. Funding for this work, equivalent to the release requested, is included in the 2020 to 2026 business plan. OPG is seeking approval to release funds for 2020 and 2021 in order to further develop the technologies and select one by November 2021. Once selected, a detailed business case and release quality estimate will be prepared by 2023. OPG has provided a release strategy for future years below.

ANALYSIS

To briefly recap, OPG has been evaluating the opportunity to deploy a First-Of-A-Kind SMR at our Darlington New Nuclear Project site which is the only site in Canada with an approved Environmental Assessment and a PRSL.

- OPG is proposing a 300-400 MW SMR plant which is the right size for coal plant replacement elsewhere in Canada, and fits into the Ontario electricity grid.
- [redacted]
- The 2028 deployment period goal for DNNP is important to
  - obtain First-mover benefits in North America (maximum supply chain in Canada, jobs and GDP) and,
  - [redacted]

(Note that this DNNP work is quite separate from OPG's support to the Global First Power micro-modular reactor project).

In 2019, OPG began a process to systematically review potential SMR Technology Developers to identify which would be the best fit for a potential new nuclear power plant at the DNNP site.

At the October 2019 Board Retreat, OPG reported on the first phase of that review, and outlined how we would undertake a more in-depth Due Diligence process to identify potential SMR technology developers that could meet the required timeline, with sufficient engineering complete, the right design features, at a competitive cost, and bringing supply chain opportunities to Ontario and Canada.

In March 2020, we reported that OPG was beginning the Due Diligence assessment of certain SMR developers, and in May we reported that commercial options were being evaluated with respect to potential funding and partnership arrangements with SMR technology developers (not yet selected as of May) and for potential future strategic alliances.

The March 2020 GOC update included an economic case and detailed the due diligence process to select two (or more) developers that had the most suitable technologies, and could meet our schedule to deploy

an SMR at DNNP by 2028. OPG also highlighted the intent to fund some detailed engineering work, as well as the preparation of a CNSC Licence to Construct (LTC) application, in order to ensure that necessary timelines are met with quality.

OPG regularly updates the Province of Ontario, as our shareholder, on our new nuclear work. Such updates have included our overall SMR strategy; potential impact on electricity rates from an SMR; benefits in terms of combating climate change; the pan-Canadian approach; potential for federal funding to support SMRs; and our SMR work with utilities in Saskatchewan, New Brunswick, as well as Bruce Power in Ontario. In particular, we have worked closely with these peer utilities to support the three provinces on the Premiers' Memorandum of Understanding on SMRs signed Dec 2019, which calls for the provinces to work collaboratively on an SMR feasibility study and a strategic plan for deployment. Additional details on collaborative work are provided in **Appendix 5.**

OPG has now completed its DNNP due diligence work, [redacted]. [redacted], OPG has selected four developers to work with more closely over the next 15 months with the goal of selecting a single technology partner and progressing the project. A detailed explanation of the DNNP due diligence outcomes is included in **Appendix 1.**

OPG has decided to progress further discussions with SMR companies GE-Hitachi, X-Energy, [redacted] and Terrestrial as those which bring the best combination of opportunities for a pan-Canadian fleet.

The work to be completed over the next 15-month period through November 2021 is to ensure project development and engineering design sufficiently complete for a Class 5 estimate and an application to the CNSC for a Licence to Construct. This will include preparing a full project scope, schedule, and cost estimate to support a Business Case, and determining which technology partner and project will deliver the best investment for OPG and Ontario. Choice of an SMR partner could happen in phases, reducing from four to one potential partner as certain hurdles are overcome as described in **Appendix 1.** This work will require certain funding, which is why we are seeking Board approval for release of the budgeted funding envelope at this time.

See **Appendix 3** for a more detailed description of the deliverables, and **Appendix 4** for a preliminary estimate of major project costs over this period.

For clarity, the request for approval is a preliminary step and does not include full project costs, such as construction. No decision to proceed with project construction has been made, and is subject to ongoing development of the project and a gated release strategy which is described below under DNNP Release Strategy.

Delegation of approval authority to the CEO for execution of the contracts is requested at this time as the detailed scope and cost estimates will be completed in Q4-2020 through discussions with developers.

DNNP Release Strategy

Funding for the DNNP will be released in phases as certain deliverables are completed and as an updated business case analysis is refined, including the total cost of the project.

Current Phase

Project OM&A for preliminary planning costs, including SMR technology development and Site Preparation relicensing were approved as part of the 2020-2026 Business Plan. Delegation of authority from the OPG Board of Directors to the CEO is being requested in August 2020, prior to issuing contracts to the SMR technology developers to continue with project development for DNNP, detailed engineering design, and preparation for DNNP licensing. Ongoing updates to the Board will be provided in November 2020 and early 2021 on the progress with commercial negotiations and the SMR companies' progress at meeting our expectations for the project.

Future Phases

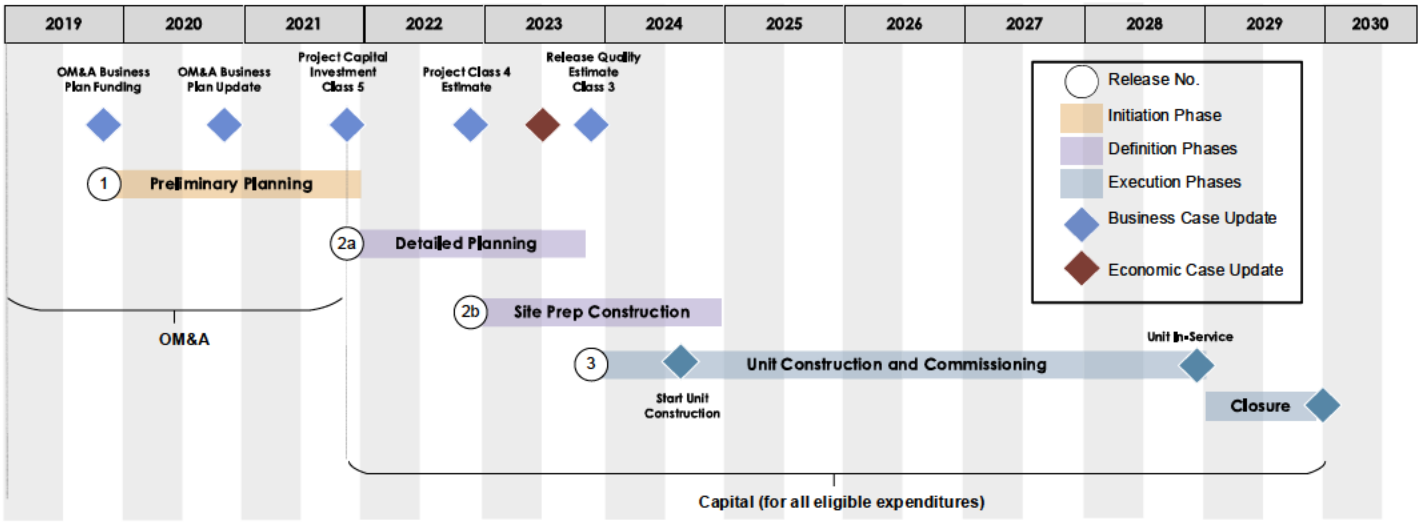
A DNNP Business Case will be developed in 2021 to incorporate project costs for site preparation and construction, for gated release decisions in the fall of 2021 and the fall of 2022, summarized as follows and as shown in the diagram below:

- Nov 2021 - Nov 2022: Class 4 estimate enabling a decision to proceed on site preparation and long lead material manufacturing with a preferred SMR technology developer [Capital Funding].

- Nov 2022 – Nov 2023: Class 3 Release Quality Estimate (RQE) to be prepared, with High Confidence schedule and cost, enabling a decision to construct and final project estimate to be approved in November 2023 [Capital Funding].

Refined classes of estimates will progressively be achieved, similar to how the Darlington Refurbishment Release Quality Estimates were prepared over time, to provide cost certainty prior to moving forward with construction and for procurement of long lead time materials.

The final project approval which includes the remaining project funding for construction, commissioning, and closeout is expected to be requested in late 2023, at the point where a Release Quality Estimate and High Confidence Schedule are available, approximately 6 months prior to the planned start of construction in Q2 2024.



RECOMMENDATION / RESOLUTION

That the Board of Directors:

(i) Approves release of a $270 M funding envelope to commence project development work on the Darlington New Nuclear Project for the approximate 2020 – 2021 period substantially consistent with the DNNP Project & Scope Breakdown set out at **Appendix 4**;

(ii) Delegates approval authority to the OPG President and CEO for the release of funds within the funding envelope referenced in (i) above;

(iii) Requires that further Board approvals be sought if the cost of the work as set out in (i) above is expected to increase.

Recommended by:

"Original signed by:"

Dominique Minière
President, Nuclear

Approved for submission to the Board of Directors by:

"Original signed by:"

Ken Hartwick
President and CEO

This Board memo was reviewed and approved for submission to the Board of Directors by the Generation Oversight Committee at their meeting of August 12, 2020.

APPENDICES

1. Update on Darlington New Nuclear Project (DNNP) small modular reactor (SMR) Due Diligence work including recommendations on SMR Developers with whom commercial negotiations are commencing
2. DNNP Illustrative Roadmap
3. Developer Deliverables
4. Projected Major DNNP spending areas
5. Update on New Nuclear growth strategy collaborative work

APPENDIX 1: UPDATE ON DARLINGTON NEW NUCLEAR PROJECT (DNNP) SMALL MODULAR REACTORS (SMR) DUE DILIGENCE WORK INCLUDING RECOMMENDATIONS ON SMR DEVELOPERS WITH WHOM COMMERCIAL NEGOTIATIONS ARE COMMENCING

Darlington New Nuclear Project

In 2019, OPG began a process to systematically review potential SMR Technology Developers to identify which would be the best fit for a potential new nuclear power plant at the Darlington New Nuclear (DNNP) site. As of July 2020, OPG has completed phase 3 of the review and assessment process (the "due diligence" phase), in collaboration with other utilities, and wishes to report the outcome to the Board.

In summary, OPG has decided to progress its options development discussions with GE-Hitachi, X-Energy, [redacted] and Terrestrial, for reasons outlined below.

Due Diligence process

Since the May update, OPG has completed the due diligence process on six potential SMR Technology Developers – [redacted].

The process entailed:

- development of questions to the developers in the subject areas of Engineering, Fuel & Physics, Reactor Safety, Licensing, Quality Assurance and Supplier Relationships, Finance, and Legal.
- provision by each developer of written materials covering the subject areas
- a deep dive review by teams of subject matter experts and representatives of each utility
- developer response to a fundamental question identified during the previous stage of the process as being key to the potential success of that developer for the DNNP process (eg: commitment to the project; timeline; fuel qualification and availability)
- review of strategy options and opportunities for OPG, taking account of potential pan-Canadian deployment [redacted] and Canadian content
- creation of recommendations and alternatives, with pros and cons

The output of the due diligence process has been reviewed by ELT members.

Due Diligence results

The result of the due diligence process is that OPG intends to continue working with four developers in order to determine which of these four developers is best fit for the project. These developers are GE-Hitachi, X-Energy, [redacted] and Terrestrial. It was not possible at this stage to confidently limit further work to fewer developers, due to pro's and con's, and the risks and opportunities associated with each of these developers. [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted]

- [redacted]
- [redacted]

- [redacted]
- [redacted]
- [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

Although OPG has decided to continue working with the above four SMR technology developers, please note that as reported in previous GOC updates, OPG may allow the other developers that can demonstrate sufficient progress on their own, to re-engage in further discussions with OPG prior to November 2021.

[redacted]

- [redacted]
- [redacted]
- [redacted]

Next steps

By about the end of 2020, our goals are to:

- have clearly identified key requirements for each potential SMR technology developer partner;
- have a path established for their work over the next year; and
- ideally to have narrowed the field to fewer than four developers to continue working with in 2021.

By Nov 2021, the goal is to finalize a decision on the single SMR technology developer, and develop a business case for Board approval to advance to a construction licence application. In order to do this, the following steps need to be completed.

Hurdles

By September 2020:

- [redacted]
- [redacted]
- [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]
  - [redacted]

By November 2020:

- [redacted]

By November 2021:

- To have from all the remaining SMR technology developers,
  - completed basic design and a certain level of detailed design of the nuclear island completed, enabling a class 5 estimate; and
  - a sufficiently advanced licensing framework to enable submission of License to Construct Application in early 2022.
- [redacted]
- [redacted]

Depending on the results of this hurdle/gating process, we could stop progressing with some developers at the different gates.

Commercial discussions

OPG will undertake further discussions with the developers GE-Hitachi, X-Energy, [redacted] and Terrestrial. [redacted]

If successful in establishing satisfactory arrangements, it is anticipated that OPG will work with these developers on the design, and preparation of construction and manufacturing strategies from mid-2020 to late-2021. This will include discussions around financing of their detailed manufacturing design, and commercial aspects such as intellectual property rights, and sharing in future contracts, etc. This is expected to include OPG funding some detailed engineering work, and preparation of a CNSC construction licence application, in order to ensure our schedule is met with quality. More details on this topic are provided in Appendix 3.

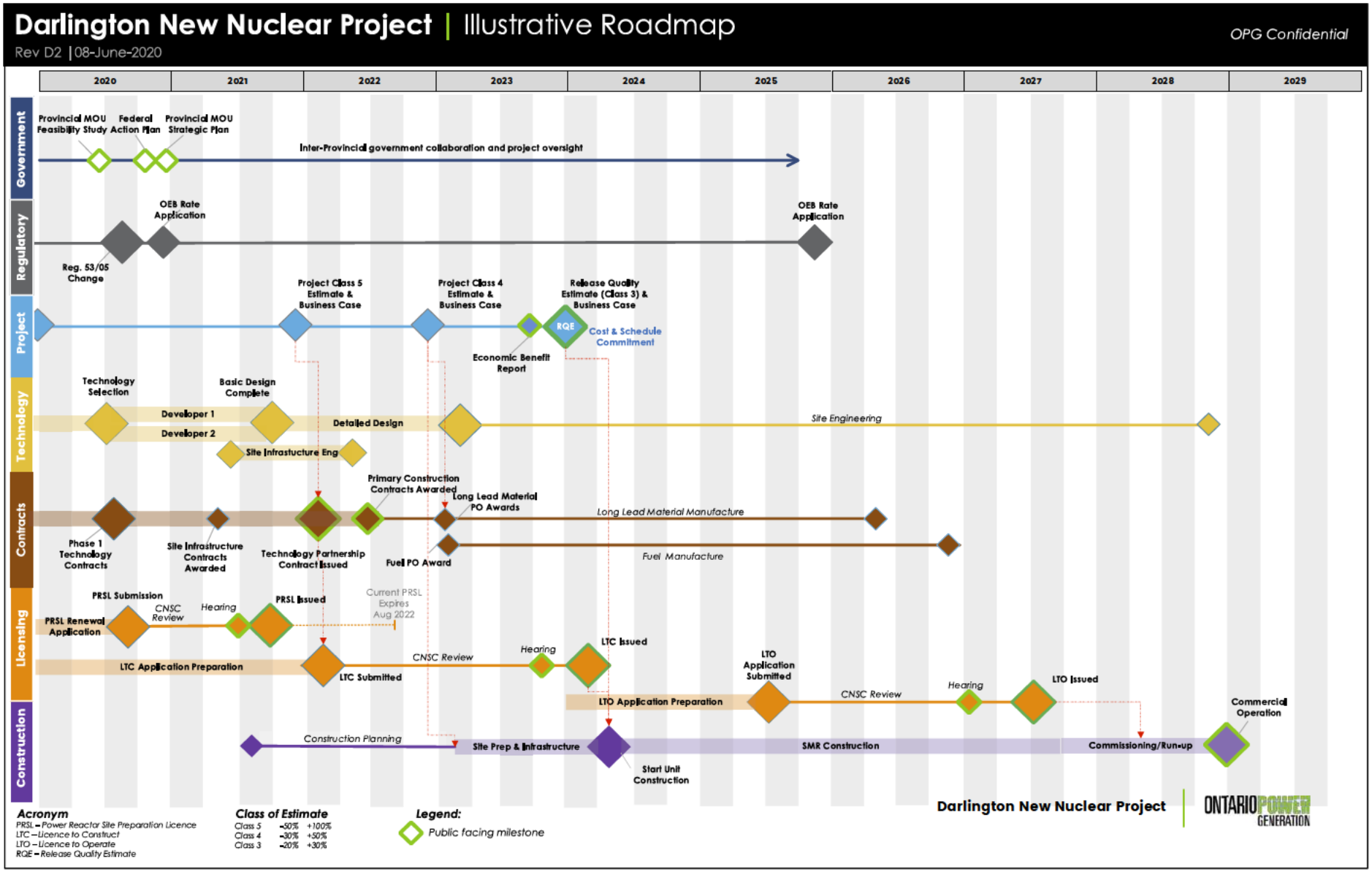
Additional Details

The main body of this report shows a simplified chart of the proposed funding release timelines, project development and plant construction. A more detailed illustrative roadmap is provided (see Appendix 2) outlining additional milestones of the project.

Funding related to this stage of the process is discussed in a separate section of this Board memo (for Approval).

Further updates on the commercial discussions described above will be brought to future Board meetings. In addition, progress on overall development of a potential DNNP new nuclear project will continue to be provided at upcoming Board meetings.

APPENDIX 2: DNNP ILLUSTRATIVE ROADMAP



APPENDIX 3: DEVELOPER DELIVERABLES

The current developmental scope of work spans about 15 months, to November 2021. During 2021, the strategy is to work with the leading Developers to progress their SMR design and the associated business case in order to make a final technology selection in Q4 2021.

For each SMR design, the following project goals are to be accomplished in this period:

1. Advancing the SMR design specific to a reactor facility for Darlington
2. Preparing the required deliverables for a Licence to Construct application
3. Preparing a full project scope, schedule and cost estimate to support a Business Case
4. Defining requirements for site preparation work, and supporting PRSL renewal as required.

Based on the outcomes of the work listed above, a business case supporting the best technology option will be developed for Board approval in November 2021.

Deliverables Summary:
Each Developer is at a different stage of design completion, and therefore the effort required, and the scope of the contracts to meet the project goals, will be specific to each. As a result, the contracts will be broken up into two phases:

1. Phase A (nominally 3 months) is focused on developing design and site requirements, gap identification, and establishing the scope and schedule for the remainder of the contract
2. Phase B (to the end of 2021) will be executing the scope agreed in Phase A to meet the project goals

Advancing the facility design is the most significant component of the work to be done. The Developers will have to review their current design and reconcile the requirements to Canadian regulations, codes, and standards. In addition, site-specific requirements, facility layout, and geotechnical testing is required. Balance of Plant design, an area that typically has not been a priority for a number of the Developers, will also need to be progressed.

The current project plan requires submission of the Licence to Construct in early 2022 to meet a 2024 start of construction. This licence application is a significant undertaking, with design and safety analyses expected to be at an advanced state. The application also calls for deliverables related to construction and commissioning programs.

In June 2020, OPG submitted an application for renewal of the current PRSL for Darlington, with a hearing projected in mid-2021. Any required support for this hearing, as well as site preparation requirements are also included in the scope of work for the Developers.

In addition to the technical deliverables, each Developer will work with OPG project staff to put together full project scope, schedule, and cost estimates, as well as OM&A and lifecycle capital cost estimates. These products will support the final technology selection and associated business case.

Other specific deliverables that the Developers will be required to produce in this period include the following:

1. Lifecycle fuel management strategy and interface with NWMO
2. Operating radiation dose estimates and minimization strategy
3. Operating radiation emission estimates and minimization strategy
4. Operating conventional emission estimates and minimization strategy
5. Low and intermediate level radiation waste estimates and minimization strategy
6. Modular construction strategy
7. Supplier strategy
8. Full Scope Simulator preliminary design

APPENDIX 4: PROJECTED MAJOR DNNP SPENDING AREAS

DNNP Project & Scope Breakdown	2020 $M	2021 $M
83274 – DNNP Program Management & Oversight • Overall Program Management • Oversee and manage the Development Partner Agreements • Stakeholder and indigenous community outreach and engagement • OPG matrixed support (SLAs) • External legal contracts • Program Contingency of $5M	6.0	18
27601 – DNNP EA & Licensing • PRSL renewal submission and support through Licence issuance (TCD Q3 2021) • LTC protocol development • Support of preparation of LTC submission for multiple Developers • Environment support of DNNP licence Commitments • CNSC Licensing fees $5M	7	13
86022 – DNNP Engineering & Oversight • Development of Engineering programs required to manage Advance reactor • Embedded engineers to directly collaborate on basic design with the development partners • Perform owners engineer activities to review and accept designs • Engineering matrixed support (SLAs) • Managed Task Contracts & Project Contingency $10.5M	5	25
86066 – DNNP Site Preparation Engineering & Planning • Engineering required to support site preparation activities (Bridges, services, roads, buildings, etc) • Geotechnical studies required for site layout	0	7
86064 & 86065 – SMR Development • SMR & BOP design • LTC Technical deliverable preparation • Site layout options and requirements • SMR OM&A and lifecycle capital cost assessment • SMR Project scope, schedule, and cost estimates	86.0	103
Total	**104**	**166**

APPENDIX 5: UPDATE ON NEW NUCLEAR GROWTH STRATEGY COLLABORATIVE WORK

As described in Appendix 1, OPG has completed a detailed due diligence review of potential SMR technology partners. [redacted]

[redacted]

[redacted] Likewise, OPG is participating in the work of the Canadian Nuclear Association-Candu Owners Group SMR Secretariat which is helping develop actions for the national SMR Action Plan to respond to the recommendations of the 2019 SMR Roadmap.

ONTARIO POWER GENERATION

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

Internal Use Only

OPG-FORM-0075-R004*

Type 2 Business Case Summary

To be used for investments/projects meeting Type 2 criteria in OPG-STD-0076.

Project Information			
Project #:	SAB10050	**Document #:**	
Project Title:	G10 Major Overhaul & Upgrade		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Sustaining
Phase:	Execution	**Release:**	Partial
Facility:	SAB1 (NF20)	**Target In-Service or Completion Date:**	Aug 2016

Project Overview

We recommend the release of $1,500k, including $55k of contingency. The estimated total project cost is $ 27,000k, including $ 2,427k of contingency. The quality of the estimate for this release is Class 3, and for the total project is Class 3.

This release will fund the following scope of work. It does not commit OPG to further investment on this project.

- Purchase the runner prior to full execution release due to the long lead time required for design and manufacture.

An Initiation and Definition BCS was approved October 18, 2013 to complete a Technical Specification and uprate analysis of critical components and complete the RFP process.

Part A: Business Need

Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Hydro-Thermal Operations maintains and develops hydro resources.

Sir Adam Beck G.S. #1 (SAB1) G10 was originally placed in-service in 1930 as a 25Hz unit rated for 45MVA then converted to 60Hz in 1956. The last major overhaul completed on the unit was in 1986. During the upcoming overhaul, the opportunity exists to execute additional work which would increase the capacity and efficiency of G10 and allow Niagara Operations to better utilize the water available to the station. The recommended alternative upgrades the current rating of the unit to the following capabilities:

	Turbine			Generator	
	Efficiency (%)	Power (MW)		Rating parameters	
	[redacted]	Best	Full Load	MVA	MW
Existing Unit		43.0	57.0	55	55
Upgraded Unit		**55.0**	**59.0**	**63**	**59**
Improvement		+12.0	+2.0	+8	+4

A Life Cycle Plan (LCP) for SAB1 (R-NF20-01556-0002) was approved July 2008. The recommended alternative was an eight unit station (G3-G10) which included overhaul and upgrade of G10. This project is also included in the 2014-16 Business Plan.

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade Unit to 55MW, 63MVA

Description of Preferred Alternative

The project would execute a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed, including installation of a new runner, headcover, and wicket gates. Further investigation and possible repair would be done on the penstock and scrollcase, including completion of a load carrying capacity analysis.

A Definition Project Charter (NPG-00121.2-0055) was approved October 2, 2013 which includes a detailed scope of work based on actual work completed on G7, G9, and G3.

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

Type 2 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release
Document #:

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade Unit to 55MW, 63MVA

Description of Preferred Alternative

An equipment supply agreement between OPG and American Hydro Corp (now Weir) was signed Feb 2007 for the supply of runners for G3-G10. The runner for G10 will be purchased under the terms of this agreement. The decision to purchase 8 runners and the SAB1 overhaul program were recommended and supported by the 2008 LCP for SAB1.

The execution strategy is to award a single contract to a general contractor. A Technical Specification is under development (95% complete) which will specify equipment and components proven and existing on previous SAB1 upgrades. The general contractor will be responsible for completing the installation design (mechanical, electrical, civil), manufacture of parts, supply of equipment (except the runner), removal of existing equipment, and installation of new and/or refurbished equipment. This strategy will reduce the cost of re-engineering equipment, lower the contract cost, and reduce the duplication of spare parts.

An Initial Project Execution Plan (PEP) and Risk Analysis have been drafted.

The unit will be overhauled during a Planned Outage from August 2015 to July 2016.

This alternative is recommended since it will address availability and reliability concerns, has the highest NPV, and lowest risk profile. It is also consistent with Hydro-Thermal Operations mandate to maintain and develop hydro resources.

Deliverables:	Associated Milestones (if any):	Target Date:
Purchase new runner	PBCS approved	July 4, 2014
	PO issued	July 11, 2014
	EBCS approved	Sept 30, 2014
Main contract for General Contractor	RFP start	July 2014
	Award main contract	Oct 2014
	Runner arrive at site	Aug 2015

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 – No Project

Do nothing, continue with the existing LEM program for the unit and corrective maintenance on an ad hoc basis.

Based on in its current condition, G10 could likely run without major investment until 2018, at which time the turbine is expected to have reduced reliability and the transformer is expected to reach end-of-life. If left unaddressed, an eventual failure will result in a forced outage during either the Nuclear Refurbishment, SAB2 Overhaul Program, or the later stages of the SAB1 Overhaul Program.

Therefore, this alternative is not recommended.

Alternative 3: Perform a Minor Overhaul for 10 Years of Operation at 45.9MW

Maintain the current rating of the generator. The scope of work would be largely focussed on cleaning, testing and repair of existing equipment, including removal of the generator rotor for cleaning and a flux test. Also included is the purchase and installation of a new transformer.

This alternative has the worst NPV due to its investment requirements and expected outcome of reliability, and the fact that the next overhaul will occur in the middle of the Nuclear Refurbishment & SAB2 Overhaul Programs.

Therefore, this alternative is not recommended.

Alternative 4: Perform Major Overhaul to Ensure 15-20 Years of Operation at 45.9MW

Maintain the current rating of the generator. The project would execute a complete refurbishment of the generator stator and rotor, including a rewind, and replacement of all supporting electrical auxillaries. A major overhaul of the turbine would be completed including weld repair of the runner, installation of new wicket gates and potential install of a new headcover.

This alternative provides for low technical risk, but is not recommended due to its lower NPV.

Internal Use Only

OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: SAB10050 Document #:

Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Alternative 5: Upgrade the Unit to 61MW, 68MVA

The scope of work for this alternative is very similar to that of the preferred alternative, with the significant difference being the purchase and installation of a new generator and all of the associated work required to the superstructure to accommodate the unit.

Due to a less favourable NPV and increased technical risk with the expanded scope, this alternative is not recommended.

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

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released		100	700						800
Requested Now	-	890	610						1,500
Future Required	-		12,300	12,400					24,700
Total Project Cost		990	13,610	12,400					27,000
Ongoing Costs	-								
Grand Total		990	13,610	12,400					27,000

Estimate Class:	Class 3	**Estimate at Completion:**	$27,000k
NPV:	$43.9M	**OAR Approval Amount:**	$1,500k

Additional Information on Project Cash Flows (optional):

(k$)	LTD	2014	2015	2016	2017	Total
BP 2014-16	0	100	10,000	15,400		25,500
Summary of Estimate	0	990	13,610	12,400		27,000
Variance	0	890	3,610	(3,000)		1,500

Approval has been requested for Niagara's 2014 annual Capital forecast; changes will be managed within the revised budget envelope.

Part E: Financial Evaluation

M$	Upgrade to 55MW, 63MVA	Base Case No Project	Minor Overhaul	Major Overhaul	Upgrade to 61MW, 68MVA
Project Cost	27.0	N/A	7.1	20.3	38.5
NPV (after tax)	27.0	24.3	19.6	19.6	23.1

Summary of Financial Model Key Assumptions or Key Findings:

Energy projections per the SAB1 LCP are still valid.

Project costs based on actual costs from G7, G9, and G3 overhauls/upgrades.

The potential for a higher MCR during the Darlington refurbishment program has not been included.

Part F: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected	Release amount requested for purchase of runner only has sufficient contingency of 9%.	Low	Low
Scope	N/A – supply of runner only			
Schedule	Runner not delivered in time, delaying the start of the execution phase	Order the runner as soon as possible. Monitor progress of supplier.	Medium	Low

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Type 2 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release
Document #:

Part F: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
Resources	Required resources are identified as per the project charter. No additional resources are anticipated.	Accept the risk.	Low	Low
Quality/ Performance	Due to volume of work and consolidation of engineering packages, technical specs and RFP package may contain errors.	Peer reviews will be used when appropriate to ensure accuracy of documentation.	Low	Low
Technical	Runner does not meet performance requirements.	Runner design based on uprate study and modeling which has been completed.	Low	Low
Other	This is a large multifaceted project with a variety of risks which may contribute to poor execution.	Niagara Operations recently completed overhauls on three other SAB1 units. Lessons learned and PIRs will be used to ensure strong project delivery.	Low	Low

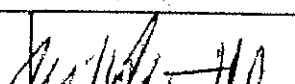
Part G: Post Implementation Review (PIR) Plan

☐ It is determined appropriate that only a Project Closure Report (PCR) is needed as the PIR for this project, due to its straight forward deliverables, which do not require any measures other than confirmation of completion or delivery.

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
N/A		

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
PIR requirements are not included in this release as they will be identified in the BCS for Full Release of funds.				

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 HTO			18 JUN 14.
I concur with the business decision as documented in this BCS.			
Finance Approval: Robin Heard SVP & CFO per OPG-STD-0076			18 JUN 14.
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 & CEO per OAR 1.1			21 JUN 14

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OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Document #:

Appendix A: Summary of Estimate										
Project Number:	SAB10050									
Project Title:	G10 Major Overhaul & Upgrade									
k$	**LTD**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Future**	**Total**	**%**
OPG Project Management		140	620	625					1,385	5.1
OPG Engineering (including Design)			120	120					240	0.9
OPG Procured Materials		485	720	170					1,375	5.1
OPG Other										
Design Contract(s)										
Construction Contract(s)			10,970	10,180					21,150	78.3
EPC Contract(s)										
Consultants		120							120	0.4
Other Contracts / Costs										
Interest		76	105	122					303	1.1
Subtotal		**821**	**12,535**	**11,217**					**24,573**	**91.0**
Contingency		169	1,075	1,183					2,427	9.0
Total		**990**	**13,610**	**12,400**					**27,000**	**100.0**

Notes			
Project Start Date	Aug-2015	**Total Definition cost** (excludes unspent contingency for Nuclear)	
Target In-Service (or AFS) Date	Jul-2016	**Contingency included in this BCS** (Nuclear only)	
Target Completion Date		**Total contingency released plus contingency in this BCS** (Nuclear only)	
Escalation Rate	1.7%	**Total released plus this BCS without contingency** (Nuclear only)	
Interest Rate	5.0%	**Total released plus this BCS with contingency** (Nuclear only)	
Removal Costs	See note	**Estimate at Completion** (Includes only spent contingency for Nuclear)	$27,000k

Note: Removal Costs are included in the Summary of Estimate, however they haven't been fully identified at this time. They will be broken out as part of the RQE for the Full Execution BCS.

Prepared by:		**Approved by:**	
Alan Lansbury Project Leader	Date 2014-06-04	Ken Prince Section Manager - Projects	Date 2014-06-04

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OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Document #:

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in k$ (by year including contingency)						Future	Total Project Estimate
			2014	2015	2016	2017	2018	2019		
Init & Def	Full	2013-10-18	100	11,500	15,400					27,000
Exec	Partial	2014-05-17	820	12,750	13,430					27,000

Project Variance Analysis

Choose an item.	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		n/a	1,385		The last BCS did not have a breakdown of costs as that was not required for a Type 2 BCS at that time.
OPG Engineering (including Design)		n/a	240		
OPG Procured Materials		n/a	1,375		
OPG Other		n/a			
Design Contract(s)		n/a			
Construction Contract(s)		n/a	21,150		
EPC Contract(s)		n/a			
Consultants		n/a	120		
Other Contracts / Costs		n/a			
Interest		n/a	303		
Subtotal		n/a	**24,573**		
Contingency		n/a	2,427		
Total		n/a	**27,000**		

ONTARIO POWER GENERATION

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

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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 #:	SAB10050	**Document #:**	NF20-BCS-08707 021-xxxx
Project Title:	G10 Major Overhaul and Upgrade		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Sustaining
Phase:	Execution	**Release:**	Full
Facility:	SAB1	**Target In-Service or Completion Date:**	July 2018

Project Overview

We recommend the release of $24.7M, including $2,427K of contingency. The estimated total project cost is $27M, including $2,427K of contingency. The quality of the estimate for this release is Class 3, and for the total project is Class 3.

This release will fund the following scope of work:

- Generator and Stator rewind and Electrical auxiliaries, new main transformer and static excitation.
- New upgraded runner and major overhaul of the turbine components.
- New PTFE thrust bearing.

The rehabilitated G10 unit is expected to produce 59 GWh annually, including an incremental increase of 13 GWh due to the installation of higher capacity stator windings, more efficient runner and transformer.

This sustaining investment is consistent with the approved Life Cycle Plan (LCP) for SAB1 and OPG's objective of continuing to increase clean, renewable generation from its existing fleet of hydroelectric assets.

Problem Statement/Business Need:

Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Hydro-Thermal Operations maintains and develops hydro resources.*

Summary of Preferred Alternative:

The project would execute a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed, including installation of a new runner, modified head cover, and new wicket gates. Further investigation and possible repair would be done on the penstock and scroll case, including completion of a load carrying capacity analysis.

A Definition Phase Charter (NPG 00121.2-0253) was approved October 2, 2013 which includes a detailed scope of work based on actual work completed on G7, G9, and G3.

This alternative is recommended since it will address availability and reliability concerns, has the highest NPV, and lowest risk profile. It is also consistent with Hydro-Thermal Operations mandate to maintain and develop hydro resources.

History of BCS releases and project cost estimates:

The project cost estimate of $27M has been consistent through all releases.

- Init/Def BCS approved Oct. 18/13 to complete Technical specification and Uprate Study.
- Partial BCS approved June 21/14 to purchase a new uprated Runner

History of scope and schedule changes:

The scope and schedule have not changed from the previous BCS's

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

Type 3 Business Case Summary

Project #: SAB10050
Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Project Overview

Key Assumptions and Risks:

The project will be executed by a single main contrector. All equipment and manpower, except for the runner purchase, will be included in the scope of work for the contractor.

Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released		990	1,310						2,300
Requested Now	-		12,300	12,400					24,700
Future Required	-								
Total Project Cost		990	13,610	12,400					27,000
Ongoing Costs	-								
Grand Total	-	990	13,610	12,400					27,000

Estimate Class:	Class 3	**Estimate at Completion:**	27,000
NPV:	26,951	**OAR Approval Amount:**	27,000

Additional Information on Project Cash Flows (optional):

The 2014 cashflow will be managed within the Niagara Operations budget envelope.

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 HTO			19 Dec 14
I concur with the business decision as documented in this BCS.			
Finance Approval: Beth Summers SVP & CFO per OPG-STD-0076			22 DEC 14
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 & CEO per OAR 1.1			13 JAN 15

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

Project #: SAB10050
Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Business Case Summary

Part A: Business Need

Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Hydro-Thermal Operations maintains and develops hydro resources.

A generator rewind and an upgraded runner will result in improved unit efficiency and a maximum continuous rating (MCR) increase of approximately 9 MW. This project is a sustaining investment required to ensure continued reliable operation of G10 and to maximize the use of water available from the Niagara River new third tunnel

Sir Adam Beck GS #1 (SAB1) G10 was originally placed in-service in 1930 as a 25Hz unit rated for 45MVA then converted to 60Hz in 1956. The last major overhaul completed on the unit was in 1986. During the upcoming overhaul, the opportunity exists to execute additional work which would increase the capacity and efficiency of G10 and allow Niagara Operations to better utilize the water available to the station. The recommended alternative upgrades the current rating of the unit to the following capabilities:

	Turbine			Generator	
	Efficiency (%)	Power (MW)		Rating parameters	
	[redacted]	Best	Full Load	MVA	MW
Existing Unit		43.0	57.0	55	55
Upgraded Unit		**55.0**	**59.0**	**63**	**59**
Improvement		+12.0	+2.0	+8	+4

A Life Cycle Plan (LCP) for SAB1 (R-NF20-01556-0002) was approved July 2008. The recommended alternative was an eight unit station (G3-G10) which included overhaul and upgrade of G10. This project is also included in the 2015-17 Business Plan.

The project cost estimate of $27M has been consistent through all releases.

- Init/Def BCS (NPG-08707.021-0127) approved Oct. 18/13 to complete Technical specification and Uprate Study.
- Partial BCS (NPG-08707.021-0141) approved June 21/14 to purchase a new uprated Runner.

Part B: Preferred Alternative: **Perform Major Overhaul and Upgrade unit to 55 MW, 63 MVA**

Description of Preferred Alternative

The project would execute a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed, including installation of a new runner, modified headcover, and new wicket gates. Further investigation and possible repair would be done on the penstock and scrollcase, including completion of a load carrying capacity analysis.

A Definition Phase Charter (NPG-00121.2-0055) was approved October 2, 2013 which includes a detailed scope of work based on actual work completed on G7, G9, and G3.

An equipment supply agreement between OPG and American Hydro Corp (now Weir) was signed Feb 2007 for the supply of runners for G3-G10. The runner for G10 will be purchased under the terms of this agreement. The decision to purchase 8 runners and the SAB1 overhaul program were recommended and supported by the 2008 LCP for SAB1.

The execution strategy is to award a single contract to a general contractor. A Technical Specification has been developed which will specify equipment and components proven and existing on previous SAB1 upgrades. The general contractor will be responsible for completing the installation design (mechanical, electrical, civil), manufacture of parts, supply of equipment (except the runner), removal of existing equipment, and installation of new and/or refurbished equipment. This strategy will reduce the cost of re-engineering equipment, lower the contract cost, and reduce the duplication of spare parts.

An Initial Project Execution Plan (PEP) with Risk Analysis (NPG-00121.1-0025) was approved June 25, 2014 and is attached below.

The unit will be overhauled during a Planned Outage from August 2015 to July 2018.

This alternative is recommended since it will address availability and reliability concerns, has the highest NPV, and lowest risk profile. It is also consistent with Hydro-Thermal Operations mandate to maintain and develop hydro resources.

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

Type 3 Business Case Summary

Project #: SAB10050 Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Deliverables:	Associated Milestones (If any):	Target Date:
Purchase new runner	PBCS approved	July 4, 2014
	PO issued	July 16, 2014
Main contract for General Contractor	RFP start	Sept 18 2014
	Full BCS Approval	Jan 2015
	Award main contract	Jan 2015
	Construction Start	Aug 2015
	Equipment in Service	July 2016

PEP SAB10050 r0 APPROVED.pdf

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 – No Project

Do nothing, continue with the existing LEM program for the unit and corrective maintenance on an ad hoc basis.

Based on in its current condition, G10 could likely run without major investment until 2018, at which time the turbine is expected to have reduced reliability and the transformer is expected to reach end-of-life. If left unaddressed, an eventual failure will result in a forced outage during either the Nuclear Refurbishment, SAB2 Overhaul Program, or the later stages of the SAB1 Overhaul Program.

Therefore, this alternative is not recommended.

Alternative 3: Perform a Minor Overhaul for 10 Years of Operation at 45.9 MW

Maintain the current rating of the generator. The scope of work would be largely focussed on cleaning, testing and repair of existing equipment, including removal of the generator rotor for cleaning and a flux test. Also included is the purchase and installation of a new transformer.

This alternative has the worst NPV due to its investment requirements and expected outcome of reliability, and the fact that the next overhaul will occur in the middle of the Nuclear Refurbishment & SAB2 Overhaul Programs.

Therefore, this alternative is not recommended.

Alternative 4: Perform Major Overhaul to Ensure 15-20 Years of Operation at 45.9 MW

Maintain the current rating of the generator. The project would execute a complete refurbishment of the generator stator and rotor, including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed including weld repair of the runner, installation of new wicket gates and potential install of a new headcover.

This alternative provides for low technical risk, but is not recommended due to its lower NPV. It also does not take advantage of the opportunity to increase capacity and efficiency to make better use of the available water.

Alternative 5: Upgrade the Unit to 61 MW, 68 MVA

The scope of work for this alternative is very similar to that of the preferred alternative, with the significant difference being the purchase and installation of a new generator and all of the associated work required to the superstructure to accommodate the unit.

Due to a less favourable NPV and increased technical risk with the expanded scope, this alternative is not recommended.

Type 3 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

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

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released		990	1,310						2,300
Requested Now	-		12,300	12,400					24,700
Future Required	-								
Total Project Cost		990	13,610	12,400					27,000
Ongoing Costs	-								
Grand Total		990	13,610	12,400					27,000

Estimate Class:	Class 3	**Estimate at Completion:**	27,000
NPV:	26,951	**OAR Approval Amount:**	27,000

Additional Information on Project Cash Flows (optional):

(k$)	LTD	2014	2015	2016	2017	Total
BP 2015-17	0	990	13,610	12,400	0	27,000
Summary of Estimate	0	990	13,610	12,400	0	27,000
Variance (SoE – BP)	0	0	0	0	0	0

The 2014 cashflow will be managed within the Niagara Operations budget envelope.

Part E: Financial Evaluation

M$	Upgrade to 55 MW, 63 MVA	Base Case No Project	Minor Overhaul	Major Overhaul	Upgrade to 61 MW, 68 MVA
Project Cost	27.0	N/A	7.1	20.3	38.5
NPV	27.0	24.3	19.6	19.6	23.1
Incremental NPV	2.7	N/A	(4.7)	(4.7)	(1.2)

Summary of Financial Model Key Assumptions or Key Findings:

Energy projections per the SAB1 LCP are still valid.

Project costs based on actual costs from G7, G9, and G3 overhauls/upgrades.

The potential for a higher MCR during the Darlington refurbishment program has not been included.

NPV SAB10050 G10 Overhaul & Upgrade

Part F: Qualitative Factors

Sustainable Development

Since hydroelectric generation is a renewable source of energy, the loss of a hydroelectric generating unit will increase the environmental impact of meeting Ontario's electricity demands. This will potentially necessitate the supply of energy from other less sustainable sources; therefore, increasing the reliability and production of SAB1 will potentially reduce the environmental impact of meeting Ontario's electricity demands.

Station Enhancement

Upgrades performed on the unit such as the modernization of the excitation system, unit protections and controls will improve the unit response and ensure compliance with Electricity market rules. This will enhance the overall station performance.

Health and Safety

The work will be completed in a manner that ensures G10 and associated equipment will be compliant with current corporate and provincial health and safety standards. Efforts will also be made to ensure that any new equipment installed is ergonomic. Enhancements such as upgraded lighting will improve the work environment and reduce health and safety risks to workers.

Type 3 Business Case Summary

Project #: SAB10050
Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Part F: Qualitative Factors

Environmental

An Environmental Assessment is not required for this project as the scope of this upgrade does not extend the operational parameters for SAB1 past the parameters associated with the original 10 unit station configuration.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected	Cost based on recent G7, G9 and G3 projects. A contingency allowance is included in the estimate (9%)	Low	Low
Scope	Planned Execution Phase not complete. Discovery Work	A very comprehensive and detailed scope has been developed, with lessons learned from previous unit scope and as-found extra work detailed in the scope.	Low	Low
Schedule	Delay in completion of construction will result in lost generation revenue.	Preliminary estimates of hours required to complete the work are based on recent G3, G7 and G9 projects.	Low	Low
Resources	Insufficient OPG resources (PES, PWU) to support the work	Required resources have been committed to per the PEP. Contract additional resources as required.	Low	Low
Quality/ Performance	Due to volume of work and consolidation of engineering packages, functional specs and RFP packages may contain errors.	Peer reviews have been used to ensure accuracy of documentation.	Low	Low
Technical	Unit does not meet performance requirements	G10 is a repeat of G3 with very minor differences.	Low	Low

Additional Risk Analysis:

G3 project was managed with multiple contractors and purchase orders which created many issues. G10 will be managed by a single main contractor with only two purchase orders. The technical specification is very specific and has reduced engineering design. Lessons learned from previous projects were analysed and included in the project.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Simplified PIR	September 2016	September 2017

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
MCR	45.9 MW	55 MW	Unit Metering	SAB1 Production
Apparent Power	55 MVA	63 MVA	Unit Metering	SAB1 Production
Runner Efficiency at best efficiency point.	1986 Gibson Test	[redacted]	Gibson Test	Tech Supp Eng HTO / P&T
Runner Cavitation	N/A	As per model testing results (cavitation guarantee is 59 MW)	Visual Inspection	NPG Asset/Projects

Type 3 Business Case Summary

Project #: SAB10050 Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Part I: Definitions and Acronyms	
BP	Business Plan
HTO	Hydro-Thermal Operations
LEM	Leading Edge Maintenance
LCP	Life Cycle Plan
MCR	Maximum Continuous Rating
MW	Megawatts
MVA	Megavolt Ampere (a unit of measure of apparent power)
NPG	Niagara Plant Group (now Niagara Operations)
NPV	Net Present Value
P&T	Performance & Testing
PES	Plant Engineering Services
PTFE	Polytetrafluoroethylene - a synthetic polymer with numerous applications. The best known brand name is Teflon.
PWU	Power Workers Union
RQE	Release Quality Estimate
RFP	Request for Proposal
SAB	Sir Adam Beck

Type 3 Business Case Summary

Project #: SAB10050 Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

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Type 3 Business Case Summary

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Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

For Internal Project Cost Control

Type 3 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release
Document #: NF20-BCS-08707.021-xxxx

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in k$ (by year including contingency)						Future	Total Project Estimate
			2014	2015	2016	2017	2018	2019		
Init & Def	Full	2013-10-18	100	11,500	15,400					27,000
Exec	Partial	2014-05-17	820	12,750	13,430					27,000
Exec	Full		990	13,610	12,400					27,000

Project Variance Analysis

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		1,385	1,385		
OPG Engineering (Including Design)		240	240		
OPG Procured Materials		1,375	1,375		
OPG Other					
Design Contract(s)					
Construction Contract(s)		21,150	21,150		
EPC Contract(s)					
Consultants		120	120		
Other Contracts / Costs					
Interest		303	303		
Subtotal		**24,573**	**24,573**		
Contingency		2,427	2,427		
Total		**27,000**	**27,000**		

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OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

Appendix A: Summary of Estimate										
Project Number:	SAB10050									
Project Title:	G10 Major Overhaul and Upgrade									
k$	**LTD**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Future**	**Total**	**%**
OPG Project Management	34	106	620	625					1,385	5.1
OPG Engineering (including Design)			120	120					240	0.9
OPG Procured Materials		485	720	170					1,375	5.1
OPG Other										
Design Contract(s)										
Construction Contract(s)			10,970	10,180					21,150	78.3
EPC Contract(s)										
Consultants		120							120	0.4
Other Contracts / Costs										
Interest		76	105	122					303	1.1
Subtotal	**34**	**787**	**12,535**	**11,217**					**24,573**	**91.0**
Contingency	0	169	1,075	1,183					2,427	9.0
Total	**34**	**956**	**13,610**	**12,400**					**27,000**	**100.0**

Notes			
Project Start Date	Aug-2015	**Total Definition cost** (excludes unspent contingency for Nuclear)	34
Target In-Service (or AFS) Date	Jul-2016	**Contingency included in this BCS** (Nuclear only)	N/A
Target Completion Date	July -2016	**Total contingency released plus contingency in this BCS** (Nuclear only)	N/A
Escalation Rate	1.7%	**Total released plus this BCS without contingency** (Nuclear only)	N/A
Interest Rate	5.0%	**Total released plus this BCS with contingency** (Nuclear only)	N/A
Removal Costs		**Estimate at Completion** (includes only spent contingency for Nuclear)	27,000

Prepared by:		Approved by:	
Nov 27 2014		Dec/3/14	
Alan Lansbury Project Leader	Date 2014-11-27	Ken Prince Section Manager - Projects	Date 2014-12-03

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OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

Appendix A: Summary of Estimate										
Project Number:	SAB10050									
Project Title:	G10 Major Overhaul and Upgrade									
k$	**LTD**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Future**	**Total**	**%**
OPG Project Management	34	106	620	625					1,385	5.1
OPG Engineering (including Design)			120	120					240	0.9
OPG Procured Materials		485	720	170					1,375	5.1
OPG Other										
Design Contract(s)										
Construction Contract(s)			10,970	10,180					21,150	78.3
EPC Contract(s)										
Consultants		120							120	0.4
Other Contracts / Costs										
Interest		76	105	122					303	1.1
Subtotal	**34**	**787**	**12,536**	**11,217**					**24,573**	**91.0**
Contingency	0	169	1,075	1,183					2,427	9.0
Total	**34**	**956**	**13,610**	**12,400**					**27,000**	**100.0**

Notes			
Project Start Date	Aug-2015	**Total Definition cost** (excludes unspent contingency for Nuclear)	34
Target In-Service (or AFS) Date	Jul-2016	**Contingency included in this BCS** (Nuclear only)	N/A
Target Completion Date	July -2016	**Total contingency released plus contingency in this BCS** (Nuclear only)	N/A
Escalation Rate	1.7%	**Total released plus this BCS without contingency** (Nuclear only)	N/A
Interest Rate	5.0%	**Total released plus this BCS with contingency** (Nuclear only)	N/A
Removal Costs		**Estimate at Completion** (includes only spent contingency for Nuclear)	27,000

Prepared by:		**Approved by:**	
Alan Lansbury	Date	Ken Prince	Date
Project Leader	2014-11-27	Section Manager - Projects	2014-12-03

Type 3 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in k$ (by year including contingency)						Future	Total Project Estimate
			2014	2015	2016	2017	2018	2019		
Init & Def	Full	2013-10-18	100	11,500	15,400					27,000
Exec	Partial	2014-05-17	820	12,750	13,430					27,000
Exec	Full		990	13,610	12,400					27,000

Project Variance Analysis

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		1,385	1,385		
OPG Engineering (including Design)		240	240		
OPG Procured Materials		1,375	1,375		
OPG Other					
Design Contract(s)					
Construction Contract(s)		21,150	21,150		
EPC Contract(s)					
Consultants		120	120		
Other Contracts / Costs					
Interest		303	303		
Subtotal		**24,573**	**24,573**		
Contingency		2,427	2,427		
Total		**27,000**	**27,000**		

Type 3 Business Case Summary

Project #: SAB10050 Document #: NF20-BCS-08707.021-xxxx
Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Appendix C: Financial Evaluation Assumptions
Key assumptions used in the financial model of the Project are (complete relevant assumptions only):

Project Cost:

1. Overall project cost estimates were heavily based on G3, G7 and G9 rehabilitations
2. Costs for components and labour were based on costs for similar work carried out in the past with appropriate escalators applied
3. Cost reduction by reducing engineering design by using proven designs from previous units

Financial:

1. The new generator and associated equipment will have a useful service life of 50 years
2. Increased capacity will generate higher revenue
3.

Project Life:

1. The project can start immediately after approval
2. The project can be completed and the generator can be commissioned by the end of Q4 2016
3.

Energy Production:

1. Energy forecasts were based on Niagara River flow models
2. Generation at the Beck plants can be maximized while adhering to the market dispatches
3. Historical forced outage rates will be typical in the future

Operating Cost:

1. There will be minimal incremental operating costs associated with the upgraded G10 unit
2.
3.

Other:

1.
2.
3.

List further detail below as appropriate from the Financial Evaluation:

Appendix D: References
SAB1 Life Cycle Plan (R-NF20-01556-0002) dated December 2007
Business Plan 2015-2017
Release Quality Estimate
Initial Project Execution Plan (NPG-00121.1-0025) approved June 25, 2014
Definition Phase Charter (NPG-00121.2-0055) approved October 2, 2013

ONTARIO POWER GENERATION

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

Internal Use Only

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 #:	BK180649 (SAB10050)	Document #:	NIAG-REP-08707.021-0201
Project Title:	G10 Major Overhaul and Upgrade		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Superseding
Facility:	SAB1	Target In-Service or Completion Date:	April 2017

Project Overview

We recommend the release of an additional $6.14M, including $1M of contingency. The project was originally released at $27M including $2.4M contingency, which will be consumed by cost variances as explained below. The revised estimated total project cost is $33.14M, including $1M of contingency. The quality of the estimate for this release is Class 1 (+15%), and for the total project is Class 1 (+15%).

This is accompanied by a shift of the in-service date from July 2016 to April 2017..

This release will provide **additional funding** to complete the following scope of work:

- Stator windings, electrical auxiliaries, new main transformer, static excitation and controls installation.
- New upgraded runner, headcover and bottom ring and overhauled turbine components installation.
- Start-up and commissioning.

The rehabilitated G10 unit is expected to produce 59 GWh annually, including an incremental increase of 13 GWh due to the installation of higher capacity stator windings, more efficient runner and transformer.

This sustaining investment is consistent with the approved Life Cycle Plan (LCP) for SAB1 and OPG's objective of continuing to increase clean, renewable generation from its existing fleet of hydroelectric assets.

Reasons for Variance:

1. **PWU support costs ($1,853):** The PWU support costs for contract monitoring and site preparation were not covered in the original EBCS; the project team initially planned to execute as an Owner Only contract at lower cost, but this did not transpire and the costs were not accounted for in the RQE.
2. **EPC contract pricing ($1,375):** The lowest contract bid price was significantly higher than the RQE allowance. It included higher than expected risk cost associated with an all-inclusive contract, which is the preferred contracting strategy as it shifts resource demand and performance liability to the contractor.
3. **New head cover and bottom ring ($1,100):** Based on emergent information from G9, a decision was made to procure a new head cover and bottom ring; these costs were not included in the original RQE or EBCS.
4. **Grit-blasting and lead abatement ($975):** A change in work method was requested to significantly improve containment of fugitive lead paint particulate, improving cleanliness in the powerhouse from a Health & Safety standpoint, thereby increasing execution cost.
5. **Interest Costs ($610):** Higher than expected EPC contract cost, combined with an overall nine month delay in the completion date contributed to higher than estimated interest costs.
6. **Runner currency exchange and escalation allowance ($450):** The value of the Canadian dollar declined significantly during execution; there was no allowance for escalation from the original blanket purchase order, in the original RQE or EBCS.
7. **Moody cone tip and stainless steel draft tube extension scope changes ($418):** Based on recent discovery of cavitation on G9, it was decided to change the draft tube extension material to stainless steel at an increased cost. In addition, after disassembly, the Moody Cone tip was discovered to be missing. A new tip was fabricated and installed to preserve runner performance guarantees.
8. **Windings delayed delivery (Schedule impact):** The EPC contractor experienced quality issues during fabrication of the generator windings which will result in an approximate nine month delay to the in-service date. Although the Contractor mitigated schedule impact where possible, this will result in carrying cost to OPG. Liquidated damages

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

Type 3 Business Case Summary

Project #: BK180649 (SAB10050) Document #: NIAG-REP-08707.021-0201
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Project Overview

recovery will be negotiated but are not included in this estimate due to remaining schedule uncertainty.

9. **Other additional scope and discovery work ($786):** Major contributors - discovery work ($257) - penstock bulge injection /Moody Cone install/lower fan repair/thrust bearing/shaft steel replacement, Schedule delays ($220k) – Andritz mobilization was impacted by IESO and Powerhouse Crane not available early in the project. [redacted]

Key Assumptions and Risks:

The project, except for the runner supply, is being executed under a single, well-qualified EPC contractor, mitigating the risk to OPG associated with coordinating multiple contractors and suppliers. The unusually complex G10 stator winding configuration resulted in significant manufacturing challenges which have now been resolved through dedicated process improvements.

Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	14,600	12,400							27,000
Requested Now	-	4,816	1,324						6,140
Future Required	-								
Total Project Cost	14,600	17,216	1,324						33,140
Ongoing Costs	-								
Grand Total	14,600	17,216	1,324						33,140

Estimate Class:	Class 1	**Estimate at Completion:**	33,140
NPV:		**OAR Approval Amount:**	33,140

Additional Information on Project Cash Flows:

The 2016 cash flow is being managed within the Niagara Operations budget envelope; the 2017 cash flow will be incorporated in the 2017 Business Plan.

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Document #: NIAG-REP-08707.021-0201

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 President, RG&PM			26 AUG 16
I concur with the business decision as documented in this BCS.			
Finance Approval: Ken Hartwick SVP & CFO per OPG-STD-0076			Aug 29, 2016
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: Jeff Lyash President & CEO per OAR 1.1			Aug 31, 2016

ONTARIO POWER GENERATION

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

Internal Use Only

OPG-FORM-0076-R005*

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)
Document #: NIAG-REP-08707.021-0201
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Business Case Summary

Part A: Business Need

Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Renewable Generation and Power Marketing maintains and develops hydro resources.

A generator rewind and an upgraded runner will result in improved unit efficiency and a maximum continuous rating (MCR) increase of approximately 9 MW. This project is a sustaining investment required to ensure continued reliable operation of G10 and to maximize the use of water available from the Niagara River new third tunnel

Sir Adam Beck GS #1 (SAB1) G10 was originally placed in-service in 1930 as a 25Hz unit rated for 45MVA then converted to 60Hz in 1956. The last major overhaul completed on the unit was in 1986. During the upcoming overhaul, the opportunity exists to execute additional work which would increase the capacity and efficiency of G10 and allow Niagara Operations to better utilize the water available to the station. The recommended alternative upgrades the current rating of the unit to the following capabilities:

	Turbine			Generator		MCR
	Efficiency (%)	Power (MW)		Rating parameters		(MW)
	[redacted]	Best	Full Load	MVA	MW	
Existing Unit		43.0	57.0	55	55	45.9
Upgraded Unit		**55.0**	**59.0**	**63**	**59**	**55**
Improvement		+12.0	+2.0	+8	+4	9.1

A Life Cycle Plan (LCP) for SAB1 (R-NF20-01556-0002) was approved July 2008. The recommended alternative was an eight unit station (G3-G10) which included overhaul and upgrade of G10. This project is also included in the 2015-17 Business Plan.

- Init/Def BCS (NPG-08707.021-0127) approved Oct. 18/13 to complete the Technical Specification and Uprate Study.
- Partial BCS (NPG-08707.021-0141) approved June 21/14 to purchase a new uprated runner.

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade unit to 55 MW, 63 MVA

Description of Preferred Alternative

The project is executing a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine has been undertaken, including installation of a new, uprated runner, headcover, lower ring and new wicket gates. Inspection of the penstock, Johnson valve and scroll case has revealed the need for significant repair and polyurethane injection.

A Definition Phase Charter (NPG-00121.2-0055) was approved October 2, 2013 which included a detailed scope of work based on actual work completed on G7, G9, and G3.

An equipment supply agreement between OPG and American Hydro Corp (now WAH) was signed Feb 2007 for the supply of runners for G3-G10. The runner for G10 was purchased under the terms of this agreement. The decision to purchase 8 runners and the SAB1 overhaul program was recommended and supported by the 2008 LCP for SAB1. The G10 RQE failed to allow for escalation and exchange rate fluctuation, as provided for in the WAH agreement.

The Technical Specification covering equipment and components which was based on previous SAB1 upgrades has stood up well during execution of the main EPC contract. That general contractor is responsible for completing the design (mechanical, electrical, civil), manufacture of parts, supply of equipment (except the runner), removal of existing equipment, and installation of new and/or refurbished equipment and installation of all of equipment and materials. It is believed that his strategy has reduced the execution cost and the associated risk to OPG, over what it would be under a multiple contracts scenario.

An Initial Project Execution Plan (PEP) with Risk Analysis (NPG-00121.1-0025) was approved June 25, 2014 and is attached below.

The unit is being overhauled during a Planned Outage from October 2015 extended to February, 2017.

This approach was recommended since it addresses availability and reliability concerns, had the highest NPV, and lowest risk profile. It is also consistent with Renewable Generation and Power Marketing mandate to maintain and develop hydro resources

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

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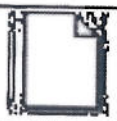
Type 3 Business Case Summary

Project #: BK180649 (SAB10050)
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release
Document #: NIAG-REP-08707.021-0201

Deliverables:	Associated Milestones (if any):	Target Date:
This phase of the project will: Complete the mechanical and electrical installation and commissioning work.	Equipment in Service	Feb 2017



EBCS BK180649
(SAB10050) G10 Majo

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

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	14,600	12,400							27,000
Requested Now	-	4,816	1,324						6,140
Future Required	-								
Total Project Cost	14,600	17,216	1,324						33,140
Ongoing Costs	-								
Grand Total	14,600	17,216	1,324						33,140

Estimate Class:	Class 1	Estimate at Completion:	33,140
NPV:		OAR Approval Amount:	33,140

Additional Information on Project Cash Flows (optional):

The 2016 cash flow will be managed within the Niagara Operations budget envelope; the 2017 cash flow will be incorporated in the 2017 Business Plan.

Part E: Financial Evaluation (Revised to reflect current approval request)

M$	Upgrade to 55 MW, 63 MVA	Base Case No Project	Minor Overhaul	Major Overhaul	Upgrade to 61 MW, 68 MVA
Project Cost	33.1	N/A	7.1	22.3	44.6
NPV	22.0	21.9	18.3	17.5	19.5
Incremental NPV	0.1	N/A	(3.6)	(4.4)	(2.4)

Summary of Financial Model Key Assumptions or Key Findings:

Energy projections per the SAB1 LCP are still valid.

Project costs are based on actual costs and current projections of work to complete.

The potential for a higher MCR during the Darlington refurbishment program has not been included.

NPV SAB10050 G10
Overhaul & Up...

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)
Document #: NIAG-REP-08707.021-0201
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Part F: Qualitative Factors

Sustainable Development
Since hydroelectric generation is a renewable source of energy, the loss of a hydroelectric generating unit will increase the environmental impact of meeting Ontario's electricity demands. This will potentially necessitate the supply of energy from other less sustainable sources; therefore, increasing the reliability and production of SAB1 will potentially reduce the environmental impact of meeting Ontario's electricity demands.

Station Enhancement
Upgrades performed on the unit such as the modernization of the excitation system, unit protections and controls will improve the unit response and ensure compliance with Electricity market rules. This will enhance the overall station performance.

Health and Safety
The work will be completed in a manner that ensures G10 and associated equipment will be compliant with current corporate and provincial health and safety standards. Efforts will also be made to ensure that any new equipment installed is ergonomic. Enhancements such as upgraded lighting will improve the work environment and reduce health and safety risks to workers.

Environmental
An Environmental Assessment is not required for this project as the scope of this upgrade does not extend the operational parameters for SAB1 past the parameters associated with the original 10 unit station configuration.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected	Allowances have been made for the expected spending trends to the end of the project. A contingency is also included consistent with the Estimate Class. Although it is possible for additional problems to arise during commissioning, Niagara has had recent success with the Weir runner/Andritz overhaul combination. The rewind portion of the contract will be transitioned to Owner Only.	Medium	Medium
Scope	Planned Execution Phase not complete. Discovery Work	The odds of there being significant additional discovery work are reduced at this point.	Low	Low
Schedule	Delay in completion of construction will result in lost generation revenue. Potential risk to coil manufacturing.	Newly qualified fabrication process has been developed with a firm delivery date. Although it is possible for additional problems to arise during commissioning, Niagara has had recent success with the Weir runner/Andritz overhaul combination.	Medium	Low
Resources	Insufficient OPG resources (PES, PWU) to support the work	Required resources committed to date have been sufficient.	Low	Low
Quality/ Performance	Due to volume of work and consolidation of engineering packages, functional specs and RFP packages may contain errors.	Confidence has been established that we will receive high quality coils based on extensive work by Andritz at the expense of a schedule delay. The prototype coils successfully passed testing requirements and will continue to be spot checked.	Low	Low
Technical	Unit does not meet performance requirements	G10 is a repeat of G3 with some additions.	Low	Low

Additional Risk Analysis:

Type 3 Business Case Summary

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Additional Risk Analysis:

G3 project was managed with multiple contractors and purchase orders which created many issues. G10 is being executed by a single general contractor under only two purchase orders. Site execution to date has been very good. Major additional work items that were not captured in the specification have been identified and addressed.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Simplified PIR	February 2017	February 2018

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
MCR	45.9 MW	55 MW	Unit Metering	SAB1 Production
Apparent Power	55 MVA	63 MVA	Unit Metering	SAB1 Production
Runner Efficiency at best efficiency point.	1986 Gibson Test	[redacted]	Gibson Test	Tech Supp Eng HTO / P&T
Runner Cavitation	N/A	As per model testing results (cavitation guarantee is 59 MW)	Visual Inspection	NPG Asset/Projects

Part I: Definitions and Acronyms

BP	Business Plan
HTO	Hydro-Thermal Operations
LEM	Leading Edge Maintenance
LCP	Life Cycle Plan
MCR	Maximum Continuous Rating
MW	Megawatts
MVA	Megavolt Ampere (a unit of measure of apparent power)
NPG	Niagara Plant Group (now Niagara Operations)
NPV	Net Present Value
P&T	Performance & Testing
PES	Plant Engineering Services
PTFE	Polytetrafluoroethylene - a synthetic polymer with numerous applications. The best known brand name is Teflon.
PWU	Power Workers Union
RQE	Release Quality Estimate
RFP	Request for Proposal
SAB	Sir Adam Beck

Type 3 Business Case Summary

Project #: BK180649 (SAB10050) Document #: NIAG-REP-08707.021-0201
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Type 3 Business Case Summary

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For Internal Project Cost Control

Type 3 Business Case Summary

Project #: BK180649 (SAB10050) Document #: NIAG-REP-08707.021-0201
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Appendix A: Summary of Estimate (Revised)										
Project Number:	BK180649 (BK180649 (SAB10050))									
Project Title:	G10 Major Overhaul and Upgrade									
k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total	%
OPG Project Management	340	695	142						1,177	3.6
OPG Engineering (including Design)	67	291	50						408	1.2
OPG Procured Materials	1,698	545							2,243	6.7
OPG Cnst Labour	368	1,245	240						1,853	5.6
Design Contract(s)										
Construction Contract(s)	14,654	9,414	572						24,640	74.3
EPC Contract(s)										
Consultants	182	79	0						261	.8
Other Contracts / Costs										
Interest	160	633	120						913	2.8
Subtotal	17,469	12,902	1,124						31,495	95.0
Removal Costs	645								645	1.9
Contingency	0	800	200						1,000	3.1
Total	18,114	13,702	1,324						33,140	100.0

Notes			
Project Start Date	Oct-2015	Total Definition cost (excludes unspent contingency for Nuclear)	34
Target In-Service (or AFS) Date	February-2017	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	February -2017	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	1.7%	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	5.26%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs	$645k	Estimate at Completion (includes only spent contingency for Nuclear)	33,140

Prepared by:		Approved by:	
Rick Comacchio Project Leader	Date 2016-05-27	Ken Prince Section Manager - Projects	Date 2016-05-27

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)
Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Document #: NIAG-REP-08707.021-0201

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in k$ (by year including contingency)						Future	Total Project Estimate
			2014	2015	2016	2017	2018	2019		
Init & Def	Full	2013-10-18	100	11,500	15,400					27,000
Exec	Partial	2014-05-17	820	12,750	13,430					27,000
Exec	Full	2015-01-13	990	13,610	12,400					27,000
Exec	Full		990	17,124	13,702	1,324				33,140

Project Variance Analysis

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		1,385	1,177	(208)	Overestimate from original RQE has resulted in modest forecasted under run.
OPG Engineering (including Design)		240	408	168	Higher than budgeted cost, partly due to additional coverage re: winding manufacturing issues.
OPG Procured Materials		1,375	2,243	868	Additional cost of changing draft tube extension to stainless and unexpected need for new Moody cone tip.
OPG CNST Labour			1,853	1,853	No budget allowance included in original RQE.
Design Contract(s)					
Construction Contract(s)		21,150	25,285	4,135	Higher than expected cost on award, and higher cost for blasting and lead abatement, Moody cone installation, stator and lower fan repairs. Removal Costs included $645k
EPC Contract(s)					
Consultants		120	261	141	IESO/Hydro 1/Pinchin, etc.
Other Contracts / Costs					
Interest		303	913	610	7 months schedule extension
Subtotal		24,573	32,140	7,567	
Original contingency		2,427		(2,427)	Consumed by cost variances
Revised Contingency			1,000	1,000	Added new contingency: 15% of remaining spend
Total		27,000	33,140	6,140	