IN-SERVICE AMOUNTS

1.0 OVERVIEW

Capital expenditures for the Darlington Refurbishment Program ("DRP") for the years 2013 to 2021 are provided in Ex. D2-2-10 Table 1. The capital in-service amounts are presented in Ex. D2-2-10 Tables 2 to 5. Capital in-service amounts are presented in four categories: (1) Unit Refurbishment – Unit 2 In-service; (2) Unit Refurbishment - Early In-service Projects; (3) Safety Improvement Opportunities ("SIO"); and (4) Facility and Infrastructure Projects ("F&IP").

2.0 CAPITAL IN-SERVICE AMOUNTS

2.1 Unit Refurbishment - Unit 2 In-service Amount

The Unit Refurbishment - Unit 2 in-service amount includes costs incurred to complete the refurbishment scope and return to service of Unit 2. It does not include any early in-service amounts that are used or useful to the Darlington station in advance of Unit 2 return to service. The in-service amounts in the test period for Unit 2 are $4,799.8M in 2020 and $0.4M in 2021.

The 2020 in-service amount includes $4,777.7M that will be placed in-service in February 2020 and an additional $22.1M capital costs for close-out activities that are forecast to be incurred and placed in-service by the end of August 2020. As discussed in section 3.1.2 of Ex. B1-1-1, the nuclear rate base values for 2020 reflect the $4,777.7M in-service amount subject to a weighting of 10.5/12 in order to recognize that it is expected to be placed in-service in February. This is shown in Ex. B3-3-1, Table 2, line 23.

Capital costs included in the Unit 2 in-service were incurred commencing in 2010 with the preliminary planning portion of the Definition Phase. Definition Phase costs are included in the Unit 2 in-service amounts as these costs would be required for a single unit refurbishment. OPG has discussed the accounting treatment with its external auditor, who concurs that this treatment is in accordance with US GAAP.

For example, Definition Phase costs for the Retube and Feeder Replacement ("RFR") work bundle include construction of the mock-up, engineering and fabrication of tooling and tool testing. This Definition Phase work was necessary to establish the target price for the Execution Phase of RFR. To the extent that there have been unit-specific engineering costs incurred during the Definition Phase that are not related to Unit 2 (i.e., relating only to other units), such costs are not included in the amounts coming into service with Unit 2 in 2020.

A description of the program underlying the requested Unit 2 in-service amount is provided in Ex. D2-2-2 through Ex. D2-2-9. A breakdown of the costs included within the Unit 2 in-service amount can be found in section 4 of Ex. D2-2-8.

2.2 Unit Refurbishment – Early In-service Projects

Some assets arising from work performed for the unit refurbishments will be placed in service and included in the rate base before the refurbishment of the first unit is completed as they provide immediate benefit to the station ahead of the Unit 2 return to service. The in-service amounts for these early in-service projects are $98.8M in the 2016 bridge year, and, in the test period, $1.1M in 2017, and $8.6M in 2018. These projects are described below.

2.2.1 RFR - Tooling for Removal Activities

The RFR Tooling for Removal Activities, namely the feeders removal tooling and fuel channel removal tooling, with a total project cost of $87M, will be placed in service in 2016. Tooling used exclusively for removal activities for the four units will be depreciated over its useful life, which is approximated by the feeder removal time periods for the four units. The unique treatment of these tools is consistent with the treatment of removal costs which, in accordance with US GAAP, are being expensed to OM&A in the period in which they are incurred[1].

2.2.2 Fuel Handling - Irradiated Fuel Bay Heat Exchanger Plate Replacement

[1] OPG's capitalization policy is discussed in Ex. D4-1-1.

The Irradiated Fuel Bay Heat Exchanger Plate Replacement project, with a total project cost of $6.4M, was placed in service in 2015 at a cost of $6.2M, with close-out costs of $0.2M forecast for 2016. The irradiated fuel bay heat exchangers serve all Darlington units and are therefore used and useful to the station upon going into service. This project is described above in section 4.3 of Ex. D2-2-5.

2.2.3 Balance of Plant - Negative Pressure Containment

The Negative Pressure Containment project, with a total project cost of $5.1M, will be placed in service over the period 2016 to 2017. This project provides a fully redundant monitoring capability in Unit 3 for negative pressure containment parameters used in three safety related systems (post-accident monitoring system, containment leak rate test system and emergency filtered air discharge system). This redundancy will be used when Unit 2 is separated from the station containment for refurbishment.

2.2.4 Balance of Plant – Heavy Water Islanding Modifications

The Heavy Water Islanding Modifications project, with a total project cost of $5.6M, will be placed in service in 2016. This project provides isolation valves and a redundant pressure relief path for the headers used to transfer moderator and primary heat transport heavy water between units and the heavy water processing facility. The transfer header systems are important to safety and these modifications eliminate the need for a header outage to meet pressure relief valve calibration regulatory requirements. This redundancy will be used when Unit 2 is islanded from the operating units during Unit 2 refurbishment.

2.2.5 Balance of Plant – Low Pressure Service Water

The Low Pressure Service Water project, with a total project cost of $6.4M, will be placed in service in 2018. The low pressure service water system needs to be shut down and isolated from the low pressure service water inter-unit service water tie header to support execution of the approved refurbishment scope of work on this system. To enable the system outages, modifications are required to provide alternate cooling to some unit loads that are normally supplied by the unit low pressure service water system and still require cooling during

refurbishment. This project installs a temporary modification to allow an alternative source of cooling.

2.2.6 Early In-service Projects <$5M

There are four other unit refurbishment pre-requisite projects that are less than $5M. The projects have an average cost of $1.4M and a total cost of $4.2M to be placed in service in the bridge and test period: $2.0M in 2016 and $2.2M in 2018.

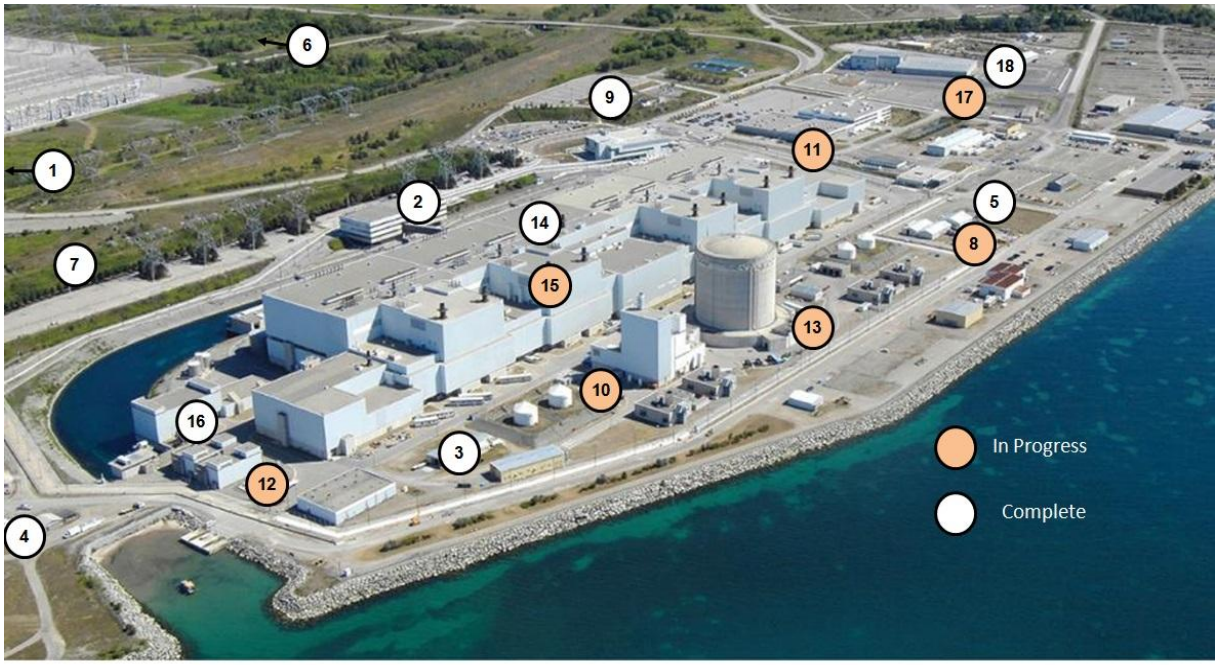
2.3 Safety Improvement Opportunities

The need for the SIO, and OPG's commitment to undertake them, was established through the Environmental Assessment ("EA") that was approved by the CNSC. They are a regulatory commitment pursuant to the Integrated Implementation Plan ("IIP") (see section 4.4 of Ex. D2-2-1, and section 3.2 of Ex. D2-2-5). The SIOs follow the DRP's release process and are included in the DRP Business Case Summary ("BCS").

The total in-service amounts for the SIO are $194.1M in the 2016 bridge year, and, in the test period, $7.4M in 2017, and $0.3M in 2018. The sections below provide a description of the SIO. They will all be completed and placed into service in the bridge year or test period (Ex. D2-2-10, Tables 2 and 3). As committed within the EA and the IIP, the SIO are to be placed into service upon completion and are useful to OPG's current and future nuclear operations independent of whether the DRP is completed.

Photo 1

Safety Improvement Opportunities and DRP Facilities and Infrastructure Projects



Safety Improvement Opportunities		Facilities and Infrastructure Projects			
12	3rd Emergency Power Generator	1	Darlington Energy Complex	2	Operations Support Building Refurbishment *
13	Containment Filtered Venting System	3	Re-tube & Feeder Replacement Island Support Annex	5	Vehicle Screening Facility
14	Power House Steam Venting System	4	Refurbishment Project Office	6	Holt Road Interchange Improvements *
15	Shield Tank Overpressure Protection	10	Heavy Water Storage	7	Electrical Power Distribution
16	Fire Water and Emergency Cooling	11	Retube Waste Processing Building	8	Auxiliary Heating System *
		17	Retube Waste Storage Building *	9	Water and Sewer
				18	Used Fuel Dry Storage Building *

* = Not in DRP Scope

2.3.1 Third Emergency Power Generator

This work involves the installation of a third Emergency Power Generator ("EPG") that can withstand a higher level seismic event than the design basis earthquake that the other two EPGs at Darlington are designed to withstand, and that can operate following a severe site flood. It will improve the availability and reliability of the emergency power system at Darlington in cases where the other two EPGs experience simultaneous failure or where one of the two EPGs is undergoing maintenance and the second EPG fails. The total project cost is $120.4M and the planned final in-service date is October 2016 in order to meet a regulatory commitment made in the EA and IIP.

2.3.2 Containment Filtered Venting System

The Containment Filtered Venting System is required to prevent the loss of containment structural integrity as a result of over pressurization in the unlikely event of a multi-unit severe accident. More specifically, the system protects the containment boundary from overpressure for a “beyond design basis event” by passively relieving a mixture of steam and air through a filtered flow path, which will reduce the likelihood of a large uncontrolled release of radioactive fission products to the environment. The total project cost is $80.3M and the planned final in-service date is August 2016.

2.3.3 Powerhouse Steam Venting System Improvements

The powerhouse steam venting system (“PSVS”) is designed to limit the harsh environmental conditions following potential secondary side piping failures, such as steam, feedwater, condensate and heating system piping breaks. These harsh conditions may impact safety-related systems, structures and components located in the powerhouse, reactor auxiliary bays and the adjoining fuelling facilities auxiliary areas. The PSVS is intended to limit the duration of the powerhouse overpressure period and minimize the spread of steam by establishing a steam chimney to vent steam from the powerhouse, thereby helping to minimize or avoid widespread equipment failures due to harsh environmental conditions.

A technical review of the performance of the PSVS identified a number of deficiencies. To address these deficiencies, this SIO modifies the PSVS programmable controllers to improve reliability. The PSVS Improvements, with a total project cost of $5.6M, were placed into service in 2015 at an amount of $5.2M, with close out costs of $0.5M forecast for 2016.

2.3.4 Shield Tank Overpressure Protection

The existing emergency filtered air discharge system is capable of mitigating the consequences of design basis accidents, but to prevent failure of containment following certain beyond design basis events (i.e. main steam line break followed by loss of Class IV power, Class III power and emergency power supply to all four units), the installation of a containment filtered venting system and shield tank overpressure protection relief is needed.

This SIO provides overpressure protection of the shield tank to prevent shield tank failure under such severe beyond design basis event conditions. The current approved plan is for the Shield Tank Overpressure Protection SIO to come into service after installation during planned unit outages in the bridge and test period: $6.9M in 2016, $6.9M in 2017, and $0.3M in 2018, however, this plan is currently being re-evaluated for scope and timing of installation.

2.3.5 Replacement of Emergency Service Water Buried Services Line 60

The Emergency Service Water ("ESW") system is a special safety system which supplies cooling water to selected safety related systems when normal water supplies are unavailable for the removal of decay heat and prevention of subsequent process failure, which would create a risk of radiation release. The existing pipe was buried approximately seven meters underground.

A partial inspection of ESW Line 60 performed in 2010 found that the condition of the piping had deteriorated and replacement of the pipe is now required. A parallel buried line was installed during the 2015 Darlington Vacuum Building Outage. Appropriate corrosion protection (e.g., surface coatings and cathodic protection) was applied along the length of the new piping to allow the pipe to operate to the end of station life. The SIO to replace ESW Line 60 came into service in 2015 at an amount of $13.3M, and $1.3M close-out in 2016, for a total project cost of $14.6M.

2.4 Facilities & Infrastructure Projects

2.4.1 Overview

Facility and Infrastructure Projects are pre-requisites for unit refurbishments and will be placed in service and included in rate base when they are used or useful to OPG. As discussed below, these projects are expected to remain useful to OPG's current and future nuclear operations independent of whether the DRP is completed.

The total in-service amounts for the F&IP are $57.4M in the 2016 bridge year, and, in the test period, $365.9M in 2017, and $9.4M in 2020. In section 2 of Ex. D2-1-3, a tiered reporting

structure, consistent with the OEB's filing guidelines, has been used to present the F&IP that have budgeted expenditures or in-service amounts during the bridge year or test period.

2.4.2 F&IP >$20M

The following F&IP greater than $20M will be completed and placed in service in the bridge year or test period (Ex. D2-2-10, Table 2):

- *Heavy Water Storage and Drum Handling Facility*: Discussed below in section 2.4.5.1.
- *Retube and Feeder Replacement Island Support Annex ("RFRISA"):* RFRISA will be used by DRP staff to execute the Program, and also in support of Darlington online and outage maintenance activities. It became used and useful when it was partially placed in service in November 2015.
- *Refurbishment Project Office ("RPO"):* The Refurbishment Project Office is a multi-purpose facility that initially will be used by DRP staff for secure access into the Darlington protected area, contractor change room and shower facilities, contractor lunchroom, offices of DRP support staff, and parking for all DRP contractor and project staff. Similar to the Darlington Energy Complex discussed below, the RPO will be used to consolidate OPG nuclear staff at Darlington and would otherwise be expected to benefit current operations if the DRP were to be discontinued. The RPO became used and useful when it was placed in service in November 2015.
- *Electrical Power Distribution System*: Discussed below in section 2.4.5.3.

The following F&IP greater than $20M were placed in service in the historical years and have minor in-service amounts associated with project close-out in the bridge year:

- Water and Sewer Project: Discussed below in section 2.4.5.2.
- Darlington Energy Complex: The Darlington Energy Complex became used and useful when it was placed in service in 2013 in providing space for training reactor mock-up, warehouse space for tooling and materials, and office space. Following the completion of the DRP, the Darlington Energy Complex will also allow the consolidation of leases and co-location of support staff, including Inspection and Maintenance, closer to Darlington.

Business Case Summaries for F&IP of $20M or greater are included in Attachment 1. Variance explanations for F&IP that varied by more than 10 per cent from the initial full release, are provided in section 2.4.5.

2.4.3 F&IP Between $5M and $20M

The following F&IP between $5M and $20M will be completed and placed in service in the bridge year or test period (Ex. D2-2-1, Table 3):

- GM Facility Interim Office Leasehold Improvements[2]
- Vehicle Screening Facility

2.4.4 Reconciliation of F&IP List to EB-2013-0321

In support of RQE, OPG reviewed the cost classification of DRP projects to ensure clarity between costs characterized as refurbishment versus costs needed for the operation of Darlington in general. This review resulted in the reclassification of certain projects, including the Operations Support Building Refurbishment and the Auxiliary Heating System projects, from DRP to the Nuclear Operations Portfolio, and certain OM&A costs to Nuclear Operations. OPG concluded that the reclassified projects were not required for refurbishment, but rather are necessary for first life operations and outage requirements. Evidence supporting projects reclassified to the Nuclear Operations Portfolio is provided in Ex. D2-1-3.

Chart 1 below reconciles the capital projects greater than $5M in DRP and the Nuclear Operations Portfolio to the F&IP capital projects in DRP in EB-2013-0321.

[2] Although classified as F&IP for internal tracking purposes, this project is treated in the same manner as other Definition Phase costs necessary for the refurbishment of a single unit and is expected to be placed in service in conjunction with Unit 2.

Chart 1

Reconciliation of F&IP Project List to EB-2013-0321 Ex. D2-2-1, Tables 3 and 4

Project	Project Number	EB-2013-0321	EB-2016-0152	Total Project Cost based on approved project BCS ($M)
Projects >$20M				
Heavy Water Storage and Drum Handling Facility	31555	DRP	DRP	381.1
Water & Sewer Project	73802	DRP	DRP	57.7
Darlington Energy Complex	73803	DRP	DRP	105.4
Retube Feeder Replacement Island Support Annex	73810	DRP	DRP	40.7
Refurbishment Project Office	73815	DRP	DRP	99.9
Darlington Operations Support Building Refurbishment	25619	DRP	Nuclear Operations Portfolio	62.7
Darlington Auxiliary Heating System	34000	DRP	Nuclear Operations Portfolio	99.5
Electrical Power Distribution System	73821	DRP	DRP	20.8
Projects $5M - $20M				
GM Facility Interim Office Leasehold Improvements	73806/ 73814	DRP	DRP	9.3

In addition to the projects in the table above, the following projects were reclassified as Nuclear Operations Portfolio projects:

- Emergency Service Water Pipe and Component Replacement (Project 73397, Ex. D2-1-3, Table 2d)
- Primary Heat Transport Pump Motor Replacements (Project 73566/ 80144, Ex. D2-1-3, Table 1)
- Primary Heat Transport Pump Motor Overhaul (Project 73566/ 80144, Ex. D2-1-3, Table 1)

- Highway 401 & Holt Road Interchange (Project 73706, Ex. D2-1-3, Table 1)

2.4.5 Project Variance Explanation

This section provides an explanation for F&IP greater than $20M for which total actual or forecast project cost variances exceed 10 per cent. Explanations are provided for the following projects:

- Heavy Water Storage and Drum Handling Facility (section 2.4.5.1)
- Water and Sewer (section 2.4.5.2)
- Electrical Power Distribution System (section 2.4.5.3)

Variances for F&IP are managed as part of the overall DRP. As presented in Ex. D2-2-8, F&IP represent 5 per cent of the overall DRP. There is $76M total contingency in the DRP budget that recognizes the risks associated with F&IP and SIO. The DRP is expected to be delivered on budget and on schedule, notwithstanding the variances described below.

Facility and Infrastructure Projects are significantly different from the Nuclear Operations Portfolio projects that OPG has undertaken in the past and from the unit refurbishment program. They are new designs of complex facilities constructed on a brownfield site. For instance, there are more engineering changes (discussed in section 3.1 of Ex. D2-2-5) required for F&IP than are required for the entirety of the Unit 2 refurbishment.

2.4.5.1 Heavy Water Storage and Drum Handling Facility

Overview

The purpose of the Heavy Water Storage and Drum Handling Facility (the “Heavy Water Facility”) is to provide heavy water storage and processing capability for the removal of heavy water from the Darlington units during refurbishment and the management of heavy water during normal operations. Heavy water, when used in a nuclear reactor, becomes radioactive material. As a result, effective management and controls are required to avoid spills and to manage potential radiological safety and environmental consequences.

CANDU nuclear generating stations such as Darlington cannot operate without heavy water. Heavy water is required for use in both the moderator and primary heat transport systems. However, heavy water is no longer produced on a commercial scale. Consequently, the existing inventory has to be managed throughout the operating life and decommissioning of all CANDU facilities. In addition, there is a need to store heavy water during the unit outages for the DRP.

However, during operations, the moderator and primary heat transport heavy water becomes contaminated with tritium and downgraded with regular or "light" water. Because of heavy water's limited availability and the need to maintain existing inventory, the tritium must be removed through the heavy water management process by way of OPG's Tritium Removal Facility ("TRF").

The importance of heavy water management to the continued operation of Darlington is highlighted by the following factors:

- There are CNSC regulatory limits on the moderator and primary heat transport system tritium levels. Without the capability to produce new heavy water that does not contain tritium, regulatory operating limits can only be maintained with the operation of the TRF.
- The ability to maintain low tritium levels in the moderator and primary heat transport systems is an important factor in minimizing tritium releases to the environment and keeping radiation exposure to workers to levels that are as low as reasonably achievable.
- The existing TRF's capability to meet the current and post Darlington refurbishment tritium removal needs has been assessed to be adequate. However, lack of storage and segregation capability limits the ability of the TRF to meet tritium removal requirements. Providing more storage tanks allows operational flexibility to feed the TRF with a continuous supply of higher tritiated water resulting in greater tritium removal efficiency.

Through more efficient use of the TRF, OPG will increase its ability to recycle water with reduced tritium emissions and reduced heavy water make-up requirements.

OPG retains the obligation for the heavy water management for its reactors at Darlington, Pickering and Bruce A and B during decommissioning. It also provides detritiation services to customers, primarily Bruce Power (see Ex. G2-1-1).

Increased storage and segregation capability for different heavy water streams will support a long-term solution to heavy water storage and tritium removal needs for the nuclear industry in Ontario. The Heavy Water Facility will increase the operational flexibility of the TRF. It will also store a buffer of detritiated heavy water which can be used to provide continued detritiation services to OPG and customers during TRF outages.

Historically OPG has relied on drums to collect and store a significant quantity of heavy water. The current backlog of drums causes radiological and conventional safety concerns. In addition, drums present an increased risk of environmental spills. The Heavy Water Facility includes a drum handling facility that will eliminate the backlog of heavy water drums that need to be processed. The drum storage facility will provide centralized drum storage for Pickering and Darlington with enhanced protection of environmental and worker safety.

The Facility

The facility is the first of its kind since it is a multifunctional building designed to safely contain and store large volumes of tritiated and detritiated heavy water while interconnected to the existing TRF for efficient tritium removal operations. As well, it can contain and store water contaminated with radionuclides other than tritium that may enter heavy water from nuclear systems, and allow efficient and safe management of these radionuclides.

The project comprises the construction of a new 2,100,000 litre heavy water storage and drum handling facility adjacent to the existing TRF to meet DRP and heavy water management operational improvement requirements.

Photo 2

Heavy Water Facility Construction

Safely storing and transferring radioactive heavy water requires unique design requirements which include the use of stainless steel piping, valves, and storage tanks to maintain the purity requirements for reactor grade heavy water. In addition, due to the high tritium concentrations, design specifications require the use of nuclear-grade tanks, piping, valves, and components. To protect the workers and the environment from tritium vapour, a vapour recovery system is included. This system directs air containing tritium moisture, which is pushed out of the storage tanks as the tanks are filled, to collection systems to remove the tritium vapour. Together, these nuclear quality requirements and design features are necessary to prevent tritium exposures to workers or releases to the environment.

To further protect the environment in the unlikely event of a severe earthquake, the storage tanks are contained in a seismically qualified reinforced concrete dyke. Compared to a conventional dyke, the seismic dyke has significantly more anchors to attach it to bedrock, over 100 more tons of rebar and more than 500 cubic metres of concrete.

Photo 3

Construction of Concrete Dyke

To improve and optimize the TRF operating efficiency, the 2,100,000 litre storage capacity is provided by 25 separate nuclear-grade stainless steel tanks. These tanks provide separation

so that moderator heavy water with high concentrations of tritium can be kept separate from heat transport system heavy water with lower levels of tritium. Separate tanks are also provided for downgraded heavy water with varying amounts of tritium as well as detritated heavy water returned from being processed in the TRF. To fully integrate the storage capacity with the TRF, each tank is fully instrumented for remote level indication and connected with stainless steel piping, valves, and pumps allowing transfer to and from the TRF and similar tanks.

As part of the efficient and practical design, the storage facility was located next to the TRF, which is within the protected area at Darlington.

The Need

The building structure, process equipment and control systems provide an integrated and efficient solution to two separate business needs.

First, the facility will provide storage capacity required to execute the DRP. Refurbishment requires heavy water to be drained from the moderator and primary heat transport systems, as well as the collection of tritiated rinse water. Second, integration with OPG's existing TRF allows for ongoing operational improvement in addition to its use during DRP. Increasing the operational storage mitigates the need to build a new TRF or refurbish the existing TRF. In addition, increased storage capacity will provide OPG with greater flexibility when accepting shipments of heavy water from external customers during TRF outages to support external heavy water management activities. The need for the project is detailed in the BCS provided in Attachment 1.

The Cost

At its forecast total project cost of $381.1M (full in-service in May 2017), the Heavy Water Facility provides substantial value to the DRP and Darlington operations. Initial scope identification for the Heavy Water Facility was limited. The initial project budget was based on a conceptual design and very preliminary design requirements. The initial full release of $110.0M (updated to $287M in EB-2013-0321) was based on an EPC contractor's

conceptual design and associated cost estimates that did not match the complex requirements of the project needs. While cited as a Class 2 estimate, this was not the case. For example, the conceptual design did not include the amount of piping, shielding requirements and vapour recovery systems required to meet operational and environmental requirements in the final design. The current project budget of $381.1M as set out in the superseding BCS dated March 2015 reflects required project scope and costs as the design now properly incorporates the engineering, design and safety requirements to address the need and complexity of the project. Therefore, the superseding BCS (see Attachment 1, Tab 1) provides the relevant and appropriate basis for evaluating the costs associated with the scope of work that is required for the Heavy Water Facility project.

The changes in the forecasted project costs are primarily associated with progressing from conceptual design requirements to detailed design requirements to ensure the proper design and functionality of the project. Design concerns were raised by OPG and independent oversight at the initial stage of the project, with work not having progressed beyond site preparation. OPG took definitive steps to become more actively involved in the facility's detailed design to ensure the proper scope. This included co-locating OPG engineering staff with the contractor's design team.

Ultimately, OPG determined that the contractor's performance on this project was unsatisfactory and in October 2014, terminated the Heavy Water Facility purchase order for default. OPG assumed the role of general contractor for an interim period while it secured a new contractor. The SNC/AECON JV has now been awarded the contract to complete the project.

The changes in project cost are design related to ensure a scope that matches the need and do not reflect any significant reworking or reconstruction of facilities. The increased project budget reflects true project costs as the design was further developed.

Design changes included the following:

(i) *Alteration to the Heavy Water Facility*: The conceptual design had the new Heavy Water Facility located immediately adjacent to the existing TRF. The new building would have a 'shared wall' in contact with the existing west wall of the TRF to reduce construction costs. As design progressed, it was determined that it was not feasible to arrange the new foundations for the Heavy Water Facility in a way that would not interfere with the foundations of the existing TRF. It was necessary to move the building seven metres to the west to avoid the foundation interference. The relocation of the building was also necessary to avoid interference with buried low pressure service water piping.

(ii) *Increased Piping, Valves and Equipment Quantities*: An increase in the quantity of process and services piping that was identified as the design was completed and full requirements were understood to achieve the TRF operational efficiency requirements. In particular, the ability to move water within the facility between multiple tanks and between facilities as well as the independent filling and emptying of each tank increased the total length of pipe. This was done to provide greater operational benefits and flexibility. Also, an increase in the sizing of heating, ventilation and air conditioning systems was required because of an increase in capacity requirements to account for additional process equipment needed to meet the defined operational design requirements and environmental tritium emission reduction equipment.

(iii) *Requirement to have process piping run in a pipe tunnel*: The Heavy Water Facility is designed to move water between the Heavy Water Facility and the TRF. The original design to transfer water via an overhead, above ground, pipe corridor was not feasible because of a water pressure issue (i.e., water hammer). Resolution of this technical design issue required the interconnecting piping to be installed at a below grade elevation of seven meters. Given the separation between the TRF and the Heavy Water Facility, and seismic and environmental protection requirements, a buried seismically-qualified pipe chase was required.

(iv) *Environmental Requirements*: The DRP EA required no net increase of tritium emissions on site as a result of refurbishment activities, including emissions from all heavy water stored in the new Heavy Water Facility in support of

refurbishment. To meet this requirement, a heavy water vapour recovery system with a dryer was added in the detailed design phase.

Photo 4

Heavy Water Facility Construction Below Grade

Also, the business case identified risks of ground conditions challenging construction, particularly with tritium contaminated soil. Managing the soil excavation and ingress of ground water was complex. The project developed and implemented a contaminated soil management plan that required the construction and operation of two soil management areas.

Current status

The Heavy Water Facility is forecast to be ready to receive the heavy water from Unit 2 in support of the refurbishment outage schedule. All 28 heavy water storage tanks have been installed in the Heavy Water Facility. Pipe and structural steel installation and preparation for erection of the building superstructure is in progress. The current in-service date for the Heavy Water Facility coincides with the current need date for the Unit 2 refurbishment[3]. Risk mitigation assessments are underway to mitigate any risk of delays and/or advancements of the need date for the Unit 2 refurbishment.

2.4.5.2 Water and Sewer Project

Overview

The Water and Sewer Project was initiated to address gaps between the current condition of the water and sewer systems and future incremental requirements identified in preparation for the DRP and continued operation of Darlington. The project involves replacing the existing on-site water and sewer system by installing a separate domestic water system and a separate fire water system, redirecting the station sanitary sewage system from the on-site sewage treatment plant to the Region of Durham's sanitary sewage system, and decommissioning the existing Sewage Treatment Plant and Domestic Water Pumphouse.

Planning and execution of the Water and Sewer Project was organized into three phases:

- Phase 1 - Holt Road Domestic and Fire Water Supply System;
- Phase 2 - Solina Road Domestic and Fire Water Supply System and Darlington Sanitary Sewer System; and
- Phase 3 - Decommissioning and Removal of Existing Darlington Domestic Water Pumphouse and Sewage Treatment Plant.

Variance

The project was fully released in May 2013 based on a BCS that included a total estimated project cost of $40.6M. The forecast in-service amount for the project is $47.5M.

[3] The facility will be available to receive heavy water aligned with the Unit 2 need date, however final in-service is planned for May 2017 when the facility will benefit current operations.

The variance was driven by three technical issues:

(i) *Additional costs and schedule delays related to a change in railway crossing construction methodology*. The original construction methodology for the railway crossing used a single boring unit. Existing soil conditions discovered during tunneling operations were found to present an unacceptable risk for loss of ground and impact on the railway tracks using this methodology. Micro-tunnelling was selected as the methodology to complete the railway crossing.

(ii) *Additional costs for a revised excavation protocol*. The contractor's initial excavation protocol resulted in unintentional contact with buried services. Following two separate incidents, OPG required the contractor to follow a revised protocol that was at a higher standard and aligned with OPG's excavation protocol. As a result of the revised protocol, several potential incidents were avoided where there were mismatches between drawings and field configuration. The revised protocol resulted in additional costs for exploratory investigations and standby costs.

(iii) *Additional costs and schedule delays resulting from revised routing of the sewage and firewater line.* The Water and Sewer project design was developed based on conceptual drawings of the RPO, which is another F&IP. During detailed design of the RPO, its location was changed to avoid costs and station impacts associated with interference with the station bulk hydrogen supply trailer. The location change of the RPO required changes to the original routing of the sewage and firewater line and changes to the depth of the west pumping station.

All phases of the project were completed, with $43.7M placed into service from 2012 to 2014, and $3.7M in close out costs in 2016.

2.4.5.3 Electrical Power Distribution Project

Overview

In preparation for the DRP and continued operations at the Darlington site, OPG determined that the existing site electrical grid, fed from the local distribution utility's transformer station, did not have sufficient capacity to supply the new facilities that would be constructed at the

site. These include the RPO, the RFRISA, the Heavy Water Facility, the Auxiliary Heating Steam Facility and the Computer and Maintenance Development Facility. The existing site electric power distribution system therefore required upgrades to increase reliability of the existing system and enable electrical service for new buildings and facilities being constructed in preparation for the DRP and continued operations.

The project was put into service in July 2015, with forecast close out costs in 2016.

Variance

The project was fully released in November 2014 based on a BCS that included a total estimated project cost of $16.9M. The project, with a final cost estimate of $20.8M, was put in-service in July 2015 at a total amount of $18.1M, with $2.4M close out costs forecasted for 2016.

The primary factor driving the variance was the requirement to address legacy equipment grounding issues on the original electrical distribution system. These issues were identified in the final acceptance of the equipment by the Electrical Safety Authority prior to initial energization. To address the issue, significant changes to the equipment grounding were required to address potential step and touch differences between the new and existing equipment to allow commissioning to proceed. In addition, there were equipment delivery and performance issues associated with the new outdoor electrical switchgear provided for this project, which caused delays and the need for rework by the original equipment vendor.

3.0 COMPARISON OF IN-SERVICE AMOUNTS

3.1 2013 Actual versus 2013 Budget

The actual 2013 in-service amounts of $99.2M were slightly lower than the budget of $104.2M due to lower construction costs and some site servicing work deferred to 2014 related to the Darlington Energy Complex, partly offset by higher costs for the Water and Sewer, and Electrical Power Distribution System projects.

3.2 2014 Actual versus 2014 OEB Approved

The actual 2014 in-service amounts of $43.5M increased from the OEB-approved amount of $18.7M. The key drivers of the variance in the in-service amounts were:

- advanced in-service date for the Heavy Water Facility relocated service tanks and pipes, tie-ins and contaminated soil laydown pad ($14.6M);
- deferred in-service amounts from 2013 for the Water and Sewer project, as a result of construction delays ($10.7M);
- delayed in-service date to 2015 for the Electrical Power Distribution System project (-$4.4M);
- the in-service amount for a new Vehicle Screening Facility project that started being used in 2014, and that was not included in EB-2013-0321 ($4.1M); and
- cancellation of a core program minor Early In-Service project (-$2.1M).

3.3 2015 Actual versus 2015 OEB Approved

The actual 2015 in-service amounts of $147.1M were slightly higher than the OEB-approved amount of $143.4M. The key drivers of the variance in the in-service amounts were:

- advanced in-service dates for the RPO and RFRISA ($96M);
- deferred in-service amount from 2014 for the Electrical Power Distribution System project ($9.3M);
- delayed in-service dates to 2017 for the Heavy Water Facility due to project engineering and construction delays (-$83.5M);
- delayed in-service dates to 2016 for the Emergency Power Generator, and Containment Filtered Venting System, and Islanding D2O Management System Modifications (-$36M); and
- the inclusion of the new Powerhouse Steam Venting System, and Emergency Service Water Buried Services SIO projects ($18M).

ATTACHMENTS

Attachment 1: Business Case Summaries

Note: Business Case Summaries included in Attachment 1 are marked “Confidential” or “Internal Use Only”, however, OPG has determined them to be non-confidential either in their entirety or with redactions as indicated.

BUSINESS CASE SUMMARIES FOR FACILITY AND INFRASTRUCTURE PROJECTS OF $20M OR GREATER

Tab No.	Project Number	Business Case Summary (BCS) Title	BCS Approval Date	Project Phase	Status of BCS	Status of BCS in EB-2013-0321
1	16-31555	Heavy Water Storage and Drum Handling Facility	Mar-15	Execution	Superseding	Partial release - Execution
2	10-73810	Retube and Feeder Replacement Island Support Annex	Feb-14	Execution	Full release	Full release - Definition
3	10-73815	Refurbishment Project Office	Feb-14	Execution	Full release	Full release - Definition
4	10-73821	Darlington Site Electrical Distribution System Upgrades	Oct-15	Execution	Superseding	Partial release - Definition
5	10-73802	Darlington Water & Sewer Project	May-14	Execution	Superseding	Partial release - Execution
6	10-73803	Darlington Energy Complex	Dec-10	Execution	Full release	Full release - Execution

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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 #:	16-31555	**Document #:**	D-BCS-09701-10007
Project Title:	Heavy Water Storage and Drum Handling Facility		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Value Enhancing
Phase:	Execution	**Release:**	Superseding
Facility:	Darlington	**Target In-Service or Completion Date:**	2017-05-01

Project Overview

We recommend the release of $270.9M, which includes [redacted] of contingency, to fund the completion of the Heavy Water Storage and Drum Handling Facility. This project is value enhancing and will introduce 2,100,000 litres of new heavy water storage capacity to support the Darlington Refurbishment Project (DRP) and ongoing operational improvements to the Tritium Removal Facility (TRF) at Darlington Nuclear. The total Class 2 estimated project cost for the 31,000 square foot facility is $381.1M, including contingency.

The purpose of the Heavy Water Storage and Drum Handling Facility is to provide heavy water storage and processing capability for OPG. Heavy water is a radioactive material with environmental consequences if it is not effectively managed. Without heavy water, CANDU nuclear generating stations such as Darlington cannot operate. Heavy water can no longer be produced.

The Heavy Water Storage and Drum Handling Facility is a first of a kind multifunctional building. The building structure, process equipment and control systems provide an integrated solution to two separate business needs. The facility will provide the storage capacity required to execute the DRP as well as integration with the existing Tritium Removal Facility (TRF) to allow for ongoing operational improvements. As stipulated by the Canadian Nuclear Safety Commission (CNSC) in October 2012, this facility is now designed with enhanced seismic protections and spill containment systems that can withstand an earthquake 1.5 times more severe than the original design basis. The facility is equipped with environmental protections including vapour recovery systems that ensure that no net increase in tritium emissions are introduced during the storage and handling of heavy water. By increasing the operational storage, the Heavy Water Management Life Cycle Management Plan can be met and the need to refurbish or build a new TRF is mitigated. These features allow the building to satisfy immediate business needs while also forming the underpinning of a long term solution to heavy water storage and treatment needs for the nuclear industry in Ontario.

Problem Statement/Business Need:

This project addresses an integrated solution to address the following individual business needs:

1) There is a need to store heavy water to facilitate the refurbishment of Darlington Nuclear Generating Station (DNGS). To accommodate the DRP execution strategy for overlapping refurbishment outages 1,700,000L of storage capacity is required. An assessment of the existing storage capacity performed by a 3rd party vendor determined that there was not sufficient storage available to meet the refurbishment needs. In assessing similar refurbishment projects that had been completed, it was determined that additional storage facilities were either built or augmented to store heavy water (Bruce) or the existing storage capacity onsite was sufficient to store the heavy water (Pt. Lepreau).
2) There is a need to improve heavy water management in support of all OPG nuclear units. The improvements to operations and OPG Heavy Water management are summarized below:
   - Improve operational flexibility and ability to segregate different heavy water streams to support Darlington operation and outages.
   - Eliminate the backlog of heavy water drums that need to be processed.

   An Operational Improvement project for the existing TRF was launched in 2006 and was subsequently merged with the DRP heavy water storage project in order to align strategies and achieve efficiencies. This operational enhancement scope minimizes the risk of incurring capital costs to refurbish the existing TRF or build a new TRF

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

Type 3 Business Case Summary

Project #: 16-31555
Project Title: Heavy Water Storage and Drum Handling Facility, Superseding Release

Project Overview

facility in 2035.

Summary of Preferred Alternative:

The preferred alternative is to construct a new 2,100,000 Litre heavy water storage and drum handling facility adjacent to the existing TRF. This option meets Darlington Refurbishment and heavy water management operational improvement requirements.

The new facility is designed to provide sufficient storage at the Darlington site for the heavy water from two units. This option will facilitate the Heavy Water Management Life Cycle Management plan to 2055 by increasing operational storage capacity.

The execution strategy for this alternative will focus on readying the facility to receive the heavy water from Unit 2 in support of the refurbishment outage schedule. This includes the implementation of a temporary modification (TMOD) to drain the unit in advance of the full in-service date of the facility to allow a partial in-service to be achieved. In this alternative, the remainder of the facility will be finalized in parallel with the execution of the Unit 2 refurbishment outage and placed fully in service prior to the Unit 3 refurbishment outage.

History of BCS Releases and Project Cost Estimates:

The initial project estimate was prepared based on conceptual design and preliminary design requirements. The estimate was not prepared in sufficient detail to reflect the final project scope and complexity. In addition to the initial underestimation, fundamental changes imposed on the project such as CNSC code revision for seismic requirements were not anticipated. During excavation activity, the realization of identified risks such as the remediation of contaminated groundwater and soil and relocation of unidentified buried services has introduced costs.

OPG removed the prime vendor from the project [redacted]. A new construction contractor has now been brought on board to execute the project. The majority of ground construction is complete and design is substantially complete. The project has been assessed for viable options to ensure the business need is met and the estimate to complete is a bounding high confidence estimate. The total project cost is now estimated at $381M ([redacted] base cost, plus [redacted] contingency), compared to $110M ([redacted] base cost, plus [redacted] contingency) in the previous release. The history of releases and project cost estimates are shown in the following table.

$k	Date	Release with Contingency	Cumulative Release	Total Cost with Contingency
Developmental Release	November 2006	3,600	3,600	36,383
Full Definition Release	June 2012	15,689	19,289	108,148
Partial Execution Release	August 2012	11,641	30,930	108,051
Full Execution Release	May 2013	79,085	110,015	110,015
Superseding Full Execution Release	Mar 2015	270,999	381,100	381,100

A detailed variance explanation is shown in Appendix B.

Background:

A purchase order was issued to a vendor in July 2012 to complete this work at a total cost of $65.7M, including Engineering, Procurement, and Construction (EPC). As a result of the evolution of design work and completion of engineering, field discoveries during site preparation, further definition of environmental and regulatory requirements, and underestimation by the EPC vendor, the cost and schedule to deliver this facility is substantially higher than originally anticipated.

Major contributors include:

- Soil contaminated with low concentrations of tritium in the footprint of the building. This low concentration of tritium was from a spill in 2009, and eliminated the option of disposing of this soil conventionally. While the concentrations are below regulatory limits, the soil has to be treated to address the tritium before it can be removed from the Darlington site. This has been a large contributor to added costs to the project, requiring the construction of a soil lay down pad to manage the tritiated soil and modified soil handling procedures to adhere to the environmental regulations. Additional water treatment equipment was also required to lower the ground water table and allow excavation during site preparation phase while meeting environmental discharge limits.
- The new structure was originally contemplated to be directly affixed to the existing Tritium Removal Facility but

Type 3 Business Case Summary

Project #: 16-31555 Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, Superseding Release

Project Overview

due to the technical complexity and risk of tying the seismic footings together the building had to be separated into a standalone structure. This has resulted in increased in construction costs. The building also had a number of structural changes (such as a second floor to accommodate the vapour recovery equipment that was required to satisfy the environmental assessment). These changes resulted in increased excavation, concrete, cladding, structural components, etc. With the relocation of the building, and to mitigate water hammer issues identified during the detailed design phase, a seismically qualified tunnel is required to route the piping between the TRF and the new facility. This tunnel installation affected numerous design packages and resulted in increased project costs.

- The permanent material requirements were under estimated due to evolution of the design. The total length of piping contained within the new facility was originally estimated to be approximately 3km. The actual design requires over 5km of piping (including all relocates, process and non-process piping) with an associated increase in supporting equipment (i.e. valve, controls, hangers, etc.). The large increase in the amount of piping is to allow for the independent filling and emptying of each tank, which provides operational benefits and flexibility.
- The field work for site preparations was completed at approximately three times the original budget. This was due in part to the higher than anticipated ground water elevation which required substantial temporary dewatering and excavating challenges. This work included the relocation of 12 services, including a 30" Low Pressure Service Water pipe, at a depth of 6 metres.

Key Risks:

Risks:

- There is a risk that the complexity of integrating a new construction vendor results in cost and schedule impacts due to interfacing issues between the multiple design, procurement, and construction vendors currently supporting the project.
- There is a risk that the use of an expedited construction strategy leads to quality issues/potential rework/turnover inefficiencies due to the complexity of the project.
- There is a risk that during execution it is determined that the contractor will be unable to meet the committed "tanks ready for U2 D2O" milestone, requiring the refurbishment organization to implement an alternate strategy so that the Unit 2 refurbishment schedule is not impacted.

Each of the above risks has been documented and risk mitigation strategies have been or are being implemented. Refer to Part G: Risk Assessment for full breakdown of risks and mitigation strategy.

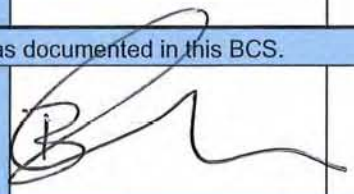
Project Cash Flows, NPV, and OAR Approval Amount

M$	LTD	2015	2016	2017	2018	2019	2020	Future	Total
Currently Released	93.0	17.2	-	-	-	-	-	-	110.2
Requested Now	30.1	96.3	125.2	19.2	-	-	-	-	270.9
Future Required	-	-	-	-	-	-	-	-	
Total Project Cost	**123.1**	**113.5**	**125.2**	**19.2**	**0**	**0**	**0**	**0**	**381.1**
Ongoing Costs	-		1.5	0.8	0.8	0.8	0.8	3.5	8.2
Grand Total	**123.1**	**113.5**	**126.7**	**20.0**	**0.8**	**0.8**	**0.8**	**3.5**	**389.3**

Estimate Class:	Class 2	**Estimate at Completion:**	$381.1M
NPV:	$73M	**OAR Approval Amount:**	$389.1M

Type 3 Business Case Summary

Project #: 16-31555
Project Title: Heavy Water Storage and Drum Handling Facility, Superseding Release
Document #: D-BCS-09701-10007

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): Dietmar Reiner Senior Vice President Nuclear Projects			Mar. 3, 2015
I concur with the business decision as documented in this BCS.			
Finance Approval: Beth Summers Chief Financial Officer per OPG-STD-0076			MARCH 5, 2015
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			March 4, 201

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Type 3 Business Case Summary

Project #: 16-31555
Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

Business Case Summary

Part A: Business Need

This project addresses two distinct business needs:

Business Need 1: Darlington Refurbishment Project (DRP)

There is a need to store heavy water to facilitate the refurbishment of Darlington Nuclear. To accommodate the DRP execution strategy for overlapping refurbishment outages 1,700,000L of storage capacity is required. An assessment of the existing storage capacity determined that there was insufficient storage available to meet the refurbishment needs. In assessing similar refurbishment projects that had previously been completed, it was concluded that storage facilities were either built or augmented to store heavy water (Bruce) or the existing storage capacity onsite was sufficient to store the heavy water (Pt. Lepreau).

Individually, each unit requires 750,000L of storage for moderator and heat transport heavy water. However, the scope of this project assumes refurbishment will be executed with over-lapping shutdown units, requiring sufficient capacity to store two units worth of heavy water, equivalent to 1,500,000L. Additionally, refurbishment requires 200,000L of storage to facilitate flushing and other support operations associated with the preparation of the Darlington units for refurbishment work. This storage is for light water, and must be segregated from reactor grade heavy water. The 200,000L storage need must be met through additional capacity as the existing Darlington operational storage is required to support the operational requirements of OPG nuclear fleet.

The 1,500,000L of reactor grade storage created under this project will be available for the long term storage of heavy water from OPG Pickering units post Darlington Refurbishment. This presents a significant ancillary benefit to OPG and addresses a significant concern as Pickering Nuclear approaches its end of commercial operations.

Business Need 2: Heavy Water Management Capability

The second business need for this project is to improve heavy water management in support of all nuclear units in Ontario. This was identified in a previously approved operational Improvement project in 2007, which was deferred and merged with the refurbishment heavy water storage project in order to facilitate cost efficiencies. The two primary needs to support heavy water management are as described below:

1) Provision of an additional 400,000L of permanent storage required to improve utilization of the Darlington Tritium Removal Facility (TRF). This storage is specific to the needs of the TRF, as the heavy water stored in these tanks has a different composition than the heavy water that will be stored for the reactors during refurbishment. The increased storage will address the TRF feed and product storage bottleneck that impacts the efficiency of the tritium removal process. Improving the efficiency of the TRF will allow increased detritiation efforts to occur, and lower both tritium emissions and employee radiation exposure.
2) A new facility that will provide services to both Pickering and Darlington stations. This facility will centralize drum storage and provide a means of long term cleaning and disposal of the current inventory of drums. The current backlog of drums stored in the Heavy Water Management Building (HWMB) has caused radiological and conventional safety concerns and operational burdens that have required increased management and controls to mitigate. The facility will also provide the ability to support any refurbishment activities requiring drum cleaning/disposal, and the ability to expedite shipments.

Overall **1,700,000L** of storage is required for Business Need 1 and **400,000L** for Business Need 2, a total of **2,100,000L** of new storage capacity that shall be addressed by this project.

Part B: Preferred Alternative: Build the remainder of the Heavy Water Storage and Drum Handling Facility with construction sequenced to meet Refurbishment requirements first, with full in-service (to meet TRF Operational Improvement needs) to follow – with the full project expedited in an accelerated manner.

Description of Preferred Alternative

The preferred alternative is to finish construction of a new 2,100,000L heavy water storage and drum handling facility adjacent to the existing TRF with an accelerated execution strategy. This option meets Darlington Refurbishment and heavy water management operational improvement requirements.

This alternative is estimated to result in a total project cost of $381M to satisfy both DRP and operational improvements needs

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

Part B: Preferred Alternative: Build the remainder of the Heavy Water Storage and Drum Handling Facility with construction sequenced to meet Refurbishment requirements first, with full in-service (to meet TRF Operational Improvement needs) to follow – with the full project expedited in an accelerated manner.

Description of Preferred Alternative

and exhibits the most positive NPV of all alternatives of $73M, as assessed against the operational improvement scope.

The major components of this alternative are as follows:

(a) **Facility:** The preferred alternative requires the design and construction of a multistory building, adjacent to the existing TRF within the protected area of the Darlington station. To prepare the site for the new facility, interferences with existing station systems (such as buried piping & electrical cable ducts, over ground structures such as bulk gases tanks, temporary trailers etc) were relocated using the engineering change control process while minimizing impact on safe plant operations.

(b) **Building:** The facility is designed to accommodate heavy water storage tanks to facilitate draining of 2 units in parallel (see details below) in the basement within a seismically qualified foundation/dyke which would be built on bedrock to prevent leakage of heavy water to the environment in the unlikely event of failure of all tanks. The facility must be seismically qualified to meet CNSC requirements. The basement would also contain a slightly negative pressure HVAC and filtering systems to minimize emissions to the atmosphere. A back-up heating system, supplied by a new system being installed by project 34000 Auxiliary Heating System, is required to ensure the heavy water does not drop below 10°C to mitigate the risk of tritium emissions by avoiding freezing and tank rupture.

A vapour recovery system consisting of dryers will be installed to remove tritiated vapour to minimize emissions to the environment and reduce radiological hazards to personnel. The building will be classified as radiological Zone 3, and contain appropriate radiation monitoring and handling systems (e.g. stack effluent monitors, personnel and materials monitors, etc.) to comply with radiological requirements.

(c) **Building Services**: The building electrical loads will be supplied by a new distribution network. A backup electrical power supply will also be provided to maintain critical loads in service at all times, including a back-up generator and battery backup for key systems. A new instrument air system will be installed to support the new facility's process systems as there is insufficient capacity in the existing system. Other support services, such as domestic water, active/inactive drains, and steam and condensate systems will also be tied in to the existing station systems.

(d) **Process and Tie-ins:** 25 tanks of various sizes, to contain the heavy water from Moderator, Heat Transport, Cleanup system, etc. are be designed and built to rigorous standards as required by applicable nuclear codes and standards. Support equipment such as piping, valves, pumps, instrumentation & controls required to be designed to the same standards is provided to monitor and operate the facility. Tie-ins to existing HWMB tanks and to the Darlington units and TRF facility for heavy water transfer capability will be provided. All this work will be coordinated and planned to ensure minimal impact on station operations.

(e) **Caissons and Excavation work:** To facilitate the excavation of the building footprint 14.5 metres below grade, a caisson wall consisting of 160 caissons were installed to provide shoring support. Due to the adjacent building and buried services inferring with the optimal number of tie-backs, internal bracing has been installed to compliment tie-backs in order to support the shoring walls. The internal bracing is specifically designed to allow the installation of the tanks prior to pouring the floor slab at grade.

(f) **Environmental Support Systems:** To manage the soil containing tritium above the level required for free release, a soil lay down pad was built to treat the soil with the goal of remediating and disposing as clean soil. A dewatering water treatment system was also designed to meet Ministry of Environment and Darlington site Certificate of Authorization requirements for discharging the water from construction projects due to excavation.

The execution of this work has been divided into 3 Phases:

Phase I, Detailed Design, June 2012 – May 2015 (In progress)

Due to design elaboration (vapour recovery system, instrument air/service air, building relocation, underground pipe tunnel connecting the new and existing facility), the detailed design portion of the work is still progressing with a completion date of June 2015 (compared to a milestone of July 2013 in the last BCS). The delay to detailed design increases schedule risk. The risk to the in service date is being mitigated by prioritizing release of design packages to match the construction schedule. The civil package for the seismic dyke has been completed, and the execution of the civil construction is underway with excavation being fully complete.

Phase II, Site Preparation, September 2012 – April 2014 (Complete)

This work was scheduled to be completed by September 2013 in the last release. This work was completed in March 2014, allowing caisson installation to be completed. This work included site preparation, construction planning, and procurement of long lead materials. Site preparation activities included demolition of TRF trailers, relocation of existing and buried services.

Type 3 Business Case Summary

Project #: 16-31555 Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

Part B: Preferred Alternative: Build the remainder of the Heavy Water Storage and Drum Handling Facility with construction sequenced to meet Refurbishment requirements first, with full in-service (to meet TRF Operational Improvement needs) to follow – with the full project expedited in an accelerated manner.

Description of Preferred Alternative

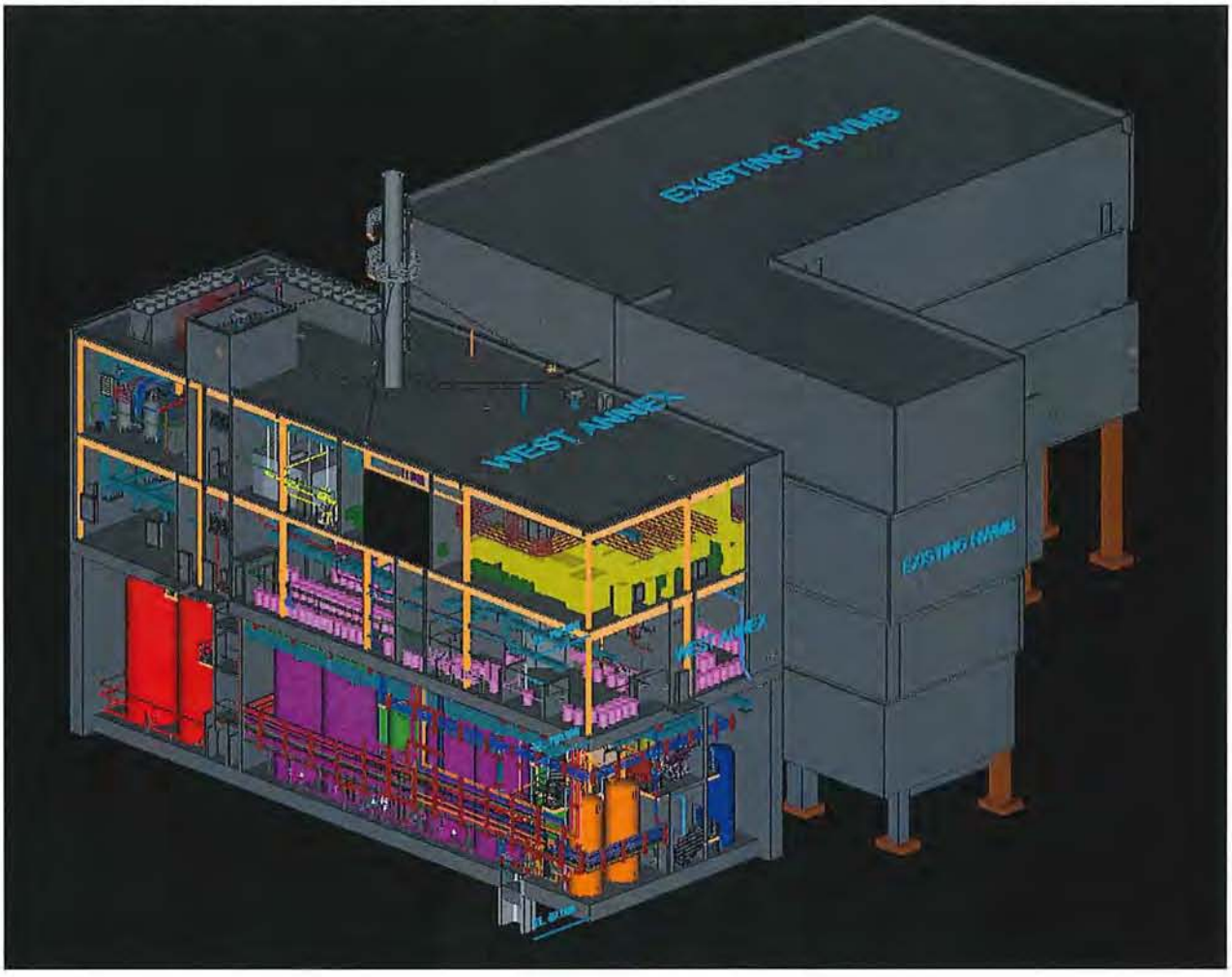
Long lead material purchase orders have been awarded as scheduled, including a purchase order for the 25 heavy water storage tanks, 12 process pumps, and 2 heat exchangers. Site preparation is substantially complete, and $14.6M of service relocations has been declared in-service.

Phase III, Full Execution, September 2013 – May 2017 (Released, Requires Superseding Release to complete)

This phase includes completion of the caisson work and excavation for TRF building connections, completion of construction planning, foundation pouring, installation of the tanks, construction of facility and supporting building and process systems, and tie-in to existing station.

Process piping, services and process controls will be included as will the updating of drawings, commissioning and training.

The following visuals are 3D renderings of the new Heavy Water Storage and Drum Handling Facility, adjacent to the Heavy Water Management Building (HWMB), also known as the Tritium Removal Facility (TRF). The first rendering shows the facility with civil installations, the second highlights the process and piping installations and the integration with the existing TRF.



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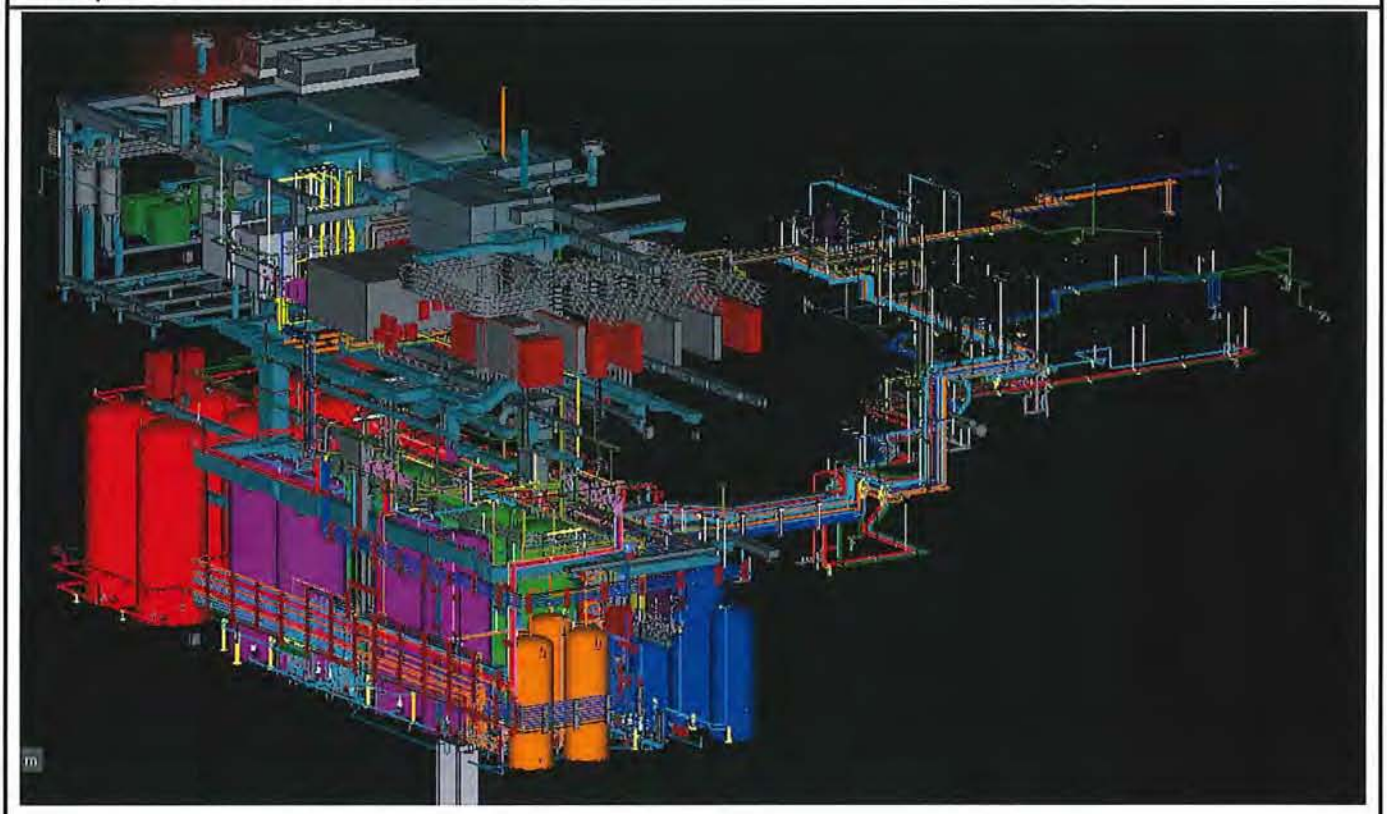
Type 3 Business Case Summary

Project #: 16-31555 Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

Part B: Preferred Alternative: Build the remainder of the Heavy Water Storage and Drum Handling Facility with construction sequenced to meet Refurbishment requirements first, with full in-service (to meet TRF Operational Improvement needs) to follow – with the full project expedited in an accelerated manner.

Description of Preferred Alternative



Deliverables:	Associated Milestones (if any):	Original 3b Target Date	Current Target Date:
Excavation Complete		New Milestone	24-DEC-2014
Detailed Design Complete	Design Documents Approved and Issued	15-JUL-2013	31-MAY-2015
Dyke Construction Complete – Ready for Tank Installation		New Milestone	22-DEC-2015
All Tanks Placed in Basement		New Milestone	21-APR-2016
Capable of receiving refurbishment water Unit 2		New Milestone	30-JUN-2016
Start of Commissioning		17-JUN-2015	12-DEC-2016
Building Shell Complete		New Milestone	03- JAN-2017
Construction Substantially Complete		New Milestone	10-MAR-2017
All Commissioning Complete, Final In-Service Declaration Complete	Available for Service	15-OCT-2015	01-MAY-2017
Project Close-out Complete	Project Close Out	15-APR-2016	01-NOV-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.

Type 3 Business Case Summary

Project #: 16-31555 Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

Alternative 2: Build the remainder of the Heavy Water Storage and Drum Handling Facility with construction sequenced to meet Refurbishment requirements first, with the balance of the facility (to meet TRF Operational Improvement needs) built in a non-accelerated manner:

The alternative is to finish construction of a new 2,100,000L heavy water storage and drum handling facility adjacent to the existing TRF. This option meets Darlington Refurbishment and the heavy water management operational improvement requirements.

The execution strategy for this alternative will focus on accelerated construction of the facility for refurbishment needs only, with a non-accelerated construction strategy then employed to complete the balance of the facility.

A summary cost and schedule analysis was performed in support of this alternative and it was determined that this approach would result in a protracted construction period with project resources deployed for a longer duration and increased interest expenditures. The additional costs that would be incurred do not outweigh the cost reductions that would be realized from reducing shift schedules.

This alternative is estimated to result in a total project cost of $391M to satisfy both DRP and operational improvements needs and exhibits a positive NPV of $63M assessed against the operational improvement scope.

Alternative 3: An alternate storage tank solution is implemented for Unit 2 heavy water storage to ensure that Unit 2 Refurbishment schedule is not compromised. The Heavy Water Storage and Drum Handling Facility will be finalized in parallel with the execution of the Unit 2 refurbishment outage and placed in service prior to the Unit 3 refurbishment outage.

The alternative is to finish construction of a new 2,100,000L heavy water storage and drum handling facility adjacent to the existing TRF. This option meets Darlington Refurbishment and the heavy water management operational improvement requirements.

The execution strategy for this alternative will focus on non-accelerated construction of the remainder of the facility, with the recognition that the facility will not be ready in time to support the Unit 2 Refurbishment outage, but will be ready to support the remaining refurbishment outages. In order to ensure the Unit 2 refurbishment schedule is not compromised OPG would be required to design, purchase, and implement an alternate tank storage solution that will hold Unit 2 heavy water during the Unit 2 refurbishment outage.

A summary cost and schedule analysis was performed in support of this alternative and it was determined that this approach, similar to Alternative 2, would result in a protracted construction period with project resources deployed for a longer duration and increased interest expenditures. The additional costs that would be incurred do not outweigh the cost reductions that would be realized from reducing shift schedules. The cost to implement a temporary storage solution does not reduce the requirements or the costs of the main facility and as such is an incremental expenditure that increases the overall cost.

This alternative is estimated to result in a total project cost of $433M to satisfy both DRP and operational improvements needs and exhibits a positive NPV of $67M assessed against the operational improvement scope.

Alternative 4: Suspend construction of Heavy Water Storage and Drum Handling Facility. Implement alternate storage tank solution that satisfies Nuclear Refurbishment needs for all four units. Implement a separate solution for the TRF operability enhancements at a later date.

The alternative considers decoupling the business needs into two separate solutions rather than a combined single solution, and suspending the construction of the existing Heavy Water Storage and Drum Handling Facility.

In order to meet refurbishment needs, OPG would be required to design, purchase, and implement an alternate tank storage solution that will span the life of the refurbishment project. This option to satisfy NR needs was proposed for analysis and was formally precluded due to operational and safety risks.

To support TRF operational improvement needs, approximately 400,000L of additional heavy water storage capacity is required. To satisfy this 26m x 12m storage building and eight 50,000L storage tanks and a drum testing facility will need to be built, as detailed in developmental business case summary November 2006. At the time this developmental BCS was prepared, the cost of this alternative was estimated at $37M (2007$), with no design started or contracts in place. As such, the developmental BCS cost estimate prepared in 2007 is not considered an accurate representation of the actual costs to complete the facility. The total costs to complete a standalone facility to satisfy the operability need is approximated at 75% of the total cost to finish the existing planned facility. A separate facility comparable to the planned D2O storage facility would still have to be built to satisfy refurbishment needs.

Overall, this alternative is not viable as the alternate tank plan while identified as suitable for temporary storage introduces operational and safety risks to DNGS when considered as a long term solution and as such this option was eliminated. Proceeding with a standalone operational improvements facility will not satisfy refurbishment needs.

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Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

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

M$	LTD	2015	2016	2017	2018	2019	2020	Future	Total
Currently Released	93.0	17.2	-	-	-	-	-	-	110.2
Requested Now	30.1	96.3	125.2	19.2	-	-	-	-	270.9
Future Required	-	-	-	-	-	-	-	-	
Total Project Cost	**93.0**	**143.7**	**125.2**	**19.2**	**0**	**0**	**0**	**0**	**381.1**
Ongoing Costs	-		1.5	0.8	0.8	0.8	0.8	3.5	8.2
Grand Total	**93.0**	**143.7**	**126.7**	**20.0**	**0.8**	**0.8**	**0.8**	**3.5**	**389.3**

Estimate Class:	Class 2	**Estimate at Completion:**	$381.1M
NPV:	$73M	**OAR Approval Amount:**	$389.3M

Part E: Financial Evaluation

Choose an item.	(Preferred) Alternative 1	Alternative 2	Alternative 3	Alternative 4
Project Cost	381M	391M	433M	N/A
NPV	73M	63M	67M	N/A
Other (e.g., IRR)	-	-	-	-

Summary of Financial Model Key Assumptions or Key Findings:

1. Project Costs shown are all in costs. NPVs are calculated based on go-forward costs.
2. NPV values are for the Heavy Water Management Operational Improvements scope of work (i.e. 400,000L and Drum Handling Facility). The NPV benefit for refurbishment scope of work is not calculated in this BCS as it enables the NPV benefit of the overall Darlington Refurbishment Project.
3. Key assumptions used to calculate the NPV include:
   a. Operational improvements result in more efficient utilization of the Darlington TRF and improved heavy water management (e.g. decreased impact from TRF outages, potential for 3rd party heavy water sales, dose savings at OPG stations)

Because of improved utilization of the existing TRF, operational improvements reduce the probability of needing to refurbish this facility, or construct a new TRF. Between 3 and 4 staff (depending on which alternative) are required to support operation of the new Heavy Water Storage and Drum Handling Facility.

Part F: Qualitative Factors

Qualitative factors associated with this project are as follows:

Ability to use this facility for long term storage of Pickering Nuclear Heavy Water

- The 1,500,000L of reactor grade storage created under this project will be available for the long term storage of heavy water from OPG Pickering units post Darlington Refurbishment.
- This presents a potentially significant ancillary benefit to OPG as Pickering Nuclear approaches its end of commercial operations.

Citizenship & Regulatory

- Reduce tritium emissions through improved efficiency for the detritiation of heavy water.
- Reduce risk of infringing on tritium emission regulatory limits

Customer Relations

- Increasing OPG's capability and flexibility to process heavy water will improve customer relations by providing flexibility in meeting contractual obligations with Bruce Power for detritiation services and provide the ability to increase detritiation services to third parties.

Type 3 Business Case Summary

Project #: 16-31555 Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

Part F: Qualitative Factors

Health and Safety

- Reduced tritium levels due to increased TRF efficiency will reduce worker dose
- Additional drum storage will improve housekeeping and reduce drum handling requirements, thereby reducing the related health and safety concerns
- Reduce operator work around and extra operation actions that are required to maneuver various grades of heavy water into unconventional storage arrangements

Part G: Risk Assessment

Risk	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Quality Issues Resulting from Expedited Construction	The risk is that the use of an expedited construction strategy leads to quality issues/potential rework/turnover inefficiencies due to complexity and production pressure.	The vendors have confirmed the do-ability of the work within the proposal. OPG will implement heightened routine and strategic oversight activities to ensure cost, schedule, and quality objectives are being met.	High	Medium
Station Tie-in Impacts	The risk is that the constraints imposed by station requirements for tie-in of the D20 facility impacts the planned cost and schedule.	The design has been structured such that all station tie-ins have been included in separate engineering change packages, to ensure the impact is minimized.	Low	Low
Pipe Chase Construction Cost Estimate	The risk is that the actual construction costs to complete the pipe chase work exceed the current estimate, due to the construction estimate being prepared without the full design completed.	Risk will be monitored. The vendor was provided the available detail in the RFP, and contingency for estimating uncertainty has been applied. This risk is for fundamental intent change which is not anticipated.	Medium	Medium
Contractor cannot meet Schedule	The risk is that during execution it is determined that the contractor will be unable to meet the committed schedule for "tanks ready for U2 D2O", requiring an alternate strategy to ensure the U2 refurbishment schedule is not impacted.	Detailed contingency plans have been developed and are ready to initiate in the event field progress monitoring indicates that the schedule is slipping and the facility will not be ready. Monitor the field progress and initiate contingency plan if the risk triggers.	Medium	Medium
Transition to New Contractor	The risk is that the new contractor selected to execute the balance of D2O storage building encounters contractual or sub contractual issues working with the existing (or new) teams supporting the project, detrimentally impacting their ability to meet cost and schedule commitments.	The RFP clearly outlines roles and responsibilities and a joint OPG/vendor cutover plan is being developed as part of the base work. Contract Terms and Conditions further mitigate OPG's exposure. This risk will be monitored but is currently perceived low.	Medium	Low
Cost and Schedule Forecast Accuracy for Non M&E Contracts	The risk is that the forecasted costs to complete the civil and design scope are understated. This includes understanding and validation of subcontracting costs.	Risk is accepted and will be monitored because the Project management team has engaged with Ellis Don (for example) directly leading up to BCS preparation. Line by line schedule reviews have been performed to validate cost and schedule estimates leading up to business case preparation. Subcontracts are now in place. OPG increased oversight and monitoring of cost and schedule will be performed.	Low	Medium

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Project #: 16-31555 Document #: D-BCS-09701-10007
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Part G: Risk Assessment

Risk	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Vendor Execution Under New Contractual Arrangement	The risk is that the vendor that is selected may not have executed a project under the existing commercial terms, which may introduce inefficiency or delays as a result of claims management or contract clarification issues.	This risk is accepted. The vendors doing work for the project have experience delivering projects to OPG. The contractual terms are not expected to present any significant risk.	Low	Low
"Tanks Ready for U2 water" Regulatory Risk	The risk is that regulatory approvals for contingency plans for D2O storage, if required, are not obtained in time to support U2 schedule.	The risk is accepted, as all the regulatory approval required to house D2O in the storage facility are on track. Risk is perceived to be low.	Low	High
OPG Acting as Integrator for the E and PC work	The risk is that, due to the new contracting/execution strategy, OPG incurs cost and schedule impacts stemming from integration/interface issues between the multiple design/procurement/ construction vendors.	This risk will be monitored. The current resource and execution strategy incorporates this contract strategy.	Medium	Medium
Field Changes Required	The risk is that the Revision 0 mechanical and electrical designs, as completed, are not fully constructible and require field changes or design revisions, resulting in additional cost and schedule impacts.	The collaborative front end planning process that involves OPG design oversight has been implemented throughout. The engineering change control process has been employed for all designs. This risk will be monitored as the project progresses.	Medium	Medium

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Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Final Target In-Service or Completion Date	Target PIR Completion Date
Comprehensive PIR	01-MAY-2017	01-MAY-2018

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Heavy water storage volume to meet needs of Refurbishment Project	No refurbishment storage	1,700,000L heavy water storage ready for Refurb project draining of Unit 2	Storage volume available in time for Refurb draining of Unit 2	VP Execution, Nuclear Refurbishment
Heavy water storage volume for TRF Operations	Insufficient storage to support optimal TRF operations	400,000L provided for improved TRF operation	Storage volume for operational improvements	SVP DNGS
Amount of Drum Handling, Cleaning and Testing Facility at DNGS	No capability to clean and test drums in-house	Ability to clean and test 100/drums per year	Amount of drum cleaning and testing.	SVP DNGS

Part I: Definitions and Acronyms

AACE – The Association for the Advancement of Cost Estimating
BCS – Business Case Summary
CDR – Conceptual Design Report
CFEP – Collaborative Front End Planning
CNSC – Canadian Nuclear Safety Commission
D_2O – Deuterium oxide, aka heavy water
DNGS – Darlington Nuclear Generating Station
ECC – Engineering Change Control
EPC – Engineer, Procure, Construct
ES-MSA – Engineering Services Master Services Agreement
HVAC – Heating, Ventilation, Air Conditioning
HWMB – Heavy Water Management Building
L - litres
LLM – Long Lead Materials
LPSW – Low Pressure Service Water
MOE – Ministry of Environment
OPG – Ontario Power Generation
OSS – Owner Support Services
PDRI – Project Definition Rating Index
PIR – Post Implementation Review
Pipe Chase – An underground pipe tunnel containing the transfer piping connecting the new and existing facility
PNGS – Pickering Nuclear Generating Station
PO – Purchase Order
QA – Quality Assurance
RFP – Request for Proposals
SVP – Senior Vice President
TRF – Tritium Removal Facility
TSSA – Technical Standards and Safety Authority
T&C – Terms and Conditions

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For Internal Project Cost Control

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Appendix A: Summary of Estimate							
Project Number:	16-31555						
Project Title:	Heavy Water Storage and Drum Handling Facility						
M$	**LTD**	**2015**	**2016**	**2017**	**Future**	**Total**	**%**
OPG Project Management	2.7	1.5	1.6	0.9	-	6.7	2
OPG Engineering (including Design)	4.4	1.9	0.5	0.6	-	7.4	2
OPG Procured Materials	0.2	0.3	0.9	-	-	1.4	0
OPG (Other)	9.5	3.6	2.8	2.8	-	18.7	5
Design Contract(s)	[redacted]						
Construction Contract(s)							
EPC Contract(s)							
Consultants							
Other Contracts/Costs							
Interest							
Subtotal							
Contingency							
Total	**123.1**	**113.5**	**125.2**	**19.2**	**-**	**381.1**	**100**

Notes			
Project Start Date	2006-11-11	**Total Definition cost** (excludes unspent contingency for Nuclear)	[redacted]
Target In-Service (or AFS) Date	2017-05-01	**Contingency included in this BCS** (Nuclear only)	
Target Completion Date	2017-10-01	**Total contingency released plus contingency in this BCS** (Nuclear only)	
Escalation Rate	2.00%	**Total released plus this BCS without contingency** (Nuclear only)	
Interest Rate	5.25%	**Total released plus this BCS with contingency** (Nuclear only)	$381.1M
Removal Costs	$650k included in (e.g., EPC Contracts)	**Estimate at Completion** (includes only spent contingency for Nuclear)	$381.1M

Prepared by:	**Approved by:**
Julian Read Section Manager, Darlington Projects Project Manager Date: Mar 2, 2015	Art Rob Vice President Projects and Modifications Date: MARCH 3/15

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Type 3 Business Case Summary

Project #: 16-31555
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Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

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
			2011	2012	2013	2014	2015	2016		
Definition	Partial	2006-10-22	35.8	0.6						36.4
Definition	Full	2012-06-14	3.0	10.8	38.4	41.3	14.6	31		108.1
Execution	Partial	2012-07-18	3.0	10.7	38.8	40.9	14.7			108.1
Execution	Full	2013-05-14	3.0	9.6	28.0	52.1	17.2			110.0
Execution	Superseding	2015-02-15	3.0	9.6	33.4	77.1	113.6	125.2	20.1	381.1

Project Variance Analysis

M$	LTD (Dec 2014)	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	2.7	1.4	6.7	5.3	See Comment (1) below
OPG Engineering (including Design)	4.4	4.6	7.4	2.8	See Comment (2) below
OPG Procured Materials	0.2	-	1.4	1.4	See Comment (3) below
OPG Other	9.5	2.8	18.6	15.8	See Comment (4) below
Design Contract(s)	[redacted]				
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total	123.1	110.0	381.1	270.9	

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Explanation of Variances above:

1. OPG Project Management – OPG Project Management costs have increased in alignment with the longer schedule to deliver the project as well as the increased amount of oversight required to actively manage the EPC vendor and support numerous initiatives which were not included at the onset of this project (i.e. Soil management, dewatering, etc.).

2. OPG Engineering (including Design) – OPG Engineering support has increased due to the schedule extension for design (extension from July 2013 completion to September 2015 target completion). As well, [redacted] of contingency was allocated to the Darlington Computer Group within OPG to complete the computer software design work for this project upon finalisation of delineation between EPC scope and OPG scope for computer software.

3. OPG Procured Materials – In the EPC contract, it is the responsibility of the vendors to procure materials for the project. On occasion, materials from OPG stores are used when lead times do not match project schedule, or field issues arise, and material is required to keep the field progressing. As well, OPG is now providing all welding consumables, and allowance has been carried for those provisions. The last BCS did not carry any budget for materials from OPG stores.

4. OPG Other – This significant increase is related to the additional OPG support required to actively support the vendors, such as security personnel to escort trucks to increase productivity at work face, additional OPG staff to support new procedure reviews, updates, etc., includes additional funds for OPG commissioning staff underestimated in the previous BCS, and additional oversight on the field progression.

5. Design Contract(s) – As a result of the EPC vendor contract termination, OPG now is carrying design contract costs directly for completion of the "Revision 0" design, which is a completed design excluding material supplier information. The new general contractor will assume the design and incorporate design changes and material supplier information into the design, which is carried as the new EPC contract.

6. Construction Contract(s) – In order to manage the transition following termination of the former EPC vendor, two Construction Only contracts were awarded. One construction contract for construction support services awarded to support OPG meet its obligations as General Contractor during civil substructure construction and one contract to complete the mechanical and electrical installations as part of the civil substructure. Lastly, following former vendor termination, a civil contractor was retained to complete the substructure work to maintain the schedule as a new General Contractor (EPC vendor) was procured.

7. EPC Contract(s) – The original contracted target price for the contract was $65.7M, subsequently updated with OPG requested scope changes in the last BCS for a total EPC contract of $77.8M. The EPC contract has increased significantly from the original $65.7M target price (see Change Summary below).

The new price includes the former General Contractor accrued costs and the new EPC contract to be awarded as General Contractor to complete the remaining work scope following substructure completion. This item includes material procurement costs related to the tanks/pumps taken over from the former EPC contractor.

During implementation of the Execution Full Release, [redacted] of the [redacted] contingency was released to increase completion of the former EPC contract. [redacted] contingency was allocated to the original EPC contractor to do the following:

- Low pressure service line Relocate and Tie-in
- Asbestos discovery and removal
- Trailer Rentals for Contractor Support On-site
- Contaminated Soil Storage including construction and operation of soil laydown areas
- Completion of additional shoring requirements utilizing night and weekend shifts

For further detail refer to Change Summary on page A-4.

8. Consultants – This project did not include costs for any consulting contracts in the last BCS. Due to the cost increases experienced on the project, a third party estimating company was brought on board to validate the EPC estimates developed by the previous vendor.

9. Other Contracts/Costs – Other contracts include re-categorization of legacy contract costs for technical evaluation, on-going temporary trailer rental for rental trailer related to project support, and previous value engineering costs. This section also covers the independent contracts with the design agency, civil construction firm and mechanical and miscellaneous support contracts after the termination of the EPC vendor.

10. Interest – Increased due to the increase in capital expenditures and schedule.

Change Summary

The original preliminary estimate, prior to detailed design of $65.7M for the EPC Contract was proposed by the EPC vendor based on a conceptual report and preliminary design requirements that were provided with the request for proposal. As the engineering design evolved and progressed towards completion, it has been identified that the original concept for the project would not meet the requirements of the design, and original assumptions were invalidated. The final design is considerably more complex and expensive to construct because of the following main categories:

A. The relocation of the building 7 metres to the west

B. Increased materials quantities of piping and valves and equipment

C. Requirement to have process piping run in a pipe chase/tunnel buried 7 metres below grade

D. Design scope growth required to meet the design requirements

E. OPG Requested Scope Changes

F. Environmental Requirements

G. Under estimate of effort

A. The relocation of the building 7 metres to the west

The original design concept had the new D2O Storage Building located immediately adjacent to the existing TRF. The new building would have a 'shared wall' in contact with the existing west wall of the TRF.

As design progressed, it was determined that it was not feasible to arrange the new foundations for the D2O Storage Building in a way that would not interfere with the foundations of the existing TRF. It was necessary to move the building 7 metres to the west to avoid the foundation interference.

The building relocate meant that the building now required 4 architecturally completed sides – rather than the original 3-sided finishes. More significantly, the secant pile (caisson) shoring system became significantly more complex, including the addition of a modified tieback system and cross braces, as well as installation of struts.

B. Increased materials quantities of piping and valves and equipment

The cost of permanent plant material is significantly higher than the original estimate for the project. The increase driven primarily by:

- Increase in the quantity of process & services piping that was identified as design was completed and full requirements were determined and designed for
- The HVAC / Chiller system is larger than originally estimated by the former EPC vendor due to additional loads of Instrument air/service air, vapour recovery system (which includes items such as heat exchanger, condensers, evaporative coolers, etc)
- Former vendor under estimate of equipment has significantly contributed to increase costs

C. Requirement to have process piping run in a pipe tunnel

The interconnecting process piping was originally conceived to be routed from the existing TRF into the new D2O Storage Building via an overhead, above ground, pipe corridor. The water hammer analysis that was done on this piping configuration indicated that a severe water hammer would occur during the start-up of the transfer pumps, eliminating this option.

A number of solutions were considered. Ultimately, engineering concluded that the most cost effective option was to route the interconnecting piping into the new building via a buried pipe chase at a low enough level to eliminate the water hammer issue. This increased the cost due to:

- Engineering rework to modify the transfer piping (and related civil design packages)
- Increased construction costs to:
  - Construct a concrete pipe chase 7 metres below grade
  - Relocate buried piping along the pipe chase route
  - Penetrate the existing TRF basement – a 1.3 metre thick concrete wall.

D. Design scope growth required to meet design requirements

Design Scope Growth represents a cost element that reflects the increased construction cost (direct labour) of the project from the original concept. While design scope growth also increases the cost of materials, the materials cost has been discussed previously. The design engineering was a fixed price scope.

Under the contract, the vendor prepared the detailed system level Design Requirements, per the OPG Engineering Change Control process. The RFP and original performance fee price was based on the preliminary design requirements and a conceptual design report. As design was progressed, many assumptions were invalidated, increasing the construction effort to build as designed.

E. Scope Changes

- The Darlington Refurbishment Environmental Assessment committed no net increase of tritium emissions on site as a result of refurbishment activities. This meant that a D2O Vapour Recovery system incorporating a Dryer would need to be added to the scope to accommodate short and long term heavy water to be stored at the Darlington site.
- The original project requirement identified existing plant instrument air/service system for the new D2O Storage project was high risk of not having sufficient capacity. The vendor bid in this area was based on the conceptual design requirements which planned for connection to the existing station. During design, it was discovered that the existing plant could not expand the air load list for the new building. It has now been determined the vendor estimate did not have any allowance for tie-in to this high risk capacity system, and in cost reimbursable contract the overall costs have increased. Furthermore, the additional equipment required that the building be enlarged to provide the equipment room on the second floor.
- Temporary construction trailers were required to be provided to support the field oversight of the work at the Darlington site.
- A maintenance procedure to pump out the box drain was completed to mitigate tritium in the ground water risk.

F. Environmental Requirements

Soil and water testing during the construction phase of the project revealed the presence of tritium above the free release limits of the Darlington license. The consequences of this were that special soil storage areas (C13 and F1) needed to be constructed to manage the soil and ground water to support required excavation activities for the project. The F1 stockpile site has the operational requirements to manage the water runoff and turn the soil on an on□going basis. The environmental requirements increased the cost of the dewatering system by impacting the supplied equipment and discharge point.

G. Under Estimate of Effort

This cost element represents the areas of the project where the effort required to execute the project was under estimated based on the original scope of work. The staffing levels required managing the work and integrating the project plans into, especially as the first large ES-MSA, EPC, and Refurbishment project were much greater than the original budgets for these positions. Additionally, the effort to generate the Construction work packages and inspection test plans were also higher. The staffing plan and organization charts were updated to provide adequate staff to manage the work.

As well, effort to relocate the LPSW line was entirely missing [redacted] this work ended up be completed for significantly higher costs (~$10M) due to increased complexity of shoring and significant overtime expended to mitigate schedule delay to TRF outage T1301.

Type 3 Business Case Summary

Project #: 16-31555 Document #: D-BCS-09701-10007
Project Title: Heavy Water Storage and Drum Handling Facility, <Superseding> <Execution> Release

Appendix C: Financial Evaluation Assumptions

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

General:

The NPV calculations include the Heavy Water Management Operational Improvements portion of the integrated Heavy Water Management Facility. The going forward costs and benefits are included in the calculation.

Project Cost:

For each alternative, a portion of the Integrated Heavy Water Management Facility capital cost, 28%, was allocated to the Heavy Water Management Operational Improvements scope for financial evaluation.

Financial:

1. 2% escalation
2. 7% discount rate

Project Life:

For the Heavy Water Operational Improvements scope of the facility (tanks and drum cleaning facility), the in service date assumed was May 2017 (for the preferred alternative) and May 2019 (for alternatives 2 and 3). The Heavy Water Operational improvements portion of the integrated facility is assumed to operate until station end of life (2055) for all alternatives considered.

Operating Cost:

For the integrated Heavy Water Management Facility, the following incremental staff requirements were assumed: Operator – 1.5 FTE, Control Maintainer – 1 FTE, Mechanical Maintainer – 1 FTE, Engineer – 1 FTE, Civil Maintainer – 0.5 FTE. For the Heavy Water Management Operational Improvements portion of the facility, one incremental operator was included in the financial evaluation for all three alternatives considered.

Other:

Benefits for Operational Improvements Management

1. Minimizes risk of capital cost of refurbishing TRF or building a new TRF facility in 2035. Assume cost of $532M (2012$) and 30% probability
2. Reduces impact of unplanned TRF outages on OPG ability to manage heavy water inventories. Assume 50% probability of saving $7.2M/yr (2012$) during operation of the facility.
3. Improves ability to achieve incremental third party heavy water sales. Assume 50% probability of $3.1M/yr (2012$) of facility operation until 2043.
4. OPG achieves dose savings during outages. Assume $450k/year (2012$) during facility operation.
5. Reduces risk of need to detritiate primary heat transport heavy water after storage in moderator S&I tanks during a Vacuum Building Outage/Station Containment Outage. Assume one occurrence eliminated saving $3.6M (2012$) and modeled as $600k (2012$) every 6 years during facility operation.
6. Elimination of Kinectrics Drum Handling Contract. Assume saving of $30k/yr (2012$) during facility operation.
7. Avoids risk of downgrading reactor grade heavy water during acute recovery events or SUP outage. Assume savings of $0.9M (2012$) over 40 years, or $22k/yr during facility operation.

Note: For alternatives 2 and 3, these benefits were started in May 2019 when the heavy water Operational Improvements portion of the integrated facility is assumed to be placed in service.

Appendix D: References

N/A

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ONTARIO POWER GENERATION

Records File Information: See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Final Security Classification of the BCS: **OPG Confidential**

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

Executive Summary and Recommendations					
Project #:	10-73810	**Title:**	Retube and Feeder Replacement Island Support Annex		
Phase:	Execution		**Release:**	Full	
Facility:	Darlington		**Records File:**	00120.3	
Class:	Capital		**Investment Type:**	Sustaining	

Project Overview

We recommend the release of $25,717 k ($18,225 k base costs plus $7,492 k contingency).

This will bring the total release to $40,738k ($33,246k base costs plus $7,492k contingency).

These funds will be used for the balance of execution work including installation of building structure and Station tie-ins, project management oversight and project close-out activities for the Retube & Feeder Replacement Island Support Annex.

1. **Project Objective**

The objective of this project is to construct the most cost effective Retube and Feeder Replacement Island Support Annex Facility that will meet the needs of the Darlington Refurbishment Project as outlined in the project charter. This facility will be used by Darlington Refurbishment to support field preparation and execution needs for the duration of the project. The facility will be located within the Protected Area at the Darlington Nuclear Generating Station and will accommodate predominantly contractor personnel in the prerequisite, outage and closeout phases.

2. **Project Need**

Based on the Retube and Feeder Replacement project scope, it was identified that Darlington does not have existing office and maintenance shop facilities inside the Protected Area to accommodate the additional contractor, project management and shop needs of the Refurbishment outage work. The Retube and Feeder Replacement project needs will be met by providing the following:

Office Space: Provide zone 1 workstations and amenities for 200 contractor and Ontario Power Generation contractor oversight staff. The office portion of the facility will also include a Refurbishment Project Control Centre for project oversight and status review meetings. The office facility will allow for the timely access to field and work crews to help with the expeditious resolution of field issues during the outage pre-requisite, execution and unit start-up phases. As well, the facility will allow for the coordination of field resources, oversight and planning of work and schedule management.

Shop Space: Provide 1160m^2 (12,500 ft^2) of unzoned shop space, including a 15 ton crane, in the Protected Area for the refurbishment contractor to perform retube and feeder replacement fabrication and preparatory work activities. Project scope excludes procurement and installation of shop equipment. The shop will also have an adjoining 90 person capacity pre-job briefing room and a contractor staging/preparation area for Retube and Feeder Replacement workers. No radioactive work will be performed in the shop.

Following Refurbishment, this facility will be used to support Darlington online and outage Maintenance work.

3. **Project Release History**

Developmental Business Case Summary - ($0.705M total, $0.501M spent): This funding was released in 2011. The result was the definition and selection of the preferred alternative for the facility. The funding also supported the preparation of Modification Design Requirements, Master Engineering Change Packages and a third party Class IV estimate.

Definition Phase Release – ($5,230K total; $4,345K base + $885K contingency): This funding was released in November 2012 to complete Preliminary and Detailed Design, Specification of Long Lead Materials, Installation Planning, project management oversight.

Execution Phase Partial Release – ($9,290K total; $7,323K base + $1,967K contingency): This funding was released in November 2013 to complete Construction, Commissioning and Turnover of Building 29 demolition and cut/cap/relocation of existing services, relocation of Transformer T11, relocation of yard drainage system; Construction of building foundations including daylighting and excavation; Procurement of materials to be installed

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Type 3 Business Case Summary

during this release as well as Procurement of Long Lead Materials.

Execution and Close-out Phase Full Release BCS Estimate – This BCS ($25,717K total; $18,225K base + $7,492K contingency): Scope of Work: Balance of Execution Work – Installation of building structure and Station tie-ins, project management oversight and Project Close-Out activities. All remaining procurement activities for the Retube and Feeder Replacement Island Support Annex are included in this release. Major risks addressed by the contingency include the potential for tritiated soil and unknown buried services within the construction area as well as cost increases to the Engineer/Procure/Construct contract resulting from construction within the Protected Area.

The scope of this project is identified in the Darlington Refurbishment Project Campus Plan which is included in the business plan.

4. Project Timeline and Constraints

The facility must be designed, built and ready for occupancy by March 2016 in order to support Refurbishment preparation and execution work.

Project Cash Flows

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	5,146	9,875							15,021
Requested Now	-	16,101	9,457	159					25,717
Future Required	-								
Total Project Cost	5,146	25,976	9,457	159					40,738
Ongoing Costs	-		305	747	766	782	803	4,389	7,792
Grand Total	5,146	25,976	9,762	906	766	782	803	4,389	48,530

Estimate Class:	Class 2	**Estimate at Completion:**	33,246k
NPV:	$-39,627 k	**OAR Approval Amount:**	$48,530k

Additional Information on Project Cash Flows (optional):

Ongoing Costs include maintenance and operation costs estimated to occur over the next 10 years. Maintenance costs are based on the 2-year maintenance contract estimate that was provided by the contractor ($639k). Ongoing costs will be charged to the Refurbishment general program support account. An estimate of $125k for annual property taxes has been included in the Ongoing Costs.

The Class 2 estimate for Project cash flows is based on the previous releases for the project and the vendor's revised estimate based on the detailed design that is complete to date.

Removal costs of **$313K** have been included in this project budget for the demolition of the Reactor Maintenance building and relocation of building services.

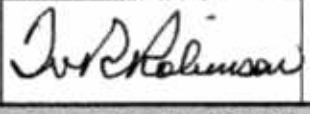
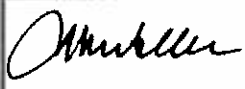
Project Contingency is estimated at $7,492K total ($2,500K general contingency; $4,500K specific contingency; $492K specific contingency for performance fee 3% profit) with the following annual cash flows ($K):
2014: $5,020 2015: $2,472

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Approvals			
	Signature	**Comments**	**Date**
This BCS represents the best option to meet the validated business need in a cost effective manner.			
Recommended by: Bill Robinson Project Sponsor			19 FEB 14
I concur with the business decision as documented in this BCS.			
Finance Approval: Robin Heard Acting CFO, Finance			20 FEB 14
I confirm this project will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell CEO, per OAR 1.1			24 FEB/14

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ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Final Security Classification of the BCS: **OPG Confidential**

Business Case Summary

Part A: Business Need

Business Need:

The Darlington Refurbishment Project initiated two infrastructure studies [R-2], [R-3] to evaluate Refurbishment Project needs. These studies evaluated scope, cost, resource implications (including support services) and risks to maximize work efficiencies and minimize impact on operating units. The studies also evaluated the scope of work required to build the infrastructure needed on site to support the refurbishment work.

Both studies identified a need for a separate shop and office facility due to the lack of available space within the Protected Area to accommodate the additional contractor, project management and shop needs of the Refurbishment outage work. The service requirements summarized in these reports were further refined based on Refurbishment Project resource estimates (i.e. building location, number of workstations, shop size and office amenities/services) and documented in the project charter. In support of the recommended alternative, comparisons of various facility configurations, including modular versus conventional construction, were performed. These comparisons were used to develop the most cost effective alternative that best meets the needs of the Darlington Refurbishment Project.

Following the completion of the Refurbishment Project, this facility will continue to be used by Station Maintenance staff and their contractors to support both online and outage-related maintenance activities such as contractor in-processing, shops, mock-ups and outage preparation.

Part B: Preferred Alternative

Description of Preferred Alternative: Retube and Feeder Replacement Island Support Annex - 2-storey Conventional Building

The Retube and Feeder Replacement Island Support Annex is a two-storey conventional facility that will be constructed inside the Darlington Protected Area just west of the Units 1 and 2 Standby Generator Oil Storage Tanks. The project includes the engineering, procurement, construction, commissioning and close-out of the following:

- Demolition of existing Building 29 and cut/cap/relocation of Building 29 services
- Relocation of Transformer T11
- Construction of the storey facility including site preparation works
- Building service and Station System tie-ins

The building will provide the following office space and shop space:

Office Space:

A minimum of 200 workstations will be provided for support and line supervision (superintendents, general foremen, foremen, field technicians (quality control), and engineering troubleshooting/field design support) required for Retube and Feeder Replacement and Balance of Plant scope including prerequisite outage work, islanding work, and return of unit back to normal operation. Of the 200 workstations, 22 cubicles are required for Ontario Power Generation Contractor oversight. The balance of the workstations will be of bullpen arrangement occupied by Contractor staff.

The office facility is required to support the following Refurbishment activities:

- Troubleshooting support.
- Coordination of field resources including pre-job briefing rooms and contractor staging area.
- Oversight of work, including provision of supervisor for safe work planning and other execution issues.
- Planning of daily work.
- Field Data Analysis.

- Schedule update and management.
- Contractor documentation control.
- Timely access to the field and work crews to help with expeditious resolution of field issues during the outage pre-requisite, execution and unit start-up phases.
- Timely access to the plant during execution preparation stages for detailed outage assessing and planning.
- Office space for contractor's and OPG supervisors who require interaction with actual workers or their support staff on a daily basis.

The office facility will be classified as radiological zone 1 to increase worker efficiency by eliminating the requirement for facility staff to leave the facility for breaks and lunch. The facility will be accessed via an approved walkway designated for transportation of lunches.

Shop Space:

A 1160m^2 (12,500 ft^2) open layout shop will be provided for the contractor to divide as they see fit. The shop height will be a minimum of 20ft to accommodate a 15 ton bridge crane. No radioactive work will be performed in this shop. No active ventilation or active liquid waste handling will be provided in this facility.

The shop facility is required to support the following for Refurbishment:

- Machining of non-contaminated materials and equipment bench-testing.
- Preparatory space for electrical and mechanical trades (pipe fabrication) pre-field installation work including short term storage and component preparation.
- Workspace for receipt of materials, short term storage, pre-use inspection and testing, and other work required by Darlington to comply with its nuclear programs and quality plans.
- Shop facilities to accommodate work, as required, resulting from System Condition Assessments and Components Conditions Assessments.

In addition to the shop portion of the building there is a 90 person pre-job brief room and washrooms over an area of approximately 272m^2 (2900ft^2). The entire shop area and pre-job brief room will be designated as an un-zoned area.

Project Funding Summary

Developmental Business Case Summary - $0.705M total; $0.501M spent: This funding was released in 2011.

The Refurbishment Project commissioned a Conceptual Design Report to evaluate the most cost effective method of constructing the Retube and Feeder Replacement Island Support Annex while meeting all charter requirements [R-4]. The Conceptual Design Report evaluated various building configurations, such as optimizing the distribution of 500 offices between the Refurbishment Project Office and the Retube and Feeder Replacement Island Support Annex, as well as reviewing modular verses conventional construction techniques.

The Conceptual Design Report determined that the most cost effective building configuration was the 300 office Refurbishment Project Office paired with a 200 office Retube and Feeder Replacement Island Support Annex for the following reasons:

- The 200 office Refurbishment Project Office did not result in a smaller building footprint.
- The 200 office Refurbishment Project Office still required a third storey.
- The Retube and Feeder Replacement Island Support Annex required a third storey to accommodate the additional 100 offices.
- It is more cost-effective to construct office space outside, rather than inside, the Protected Area, due to additional requirements and productivity losses that occur when constructing inside the Protected Area.

The recommended alternative was a conventionally-constructed, 2-storey, 200 office/ shop facility, which was estimated in the Conceptual Design Report to be the most cost-effective solution while meeting all charter requirements.

The result was the definition and selection of the preferred alternative for the facility. The funding also supported the preparation of Modification Design Requirements, Master Engineering Change Packages and a third party Class IV estimate

Release 1 – November 2012 - Definition Full Release – $5,230K was released to complete Preliminary and

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Detailed Design, Specification of Long Lead Materials and Installation Planning. (Class 3 Estimate)

The project is approximately 2 months behind schedule for completion of detailed design and installation planning work. To date the following work has been completed:

- All Engineering Change packages supporting Release 2 scope
- Mechanical and Electrical systems internal to the building
- The building's structure (Ontario Power Generation Design Acceptance is pending Contractor submittal of a third party fire assessment).
- All Engineering Change packages supporting tie-ins to Station Systems.

The remainder of the design work will be completed by April 1, 2014. The remaining design work is not anticipated to affect the Construction schedule. Subsequently, Installation Planning milestones are also approximately two months behind. Installation planning work is being performed in a manner that supports the schedule.

Release 2 – November 2013 - Execution Partial Release - $9,290K was released to complete Construction, Commissioning and Turnover of Building 29 demolition and cut/cap/relocation of existing services, relocation of Transformer T11, relocation of yard drainage system; Construction of building foundations including daylighting and excavation; Procurement of materials to be installed during this release as well as Procurement of Long Lead Materials. (Class 3 Estimate)

Release 2 procurement and Long Lead procurement is underway. Fieldwork is underway however construction is approximately 2 months behind schedule.

The project is forecasting to complete the released scope within the released funding. As a result of use of schedule float, in-service date for the facility has been pushed by approximately 4 weeks. The facility will be ready by the Nuclear Refurbishment need date of March 31, 2016.

Release 3 – March 2014 – Execution Full Release (This BCS) – The project is requesting $25,717K to complete the balance of Execution Work – Installation of building structure and Station tie-ins, project management oversight and Project Close-Out activities. All remaining procurement activities for the Retube and Feeder Replacement Island Support Annex are included in this release.

This execution phase full release will be used to complete the balance of execution work including installation of building structure and Station tie-ins, project management oversight and project close-out activities for the Retube & Feeder Replacement Island Support Annex; All remaining procurement activities for the Retube and Feeder Replacement Island Support Annex are also included in this release.

The scope of this project is identified in the Darlington Refurbishment Project Campus Plan which is included in the business plan.

The project estimated cost at completion has increased by approximately $7.2M from the previous Business Case Summary.

Deliverables:	**Associated Milestones (if any):**	**Target Date:**
Start of Installation - Structure	Start of Installation	Jun. 12, 2014
Start of Installation – Tie-Ins	Start of Installation	Feb. 12, 2015
Start of Commissioning – Tie-Ins	Start of Commissioning	Mar. 23, 2015
Start of Commissioning – Structure	Start of Commissioning	Jun. 27, 2015
Available for Service	Available for Service	Oct. 7, 2015
Project Close-Out Complete	Close-Out Complete	Oct. 7, 2016

ONTARIO POWER GENERATION

Records File Information
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Part C: Other Alternatives

Base Case: Status Quo – No Project

If Ontario Power Generation does not build a new shop and office facility inside the Protected Area, there could be impacts to the cost and efficiency (work delay) of the Refurbishment Project as follows:

If additional zone 1 workstations are not constructed:

- Worker efficiency will be reduced, due to increased travel times to and from work locations, which will impact Refurbishment Project cost and schedule.
- Lack of on-site facilities for preparation purposes may reduce the quality of work packages, resulting in increased errors and rework, and impacts to schedule and costs.
- Risks of worker error and safety incidents may increase due to lack of onsite oversight.
- Increased reaction time for field issues may result due to the need to move people and materials through the Protected Area boundary. This may have significant impact to cost and schedule if this occurs during critical path work.

If additional shop space is not constructed:

- The ability to pre-stage material and work packages, in order to mitigate the delays resulting from materials and people moving thought the Protected Area boundary, will be lost.
- The amount of material handling and its associated costs may increase.

Alternative 2: Delay Work

Delaying the construction of this facility is not a feasible option. If the project is not executed at this time, the building will not be completed in time to support the Refurbishment of the first unit. This will result in delays getting support from project personnel when problems arise during execution and will not allow for the pre-staging of materials. This investment is required to support the efficient and effective execution of the Darlington Nuclear Generating Station Refurbishment Project.

Alternative 3: Conventional Building with 300 Offices to Meet Office Space Needs

During the completion of the Conceptual Design Report, the project sponsor approved the re-distribution of offices between the Retube and Feeder Replacement Island Support Annex and the Refurbishment Project Office, provided the total number of offices within both facilities was 500. The minimum number of offices required in the Retube and Feeder Replacement Island Support Annex was 200.

Due to building footprint restrictions at the Retube and Feeder Replacement Island Support Annex location as well as efforts to minimize footprint and maximize parking in the Refurbishment Project Office building location, the Conceptual Design Report evaluated 2 building configurations:

- 3-storey, 300 office Retube and Feeder Replacement Island Support Annex (with a 3 storey, 200 office Refurbishment Project Office)
- 2-storey, 200 office Retube and Feeder Replacement Island Support Annex, (with a 3 storey, 300 office Refurbishment Project Office)

The Conceptual Design Report evaluated the option of using modular or conventional construction for the 3-storey, 300 office facility. The report determined that it was more cost effective to use conventional construction techniques based on the rationale described in Alternative 4, below.

The Conceptual Design Report determined that moving 100 offices to the Refurbishment Project Office reduces costs for the Retube and Feeder Replacement Island Support Annex by enabling the facility to meet office requirements with only 2 storeys instead of 3 storeys. The increase in offices to the Refurbishment Project Office has minimal effect on the cost, as the facility is able to accommodate the additional offices without increasing building size. Therefore, the option of constructing a 3 storey, 300 office Retube and Feeder Replacement Island Support Annex is not the preferred alternative.

Alternative 4: Modular Building with 200 Offices to Meet Office Space Needs

The Conceptual Design Report evaluated the option of using modular construction or conventional construction for the office portion of the facility. The shop portion of the facility is constrained to using conventional construction due

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ONTARIO POWER GENERATION

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See Guidance Section

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Type 3 Business Case Summary

to shop craning and ceiling height requirements.

The Conceptual Design Report concluded that although both conventional and modular offices would meet charter requirements, the Engineer/Procure/Construct installation cost was less expensive for the conventional office facility for the following reasons:

(a) When modular offices are constructed using non-combustible materials, and in accordance with CSA N293-07, the cost of the modular unit increased significantly since this departs from standard modular office construction.

(b) There was an increased cost due to the structural complexities of combining the modular office portion with the conventionally-constructed shop area.

(c) Codes and standards do not make any distinction between a modular facility or a conventional facility.

The option of constructing a modular, 2-storey, 200 office Retube and Feeder Replacement Island Support Annex is not the preferred alternative due to higher initial construction costs.

Part D: Project Cash Flows

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	5,146	9,875							15,021
Requested Now	-	16,101	9,457	159					25,717
Future Required	-								
Total Project Cost	5,146	25,976	9,457	159					40,738
Ongoing Costs	-		305	747	766	782	803	4,389	7,792
Grand Total	5,146	26,465	9,762	906	766	782	803	4,389	48,530

Estimate Class:	Class 2	**Estimate at Completion:**	$33,246	**OAR Approval Amount:**	$48,530

Additional Information on Project Cash Flows (optional):

Ongoing Costs include maintenance and operation costs estimated to occur over the next 10 years. Maintenance costs are based on the 2-year maintenance contract estimate that was provided by the contractor ($639k). Ongoing costs will be charged to the Refurbishment general program support account. An estimate of $125k for annual property taxes has been included in the Ongoing Costs.

The Class 2 estimate for Project cash flows is based on the previous releases for the project and the vendor's revised estimate based on the detailed design that is complete to date.

Removal costs of **$313K** have been included in this project budget for the demolition of the Reactor Maintenance building and relocation of building services.

Project Contingency is estimated at $7,492K total ($2,500K general contingency; $4,500K specific contingency; $492K specific contingency for performance fee 3% profit) with the following annual cash flows ($K):
2014: $5,020 2015: $2,472

Part E: Financial Evaluation

k$	Preferred Alternative	Base Case	Delay Work	Alternative 3	Alternative 4
Project Cost	38,878	N/A	N/A	40,712	41,245
NPV (after tax)	-39,627	N/A	N/A	-46,600	-41,925
Other (e.g., LUEC)					

Summary of Financial Model Key Assumptions (see Guidance on this Type 3 BCS Form):

Type 3 Business Case Summary

Alternative 3: 3-Storey Conventional Building with 300 Offices

Alternative 4: 2-Storey Modular Building with 200 Offices.

Project Cost includes capital project costs with contingency and excludes on-going operations and maintenance costs.

Net Present Value calculations include project costs including contingency and building lifecycle (operation and maintenance) costs. Interest was excluded from Net Present Value calculations.

Part F: Qualitative Factors

Minimizing delays getting Retube and Feeder Replacement support staff and material to the workface: Providing offices and a shop space for refurbishment support staff will result in:

- Timely access to the field and work crews to help with expeditious resolution of field issues during the outage prerequisite, execution and unit start up phases.

- Reduced delays caused by constraints on available shop space to complete work by providing the Refurbishment staff with the necessary preparatory space required for electrical and mechanical trades (pipe fabrication) pre-field installation work including component staging and preparation.

Type 3 Business Case Summary

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Tritiated Soil: There is a risk that costs for testing and material handling of the tritiated soil found in the vicinity of the Annex may be higher than expected. The extent of the contamination and the additional cost to process contaminated soil are currently unknown.	Mitigate: Additional soil testing is underway to determine extent of contamination. A local decontamination area with the ability to handle contaminated Annex soil is being constructed by a separate project however this facility is not yet operational. (TCD is end of February 2014). Contingency funding has been allocated for this specific risk ($1,120k).	Medium	Medium
Scope	Shop Requirements: There is a risk that additional shop requirements may arise. Shop requirements are being developed in parallel to this project's execution. Retube and Feeder Replacement Contractor may develop additional shop requirements as they progress their Front End Planning.	Mitigate: The Project Sponsor has approved the scope of the project via the Project Charter. Any new requirements would be assessed on a case-by-case basis to ensure value for money for OPG. Project Team has engaged the Retube and Feeder Replacement project team through Constructability, Operability, Maintainability and Safety review meetings as well as Retube and Feeder Replacement project's review of design documentation to identify any known gaps. Some changes have been realized to date.	Low	Medium
Schedule	Vacuum Building Outage: There is a risk that schedule delays may occur due to conflicts with other activities. The Darlington Station Containment/ Vacuum Building Outage scheduled for April 2015. This coincides with the start of commissioning of the Annex facility systems and tie-ins which may impact the schedule.	Mitigate: Commitments will be proactively discussed with Operations and Maintenance and work requiring Operations and Maintenance support will be scheduled outside of the Vacuum Building Outage window where possible. Project Team will continue to work with the Contractor to ensure they have accounted for the the Vacuum Building Outage in their schedule.	Medium	Low
Resources	Sub-Contractor Inexperience: There is a risk that additional level of effort will be required by the sub-contractor constructing the facility due to their inexperience working inside the Darlington Protected Area. The sub-contractor is not familiar with all Ontario Power Generation processes and procedures for performing work inside the Protected Area. Unforseen cost and schedule impacts may result.	Mitigate: Project will seek out lessons learned from other Campus Plan Projects using the same process; Perform specific oversight as per the Project Oversight Plan; Perform risk reviews in conjunction with the Contractor. Contigency funding has been allocated for this risk.	High	Medium

Type 3 Business Case Summary

Part G: Risk Assessment				
Quality/ Performance	Work Planning: There is a risk that inadequate work planning by the Contractor results in increased level of effort gaining workplan approvals by Ontario Power Generation Stakeholders. The engineering sub-contractor is not familiar with workplan preparation and does not have a Modification Team Leader on-site regularly to resolve issues.	Mitigate: The Contractor is developing a process to simplify workplan comment and disposition process with Ontario Power Generation Stakeholders. The Contractor is working to provide a dedicated on-site presence to interface directly with Stakeholders. Contingency funding has been allocated ($355k).	Medium	Medium
Technical	Campus Plan Nuclear Safety Assessment: There is a risk that the aggregate Campus Plan Hazard Assessment being performed by Nuclear Refurbishment Nuclear Safety results in the need to implement mitigating actions to address the impact of all Campus Plan facilities on the Darlington site. Results of this assessment will not be available until late 2014.	Accept: The Project commissioned a separate Nuclear Safety Hazards Assessment to assess the impact of this facility on a stand-alone basis. Design requirements of the stand-alone study have been incorporated into the design of the facility.	Low	Medium
Cost	Buried Services: There is a risk that unknown buried services may be encountered that require relocation, resulting in a subsequent cost and schedule impact.	Mitigate: Field Engineering scans and drawing searches were performed to identify all known services. Daylighting for buried services is progressing in a manner that supports schedule requirements. Buried service relocations to be designed prior to impacting critical path. Contingency funding has been allocated for the removal/relocation of buried services ($1,054k).	High	Mediu m

Additional Risk Analysis:

Refer to Risk Register in Project Management Plan, NK38-PLAN-09701-10179 R001.

Type 3 Business Case Summary

Part H: Post Implementation Review (PIR) Plan				
Type of PIR	**Target Project In Service Date**		**Target PIR Completion Date**	
Comprehensive	2015-10-07		2016-01-07	
Measurable Parameter	**Current Baseline**	**Target Result**	**How will it be measured?**	**Who will measure it? (person/group)**
Performance Retube and Feeder Replacement Island Support Annex meets Design Requirements specified in the Project Charter.	Currently, there is no Contractor or Project Management workspace or shop capacity at the Darlington site, (in close proximity to the powerhouse) to accommodate Refurbishment work and personnel.	-200 offices for Project Management and Contractor staff (zone 1) -90 Person Pre-Job Brief area for Retube & Feeder Replacement workforce -1-40 person conference room with video conf. -1150m^2 of shop space -1-15 ton bridge crane -Project Monitoring & Job Clock System functions as per Design Requirements. -Building systems and services function as per Design Requirements.	Nuclear Refurbishment to confirm and accept Retube and Feeder Replacement Island Support Annex through turnover process.	Project Sponsor

Part I: Definitions and Acronyms

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For Internal Project Cost Control

Type 3 Business Case Summary

Appendix A: Summary of Estimate										
Project Number:	10-73810		**Facility:**	Darlington						
Project Title:	Retube And Feeder Replacement Annex									
Estimated Cost in k$										
	LTD	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Future**	**Total**	**%**
OPG Project Management	770	1,289	1,357	125					3,541	11
OPG Engineering	150	173	24						347	1
Permanent Materials										
EPC & Other Contract Costs	4,119	18,698	4,541	34					27,392	82
Interest	107	796	1,063						1,966	6
Subtotal	**5,146**	**20,956**	**6,985**	**159**					**33,246**	**100**
Contingency		5,020	2,472						7,492	22
Total	**5,146**	**25,976**	**9,457**	**159**					**40,738**	
Removal Costs Included		313								

Notes			
Project Start Date	2011-09-15	**Project Completion or In-Service Date**	2015-10-07
Interest Rate	5%	**Escalation Rate**	2%
Definition Cost Included	$6,312 k	**Estimate at Completion**	$33,246 k

Prepared by:	**Approved by:**
C. Brisebois 18-Feb-2014	18-Feb-2014
Courtney Brisebois Project Manager	Scott Ritzie Section Manager, Projects

Type 3 Business Case Summary

Appendix B: Comparison of Total Project Estimates

Phase	Release	Date (YYYY-MM-DD)	Total Project Estimate in k$ (by year including contingency)						Later	Total Project Estimate
			2012	2013	2014	2015	2016	2017		
Definition	Full	2012-10-31	649	5,359	16,820	9,307	1,711		4,493	38,339
Execution	Partial	2013-11-29	510	4,343	19,980	6,163	106			31,101
Execution	Full	2014-03-06	510	4,636	25,976	9,456	159			40,738

Project Variance Analysis

Estimated Cost in k$

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		3,123	3,541	418	-Vendor Core Team costs have increased ($150k). -Funding added for Ontario Power Generation Radiation Protection field support ($106k) -Funding added for portion of Ontario Power Generation Construction Advisor to support west-end Protected Area Projects ($70k). -Funding added to support portion of Campus Plan Manager and Campus Plan support staff member ($45k).
OPG Engineering		342	347	5	
Permanent Materials					

Type 3 Business Case Summary

EPC		18,904	25,328	6,424	Engineering/Procure/Construct Contract costs have increased due to approved and pending Consents to Proceed and Project Change Authorizations: -Contractor cost to finish the design of the facility higher than expected ($1,493k). -Contractor cost to complete procurement and construction higher than expected ($1,182k). -Contractor's engineering support costs during installation, commissioning and close-out higher than expected ($794k). -Contractor's cost to complete all required daylighting activities higher than expected ($649k). -Cost for facility's fire suppression system higher than expected ($530k). -Directed change to design of facility shop area by Project Sponsor ($525k). -Pending additional scope for the removal of an inactive Municipal/Industrial Strategy for Abatement shed and telephone box ($364k). -Electrical Power Systems Construction Association (EPSCA) and training allowance has increased ($315k). -Cost to perform additional soil testing/handling for tritiated soil ($300k). -Other ($272k)
CIO		1,563	1,563	0	
Developmental		501	501	0	
Interest		1,589	1,966	377	Interest has increased as the project cost has increased.
Subtotal		**26,022**	**33,246**	**7,224**	
Contingency		5,079	7,492	2,413	General contingency: $2,500k Specific contingency: $4,992k Specific Contingency allocated to major risks: -Tritiated Soil ($1,120k) -Buried services ($1,054k) -Contractor undefines ($727k) -3% Performance Fee bonus ($492k) Note: $1,967k contingency from previous release has been requested and brought into project base costs.
Total		**31, 101**	**40,738**	**9,637**	
Removal Costs Included		313	313		

Type 3 Business Case Summary

Appendix C: Financial Evaluation Assumptions

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

Project Cost:

(1) Contractor roles and responsibilities will be as per the Extended Services Master Service Agreement Contractor/Owner Interface Requirements for Nuclear and applicable project List of Deviations.

(2) All Ontario Power Generation Nuclear Refurbishment staff support has been included in the resource estimate.

(3) 5% of the Engineer Procure Construct contract labour costs were included to cover Extended Services Master Service Agreement contractor Core Team costs.

(4) A potential contractor additional bonus of 3% of the project value is carried as specific contingency.

Financial:

(1) This estimate assumes an escalation rate of 2%.

(2) The discount rate used is 7%.

Project Life:

(1) This facility must be designed, built and ready for occupancy by March 2016 in order to support Refurbishment preparation and execution work

Energy Production:

(1) Not Applicable.

Operating Cost:

(1) Darlington Refurbishment budget includes operating costs for the Retube and Feeder Replacement Island Support Annex beginning in June, 2015. This includes maintenance, custodial duties, telecommunications and waste services as per the Conceptual Design Report estimate [R-7].

Other:

(1) This building will be used by the Darlington Nuclear Generating Station following the completion of the Darlington Refurbishment Project.

Attach further detail as appropriate from the Financial Evaluation spreadsheet.

Appendix D: References

[R-1]	N-BCS-00120.3-10016, West Security And Office Building 10-73815 Lunch Change Room Facility 10-73807 Retube And Feeder Replacement Island Support Annex 10-73810
[R-2]	NK38-REP-09701-10001, Darlington Refurbishment – Infrastructure Summary Report
[R-3]	NK38-REP-09701-10003, Islanding Study Integrated Report
[R-4]	D-PCH-09701-10008, Darlington Refurbishment – Retube & Feeder Replacement Island Support Annex
[R-5]	NK38-BCS-09701-10002, Retube and Feeder Replacement Island Support Annex Business Case Summary
[R-6]	NK38-PLAN-09701-10179, Retube and Feeder Replacement Island Support Annex Project Management Plan
[R-7]	NK38-REP-09701-10086, Darlington West Security and Office/Lunch and Change Room Building and Retube and Feeder Replacement Island Support Annex Conceptual Report – Options 1 and 2
[R-8]	D-BCS-09701-10004, Retube and Feeder Replacement Island Support Annex Business Case Summary

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Final Security Classification of the BCS: **OPG Confidential**

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

Executive Summary and Recommendations			
Project #:	10-73815	**Title:**	Refurbishment Project Office
Phase:	Execution	**Release:**	Full
Facility:	Darlington	**Records File:**	00120.3
Class:	Capital	**Investment Type:**	Sustaining

Project Overview

We recommend the release of $77,825 k ($64,099 k base costs plus $13,726 k contingency).

This will bring the total release to $99,939k ($86,213k base, $13,726 k contingency).

These funds will be used for the balance of execution work including installation of the building structure and parking lots, security fence modifications and station tie-ins, project management oversight and project close-out activities for the Refurbishment Project Office.

1. **Project Objective**

The objective of this project is to build a cost effective Refurbishment Project Office and parking facilities to meet the needs of the Darlington Refurbishment Project as outlined in the project charters. This multi-purpose facility will be used by Darlington Refurbishment staff for secure access into the Darlington Nuclear Generating Station Protected Area, contractor change room and shower facilities, contractor lunchroom, offices for Refurbishment project support staff and parking for all site Refurbishment contractor and project staff.

2. **Project Need**

Based on the Refurbishment Project scope and staffing estimates, it was identified that Darlington does not have sufficient infrastructure to support the additional contractors and OPG staff that will be accessing the station each day. The Darlington Refurbishment Project Office will provide the following facilities to ensure delays related to station access are minimized:

Secure Access: Provide a secure entry point through the Protected Area Boundary for Refurbishment Workers at a rate of 600 people per half hour. The existing protected area boundary access points cannot accommodate the additional staff. The additional access point will eliminate the risk of delays accessing the workface for both refurbishment and regular station operations staff.

Office Space: Provide office space and amenities that are outside of the Protected Area but in close proximity to the outage unit(s) in refurbishment for 300 staff (estimated at 60% Ontario Power Generation staff and 40% Contractor project management staff). The office facility will allow for the timely access to field and work crews to help with the expeditious resolution of field issues during the outage pre-requisite, execution and unit start-up phases, coordination of field resources, oversight and planning of work and schedule management.

Lunchroom / Change Room: Provide a change room inside the Protected Area for 1100 Refurbishment workers. The facility shall also provide a lunchroom inside the Protected Area to accommodate 400 people per half hour and food storage for 1100 lunches. Existing change rooms and lunchrooms at the Darlington station cannot accommodate the additional contract staff that will be working to support the Darlington Refurbishment Project.

Parking: Provide 1550 onsite paved parking spaces to support the Refurbishment Contractor and Ontario Power Generation Refurbishment Project staff accessing the site on a daily basis.

This building will be used to consolidate OPG nuclear staff at the Darlington site following the completion of the Darlington Refurbishment Project.

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

Type 3 Business Case Summary

3. **Project Release Strategy**

The project release strategy includes the following phases:

Developmental funding was released in September 2011 to fund an assessment of the alternatives to meet the Refurbishment project's need for secure access, office space, lunchroom / change room facilities and parking ($1.203M spent).

Definition Phase funding ($11,880k total; $9,905K base + $1,975K contingency) was released in November, 2012 to complete Preliminary and Detailed Design, Specification of Long Lead Materials, Installation Planning, Project Management Oversight and preparation of Gate Review Board Gate 3 submission package.

Partial Execution Phase funding ($9,031k total; $7,133K base + $1,898K contingency) was released in May, 2013 to complete Construction, Commissioning, Turnover and Closeout of De-Vegetation, Lower Road relocation, demolition of Facility Sheds, Security Camera Relocation, as well as the procurement of materials including Long Lead Materials for the future release scope of work.

Full Release Execution Phase and Close-out Phase funding ($77,825K total; $64,099K base + $13,726K contingency) is being requested in this business case summary to fund the balance of the Execution Phase Work and Project Close-Out Activities.

The scope of this project is identified in the Darlington Refurbishment Project Campus Plan which is included in the business plan.

4. **Project Timeline and Constraints**

The facility must be designed, built and ready for occupancy by April 2016 to support Refurbishment preparation and execution work.

Project Cash Flows

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	10,491	11,059	564						22,114
Requested Now	-	39,275	37,101	1,449					77,825
Future Required	-								
Total Project Cost	10,491	50,334	37,665	1,449					99,939
Ongoing Costs	-			3,335	3,408	3,476	3,553	28,620	42,392
Grand Total	10,491	50,334	37,665	4,784	3,408	3,476	3,553	28,620	142,331

Estimate Class:	Class 2	**Estimate at Completion:**	86,213
NPV:	$-90,756 k	**OAR Approval Amount:**	142,331

Additional Information on Project Cash Flows (optional):

Ongoing Costs include maintenance and operation costs estimated to occur over the next 10 years. Maintenance costs are based on the 2-year maintenance contract estimate that was provided by the contractor ($2,778k). Costs will be charged to the Refurbishment general program support account. An estimate of $325k for annual property taxes has been included in the Ongoing Costs.

The Class 2 estimate for Project Cash Flows is based on the previous releases for the project and the vendor's revised estimate based on the detailed design that is completed to date.

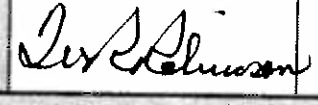
Project Contingency is estimated at $13,726K total with the following annual cash flows ($K):
2014: $7,085, 2015: $6,402, 2016: $239

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Approvals			
	Signature	**Comments**	**Date**
This BCS represents the best option to meet the validated business need in a cost effective manner.			
Recommended by: Bill Robinson Project Sponsor			19 FEB 14
I concur with the business decision as documented in this BCS.			
Finance Approval: Robin Heard Acting CFO, Finance			20 FEB 14
I confirm this project will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell CEO, per OAR 1.1			24 Feb 14

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

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Final Security Classification of the BCS: **OPG Confidential**

Business Case Summary

Part A: Business Need

Business Need:

The Darlington Refurbishment Project initiated two infrastructure studies [R-3, R-4] to evaluate Refurbishment Project needs. These studies evaluated scope, cost, resource implications (including support services) and risks to maximize work efficiencies and minimize impact on operating units. The studies also evaluated the scope of work required to build the infrastructure needed on site to support the refurbishment work.

Together, the Darlington Refurbishment infrastructure studies [R-3, R-4] identified the need for increased secure access processing capability to the Darlington Protected Area, office space, and an additional contractor change room and lunchroom due to the lack of available space within the Station. The service requirements summarized in these reports were further refined using Refurbishment Project resource estimates (i.e. building location, number of offices, shop size and office amenities/services) and documented in the project charters [R-1, R-2]. In support of the recommended alternative, comparisons of various facility configurations, including modular versus conventional construction, were performed. These comparisons were used to develop the most cost effective alternative that best meets the needs of the Darlington Refurbishment Project.

The project charter identifies that Darlington does not have capacity within its existing facilities to accommodate the additional contractor and project management staff that will be accessing the Darlington Site on a daily basis to support the Darlington Refurbishment Project. Additional lunchroom facilities, change room facilities and secure access throughput are necessary to ensure the Darlington Refurbishment Project is successful.

Upon completion of the Darlington Refurbishment Project this building will be used to consolidate OPG nuclear staff at the Darlington site.

Part B: Preferred Alternative

Description of Preferred Alternative: Refurbishment Project Office as a 3-Storey, 300 Office Conventional Building

A 3 storey conventional building will be constructed on the west side of the powerhouse with a total building size of approximately 97,000 ft^2 spread over 3 floors. The building has two distinct sections; the public domain section and the secured section. A security boundary will intersect this building between these two sections, with walls, floors and roof strengthened to delay a potential breach in security. The public domain side of the building will contain 300 offices for contractor and Ontario Power Generation staff. Secure access will be provided at a rate of 600 people per half hour into the Protected Area. The lunchroom (capacity of 400 people and lunch storage capability for 1100 lunches) and change rooms (men's and women's change rooms with a total capacity of 1100 people) will be located inside the secured side of the building. The lunchroom will be designated as a radiological zone one area.

A minimum 1550 parking spaces will also be created, spread over multiple paved parking lots, including road modifications for safe access and traffic flow to all lots.

The project scope also includes site preparation, building design and commissioning, station tie-ins; security fence modifications and project close-out activities.

Project Funding Summary

Developmental Release - September 2011 – This funded an assessment of the alternatives to meet the Refurbishment project's need for secure access, office space, lunchroom / change room facilities and parking ($1.203M spent).

The Project commissioned a Conceptual Design Report to determine the most cost effective method to construct the Refurbishment Project Office while meeting all charter requirements [R-1, R-2]. The Conceptual Design Report evaluated various building configurations, such as optimizing the distribution of 500 offices between the

ONTARIO POWER GENERATION

Records File Information:
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Type 3 Business Case Summary

Refurbishment Project Office and the Retube and Feeder Replacement Island Support Annex, as well as reviewing modular versus conventional construction techniques.

The Conceptual Design Report determined that the most cost effective building configuration is the 300 office Refurbishment Project Office (paired with a 200 office Retube and Feeder Replacement Island Support Annex) configuration for the following reasons:

- The 200 office Refurbishment Project Office did not result in a smaller building footprint
- The 200 office Refurbishment Project Office still required a third storey.
- The Retube and Feeder Replacement Island Support Annex required a third storey to accommodate the additional 100 offices.
- It is more cost-effective to construct office space outside, rather than inside, the Protected Area, due to additional requirements and productivity losses that occur when constructing inside the Protected Area.

The recommended alternative was a conventionally-constructed, 3-storey, 300 office, security processing and lunchroom/change room facility.

Release 1 - November 2012 - Definition Full Release - $11.88M was released to complete Preliminary and Detailed Design, Specification of Long Lead Materials and Installation Planning.

The project is approximately 2 months behind on the detailed design. The contractor has completed 80% of the detailed design packages have been completed to date, including the following major scope:

- Building structure
- Mechanical and electrical systems in the building
- Mechanical and electrical systems tie-ins
- Site civil work include parking, road and drainage modifications
- Municipal Building permits for the foundation work and Central Lake Ontario Conservation Authority (CLOCA) permits have been approved. The remaining permits are at 90% complete.

The remainder of design work will be complete by May 15, 2014. The portions of the design that are remaining will not affect the project schedule as these work packages will not be installed until after the building structure is complete (Q4, 2014). Subsequent installation planning milestones have been pushed accordingly.

Release 2 – May, 2013 - Execution Partial Release - $9.03M was released to complete De-Vegetation, Lower Road relocation, demolition of Facility Sheds and Security Camera Relocation. Procurement of materials to be installed during this release, as well as procurement of long lead materials for the Refurbishment Project Office were also included.

The project is approximately 2 months behind on this installation. The contractor has completed the following major scope to date:

- Mobilization and construction trailer compound installation
- De-vegetation of upper and lower parking lot areas and silt fence installation
- Lower Road Relocation
- Light Pole Demolition

The project is forecasting to complete the released scope within the released funding. Although the project schedule has slipped by approximately 2 months, a recovery plan is in place and the project is still forecasting to complete within the target BCS Available for Service Milestone of January 2016.

Release 3 - This BCS - Execution and Close-out Phase Full Release - $77.8M. The funds will be used to complete construction, commissioning, turnover and closeout of the balance of the execution work including installation of the building structure, tie-ins and site modifications including parking lots and security fence modifications.

Deliverables:	**Associated Milestones (if any):**	**Target Date:**

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Type 3 Business Case Summary

1.	Start of Installation – RPO Structure (foundations)	Start of Installation	May 30, 2014
2.	Start of Commissioning – Building Systems	Start of Commissioning	August 10, 2015
3.	Available For Service	Available for Service	January 29, 2016

Part C: Other Alternatives

Base Case: Status Quo – No Project

If Ontario Power Generation does not build a new Refurbishment Project Office there could be impacts to the efficiency (work delay) of the Refurbishment Project as follows:

(a) The existing security facilities will be over their capacity during non-refurbishment outages, Station Containment Outages and Vacuum Building Outages. This will increase costs to operating units, non-refurbishment outages and refurbishment work, due to the delays from the workers entering the plant and getting to the work site.

(b) If Project Management and Contractors were housed in an offsite facility, worker efficiency will be reduced due to increased travel times for project management and contractor support to respond to worksite issues.

(c) If additional lunchroom / change room facilities are not provided, the existing Construction Change Room (CCR) will be overcrowded resulting in longer wait times for showers as well as longer lunch breaks and shift turnovers.

(d) If additional onsite parking is not provided, offsite parking would be required with shuttles to the secure entrance. This would result in delays getting contractors to the worksite.

Alternative 2: Delay Work

Delaying the construction of this facility is not a feasible option. If the project is not executed at this time, the building will not be completed in time to support the Refurbishment of the first unit. This will result in delays getting labourers to the workface each day as well as delays getting support from other project personnel (project managers and engineering) when problems arise during execution. This investment is required to support the efficient and effective execution of the Darlington Refurbishment Project.

Alternative 3: Two Separate Buildings (West Security Office Building and Lunchroom / Change Room)

The Conceptual Design Report evaluated several building alternatives. The option of constructing two separate facilities, a West Security Office Building and a Lunchroom/Change Room, was evaluated.

For this option, the West Security and Office Building would be constructed in its current proposed location with a separate Lunchroom / Change Room constructed inside the Protected Area within the footprint of the existing Reactor Maintenance Building (Building 29). The Retube and Feeder Replacement Island Support Annex would be constructed in the south east corner of the Protected Area.

This option is not recommended since the Conceptual Design Report cost estimate of constructing two separate facilities was higher than the cost estimate for constructing a combined facility. Combining the West Security and Office Building Project and the Lunchroom / Change Room Project into the Refurbishment Project Office provided preferable real estate inside the Protected Area for the construction of the Retube and Feeder Replacement Island Support Annex.

Alternative 4: Refurbishment Project Office as a 3-Storey, 300 Office Modular Building

The Project commissioned a Conceptual Design Report to determine the most cost effective method to construct the Refurbishment Project Office while meeting all charter requirements [R-1, R-2]. The Conceptual Design Report evaluated various building configurations, such as optimizing the distribution of 500 offices between the Refurbishment Project Office and the Retube and Feeder Replacement Island Support Annex, as well as reviewing modular versus conventional construction techniques.

The Conceptual Design process found that the construction cost for a modularly-constructed facility was higher than

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

that of a conventionally-constructed facility for the following reasons:

- When modular offices are constructed using non-combustible materials, and in accordance with CSA N293-07, the cost of the modular unit increased significantly since this departs from standard modular office construction.
- There was found to be significant cost increases with the use of a third storey since this departs from standard modular construction which is normally relegated to one or two storeys.
- The modular units are required to have extensive security enhancements for the walls and floors to meet Nuclear Security Regulations.
- There is a cost increase due to the design complexities of incorporating elevators into modular building design.
- It was estimated in the Conceptual Design Report that both the conventionally-constructed and modularly-constructed facility have the same operating costs. The net present value for each alternative was calculated using construction, operation and removal costs and the results confirmed that the conventionally-constructed facility is less expensive than the modularly-constructed facility.

Therefore, this option is not the preferred alternative.

Part D: Project Cash Flows

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	10,491	11,059	564						22,114
Requested Now	-	39,275	37,101	1,449					77,825
Future Required	-								
Total Project Cost	10,491	50,334	37,665	1,449					99,939
Ongoing Costs	-			3,335	3,408	3,476	3,553	28,620	42,392
Grand Total	10,491	50,334	37,665	4,784	3,408	3,476	3,553	28,620	142,331

Estimate Class:	Class 2	Estimate at Completion:	86,213	OAR Approval Amount:	142,331

Additional Information on Project Cash Flows (optional):

Ongoing Costs include maintenance and operation costs estimated to occur over the next 10 years. Maintenance costs are based on the 2-year maintenance contract estimate that was provided by the contractor ($2,778k). Costs will be charged to the Refurbishment general program support account. An estimate of $325k for annual property taxes has been included in the Ongoing Costs.

The Class 2 estimate for Project Cash Flows is based on the previous releases for the project and the vendor's revised estimate based on the detailed design that is completed to date.

Project Contingency is estimated at $13,726K total with the following annual cash flows ($K):
2014: $7,085, 2015: $6,402, 2016: $239

Part E: Financial Evaluation

k$	Preferred Alternative	Base Case	Delay Work	Alternative 3	Alternative 4
Project Cost	99,939	N/A	N/A	116,303	107,464
NPV (after tax)	-90,756	N/A	N/A	-102,832	-95,107
Other (e.g., LUEC)					

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See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Part E: Financial Evaluation
Summary of Financial Model Key Assumptions (see Guidance on this Type 3 BCS Form): Alternative 3: Two separate buildings including the Lunchroom/Change Room located inside the Protected Area and the West Security and Office Building in its current location. Alternative 4: A modular building with 300 Offices; same location and supporting infrastructure. Project Cost includes capital project costs with contingency and excludes on-going operations and maintenance costs. Net Present Value calculations include project costs including contingency and building lifecycle (operation and maintenance) costs. Interest was excluded from Net Present Value calculations.

Part F: Qualitative Factors
Minimizing effects on regular operation of the Station: By installing a separate entrance to the Protected Area and a separate lunchroom / change room for Refurbishment staff, delays and congestion for regular Station staff will be minimized. This can be measured through monitoring increases to the Main Security Building traffic as well as Station Condition Records relating to delays entering the station.

Type 3 Business Case Summary

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Soil Contamination: There is a risk that more than 10% of the soil that will be removed from the RPO and parking lot footprint is contaminated with Hydrocarbons. This would result in additional costs for soil treatment before disposal.	Monitor: The vendor is completing additional boreholes localize the affected areas and minimize the amount of soil that will require treatment. Soil is being re-used as part of the project grading wherever possible.	Medium	Medium
Scope	Buried Services: There is a risk that the contractor will come in contact with an unidentified buried service which could lead to addition engineering and investigation to identify or possibly re-route buried or exposed services. This would result in addition engineering and execution costs as well as delays to the execution work.	Mitigate: OPG has completed scanning in the area and prepared a package with drawings showing known services in the area. The contractor is also completing independent ground scans. A vacuum truck will be used to determine locations of known services prior to excavation. A protocol for dealing with legacy buried services will be developed with the Contract Management Office.	Low	Medium
Schedule	Interfacing Projects: There is a risk that a delay in interfacing projects would cause delays to this project as well. There are several projects executing work on the west side of the Darlington site. Co-ordination is required between the contractors to ensure work is planned as efficiently as possible.	Mitigate: Regular co-ordination meetings will continue to ensure that projects working on the west side of the site have open communication about execution scope and schedule.	Medium	Medium
Resources	Vacuum Building Outage: There is a risk that contractor resources may not be available due to conflicting priorities. The Darlington Vacuum Building Outage is scheduled for April 2015 which coincides with the start of commissioning for the Refurbishment Project Office facility systems and tie-ins. There is potential for conflicting construction priorities due to other Engineer/ Procure/Construct work underway.	Mitigate: Secure resource commitments early. Schedule work appropriately per N-PROC-MA-0022. There is sufficient float in the Refurbishment Project Office schedule to accommodate a delay if required.	Medium	Low
Quality/ Performance	Work Planning Approvals: There is a risk that improper planning and follow-up by the Contractor leads to an increased effort to get workplans approved by OPG Stakeholders. The contractor is not experienced with OPG Processes and Procedures that must be adhered to when interfacing with the station systems. The contractor is still learning the importance of having a dedicated modification team leader onsite to resolve issues quickly. This could result in schedule delays and additional project costs to regain the schedule.	Mitigate: The contractor is developing a new processes to simplify efficient work plan review and approval. The contractor will submit a project matrix identifying stakeholders for each work plan. The contractor will provide a knowledgeable design resource onsite to work through workplan issues with stakeholders.	Medium	Medium

Type 3 Business Case Summary

Part G: Risk Assessment				
Technical	Security Design Strategy: There is a risk that the new strategy for the security design requires more modifications to the building shell than anticipated. The detailed design for the security portion of the scope is not yet complete.	Monitor: The current solution simplifies the technology requirements significantly. The solution has been socialized with Regulatory Affairs, Fire and Emergency Response, Security Operations and Maintenance. OPG Project Manager to socialize further with Security and the Canadian Nuclear Safety Commission to ensure the strategy is supported.	Low	Medium

Additional Risk Analysis:

See Risk Register in Project Management Plan [R-8].

Part H: Post Implementation Review (PIR) Plan

Type of PIR	Target Project In Service Date	Target PIR Completion Date
Comprehensive	2016-01-29	2017-06-29

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Nuclear Security	Existing Protected Area Boundary fence (to be modified) meets all requirements and Nuclear Security Regulations .	Refurbishment Project Office Security modifications function as per Design Requirements and are in compliance with Nuclear Security Regulations. (e.g.: 7., 7.1, 9., 10., 11., 15., 15.1, 17.1, 25., 26., 27., etc.)	Nuclear Security to confirm and accept Security Modifications through turnover process	Nuclear Security
Performance Refurbishment Project Office meets processing times and Design Requirements specified in the Project Charter.	Currently, there is no Security processing, parking, change room and lunchroom capacity at the Darlington site to accommodate the Refurbishment workforce.	-Security Processing of 600 per ½ hour -1550 parking spots to meet Parking Charter -300 offices for Project Management staff -Lunchroom capacity of 400 per ½ hour (1100 lunches) -Change room capacity of 1100 persons -Project Monitoring & Job Clock System functions as per Design Requirements. -Building systems and services function as per Design Requirements	Nuclear Refurbishment to confirm by performing walkthroughs and measuring process rates.	Project Sponsor

Part I: Definitions and Acronyms

Type 3 Business Case Summary

Not Applicable, no acronyms used.

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Type 3 Business Case Summary

For Internal Project Cost Control

Type 3 Business Case Summary

Appendix A: Summary of Estimate			
Project Number:	73815	**Facility:**	Darlington
Project Title:	Refurbishment Project Office		

Estimated Cost in k$

	LTD	2014	2015	2016	2017	2018	2019	Future	Total	%
OPG Project Management	1,460	1,072	2,197	693	-	-	-	-	5,422	5%
OPG Engineering	248	279	129	35	-	-	-	-	691	1%
Permanent Materials	408	7,675	3,512	-	-	-	-	-	11,595	12%
Design and Construction	7,855	28,989	19,645	482	-	-	-	-	56,971	57%
Consultants	-	-	-	-	-	-	-	-	-	0%
Other Contracts/Costs	300	3,616	3,002	-	-	-	-	-	6,918	7%
Interest	220	1,618	2,778	-	-	-	-	-	4,616	5%
Subtotal	**10,491**	**43,249**	**31,263**	**1,210**	**-**	**-**	**-**	**-**	**86,213**	
Contingency	-	7,085	6,402	239	-	-	-	-	13,726	14%
Total	**10,491**	**50,334**	**37,665**	**1,449**	**-**	**-**	**-**	**-**	**99,939**	
Removal Costs Included	-	-	-	-	-	-	-	-	-	

Notes			
Project Start Date	2011-09-15	**Project Completion or In-Service Date**	2016-01-29
Interest Rate	5%	**Escalation Rate**	2%
Definition Cost Included	$14,982 k	**Estimate at Completion**	$86,213 k

Prepared by:	Approved by:
J Ciccarelli Feb 18, 2014	Feb 18, 2014
Jacquie Ciccarelli	Scott Ritzie
Project Manager	Section Manager, Infrastructure Projects

Type 3 Business Case Summary

Appendix B: Comparison of Total Project Estimates

Phase	Release	Date (YYYY-MM-DD)	Total Project Estimate in k$ (by year including contingency)						Later	Total Project Estimate
			2011	2012	2013	2014	2015	2016		
Definition	Full	2012-10-30	299	1,086	21,593	47,215	22,013	4,141	12,712	109,059
Execution	Partial	2013-04-12	299	771	17,799	44,202	23,125	519		86,717
Execution	Full	2014-03-06	299	771	9,421	50,334	37,665	1,449		99,939

Project Variance Analysis

Estimated Cost in k$

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	1,460	6,007	5,422	(584)	1) $1,020k in Core Team costs were removed from this total and redistributed into Design and Construction 2) Increase to OPG PM Costs another year to extend into project Closeout. 3) Field engineering increased to support planned quality surveillance.
OPG Engineering	248	663	691	28	4) Design costs increased due to schedule delay.
Permanent Materials	407	27,349	11,595	(15,754)	5) $17,545k removed. Vendor redistributed these costs to Construction. 6) Vendor costs for Fire Protection System design and installation from sub-contractor increased by $1,140k
Design and Construction	7,855	28,436	56,971	28,535	7) $17,545k added. Vendor redistributed these costs from Procurement. 8) Vendor Core Team costs were removed from OPG Project Management and redistributed into Design and Construction. Cost increase of $1,020k. 9) EPC Vendor design costs were increased by $3,175k. Cost increase is primarily due to unfamiliarity with OPG process requirements. 10) EPC Vendor design and construction costs were increased by $1,260k due to scope additions and delays. 11) EPC Vendor underestimated the cost for construction and procurement. Costs increased by $3025. 12) Additional costs required for excavation on the water sewer project due to change in the building location from what was described in the conceptual design report. The cost impact to the water sewer project is an increase of $680k. 13) Vendor Core Team take-offs increased from 2.5% to 5%. Cost increased by $1,455k 14) Municipal Permit Costs increased by $695k
Consultants	-	-	-	-	
Other Contracts/Costs	300	2,997	6,918	3,921	15) RPO project includes costs for 10 additional Security Officers to support from Q2 2014 – Q4 2015. Cost increase of $2,445k

Type 3 Business Case Summary

					16) Soil in RPO footprint is contaminated with hydrocarbons and requires more expensive disposal. Cost increase of $1,500
Interest	219	5,935	4,616	(1,319)	
Subtotal	**10,491**	**71,387**	**86,213**	**14,826**	
Contingency		15,330	13,726	(1,604)	17) Contingency ($3,874k) from the previous releases has been transferred to base costs. Risk has been re-assessed. Specific Contingency: $11,500 General Contingency: $417 ES MSA Performance Fee Pool: $1,809 **Major Specific Risk Items** Risk that more than 10% of Soil is Contaminated: $5,000 Risk due to incomplete assessing: $4,200 Risk of unknown buried services: $750
Total	**10,491**	**86,717**	**99,939**	**13,222**	
Removal Costs Included	-	0	0	0	

Type 3 Business Case Summary

Appendix C: Financial Evaluation Assumptions

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

Project Cost:

(1) Contractor roles and responsibilities will be as per Extended Services Master Services Agreement Contractor /Owner Interface Requirements for Nuclear and applicable project List of Deviations.

(2) All Ontario Power Generation Darlington Refurbishment staff support has been included in the resource estimate.

(3) 5% of the Engineer Procure Construct contract labour costs were included to cover Extended Services Master Service Agreement contractor Core Team costs.

(4) A potential contractor additional bonus of 3% of the project value is carried as specific contingency.

(5) Included 20 New Security Response Force resources starting in the beginning of Q2 2014 to year end 2015.

Financial:

(1) This estimate assumes an escalation rate of 2%.

(2) The discount rate used is 7%.

Project Life:

(1) The facility must be designed, built and ready for occupancy by April 2016 in order to support Refurbishment preparation and execution work.

Energy Production:

(1) Not Applicable.

Operating Cost:

(1) Darlington Refurbishment budget includes operating costs for the Refurbishment Project Office starting in Q3 2015.

Other:

(1) This building will be used to consolidate staff at the Darlington site following the completion of the Darlington Refurbishment Project and the safe storage project at the Pickering site.

Attach further detail as appropriate from the Financial Evaluation spreadsheet.

Appendix D: References

[R-1] D-PCH-09701-10020, Darlington Refurbishment: West Security, Office and Lunchroom/Change Room facility

[R-2] D-PCH-09701-10014, Darlington Refurbishment Parking Areas And Supporting Facilities

[R-3] NK38-REP-09701-10001 - Darlington Refurbishment – Infrastructure Summary Report

[R-4] NK38-REP-09701-10003 – Islanding Study Integrated Report

[R-5] NK38-PLAN-09701-10005 - Darlington Refurbishment West Project Office Building Need Statement

[R-6] N-BCS-00120.3-10016, Developmental Business Case Summary: West Security And Office Building 10-73815; Lunch Change Room Facility 10-73807; Retube And Feeder Replacement Island Support Annex 10-

Type 3 Business Case Summary

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[R-7] NK38-BCS-09701-10001 - Refurbishment Project Office Business Case Summary – Definition Phase

[R-8] NK38-PLAN-09701-10193 - Refurbishment Project Office Project Management Plan

[R-9] NK38-REP-09701-10086 - Darlington West Security And Office / Lunch And Change Room Building, And Retube And Feeder Replacement Annex Conceptual Report - Options 1 And 2

[R-10] NK38-BCS-09701-10002 - Refurbishment Project Office Business Case Summary – Partial Execution

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Records File Information:
Records SCI/USf 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 #:	10-73821	Document #:	D-BCS-53600-10004
Project Title:	Darlington Site Electrical Distribution System Upgrades		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Superseding
Facility:	Darlington Nuclear	Target In-Service or Completion Date:	October 31, 2015

Project Overview

The purpose of this release is to provide an additional release of $3,817k, including $350k of contingency to complete the commissioning and close out phase of the project.

The estimated total project cost is $20,766k, including $350k in contingency.

The quality of the estimate for this release is Class 2.

Problem Statement/Business Need:

As part of the site campus plan, there are new facilities being built at the Darlington site to support the Refurbishment program. The existing site electrical distribution for the Darlington site does not have the required capacity to provide the required electrical supply to the new campus plan buildings. These new facilities include the Refurbishment Project Office (RPO), the Re-tube & Feeder Replacement Islanding Support Annex (RFRiSA), Heavy Water Management Building Annex (D2O Storage), Auxiliary Heating Steam Facility (AHSF). In addition, the project will allow for a new supply to be provided to the existing Computer and Maintenance Development Facility (CMDF).

The Business need for this project is to upgrade the existing Darlington Site Electric Power Distribution System in order to:

- Increase reliability of the existing site electric power distribution system (Distribution Station 1 & 2)
- Facilitate the power distribution system for new buildings/facilities which are currently being constructed as part of Darlington Campus Plan and Refurbishment initiatives. (Distribution Station 5)

The project modified/replaced components to an existing distribution station (DS1), upgraded components and installed new switchgear at DS2 and replaced the aging, lower capacity DS4 with a larger capacity distribution station and switchgear called DS5.

The work at DS1 and DS2 is complete and the Available for Service Declaration has been completed. Electrical supplies for the AHSF and RPO projects have been connected and power to these buildings is in service. The installation and commissioning of the DS5 network is complete and the new switchgear associated with this distribution station has been placed in service. The new switchgear is available to be used to connect the planned loads from the Heavy Water Management building and RFRiSA. The remaining work is comprised of the decommissioning and removal of the old Distribution Station DS4 and site restoration activities including final access road and retaining wall structures and some access improvement for the new switchgear and associated project close out tasks.

The completion of the electrical distribution project has been impacted by two issues that caused delays and which require the release of additional funding beyond the previously released amounts and contingency

The most significant issue was the requirement to address legacy equipment grounding issues on the original electrical distribution system that existed from the original station design. These were identified in the final acceptance of the equipment by the Electrical Safety Authority prior to initial energization. To address this issue, significant changes to the equipment grounding was required to address potential step and touch differences on the new and existing equipment to allow the commissioning phase to proceed.

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Type 3 Business Case Summary

Project #: 10-73821 Document #: D-BCS-53600-10004
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

Project Overview

In addition, there were equipment delivery and performance issues associated with the new outdoor electrical switchgear provided for this project that caused project delays and rework by the original equipment vendor was required.

History of BCS releases and project cost estimates:

The estimate at completion (EAC) from the previous Full Execution Release was $16.9M (including $0.3M contingency). This EAC was reduced from the prior Partial Execution Release of $23.8M (including $4M contingency) due to the removal from project scope of the installation of an additional 44Kv feeder line from the local distribution utility to the DNGS site electrical grid. The 44kv feeder line wes removed from scope as a result of the deferral of the Darlington New Build project as well as the elimination of additional new site facilities on the Darlington site along Park Road.

The revised EAC to complete the remaining Electrical Distribution project scope including the current request is $20.8M (including $350k contingency).

Release Gate	($M with contingency)		Status of Major Scope Items
	Releese amount per release	Total Project Estimate per Release	
Initiation	0.3	N/A	Initiation of the project. Feasibility study of various options to improve the site electrical network complete.
Partial Definition and Execution	5.7	17.8	DS1 overhaul complete; DS2 and DS5 design complete; Long-lead switchgear and transformers ordered
Partial Execution	13.8	23.8	Upgrades to DS2 complete; Installation of DS5 and 13.8kV distribution network installation
Full Execution	3.1	16.9	Reduction of scope to eliminate the 44 kV line that was part of the original scope
Superseding	3.8	20.8	Completion of new scope associated with equipment grounding issues and de-commissioning of DS4 including close out phase of project

Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD 2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	14,454	2,495						16,949
Requested Now	-	3,702	115					3,817
Future Required	-							
Total Project Cost	14,454	6,197	115					20,766
Ongoing Costs	-	41	42	43	44	45	233	448
Grand Total	14,454	6,238	157	43	44	45	233	21,214

Estimate Class:	Class 2	Estimate at Completion:	$20.42M (excluding contingency)
NPV:		OAR Approval Amount:	$21.21M

Additional Information on Project Cash Flows (optional):

1. Ongoing cost is estimated at $40k/year (2016) with 2.5% escalation rate for new distribution system to be operated and maintained for 35 years.
2. Requested contingency = $350k

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Type 3 Business Case Summary

Project #: 10-73821
Document #: D-BCS-53600-10004
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

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): Dietmar Reiner Senior Vice President, Nuclear Projects			2015-09-14
I concur with the business decision as documented in this BCS.			
Finance Approval: Beth Summers Chief Financial Officer per OPG-STD-0078			2015-09-30
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 and CEO per OAR 1.1			2015-10-07

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

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Type 3 Business Case Summary

Project #: 10-73821
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

Document #: D-BCS-53600-10004

Business Case Summary

Part A: Business Need

Electrical power is supplied to Darlington site facilities and buildings located outside the site security protected area by the M15 44kV feeder line from the local distribution utility. This system was designed and installed during the original station construction and has reached the end of its operational life. Redundancy in the original distribution system has diminished due to growth in electricity demand resulting from the addition of several new buildings on site. The performance and reliability of the system has gradually degraded over time. The existing system is not capable of supplying power to the new buildings proposed to support the Darlington Refurbishment program.

There is a need to upgrade the existing electrical power distribution system by increasing the system capacity to supply electricity to existing and new Refurbishment facilities buildings at Darlington site. The upgrades will include refurbishment/overhaul of the existing equipment and installation of the new power distribution infrastructure.

Part B: Preferred Alternative: Complete Remaining Electrical Distribution Installation and 13.8kv Duct Bank

Description of Preferred Alternative

The extra funding is required to complete the Commissioning and in-service of the Electrical distribution project and make it fully available to support the new refurbishment facilities.

Deliverables:	Associated Milestones (if any):	Target Date:
DS5 in service.	Available for Service	30June2015
Completion of DS5 switchgear access stairs, access roads, temporary equipment grounding and final demolition and restoration of the redundant Distribution Station #4 (DS4)	Operations Acceptance	31Oct2015

Part C: Other Alternatives – Do Nothing

This is not an acceptable alternative because the Site Electrical project is nearing completion and site campus plan buildings require permanent, reliable power in order to be placed in service

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

$k	LTD 2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	14,454	2,495						16,949
Requested Now	-	3,702	115					3,817
Future Required	-							
Total Project Cost	14,454	6,197	115					20,766
Ongoing Costs	-	41	42	43	44	45	233	448
Grand Total	14,454	6,238	157	43	44	45	233	21,214

Estimate Class:	Class 2	**Estimate at Completion:**	$20.42M (excluding contingency)
NPV:		**OAR Approval Amount:**	$21.21M

Additional Information on Project Cash Flows (optional):

1. Ongoing cost is estimated at $40k/year (2016) with 2.5% escaletion rate for new distribution system to be operated and maintained for 35 years.
2. Requested contingency = $350k

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

Type 3 Business Case Summary

Project #: 10-73821
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

Part E: Financial Evaluation

k$	Preferred Alternative	Cancel Project	Delay Work
Project Cost	$21,214	N/A	N/A
NPV			
Other (e.g., IRR)			

Summary of Financial Model Key Assumptions or Key Findings:

Other alternatives were not evaluated because the project needs to be completed to ensure reliable power is available for key campus plan projects (RPO, D_2O Storage, RFRISA).

Part F: Qualitative Factors

- Increased reliability of the existing site electric distribution system
- Obsolete equipment replaced with commercial, off the shelf, modern system.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost/ Schedule	There is a risk that unknown underground services not shown on drawings are discovered during excavation of the DS5 access road. These services would need to get moved prior to completion of the road causing delay to the schedule and increased cost.	The project is already aware of some underground services in the area. An underground services information package was assembled and given to the installation contractor. The project will accept and manage any discovered underground services.	Low	Low
Cost/ Schedule	Cost and schedule risks associated with any discovery issue during removal of DS4 and its surroundings	Project contingency will mitigate the risk.	Medium	Low

Additional Risk Analysis:

A detailed analysis of the risks was completed and a Monte Carlo simulation provided the contingency to be applied.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Simplified PIR	31Oct2015	31Oct2016

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Reliability of the power supply fed from distribution substations	Average of two forced outages per year	Average forced outage less than two per year	Monitor the system performence, outages, SCRs, work orders	Nuclear East Facilities (NEF)
Power supply to new buildings for the Darlington Refurbishment	No power distribution system is available to feed new buildings	Power distribution system is available in time for buildings to ba placed in service	New power distribution systems are in-service.	Nuclear East Facilities (NEF)

Part I: Definitions and Acronyms

- AFS – Available For Service
- AHS – Auxiliary Heating Steam facility (New DNGS boiler house)
- BCS – Business Case Summary

Type 3 Business Case Summary

Project #: 10-73821 Document #: D-BCS-53600-10004
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

Part I: Definitions and Acronyms

- CT- Current Transformer
- DNGS – Darlington Nuclear Generating Station
- DS – Distribution Substation
- EAC – Estimate at Completion
- HWMB – Heavy Water Management Building
- MCDF – Maintenance and Computer Development Facility
- NEF – Nuclear East Facilities
- OEM - Original Equipment Manufacturer
- RFRISA – Retube and Feeder Replacement Islanding Support Annex
- RPO – Refurbishment Project Office

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Type 3 Business Case Summary

Project #: 10-73821
Document #: D-BCS-53600-10004
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

For Internal Project Cost Control

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Type 3 Business Case Summary

Project #: 10-73821
Document #: D-BCS-53600-10004
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

Appendix A: Summary of Estimate										
Project Number:	10-73821									
Project Title:	Darlington Site Electrical Distribution System Upgrades									
k$	**LTD 2014**	**YTD 2015**	**2015**	**2016**	**2017**	**2018**	**2019**	**Future**	**Total**	**%**
OPG Project Management	1,835	228	208	30					2,301	11%
OPG Engineering (including Design)	89	180	313	45					627	3%
OPG Procured Materials	3,707	5	0	0					3,712	18%
Design Contract(s)	1,504	252	477	30					2,263	11%
EPC Contract(s)	6,813	2,409	1,500	0					10,722	52%
Interest	506	194	81	10					791	4%
Subtotal	**14,454**	**3,268**	**2,579**	**115**					**20,416**	
Contingency	0	0	350	0					350	1%
Total	**14,454**	**3,268**	**2,929**	**115**					**20,766**	**100**

Notes			
Project Start Date	Nov 2010	**Total Definition cost** (excludes unspent contingency for Nuclear)	$1.9M
Operations Acceptance	31OCT2015	**Contingency included in this BCS** (Nuclear only)	$350k
Target Completion Date	31OCT2015	**Total contingency released plus contingency in this BCS** (Nuclear only)	$350k
Escalation Rate	2%	**Total released plus this BCS without contingency** (Nuclear only)	$20,416k
Interest Rate	6%	**Total released plus this BCS with contingency** (Nuclear only)	$20,766k
Removal Costs	$200k	**Estimate at Completion** (includes only spent contingency for Nuclear)	$20,416k

Prepared by:	**Approved by:**
Ajoy Mukhopadhyay Date Project Manager Design Projects - Darlington	Stephanie Tham Date Section Manager Design Projects - Darlington

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Type 3 Business Case Summary

Project #: 10-73821
Document #: D-BCS-53600-10004
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

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 LTD	2014	2015	2016	2017	2018		
Initiation	Full	2010-11	250	-	-	-	-	-	-	250
Definition & Execution	Partial	2011-11	8,173	5,474	2,893	1,235	-	-	-	17,775
Definition & Execution	Partial	2013-05	10,919	2,850	2,500	7,420	80	-	-	23,770
Execution	Full	2014-10	7,881	8,226	842	-	-	-	-	16,949
Execution	Superseding	2015-05	7,881	6,573	6,197	115	-	-	-	20,766

Project Variance Analysis

k$	LTD 2014	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	1,835	1,902	2,301	399	Increased project management was required to follow up resolution on equipment deficiencies and delay, mitigate various field discovery issues. Discovery of legacy equipment grounding issues that required modification to complete permits approval with the Electrical Safety Authority
OPG Engineering (including Design)	89	384	627	243	Additional OPG engineering oversight and technical support were required to resolve field discovery issues, support design changes due to equipment deficiencies. Addition of grounding interconnections for Site Electrical project.
OPG Procured Materials	3,707	3,707	3,712	5	
Design Contract(s)	1,504	1,986	2,263	277	Additional design agency support required to address design changes associated with equipment deficiencies, mitigate various interferences and Equipment Grounding issues.
EPC Contract(s)	6,813	8,493	10,722	2,229	Additional construction management costs associated with field changes to resolve equipment deficiencies and additional scope to address legacy issues with equipment grounding required to obtain permits from the Electrical Safety Authority. Increase in contractor project support due to schedule extension.
Interest	506	477	791	314	Increase in capital costs due to extended schedule and additional scope.
Subtotal	**14,454**	**16,949**	**20,416**	**3,467**	
Contingency	-	-	350	350	Contingency estimate considers risks associated with completion of installation, commissioning, AFS and close-out for the Electrical Distribution project.
Total	**14,454**	**16,949**	**20,766**	**3,817**	

Type 3 Business Case Summary

Project #: 10-73821
Project Title: Darlington Site Electrical Distribution System Upgrades, Superseding Execution Release

Document #: D-BCS-53600-10004

Appendix C: Financial Evaluation Assumptions

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

Project Cost:

- The estimate at completion considers the final field installation, commissioning, AFS, and close-out for the Electrical distribution network as well as a detailed analysis of potential risks.

Project Life:

- The life cycle for this new system is forecasted as 35 years.

Energy Production:

- There is no impact to Darlington energy production as part of completion of this project

Operating Cost:

- The cost of operation and maintenance is estimated at an average of $40k/year with 2.5% escalation rate.

Appendix D: References

[1] D-PCH-53600-10001, Project Charter – Electrical Project
[2] D-BCS-53600-10001, 10002 Partial Release BCS – Electrical Project
[3] D-BCS-53600-10003, Full Release BCS-Electrical project
[4] NK38-PLAN-53600-10003, Project Management Plan – Electrical Project

Type 3 Business Case Summary

Final Security Classification of the BCS: **Internal Use Only**

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

Executive Summary and Recommendations

Project Information			
Project #:	10-73802	**Document #:**	NK38-BCS-72700-10002
Title:	Darlington Water and Sewer Project		
Class:	Capital	**Investment Type:**	Sustaining
Phase:	Execution	**Release:**	Superseding
Facility:	Darlington	**Target In-Service or Completion Date:**	2016-01-18

Project Overview

We recommend the release of $12,008 k, including $3,014 k of contingency.
The estimated total project cost is $57,711 k, including $3,014 k of contingency.

We recommend a superseding release of $12,008k (including $3,014k contingency) to complete the following scope of work:

- Phase II - Solina Road Domestic and Fire Water Supply System, and Darlington Sanitary Sewer System
  - Installation and commissioning of Domestic / Fire Water System **(In Progress)**
  - Installation and commissioning of Water and Sewer Systems for Refurbishment Project Office **(In Progress)**
  - Design Closeout
- Phase III – Decommissioning and removal of existing Domestic Water Pumphouse (DWP) and Sewage Treatment Plant (STP)
  - Detailed Design **(In Progress)**
  - Procurement and Construction to decommission and demolish the STP and DWP
  - Design Closeout
  - Project Closeout

The business objectives of the Darlington Water and Sewer project is to:

- Install new domestic and fire water supply lines from Oshawa and Bowmanville municipalities to ensure adequate supply for the continued operation of the Darlington Nuclear Generating Station (DNGS) post refurbishment.
- Re-route the station sewer system to the Courtice Water Pollution Control Plant to support the continued operation of the Darlington Nuclear Generating Station (DNGS) post refurbishment.
- Decommission and remove the existing DWP, water storage bladders and associated chlorination systems, and STP
- Provide sewage and water connections for future Darlington Refurbishment facilities

Problem Statement/Business Need:

In preparation for the continued operation of the Darlington Nuclear Generating Station (DNGS), the Darlington Water and Sewer Project was initiated based on the finding of gaps between the current domestic/fire water and sewage system condition and future incremental requirements.

The project entails replacing the existing on-site water and sewer system by installing a separate domestic water system and a separate fire water system; redirecting the station sanitary sewage system from the Sewage Treatment Plant (STP) to the Region of Durham's sanitary sewage system; and decommissioning of the existing STP and Domestic Water Pumphouse (DWP).

The planning and execution of the Darlington Water and Sewer Project is broken up into 3 phases:

- Phase I - Holt Road Domestic and Fire Water Supply System (Complete)
- Phase II - Solina Road Domestic and Fire Water Supply System, and Darlington Sanitary Sewer System (In Progress)
- Phase III – Decommissioning and removal of existing DWP and Sewage Treatment Plant STP (In Progress)

History of BCS releases and project cost estimates:

The total project cost is now estimated at $57,711k (including contingency), compared to $45,704k (including contingency) in the previous Over Variance Approval.

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Type 3 Business Case Summary

The project was fully released in May 2013 with an estimated cost of $40,607k (with contingency). An Over Variance Approval was required in August 2013 ($45,704k including $3,525k contingency) due to significant cost increases which were attributed to the following:

- Cost and schedule delays related to the change in railway crossing construction methodology due to existing soil conditions discovered during tunnelling operations, and the subsequent risk for loss of ground and impact on the railway tracks.
- Additional costs for exploratory investigations and standby costs associated with the Revised Excavation Protocol. The enhanced protocol exceeds industry requirements and was put forth to ensure no unintentional contact with buried services.
- Additional costs and schedule delays resulting from the design and location change of the Refurbishment Project Office.
- Additional costs and schedule delays due to construction methodology changes for high voltage crossings.
- Additional contingency to address an updated evaluation of remaining risks.

Through the Over Variance Approval, the project requested additional funding to cover approved and anticipated change requests for Phase II execution. These change requests have since been realized and are significantly higher than anticipated which was not properly quantified in the risk assessment. Furthermore, additional change requests are forthcoming which were not identified at the time of preparing the Over Variance Approval Form. Phase III costs and schedule were assumed to be in line with the previous BCS and therefore no additional funding or schedule changes were requested through the Over Variance Approval. The proposal submissions for the Engineering, Procurement, Construction (EPC) contract were higher than the allocated budget and requested schedule milestones could not be achieved. This was identified as a risk in the previous Full-Execution BCS.

Increased cost and schedule variances related to the outstanding work remaining under the August 2013 Over Variance Approval requires a superseding BCS. The requirement for the additional funds are attributed to the following:

- Underestimating the value of change requests identified in the Over Variance Approval
- Additional change requests not identified or anticipated at the time of the Over Variance Approval
- Increased Contractor indirect costs (Project Management) due to schedule delays
- Underestimating the Engineering, Procurement, Construction (EPC) budget for Phase III

The cumulative effect of the issues identified above has delayed the Phase II final Available for Service (AFS) date to 30-Nov-2015, and the Phase III AFS date to 18-Jan-2016. The table below demonstrates the schedule variances between the previous Full-Execution BCS and the proposed dates:

Milestone Name/Deliverable Name	Previous BCS Approved Date	Proposed Date
Phase III Detailed Design Complete	23-Jun-2014	30-Jan-2015
Phase III Start of Decommissioning (T-0)	11-Dec-2014	27-Jul-2015
Phase II - RPO Water and Sewer System Available for Service	N/A	30-Nov-2015*
Phase III Available for Service	05-Jun-2015	18-Jan-2016
Project Closeout	24-Feb-2016	1-Sep-2016

***AFS cannot be completed until after completion of the RPO building AFS. TCD for the commissioning of the RPO Water and Sewer systems is 28-Nov-14.*

History of scope and schedule changes:

The scope of work for the project has not changed. Several challenges have occurred during field execution which has led to significant cost increases and schedule delays. A summary of the major items is as follows:

Phase II – Solina Road Water and Sewer

- Standby labour and equipment costs, and schedule delays resulting from contact with undocumented and undetectable buried services.
- Additional labour and equipment costs due to the Revised Excavation Protocol, which was put forth to ensure no unintentional contact with buried services.
- Significant cost increase and schedule delays resulting from the design and location change for the Refurbishment Project Office (RPO), as specified by OPG.
- Additional labour and equipment costs for change in construction methodology for five (5) existing electrical transmission lines not properly identified on Contract Drawings.

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- Additional costs for geotechnical analysis and construction methodology changes to mitigate adverse soil conditions
- Additional costs for construction strategy changes from Owner Only to Owner Constructor for tie-in and decommissioning work.
- Additional costs for scope not submitted within the Contractor's original bid.

Phase III – Decommissioning and Removal of STP and DWP

- Proposals received were higher than allocated budget for EPC contract.
- Schedule timelines for EPC could not be achieved.

The revised estimate to completion includes approximately 16% contingency allowance on the remaining scope of work for Phase II and III. Significant work amounting to roughly 80% (life to date) of the Phase II scope has been completed since the Full-Execution BCS and Over Variance Approval which has led to a number of risks being retired. The completion of the railway crossing eliminated the risk for damage to property outside of the Contractor's work limits, availability of materials, and equipment failure. Discovery work and underground utilities risk has been substantially reduced due to the amount of completed scope and implementation of the Revised Excavation Protocol.

All submissions from the Contractor have been challenged for validity and pricing resulting in some submissions being rejected and others being reduced through negotiations. Third party estimates are also utilized to challenged and validate the accuracy of the estimates provided.

Key Assumptions and Risks:

Funding totalling $4,875K has been allocated in the Base Project Cost due to the high certainty of realizing the following risks; Payment of all repair work related to sedimentation in pipeline, Fire Main pressure test failure and the Fire Main leak. Distribution of these funds will be released through the Purchase Order following the Contract Management Process if these risks are realized.

Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	35,822	5,508	3,629	744					45,703
Requested Now	-	10,029	1,348	631					12,008
Future Required	-								
Total Project Cost	35,822	15,537	4,977	1,375					57,711
Ongoing Costs	-			221	225	230	235	1,509	2,420
Grand Total	35,822	15,537	4,977	1,596	225	230	235	1,509	60,131

Estimate Class:	Class 3	**Estimate at Completion:**	$54,697 k
NPV:	$(20,855) k	**OAR Approval Amount:**	$60,131 k

Additional Information on Project Cash Flows (optional):

The incremental ongoing cost for the treatment of Darlington water and sewage and additional water supply is estimated at $221K per year, for 10 years, with an escalation factor of 2% after 2016.

The Cost estimate for the completion of Phase 2 is based on the existing ES MSA contract, plus approved, pending and anticipated change orders.

The cost estimate provided for Phase III Decommissioning of the DWP and STP is based on the existing ES MSA contract.

Decommissioning and removal cost (Phase III) has been estimated at $4.7M.

Estimate at Completion is based on our projected cost without contingency.

Contingency: $3,014k

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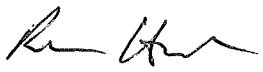
Document #: NK38-BCS-72700-10002
Title: Darlington Water and Sewer Project

Approvals				
Project #:	10-73802	**Document #:**	NK38-BCS-72700-10002	
Title:	Darlington Water and Sewer Project			
Phase:	Execution	**Release:**	Superseding	
	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: Bill Robinson Senior Vice President, Nuclear Projects Project Sponsor				2014.05.01
I concur with the business decision as documented in this BCS.				
Finance Approval: Robin Heard Senior Vice President & Chief Financial Officer (Acting)				2014-05-05
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				2014-05-06

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Final Security Classification of the BCS: Internal Use Only

Business Case Summary

Part A: Business Need

In preparation for the continued operation of the Darlington Nuclear Generating Station (DNGS) post refurbishment, the Darlington Water and Sewer project was initiated based on the finding of gaps between the current domestic & fire water and sewage system condition and future incremental requirements.

Domestic & Fire Water Supply

The site domestic water system was installed during the construction of the station and was not intended to remain in service following construction. The design included a diesel booster pump located in the Domestic Water Pumphouse (DWP) and two 250,000 gallon water storage bladders to provide water supply for the booster pump. The pump is triggered by falling domestic water pressure, which while operating, increases the domestic water pressure to provide the additional water that is needed due to the operation of a fire sprinkler in the service buildings outside of the protected area.

A series of reported events (recorded in Station Condition Records (SCR) #s D-1998-00944, D-1998-0143, D-2001-06602, D-2003-08451, and D-2005-06206 resulting from the continued use of the DWP, temporary water storage bladders and diesel booster pump raised concerns about the site domestic water system. On several occasions, the fire pump has started unexpectedly due to mechanical problems or pressure transients which results in the water from the bags entering the active part of the domestic water system. Our station procedures require that the domestic water system be quarantined and flushed following operation of the diesel pump, which represents a significant disruption to normal station operation and a considerable cost to the corporation.

Sanitary Sewer Upgrades

Sewage Treatment Capacity:
The existing sewage system average flow rate and treatment capacity is not adequate to accommodate the future demand during Refurbishment and the continued operation of the station post refurbishment. New campus plan and refurbishment facilities being constructed during the next decade would also require additional sewage system capacity.

Environmental Concerns:
The STP was erected during the construction of the station as a municipal waste line did not exist in the vicinity.

The existing Sewage Treatment Plant (STP) exposes OPG to Ministry of Environment (MOE) violations and potential negative public perception due to MOE non-compliances. In 2007 alone, there were four MOE reportable events due to unmonitored release which were a result of equipment failures and lack of operator monitoring. Design changes to eliminate the possibility of unmonitored discharges have been considered, but are considered too complex and too expensive to implement.

Once the Sanitary Sewer Systems are re-directed to the municipality, the existing STP will be de-commissioned and removed. This will eliminate the above stated environmental concerns, as well as eliminate asset maintenance and operating costs.

Part B: Preferred Alternative

Description of Preferred Alternative: Install new domestic and fire water mains and redirect the sanitary sewage system to the Municipality

Domestic & Fire Water Supply
Installation of domestic water and fire water lines from the municipality of Oshawa at Osborne Road and a new fire water line from the municipality of Bowmanville on Holt Road just south of Highway 401. Install tie-in points in strategic locations for supply of water to various station facilities.

Bypass the domestic water supply to the existing pump house equipment to allow the existing bladders, fire pump and chlorination equipment to be removed from the water system which will reduce maintenance and operating costs, simplify the functionality of the system and improve the water quality, thus eliminating employee concerns.

Installation of water distribution lines and tie-in points to proposed Refurbishment and Campus Plan facilities.

Sanitary Sewer Upgrades
Installation of a sanitary sewer line from the station to the Courtice Water Pollution Control Plant along with the construction of two new pumping stations. This would allow OPG to send sewage directly to the municipality and de-commission the existing

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deteriorating Sewage Treatment Plant.

Installation of sewer distribution lines and tie-in points to proposed Refurbishment and Campus Plan facilities.

The project boundaries for the domestic/fire water supply will be from the municipality tie-ins points to the station inlet flange in the existing Domestic Water Pumphouse. The project boundaries for the sanitary sewer system discharge will be from a new Lift Station at the west of the existing Project Office to the municipality tie-ins point. The systems conditions and the documentation outside these boundaries are not included in the scope of this project.

Deliverables:	Associated Milestones (if any):	Target Date:
Phase III - Detailed Design Complete	Design Complete	30-Jan-2015
Phase III - Completion of Work Plans		21-Apr-2015
Phase III - Start of Decommissioning	Start of Installation	27-Jul-2015
Phase II - RPO Water and Sewer System	Available for Service Completed	30-Nov-2015
Phase III - Decommissioning and Removal Complete	Available for Service Completed	18-Jan-2016
Phase II - Design Closeout	Design Closeout Completed	30-May-2016
Phase III - Design Closeout	Design Closeout Completed	18-Jul-2016
Project Closeout	Project Closeout Completed	01-Sep-2016

Part C: Other Alternatives

Summarize all reasonable 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.

Base Case: Do Nothing More

To do nothing more is not recommended because this alternative will not allow DNGS to meet the domestic/fire water and sewage treatment demand for refurbishment work and continued station operation post refurbishment. This alternative has not been estimated and is used as a basis to evaluate the incremental cost of other alternatives.

Alternative 2: Delay Work – Delay the decommissioning of DWP and STP

To delay the decommissioning of the DWP and STP is not recommended as the removal of these facilities will provide additional real estate for future Campus Plan facilities, eliminate the need for asset maintenance and operating costs and eliminate environmental concerns.

Alternative 3: Do Less - Remove the decommissioning of DWP and STP from scope

Similarly to Alternative 2, to remove the decommissioning of the DWP and STP from scope is not recommended as the removal of these facilities will provide additional real estate for future Campus Plan facilities, eliminate the need for asset maintenance and operating costs and eliminate environmental concerns.

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

k$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	35,822	5,508	3,629	744					45,703
Requested Now	-	10,029	1,348	631					12,008
Future Required	-								
Total Project Cost	35,822	15,537	4,977	1,375					57,711
Ongoing Costs	-			221	225	230	235	1,509	2,420
Grand Total	35,822	15,537	4,977	1,596	225	230	235	1,509	60,131

Estimate Class:	Class 3	**Estimate at Completion:**	$54,697 k
NPV:	$(20,855) k	**OAR Approval Amount:**	$60,131 k

Additional Information on Project Cash Flows (optional):

The incremental ongoing cost for the treatment of Darlington water and sewage and additional water supply is estimated at $221K per year, for 10 years, with an escalation factor of 2% after 2016.

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The Cost estimate for the completion of Phase 2 is based on the existing ES MSA contract, plus approved, pending and anticipated change orders.
The cost estimate provided for Phase III Decommissioning of the DWP and STP is based on the existing ES MSA contract.
Decommissioning and removal cost (Phase III) has been estimated at $4.7M.
Estimate at Completion is based on our projected cost without contingency.
Contingency: $3,014k

Part E: Financial Evaluation

k$	Preferred Alternative	Base Case	Alternative 2	Alternative 3	Alternative 4
Project Cost	(57,711)	N/A			
NPV	(20,855)	N/A			
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

The Darlington Water and Sewer project is not a value enhancing project and therefore has a negative NPV. The financial model considers the following:

- Capital and OM&A Costs
- Operating/Ongoing costs associated with Municipal water and sewage treatment and additional water supply
- Cost savings from abandoning the operation of the DWP and STP, including material/consumables, rentals, and maintenance and operation cost.

Ongoing and savings costs were calculated until 2061 (Assumed end of Darlington Station life including safe storage activities).

Part F: Qualitative Factors

The qualitative factors resulting from this project are:

- Eliminate employee concerns regarding the appeal of domestic water for staff consumption.
- Provide redundancy in supply of domestic and fire water to the station from the municipality.
- Reduce risk of MOE violations and non-compliances with continuing operation of the Sewage Treatment Plant.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that the Contractor comes into contact with underground utilities and services while performing excavation activities. Such incidents can lead to safety infractions and stand downs. Additional engineering may be required to address the situation and determine path forward. This would lead to additional engineering and execution costs as well as delays to the execution schedule	An excavation protocol is in place to determine the location of any existing underground utilities inside the limits of construction. OPEX indicates that even with the excavation protocol, the detection of some types of services may be difficult.	Medium	Medium
Scope	There is a risk that the excavation required for the West Pumping Station will undermine the future footings for the RPO building due to the size of the excavation footprint and the close proximity to the RPO footprint. The impact will be additional costs for engineering, geotechnical analysis and construction scope as well as potential schedule	Work with RPO project to determine the best alternative construction method if it is determined that the excavation footprint impacts the RPO footings	Low	Medium

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	delays for installation.			
Schedule	There is a risk that foreign material enters the pipelines if proper preventative measures are not made during installation, or foreign material entering due to joint/pipe failure. The cause of this would be related to human performance and workmanship issues. The impact can lead to significant delays to the execution schedule for flushing and sampling the lines for potability.	Contractor to apply proper FME covers to all pipes which are staged for installation. Field oversight to ensure that the appropriate measures are taken to prevent foreign material from entering the system.	Low	Medium
Quality/ Performance	There is a risk that the pressure testing is not successful during the commissioning on the RPO domestic and fire water lines. The impact would be a delay in schedule and potential costs to rectify the problem in order to achieve a passing result.	OPG to provide Oversight during installation to ensure construction meets the design specifications and workmanship. Quality control to be performed by the Contractor to ensure construction meets the design specifications and workmanship.	Low	Medium
Technical	There is a risk that designated substances such as asbestos, lead paint etc are discovered to be present in the facilities which are to be demolished. The impact will be additional costs required for the remediation of discovered substances.	Contractor to perform required sampling as per SOW.	Low	Medium

Additional Risk Analysis:

Funding totalling $4,875K has been allocated in the Base Project Cost due to the high certainty of realizing the following risks; Payment of all repair work related to sedimentation in pipeline, Fire Main pressure test failure and the Fire Main leak. Distribution of these funds will be released through the Purchase Order following the Contract Management Process if these risks are realized.

Please refer to the Water and Sewer Risk Register – "Contingency Evaluation Template for Gate 2+ Submission" for additional risks.

Part H: 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
Simplified PIR Report	2016-01-18	2016-12-15

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Domestic Water Pressure	450kPa - 460kPa at the Domestic Water Pumphouse	Maintain adequate domestic water pressure: 450kPa - 460kPa at the new Pressure Reducing Valves located south of the existing Domestic Water Pumphouse	Pressure Reducing Valves set to 460kPa.	Station Engineering

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Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Fire Water	Fire water supplied by Water Bladders and Diesel Fire Pump	Fire water supplied from the Municipality of Oshawa and Municipality of Bowmanville	New Lines in service/project AFS	Station Engineering
Sewage Treatment Plant	Sewage treated at on-site Sewage Treatment Plant	Sewage redirected and treated by the Municipality. Reduce risk of MOE violations due to operation of STP	Flow of Sanitary Sewer to the Municipality/Project AFS	Station Engineering
Sewage Treatment Plant	Operating	Decommissioned and removed	Flow of Sanitary Sewer to the Municipality/Project AFS	Station Engineering
Domestic Water Pumphouse	Operating	Decommissioned and removed	Pumphouse by-passed decommissioned and removed. Project AFS	Station Engineering
Water Bladders	Operating	Decommissioned and removed. Eliminate employee concerns regarding water quality	Bladders by-passed decommissioned and removed. Project AFS	Station Engineering

Part I: Definitions and Acronyms

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For Internal Project Cost Control

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Appendix A: Summary of Estimate (Numbers may not add up due to rounding.)										
Project Number:	10-73802									
Title:	Darlington Water and Sewer Project									
k$	**LTD 2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Future**	**Total**	**%**
OPG Project Management	2,095	712	580	376					3,764	7
OPG Engineering (including Design)	214	198	146	129					688	1
OPG Procured Materials										
OPG Other	1,241	583	349	125					2,298	4
Design Contract(s)	1,343	250	7	33					1,633	3
Construction Contract(s)	29,907	9,938	92						39,937	73
EPC Contract(s)		1,282	2,902	523					4,707	9
Consultants										
Other Contracts/Costs										
Interest	1,022	433	216						1,671	3
Subtotal	**35,822**	**13,397**	**4,292**	**1,186**					**54,697**	
Contingency		2,139	685	189					3,014	6
Total	**35,822**	**15,537**	**4,977**	**1,375**					**57,711**	**100**

Notes			
Project Start Date	2010-06-24	**Definition Cost Included** (includes contingency only if spent)	$3,005 k
Target In-Service (or AFS) Date	2015-11-30	**Contingency Included in this Release**	$3,014 k
Target Completion Date	2016-09-01	**Total-to-Date Contingency**	$5,233 k
Escalation Rate	2%	**Total-to-Date Released** (excluding contingency)	$42,179 k
Interest Rate	5%	**Total-to-Date Released** (including contingency)	$45,704 k
Removal Costs	$4,707 k included in EPC Contrac for Phase III	**Estimate at Completion** (includes contingency only if spent)	$54,697 k

Prepared by:	Approved by:
Kyle Money Sr. Technical Engineer/Officer Darlington Projects 25-APR-2014 Date	Mike Nairne Section Manager Darlington Projects 25-Apr-2014 Date

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Appendix B: Comparison of Total Project Estimates

Phase	Release	Date	Total Project Estimate in k$ or M$ (by year including contingency)						Future	Total Project Estimate
			2010	2011	2012	2013	2014	2015		
Definition	Developmental	2010-07-22	265	3,590	11,542	9,980	8,380	6,243		40,000
Execution	Partial	2011-08-08	180	1,908	8,964	16,897	7,486	565		36,000
Execution	Full	2013-05-23	164	1,733	11,051	21,164	2,578	3,896	20	40,607
Execution	Over Variance	2013-08-08	164	1,733	11,051	26,261	2,578	3,896	20	45,703
Execution	Superseding	May 2014	164	1,733	11,051	22,873	15,537	4,977	1,375	57,711

Project Variance Analysis

k$ or M$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	2,095	2,882	3,764	882	See Note 1 below
OPG Engineering (including Design)	214	674	688	14	See Note 2 below
OPG Procured Materials					
OPG Other	1,241	1,369	2,298	929	See Note 3 below
Design Contract(s)	1,343	1,510	1,633	123	See Note 4 below
Construction Contract(s)	29,907	32,077	39,937	7,860	See Note 5 below
EPC Contract(s)		2,700	4,707	2,007	See Note 6 below
Consultants					
Other Contracts/Costs					
Interest	1,022	967	1,671	704	See Note 7 below
Subtotal	**35,822**	**42,179**	**54,697**	**12,518**	
Contingency		3,524	3,014	(510)	
Total	**35,822**	**45,703**	**57,711**	**12,008**	

Note 1: OPG Project Management

The Available for Service milestone date for the Domestic Water / Fire Water system has been delayed by approximately 6 months, the Water and Sanitary Service installation for the RPO facility has been delayed over one (1) year, and Phase III Engineering is expected 6 months later than the previous BCS commitment. Due to the schedule extension for both Phase II and Phase III, OPG Project Management Team costs have increased for the period of 2014 to 2016.

Description:	RC	Cost Increase
Design Projects	1811	$382k
Project Controls	2894	$107k
Supply Chain	6469	$11k
Core Team	N/A	$95k
		$595k

The burn rate for Project Management personnel was higher than anticipated resulting in a 2013 budget overspending of $287k.

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Note 2: OPG Engineering

The burn rate for OPG Engineering has been lower than anticipated and therefore the project does not require a significant increase to account for the cumulative delay of 1 year on Phase II and 6 months for Phase III.

Note 3: OPG Other

Due to the schedule extension for both Phase II and Phase III, estimated costs have increased for the period of 2014 to 2016.

Description:	RC	Cost Increase
Operations Manager	1610	$53k
Operations	1619	$67k
Drawing Office	2417	$112k
Contract Mgmt Office	2898	$437k
		$668k

The burn rate for project oversight and support personnel such as CMO, FE, DO, and OPS was higher than anticipated resulting in a 2013 budget overspend of $138k

Note 4: Design Contracts

The delay of 1 year on Phase II scope has increased the costs required for Design Agency support during Installation and Commissioning. Furthermore, because the AFS for the RPO water and sewer service cannot be completed until the RPO AFS, the Design Agency support contract will also be extended to support the closeout of the design packages. The additional services provided on this project represent the ongoing support for the Water and Sanitary Project beyond the original scope and time frame which assumed that the bulk of the services to be provided to Sept 2013. The cost increase over and above the approved budget is as follows:

Description:	Cost Increase
Sept 2013 to May 2015	$142k

Note 5: Construction Contract(s)

The increases in construction costs related to the outstanding work remaining under the August 2013 Over Variance Approval are related to:

- Underestimating the value of change requests identified in the Over Variance Approval
- Additional change requests not identified or anticipated at the time of the Over Variance Approval
- Increased Contractor indirect costs (Project Management) due to schedule delays

These change requests and cost impacts are summarized below:

Category	Title	Description	Cost
Approved Contract Changes – Not Invoiced	Refurb Project Office (RPO) Design & Location Change Impact	Cost increase and schedule delays for the Refurbishment Water and Sanitary Services due to the changes in design and location of the RPO, as specified by OPG.	$1,450k
Anticipated Contract Changes	Repair Work	Additional costs for repair work which was carried out by the Contractor to rectify issues with sediment in fire main and failed pressure testing of fire main. Standby labour and equipment costs are included.	$4,875k
	Additional PMT	Additional costs for Contractor Project Management Team due to the delays in the schedule	$925k
	Additional Paving	Additional costs over and above the original scope for paving Park Rd North and along Lakefront Rd. Increased scope was required due to the extent of damage caused to the existing roads during pipeline installation.	$406k
	Various Others	Costs for attempted advancement of Water Main Installation Manhole Modifications Grade Drainage Issues at East Pumping Station Meter House Roof Frame	$207k

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		Additional Costs for Decommissioning Existing Lift Station	
Invoiced Changes	Execution of Revised Excavation Protocol between Mar 13, 2013 to Oct 2, 2013	Additional labour and equipment costs due to the Revised Excavation Protocol which increased the requirements for excavation preparatory work including drawing reviews, scanning, hydro vac operations, walk downs and secondary verifications.	$781k
	Construction Methodology Change for KV Crossings	Additional labour and equipment costs for change in construction methodology due to five (5) existing high voltage electrical transmission line crossings which were not properly identified on contract drawings. Directional drilling was required as an outage could not be accommodated due to the fact these lines supply the Main Security Building, Boiler House, and Information Center.	$611k
	Standby Costs	Standby labour and equipment costs for an incident where an undocumented and undetectable buried service was contacted by excavation equipment and another where inadvertent ground movement occurred during excavation resulting in damage to a buried service conduit. An enhanced excavation protocol exceeding industry requirements was required to prevent future occurrences.	$598k
	Waterfront Trail Sub-excavation	Additional costs for geotechnical analysis and construction methodology changes to mitigate adverse soil conditions identified as unstable and inadequate for supporting proposed pipelines along the Waterfront Trail.	$101k
Total Cost of Changes *(Not Including Invoiced Changes)*			**$7,862k**

Note 6: EPC Contracts

The Request for Proposal and subsequent proposal submissions for Phase III were not issued to the proponents prior to the August 2013 Over Variance request. At the time of preparing the Over Variance request, Phase III costs and schedule were assumed to be in line with the previous BCS and therefore no additional funding or schedule changes were requested. The increase in the Phase III EPC cost is due to the proposal submissions for the Engineering, Procurement and Construction (EPC) contract being higher than the allocated budget and requested schedule milestones could not be achieved. This was identified as a risk in the previous Full-Execution BCS.

Note 7: Interest

Schedule delays have pushed phase II scope into 2014 and 2015 resulting in an increase in capital cost and a $700k increase in interest cost. This was not included in the August 2013 Over Variance Approval as it was anticipated that the completion of phase II was on track.

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

Project Cost:

1. The project costs for the completion of Phase II are based on the existing ES MSA Procurement and Construction contract, including all approved, pending, and anticipated change requests.
2. The project costs for the completion of Phase III are based on the ES MSA Engineering, Procurement, and Construction contract.

Financial:

1. The ongoing cost for the treatment of Darlington water and sewage is estimated at $221k per year until 2062 (assumed end of Darlington station life including safe storage activities).
2. Cost savings from abandoning the operation of the DWP and STP, including material/consumables, rentals, and maintenance and operation cost.

Project Life:

1. The life cycle analysis for this project forecasts costs until 2062. This assumes the need for water and sewer services until the end of Darlington station life including safe storage of the nuclear units.

Energy Production:

1. This project does not have any impact on the energy production of the Darlington units.

Operating Cost:

1. The operating and maintenance costs associated with the DWP and STP will no longer be applicable once Phase II and III are complete. This has been reflected in the NPV calculations.3.

Type 3 Business Case Summary

Project #: 10-73802
Document #: NK38-BCS-72700-10002
Title: Darlington Water and Sewer Project

Appendix D: References

Project Charter D-PCH-72700-10002-R001 – Domestic Fire Water Replacement Project 38308
Conceptual Design Report NK38-REP-72700-10021-R000 – Darlington Water and Sewer Project
Developmental Release BCS, NK38-BCS-72700-10007-R000 – Darlington Water and Sewer Project
Execution-Partial Release BCS, NK38-BCS-72700-10008-R000 – Darlington Water and Sewer Project
Execution-Full Release BCS, NK38-BCS-72700-10010 – Darlington Water and Sewer Project

ONTARIO POWER GENERATION

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DRC at the Clarington Energy Centre
Full Release Business Case Summary
OPG CONFIDENTIAL

ROUTING	LOCATION	ACTION	SIGNATURE	DATE
PROJECT MANAGER				
Don Seedman (Project Manager) Manager, Facilities & Projects Real Estate & Services	H18-H11	Review BCS	D. Seedman	Dec 06/10
Glenn Temple VP, Real Estate & Services	H18-J11	Review BCS	G. Temple	Dec 7/10
PROJECT SPONSOR				
Gary Rose Director, Planning & Control Nuclear Refurbishment	O11	Review BCS		Dec. 9/10
Mark Arnone VP, Refurbishment Execution Nuclear Refurbishment	O11	Review BCS		9 Dec 2010
Dietmar Reiner SVP, Nuclear Refurbishment	O11	Submit BCS		Dec 9, 2010
Bill Robinson EVP, Nuclear Refurbishment Projects & Support	P82-2	Recommend BCS		Dec 10, 2010
FINANCE REVIEW				
Jamie Lawrie Director Nuclear Investment	P82	Review BCS		Dec 9/2010
Randy Leavitt Vice President, Nuclear Finance	P82	Review BCS	R Leavitt	Dec 10, 2010
Don Power Vice President, Corporate Investment Planning	H07-G05	Review BCS		Dec 7/10
BCS APPROVAL				
Donn Hanbidge SVP & Chief Financial Officer	H19-F27	Approve BCS		Dec 31/10
Tom Mitchell President & Chief Executive Officer	H19-A24	Approve BCS		28 Dec 2010
FOR DISTRIBUTION				
Magued Ernest Refurb Planning & Controls 703-5428	O11	Return for Distribution & Filing	M Ernest	Jan 03/11

DARLINGTON REFURBISHMENT COMPLEX AT THE CLARINGTON ENERGY CENTRE
PROJECT ID 10-73803

PHASE 3: DESIGN, CONSTRUCT AND COMMISSION THE DARLINGTON REFURBISHMENT COMPLEX

1. RECOMMENDATION:

Approval is requested for a full release of $85.7M ($84.0M Capital and $1.7M OM&A) for a total release value of $105.4M including contingency to carry out design and construction of the OPG Darlington Refurbishment Complex ("DRC") at the Clarington Energy Centre ("CEC"), in support of the Darlington Refurbishment Program. Funding is specifically requested in order to:

- Complete negotiations and award a Design-Build contract,
- Manage the Design-Build contract during the design and construction period,
- Commission the completed building and furnish the office areas to OPG standards, and
- Provide owner's oversight, project controls, and reporting on the progress of the Project.

The following table summarizes releases to date and the full release project estimate.

$000's	Funding	LTD 2010	2011	2012	2013	2014	2015	Later	Total
Currently Released	Partial	7,248	7,098	4,480	860				**19,686**
Requested Now	Full	(5,157)	24,593	40,795	25,444				**85,676**
Future Funding Req'd	Full	-	-	-	-	-			-
Total Project Costs		2,091	31,691	45,275	26,304	-	-	-	105,362
Ongoing Costs	~6M/year	-	-	-	2,820	5,752	5,867		**14,439**
Grand Total		2,091	31,691	45,275	29,124	5,752	5,867	-	119,801
Investment Type Strategic		Class Cap & OM&A		NPV or IEV -96,556		IRR N/A		Discounted Payback N/A	

A request for proposals (RFP) was issued on September 24, 2010 to 5 proponents. The RFP included the statement of needs for the facility. The RFP closed on November 17, 2010. Evaluation of the proposals is underway. OPG will select a proponent or proponents to negotiate with, and finalize a contract by March 2011. The project estimate included in this BCS is based on OPG's review of pricing as provided in the RFP responses. Award is planned to be complete by mid March 2011 in order to maintain the overall project schedule and to start construction by July 2011.

Expected Business Results

The expected business results are:

- Design, construction and commissioning of a multi-purpose complex, referred to as the Darlington Refurbishment Complex ("DRC") which will support project readiness for the Darlington Refurbishment Program. This complex will provide the long-term facility for specialized maintenance and other Darlington support functions upon completion of the Darlington Refurbishment program.

The expected benefits of the DRC include:

- A multi-purpose building to meet the needs and timeline of the Darlington Refurbishment Program, including an area available for usage for a mock-up and testing facility for fuel channel and feeder replacement ("R&FR") work in preparation for refurbishment outage execution, a warehouse, a new Information Centre, training and security in-processing centres, and as a project management team office for the Refurbishment Program.

- Upon completion of the refurbishment project, the DRC will allow the consolidation of leases and co-location of support staff, including Inspection and Maintenance (IMS), closer to the Darlington site.

This project is categorized as a Strategic investment due to its requirement to be in place to meet the timeline of the Darlington Refurbishment Program. The in-service date of mid 2013 for this facility will provide sufficient time for the reactor mock-up tool testing and training in order to meet the timeline for the early start date of the first unit refurbishment in October 2015.

The reactor mock-ups are excluded from the scope of the DRC. The reactor mock-ups project will include the design, supply and installation of the reactor mock-ups, and any required changes to the DRC including electrical trenching to house and support the mock-ups.

Funding for this project is listed in the approved Nuclear Refurbishment Business Plan and included as part of the Darlington Refurbishment Preliminary Planning Release #3 as approved by OPG's Board of Directors on November 19, 2009. The current estimate exceeds the estimate in that Release by $14.9M.

In March 2010, a total release of $19.7M was approved for Phase 1, Land Development and Phase 2, Site Servicing and Contract Tendering of this project. OPG executed subdivision and servicing agreements with the Municipality of Clarington and Durham Region. The tendering process for installation of services is scheduled to be initiated in December 2010. Site servicing installation is planned to commence in February 2011 with completion of necessary infrastructure to the DRC by June 30, 2011 to allow construction to commence in July, 2011. Specifications for the DRC were finalized; an RFP was issued and closed and evaluation of the proposals is currently underway.

The purpose of this Business Case Summary is to obtain Senior Management and Board concurrence to access previously approved funds under Release #3, to award a contract in Q1 2011, and to design, construct, and commission the Darlington Refurbishment Complex Project.

2. SIGNATURES

Submitted by:

Dec 9, 2010

Dietmar Reiner — Date
SVP - Nuclear Refurbishment

Recommended by:

DEC 10, 2010

Bill Robinson — Date
EVP - Nuclear Refurbishment, Projects, and Support

Finance Approval by:

Dec 13, 2010

Donn Hanbidge — Date
SVP & Chief Financial Officer

Executive Approval by:

Dec 13, 2010

Tom Mitchell — Date
President & CEO

3. BACKGROUND & ISSUES

Based on an identified need for additional facilities in the Clarington area, Real Estate Services contracted a national real estate brokerage firm to pursue land acquisition opportunities. A conditional Agreement of Purchase and Sale was signed in March 2007 to purchase a 61 acre property on Osborne Road, west of the Darlington Site. Due diligence activities were completed in June 2007, and the purchase closed in July 2007. The Draft Plan of Subdivision was approved by the Municipality of Clarington on March 24, 2009, and the Subdivision Agreement was executed on July 27, 2010.

The Darlington Refurbishment project, through a Retube and Feeder Replacement ("R&FR") this study, and as documented in NK38-REP-09701-10001, identified the need for a training, mock-up and testing facility within 20 km of the station. The facility will include an extensive reactor mock-up, training, and warehousing facilities to support full R&FR tool set integration testing, for procedure development and crew training. Based on operating experience from other refurbishments, the R&FR study recommended that the training and mock-up facility be available by the fall of 2013 for tool testing and training.

In November, 2009, OPG's Board of Directors approved the overall timeline and release strategy for the refurbishment of the Darlington NGS units, and funding for the preliminary planning phase which includes the development of infrastructure such as the Darlington Refurbishment Complex.

As part of a strategy to address other business needs, create efficiencies and maximize the occupancy of the facilities, the DRC will house other OPG programs and services including components of the Security Program, processing for new staff and a new Information Centre to replace the current facility on-site which will be used by the Nuclear Refurbishment organization. Further, during the refurbishment period, due to the increased volumes of construction staff and transport vehicles for material and equipment, it is advisable to limit public access to the site, to the extent feasible, during the refurbishment period. The DRC is a good location due to its proximity to the Darlington station, Waterfront Trail, Highway 401 and access roads.

Specifications for the DRC were finalized in 2010 and an RFP was prepared and issued. Based on the operating experience from other nuclear unit refurbishments underway a 70,000 sq. ft. Warehouse is included to meet the needs of two units being refurbished in a staggered pattern. The RFP closed on November 17, 2010. Proposals are currently being evaluated and form the basis of the Full Release amount. The contract will be awarded subsequent to this Full Release.

The following is a summary of the components and square footage of the proposed facility per the RFP Layout Plans:

Component	Footage in Sq. Ft.
Office Space with 448 offices per block plans approved July 23, 2010.	100,000
TMB Mock-up area – with 50' Ceiling	49,922
Refurbishment Warehouse & Storage for Tools	69,500
Change Rooms, Cafeteria, Miscellaneous Training Facilities	25,998
Calibration, Welding and Fabrication Shops	6,600
Information Centre	9,000
Security Loading Bay	9,450
Aisle ways & corridors	10,000
Total	**280,470**

The following is a breakdown of offices by floor and user:

Offices by Floor & User	Refurbishment	Security	Public Affairs	Facilities	Total Offices
First Floor	0	15	11	8	34
Second Floor	176	32	0	0	208
Third Floor	206	0	0	0	206
Total	**382**	**47**	**11**	**8**	**448**

4. ALTERNATIVES & ECONOMIC ANALYSIS

The following alternatives were considered:

Base Case: Do Nothing (Contractor provides Training and Mock-up Facility)

Assume that the Retube and Feeder Replacement contractor has a training and mock-up facility in place and that OPG is not required to develop one.

Additionally, OPG would still need to construct a complex to meet Refurbishment Program needs such as training, additional project management offices in addition to the Construction management office to be build on the Darlington site, security in-processing for new hires (staff or contractors), and warehousing.

To do nothing would have the following impacts:

- Additional travel time and potential schedule delays for tooling modifications as the contractor facility would be further away.
- Increases the risk of a delay in the start of the Darlington Refurbishment outages and a risk of increased idle time on the third and fourth units to be refurbished due to the delayed start.
- Increased risk of critical path delays during the Darlington Refurbishment outages as a result of incomplete tool testing and training.
- Longer security processing of contractors/staff supporting Refurbishment as the DRC will include a security processing centre.

Due to the above noted impacts, the Base Case is not recommended.

Alternative 1: Construct a Darlington Refurbishment Complex at the Clarington Energy Centre (Recommended Alternative).

This alternative is the development of a 280,000 sq. ft. Darlington Refurbishment Complex ("DRC") on OPG owned lands in the Clarington Energy Centre to the west of the Darlington NGS site. This multi-purpose DRC will meet the needs and timeline of the Darlington Refurbishment project, including housing of the full-size mock-up, tooling, training and testing facility for fuel channel and feeder replacement work in preparation for refurbishment execution, a 70,000 sq. ft. warehouse to store refurbishment materials, an office area to accommodate the off-site project management team and support staff, a security in-processing centre, and a new information centre.

The Present Value of this option is -$96.6M. This NPV does not include the benefit of additional OPG usage of the DRC post refurbishment. Additionally, this NPV does not consider the benefit of reducing the refurbishment outage period; the DRC and mock-ups will be used to test tooling and train staff in order to reduce delays on the critical path of the refurbishment outage. Without the DRC and mock up, due to increased risks, the refurbishment duration would be expected to be longer. This benefit has not been considered, however, a savings of just 2 months per unit would result in a positive NPV for this project.

Alternative 1 is being recommended for the following reasons:

- The proposed location for the DRC at the Clarington Energy Centre is in close proximity to the Darlington site resulting in decreased transportation and relocation costs associated with the use of an alternate OPG-owned site, such as Wesleyville.
- The DRC consolidates facilities to meet Darlington Refurbishment needs, including project offices, warehousing, training and in-processing.
- Co-location of the project team into a single facility will improve communication, teamwork, and productivity during the Darlington Refurbishment project life cycle.
- A custom-built warehouse will meet the special refurbishment requirements such as floor loading and ability to ship secure loads of materials to site reducing need for Salley port upgrades at Darlington.
- The off-site complex will alleviate the Security processing burden and congestion for the station.
- As the facility would be built off-site, it would be a commercial facility that would have commercial value in the marketplace.

Alternative 2: Construct a Darlington Refurbishment Complex with no Warehouse; and Lease Warehouse space.

This alternative is the Darlington Refurbishment Complex as described in Alternative 1 except with no warehouse, resulting in a total footage of 211,000 square-feet. Approximately 69,000 sq. ft. of warehouse space with 20,000 sq. ft. of office/common services space for procurement staff would be required.

For financial evaluation, 89,000 sq. ft. of warehouse space, at current lease rates, was considered; however, OPG would lease a facility that would meet the needs of OPG that was of similar size but likely not exactly 89,000 sq. ft. This would have a bearing on the final lease rates. Assuming that the warehouse was in the Durham region, extra transportation and labour costs

were included, however, based on two shipments every day, are not significant (about $18,000 per year). In addition to the ongoing rent, landlord operating costs and OPG operating costs, a same size loading bay, costing about $1M, would be required to meet the security requirement to fully enclose the transport truck and trailer. Based on the condition of the selected leased facility, additional leasehold improvements may also be required.

Not building a warehouse at the DRC could save approximately $10M (without escalation, contingency and capitalized interest) in project costs.

The Present Value of this option is -$97.7M, a difference of -$1.2M from recommended Alternative 1.

Alternative 2 is not recommended for the following reasons:

- The risks for damaging the tools would be increased due to transporting them from the leased warehouse to the Darlington Refurbishment Complex.
- Productivity could be impacted due to delayed shipment of tools from the leased warehouse as a result of unexpected traffic jam or accidents.
- Uncertainty in available warehouse space, requirements for leasehold improvements, and potential implications of a long term tenancy.

Alternative 3: Construct a Darlington Refurbishment Complex on the Darlington NGS site.

The Darlington Refurbishment Program explored the opportunity of locating the same Darlington Refurbishment Complex on the Darlington site.

This alternative is not recommended for the following reasons:

- The Present Value of this option is -$135.3M, a difference of -$38.7M from recommended Alternative 1. This is due to the higher cost to construct the facility on the Darlington Nuclear site.
- Due to limited land available on the Darlington site, the need to preserve the New Build lands and the increased traffic resulting from building the DRC on the Darlington site, this option is not preferred. The land should be used for personnel that directly support and interact with station workers reducing congestion on the Darlington site.
- Facilities constructed on the Darlington site would not have a commercial value (i.e. could not be sold) if no longer needed.

The key variables for each alternative are summarized below:

	Alternative 1	Alternative 2	Alternative 3
Location of DRC	CEC	CEC	DNGS
Refurbishment Warehouse	At the DRC	Lease 89,000 sq-ft	At the DRC
Total DRC Footage	280,000 sq-ft	211,000 sq-ft	280,000 sq-ft

Financial Analysis $M (until Refurbishment Project Close-out):

	Base Case	Alt. 1 (Recommended)		Alt. 2	Alt. 3
		Full Costs	Incremental Costs		
Initial Costs (Gross $M)*	N/A	105.4	103.6	96.1	164.3
NPV (2010 PV)	N/A	(98.1)	(96.6)	(97.7)	(135.3)

* Excludes Operating Costs and Leasing Costs.

Utilization of the DRC post-refurbishment, by IMS and/or other Nuclear Support organizations, and consolidation of lease costs (cost savings) were not included in the financial evaluations, however, provides additional value to the recommended alternative.

Warehouse fitting, racking, and the reactor mock-up are excluded from the financial evaluations. These options are required for all options and are treated as separate projects within the Darlington Refurbishment Program. See Section 5 for further details.

Additional Alternatives

The following alternatives were considered and eliminated.

Construct a Darlington Refurbishment Complex at another OPG location, i.e. Wesleyville
The Darlington Refurbishment Program explored and discounted the opportunity of locating the DRC and warehouse at OPG's Wesleyville site due to the following reasons:

- This location would result in additional transportation costs (staff and material) and employee relocation costs.
- The Wesleyville location (37 kilometres from Darlington site) would not be a feasible location to accommodate the Refurbishment project team, as suggested by Operational Experience from other refurbishment projects.

Construct a smaller Darlington Refurbishment Complex with less Office Space
This alternative is the Darlington Refurbishment Complex as described in Alternative 1 except with no third floor offices, resulted in a total footage of 242,000 square-feet.

This alternative would save approximately $14M in construction and associated furniture and information telecommunication infrastructure (without escalation, contingency and capitalized interest).

Insufficient offices at the DRC will require alternative leased office space and/or use of modular offices. Reducing the planned office space will likely move costs to other project rather than reduce them. As well, having refurbishment staff at many locations will reduce efficiency.

It was assumed that the same 39,000 square-feet of office space on the third floor would have to be leased somewhere in the Durham Region to meet the Darlington Refurbishment office need. In addition to the ongoing rent, and operating costs, leasehold improvements of about $5.8M would be required.

This option is not recommended for the following reasons:

- There are risks in assuming a 39,000 square-feet office facility will be available for lease in the Durham Region for occupancy in mid 2013. The Durham Region office market is very small with no significant development.
- Having some staff located in a separate leased facility is against the original intent of co-location of the project team into a single facility to improve communication, teamwork, and productivity.
- There would be increased traveling time and costs from staff located at the separate leased facility.
- Reduced flexibility to consolidate staff from the Pickering location to co-locate to Darlington upon closure of the Pickering Nuclear Station.

5. THE PROPOSAL

The scope of this full release includes work associated with the design, construction, and commissioning of the DRC at the Clarington Energy Centre.

The work plan for Phase 3 includes:
a) Negotiations and awarding the Design-Build contract for the DRC,
b) Execution of the contract by the Proponent,
c) Owners oversight of the contract, including project controls, and internal OPG reporting,
d) Taking possession and furnishing the offices by OPG, and
e) Commissioning of the facility by the Proponent and OPG.

This proposal excludes:
1. Design, construction, delivery and installation of the reactor mock-ups will be procured under a separate agreement and project. The DRC, however, will house the reactor mock-ups. Costs to service the property after construction and potential increased electrical service, floor work (trenches, conduits), until further defined, to house and support the mock-up will be included in the reactor mock-up project.
2. Racking, carousels or storage units in the warehouse and associated changes to lighting, HVAC, and sprinklers, as required. This will be managed as a separate project.
3. Equipment & infrastructure such as: forklifts, carts, welders, security x-ray machines, relocation changes for equipment or requirements of the x-ray machine & equipment, and tools and devices to support specific work group needs.
4. Information Centre custom artwork, exhibits or decals.
5. Internet wireless service in the building.
6. Staff relocation or move costs.

Project Assumptions include:
1. Floor loading for the reactor/fuel channel mock-up (85' x 259'), approximately 21,900 square-feet, would be 2400 Kg/square-metre. All other areas in the warehouse would be 440 lbs./sq.ft. live loads.
2. All classrooms, briefing rooms, and workstations are located in the office area of the building.
3. There are no mezzanines for storage of equipment or for use as classrooms in the warehouse.

The key milestones of this project are summarized below.

Phase 2: Site Servicing and RFP Phase (Funded by Phase 2 Partial Release)

Municipal Services

- Finalize Clarington Subdivision Agreement — Completed July 27, 2010
- Finalize Regional Subdivision & Servicing Agreement — October 29, 2010
- Award Tender for Site Servicing – Clarington (1) — January 31, 2011
- Award Tender for Site Servicing – Durham Region — January 31, 2011
- Site Servicing (2) — February, 2011 to June 30, 2013

Darlington Refurbishment Complex RFP

- Prepare DRC Specification — Completed
- Full Release BCS Approved — December 16, 2010
- Select EPC Contractor — January 31, 2011

Phase 3: Design, Construct, Commission TMB Complex (This Full Release) (3)

- Award EPC Contract — Mid March, 2011
- Design Complete — June 30, 2011
- Construction Start — July 1, 2011
- In-Service — July 1, 2013

(1) Both Clarington and Durham Region have confirmed that site services required for construction will be in place by June 2011 with all site servicing in place at time of full in-service of the DRC.
(2) The municipal services and the internal road works for the OPG CEC property and the municipal services to DNGS will be constructed during 2011 and the additional works scheduled for 2012 to 2013, are related to the South Service Road upgrades and local intersection improvements.
(3) Dates for Phase 3 are indicative, and were the basis for the RFP; however, exact timing will be confirmed upon selection of the EPC Contractor.

6. QUALITATIVE FACTORS

Other benefits associated with this project are as follows:

- The DRC provides additional benefits to the Darlington NGS station due to the water main design, water and sanitary sewer services to the site. This will provide the ability for the station to connect to regional water and sanitary sewer services and mitigating environmental concerns related to the operation of the waste treatment facility on the Darlington site. The addition of a sewage line addresses long standing MOE concerns with sewage discharge and removes the requirement for training and qualifying Nuclear Operators under Provincial license standards for Sewage Treatment Plant operations. Currently the station has only one source of domestic water; thus, the scheduling of water outages is difficult. The new water main design would eliminate the need for future domestic water outages at the station.
- OPG owned warehouse and offices at the DRC will add value as future warehouse and office space for Nuclear support functions, including Inspection and Maintenance Services Division, and in support of post refurbishment operations at Darlington.
- The DRC would follow the Leadership in Energy and Environmental Design Green Building (LEED) Canada guideline for green buildings that improves occupant well being, environmental performance and economic benefits through efficiency and sustainability. OPG has set an objective of a LEED 'Silver' rating for the building. Clarington recognizes

the community benefits of a LEED certified building and it may offer a reduced development charge fee.

- The DRC strengthens OPG's commitment to the Clarington community and Durham Region.

7. RISKS

The following project risks are being managed with respect to this Project:

Table - Risk Management and Contingency Plan

Risk Class	Description of Risk	Risk Probability	Risk Impact	Risk Management Strategies: Avoidance/Mitigation/Correction
Cost	Service cost increases due to change in scope after the Pre-submission Consultation.	Low	Low	OPG, Clarington and Durham have had several meetings to discuss the amount of supporting plans and technical reports required to complete the submission.
Cost	Higher than planned site servicing costs.	Low	Medium	The site servicing costs is based on an engineering estimate prepared by an external party and includes a 5% contingency. OPG has included 5% owner's contingency to deal with scope changes.
Cost	Higher than planned design and construction costs (Phase 3 risk)	Medium	Medium	The Full Release estimate represents the highest bid of the proponents and is based on project needs as identified in the RFP specifications. A 15% owner's contingency has been added to the Full Release estimate to deal with scope changes.
Cost	Costs will increase if the exclusions noted in Section 5 above are brought into the scope of this contract.	High	High	a) Scope and manage exclusions as a separate contract, where appropriate. b) Where appropriate and possible, scope and estimate exclusions early in the time period of this PO to minimize re-work.
Schedule	Delay in municipal approvals.	Low	Low	Clarington has verbalized support for the Site development and the development does not require changes to the Official Plan or Zoning By Law. Clarington has indicated priority processing for OPG development application. A delay is not anticipated but ongoing discussions with Clarington will ensure a timely delivery.
Schedule	Delay in awarding the tender and, hence, the completion of the site services, that are sensitive to seasonal construction, could have cost and schedule implications.	High	High	Provide the required documents and security bonds in a timely manner required for the tender. Escalate to Clarington Mayor and Regional Chair if staff is unable to resolve OPG's concerns on timing to tender for the works.

Table - Risk Management and Contingency Plan

Risk Class	Description of Risk	Risk Probability	Risk Impact	Risk Management Strategies: Avoidance/Mitigation/Correction
Schedule	Delay in the completion of the project (available for service date – July 2013)	Medium	High	There are only 3 months of float between the AFS and the need date for the R&FR contractor. Any delay beyond 3 months may reduce the testing and tool development time for the R&FR contractor increasing Refurbishment project execution risk. The EPC contract will require on-time delivery of this project. This risk will be re-evaluated closely upon awarding the EPC contract. In particular, the EPC contractor will need to submit their site plans as soon as possible after receipt of PO to ensure minimum delay as the submission is reviewed by Municipality.

8. POST IMPLEMENTATION REVIEW (PIR) PLAN

A simplified PIR will be carried out within one year of the completion of Phase 3, consistent with the Corporate PIR procedure.

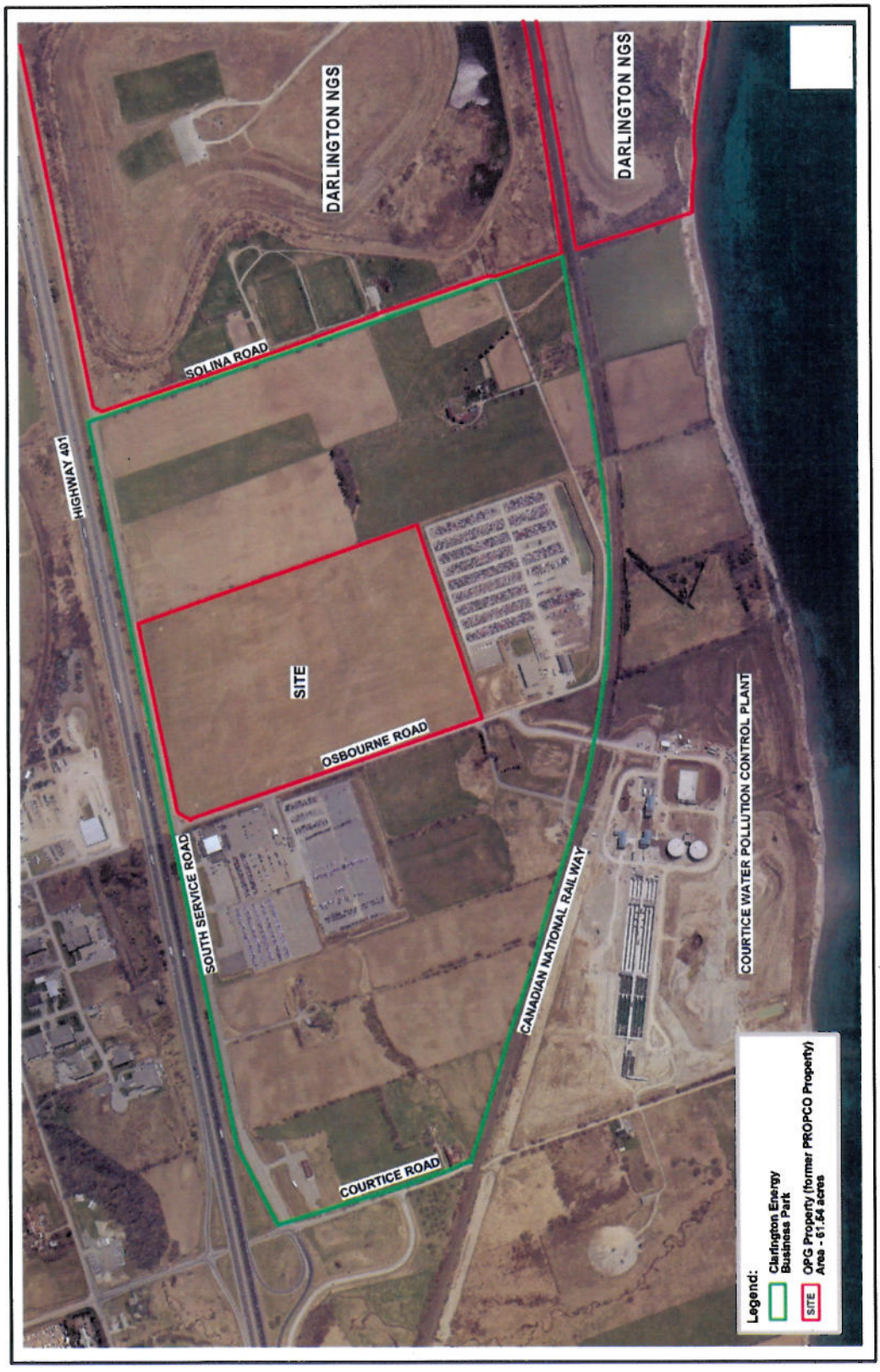
The PIR will be an independent and systematic performance evaluation of the project for these objectives:

- Assess the realization of the project benefits;
- Review project plan, implementation and operational performance;
- Review BCS – major assumptions, economic and financial evaluations looking back from results, for future decisions;
- Review project risk management; and
- Identify lessons learned for future improvement.

Type of PIR:	Target Project In Service date:	Target PIR Approval date:	PIR Responsibility (PIR Co-ordinator):
Simplified	**28-Jun-13**	**30-June-14**	Director, Planning & Project Control Nuclear Refurbishment

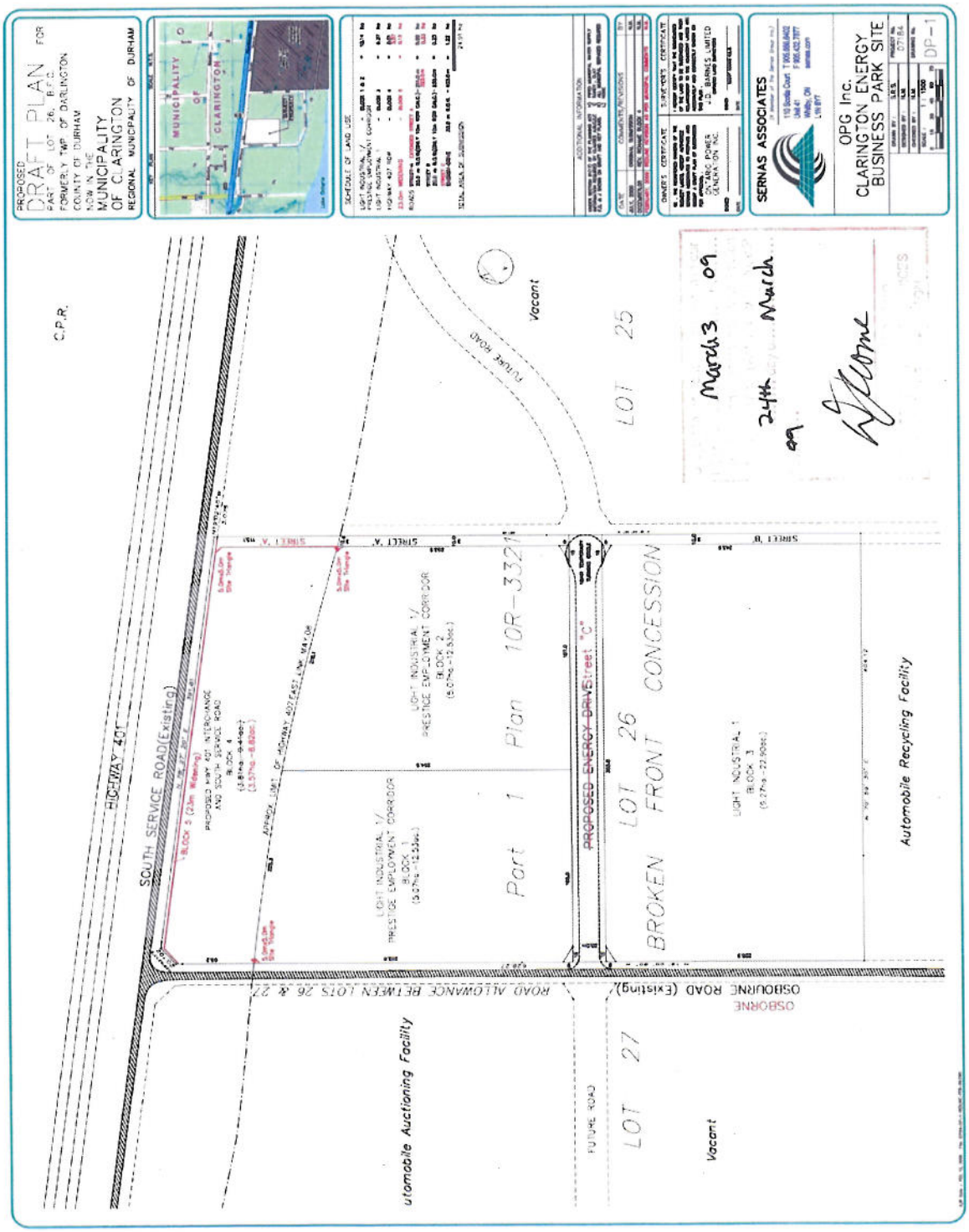
	Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
1.	Cost – Cost of Site Servicing	$15.8M including contingency and escalation	$15.8M	Final Project Cost Report	Director, P&PC
2.	Cost – Cost of DRC Construction	$70.8M Including apportionment of contingency and escalation, excluding furniture and IT	$70.8M	Final Project Cost Report	Director, P&PC
3.	Schedule – In-Service date	July 2013	July 2013	Date of Occupancy Permit	Director, P&PC
4.	LEED Certification	Achieves LEED Silver	Achieves LEED Silver Certification by June 30, 2014	Receipt of certification	VP, Real Estate Services
5.	Occupancy	Occupied by NR staff within 3 months of in-service	Oct 2013	Oct 2013	Director, P&PC

APPENDIX A: Site Plan

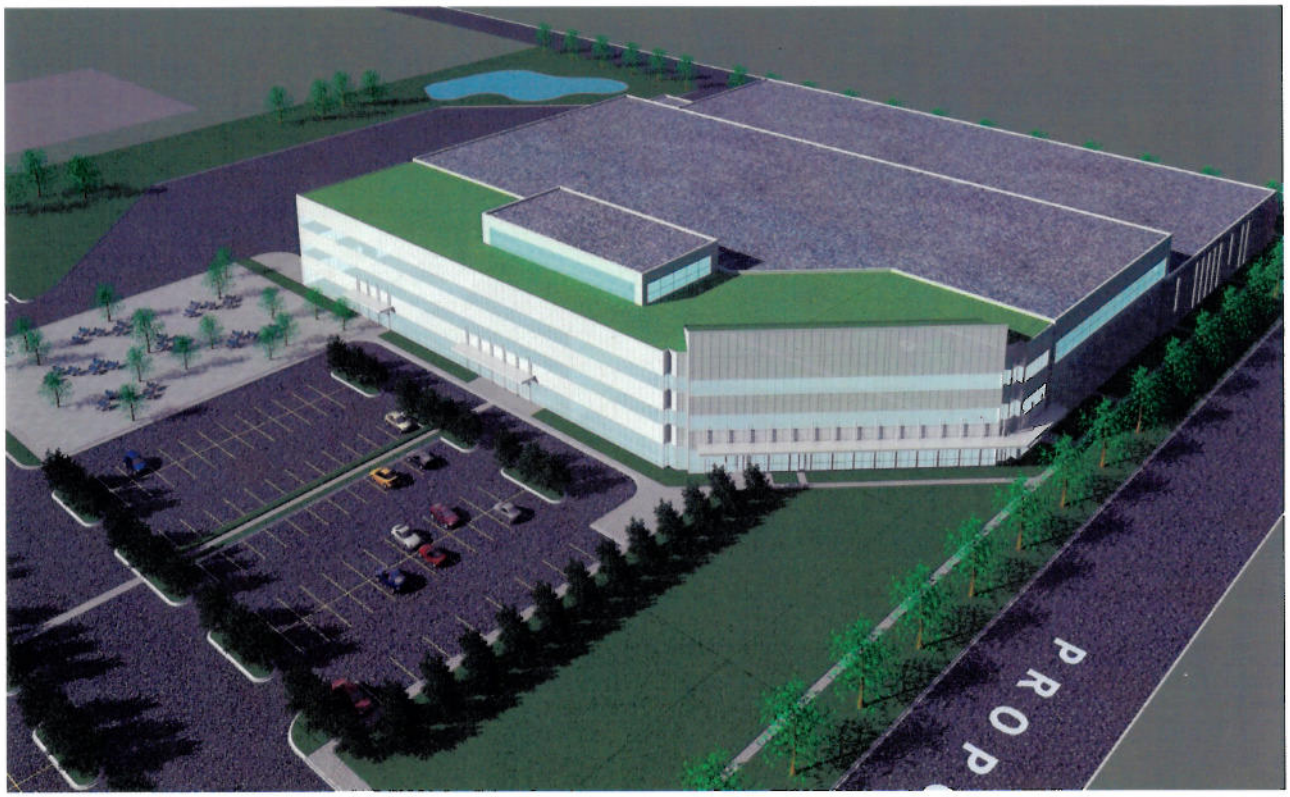


APPENDIX B: Approved Draft Plan of Sub-Division

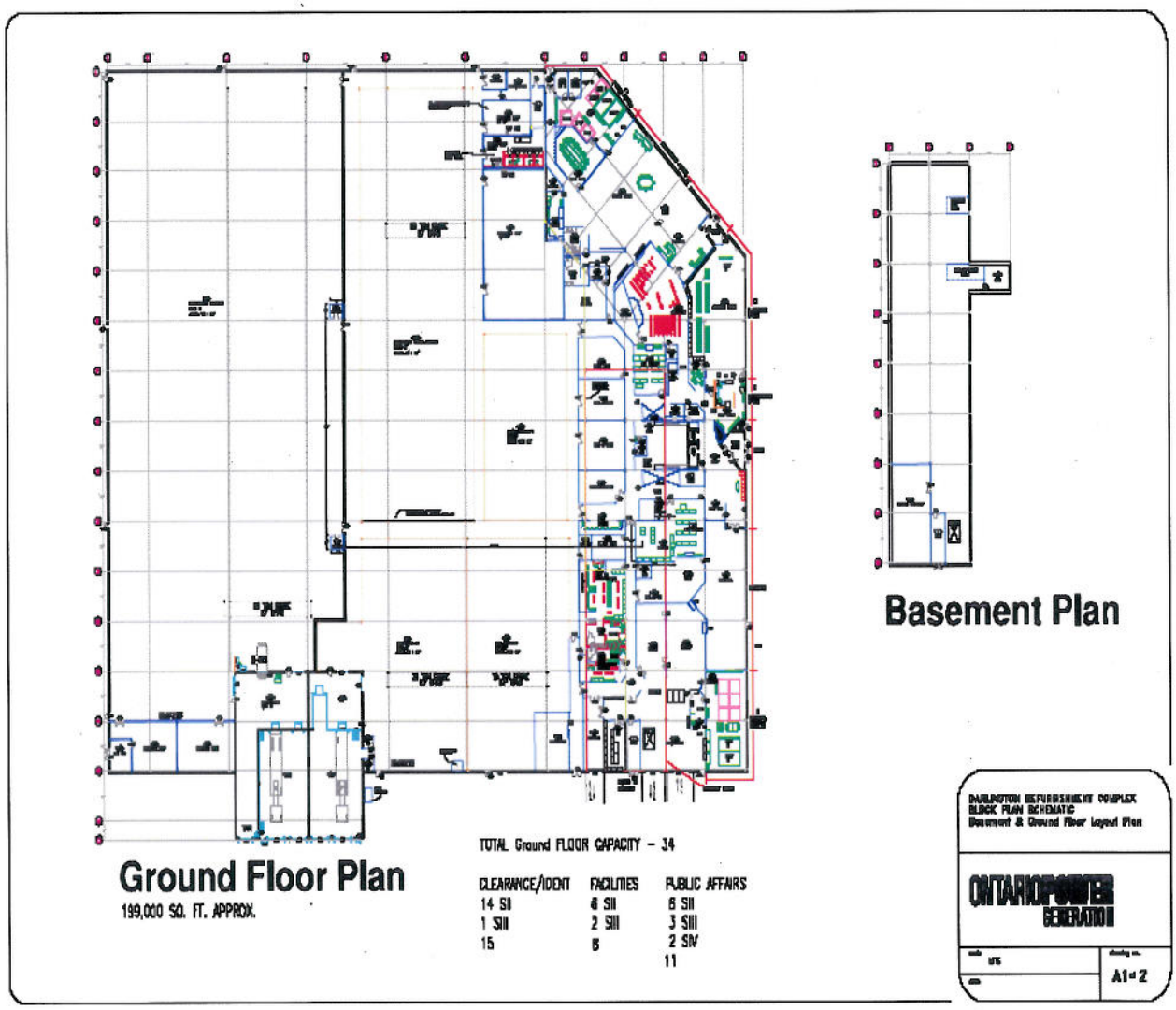
The following draft plan of sub-division was approved by the Municipality of Clarington on March 24, 2009:



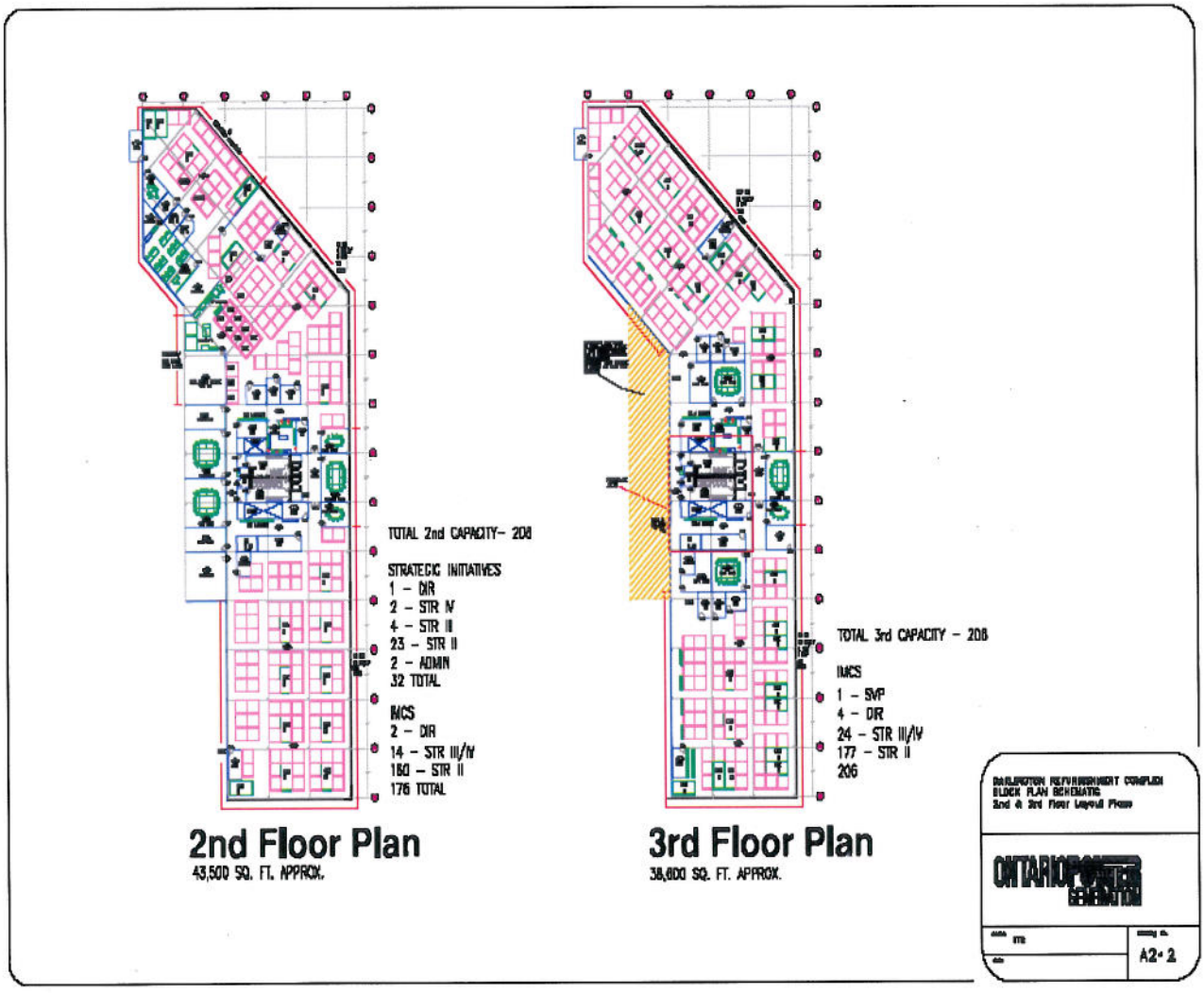
APPENDIX C: Proposed Site Plan



APPENDIX D: Ground Floor Layout Plan



APPENDIX E: Second & Third Floors Layout Plans



APPENDIX F: Summary of the Darlington Refurbishment Complex Needs Statement

The following is a summary of the needs of the DRC facility:

Organization	Function	Business Drivers
Nuclear Refurbishment	• Training for the re-tube and feeder replacement (R&FR) project • Mock-ups for training and equipment testing • Support R&FR prototype tool testing and development, as well as storage for R&FR tools. • Offices for project management team and support staff. • Warehouse in close proximity to site and mock-up to store tools, retube and other components with secure loading capability	• Address a need that provides training, mock-up, and testing in support of the Darlington Refurbishment timeline. • Provide facilities to accommodate the OPG project Management team. • Eliminate leasing costs.
IMS	• Location and design satisfies long-term business plan for IMS, enabling the discontinuance of multiple leases offsetting ongoing operational costs.	• Consolidate IMS Operations starting in 2024 upon completion of refurbishment. • Eliminate leases
Information Centre	• CEC is a good location for a temporary facility for the Information Centre due to its proximity to the Darlington station, Waterfront Trail, natural vegetation, 401 and access roads, including access roads to the station.	• Accommodates the Information Centre which will be over 30 years old when refurbishment ends, it will most likely at end of service life without significant re-investment.
Security	• Enhanced efficiency and effectiveness through consolidation of Nuclear Security Strategic Initiatives (Tactics and Training, Programs), Security Clearance, and Identification Office functions (badging, parking passes, etc.)	• Eliminate leasing costs. • Greater efficiencies and effectiveness in delivery of security program processing
Training	• Facilitation of Nuclear General Employee Training process for new hires (staff/contractors).	• Increased access and efficiency in Nuclear General Employee Training processing

The following is a summary of the components and square footage of the proposed facility per RFP Layout Plans:

Component	Footage in Sq. Ft.
Office Space for workstations/offices for 448 staff per block plans approved July 23, 2010.	100,000
TMB Mock-up area – with 50' Ceiling	49,922
Refurbishment Warehouse & Storage for Tools	69,500
Change Rooms, Cafeteria, Misc Training Facilities	25,998
Calibration, Welding and Fabrication Shops	6,600
Information Centre	9,000
Security Loading Bay	9,450
Aisle ways & corridors	10,000
Total	**280,470**

For Internal Project Cost Control

APPENDIX G: Phase 2 Partial Release Estimate

	Phase 1 Partial Release Approved $1,244k			Phase 2 Partial Release Approved at March 2010 Board Meeting					
	Actual Cost (k$)			Estimated Costs (k$)					
Year	2008	2009	Total	2010	2011	2012	2013	Total	%
Engineering Design		270	270	56	25	25	25	131	1
Consultants/Application Fees	150	339	489						
Subdivision Agreement				199	315	57	5	576	3
Construction				150	9,257	3,160	250	12,818	69
Other Contracts - Hydro One WAN Costs				50	600	600	33	1,283	7
RFP Specification & Tender				840				840	5
Owner's Contingency (5%)				15	510	192	16	733	4
Cost Escalation (2%/year)				0	214	163	20	397	2
Interest on Capital (6%)				22	373	855	618	1,868	10
Total Project	**150**	**609**	**759**	**1,332**	**11,294**	**5,053**	**966**	**18,645**	100
	Phase 1 (Capital) $759k			**Phase 2 (Capital) $18,645k**					

Project Estimates Approved By:

Ray Davies — Dec 7/10.
Ray Davies — Date
Real Estate Strategy Manager
Real Estate & Services

Assumptions

Following are the key assumptions used during the development of this release:

1. Phase 2 cost estimates were provided by OPG consultant Sernas Associates, and are in 2010 dollars($).
2. Phase 2 work on Subdivision Agreement, Site Servicing, DRC RFP Specification and Tender are treated as capital costs.
3. Owner's Contingency allowance is based on 5% of total direct costs.
4. Cost escalation was added to total costs including contingency based on 2% per annum.
5. Interest charge on capital is based on 6% per annum, and Phase 2 will be 100% in-service July 1, 2013.
6. No cost sharing from Durham, Clarington or others assumed at this time.

In 2007 the following costs were incurred as the result of the land purchase, this is excluded from above estimate.

Land Purchase	$4,923 K
Real Estate Commission	98
Land Transfer Tax	72
Realty Taxes	1
Consultants for Due Diligence	87
Total 2007 Costs	**$ 5,181 K**

APPENDIX H: Phase 3 Full Release Estimate

The following chart summarizes the Full Release estimate for Phase 3, the design and construction of the DRC and includes an analysis of estimate change since the March 2010 Partial Release.

	Phase 3 DRC Design and Construct Release Estimate (+15%/ -10%)						
	Estimated Costs (k$)						
Year	2010	2011	2012	2013	Total		%
Capital Costs							
Design and Construction		17,021	28,511	14,468	60,000		70
Commissioning				130	130		0
LEED Consultant			100	250	350		0
Other Contracts		200	300	190	690		1
IT & Furniture for Refurb Offices			3,365	4,207	7,572		9
Owner's Contingency (15%)		2,583	4,673	2,676	9,933		12
Cost Escalation (2%/year)		56	341	456	853		1
Interest on Capital (6%)		537	2,206	2,035	4,778		6
Total Capital Costs		**20,397**	**39,496**	**24,412**	**84,306**		**98**
OM&A Costs							
IT & Furniture for other offices			635	793	1,428		2
Owner's Contingency (10%)			63	79	143		0
Cost Escalation (2%/year)			28	53	82		0
Total OM&A Costs			**726**	**926**	**1,652**		**2**
Total Project	**0**	**20,397**	**40,222**	**25,338**	**85,958**		**100**

Project Estimates Approved By Project Manager:

Dec 7, 2010

Don Seedman — Date
Manager, Facilities & Projects
Real Estate & Services

Assumptions

Following are the key assumptions used in the above Full Release estimates (based on highest RFP bid price):

1. The total design & construction costs for Phase 3 equates to $259 per square-feet at 2010$ for non-warehouse and $100 per square-feet for warehouse & loading bay, based on the gross building area of 280,000 square-feet.

2. Owner's Contingency allowance is based on 10% of IT & Furniture and 15% of design & construction direct costs.
3. Cost escalation was added to total costs including contingency based on 2% per annum.
4. Interest charge on capital is based on 6% per annum, and Phase 3 will be 100% in-service July 1, 2013.
5. Annual operating costs is about $5.3M in 2010$ including utility costs, property taxes, facilities and IT services costs, commencing July 1, 2013; It equates to $10 per square-feet for warehouse/Mock-ups/Shops and $29 per square-feet for offices, Information Centre and other miscellaneous facilities.
6. Further development of the DRC design requirements, since the March Definition Phase release, has led to additional project design & construction costs of approximately $7M (excluding capitalized interest and contingency) due to the following:

   Clarington Energy Centre related requirements:
   a) Prescribed requirements for external finishes, storm water location, etc. (+$1.3M)
   b) Unexpected site conditions: sub-soil investigation revealed a higher than anticipated water table, requiring dewatering during construction, foundation construction changes and on-going maintenance (+$0.7M)

   OPG newly identified requirements:
   a) Security upgrades around the Loading Bay (+$1.0M)
   b) Hallways and walkways (+$1.0M)
   c) Increased Refurbishment warehouse space of 30,000 square-feet (+$3.0M)

   Item (c) is an increased scope based on OPEX from other current refurbishments and further consideration of Darlington Refurbishment's unit overlap execution scenario.

APPENDIX I: Cost Variances from Business Plan

The following summarizes the cost variances from the 2010 to 2014 approved business plan, as related to the Darlington Refurbishment Complex project:

Total Investment Cost: $105,362k ($103,710k Capital & $1,652k OM&A)
(Including $19,686k Capital previously approved)

1) Capital Cost Summary

Capital Funding $ 000's		LTD Dec 2009	2010	2011	2012	2013	2014	Total
Current Release	Project Costs	759	6,188	6,795	4,318	846	0	18,906
	Contingency	0	301	303	162	14	0	780
	Total	**759**	**6,489**	**7,098**	**4,480**	**860**	**0**	**19,686**
This Release	Project Costs	0	(4,871)	21,803	35,366	21,841	0	74,139
	Contingency	0	(286)	2,790	4,703	2,678	0	9,885
	Total	**0**	**(5,157)**	**24,593**	**40,069**	**24,519**	**0**	**84,024**
Total Release	Project Costs	759	1,317	28,598	39,684	22,687	0	93,045
	Contingency	0	15	3,093	4,865	2,692	0	10,665
	Total	**759**	**1,332**	**31,691**	**44,549**	**25,379**	**0**	**103,710**
Future Release	Project Costs	0	0	0	0	0	0	0
	Contingency	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Project Costs		**759**	**1,317**	**28,598**	**39,684**	**22,687**	**0**	**93,045**
Contingency		**0**	**15**	**3,093**	**4,865**	**2,692**	**0**	**10,665**
Total		**759**	**1,332**	**31,691**	**44,549**	**25,379**	**0**	**103,710**

Approved 2010-2014 BP		8,327	25,968	22,535	23,391	10,280	90,500
Variance to Business Plan		**(6,994)**	**5,724**	**22,014**	**1,987**	**(10,280)**	**13,210**

Removal Cost (Above)		0	0	0	0	0	0
Inventory W/O		0	0	0	0	0	0
Spare Parts in Inventory		0	0	0	0	0	0

2) OM&A Cost Summary

OM&A Funding $ 000's		LTD Dec 2009	2010	2011	2012	2013	2014	Total
Current Release	Project Costs	0	0	0	0	0	0	0
	Contingency	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
This Release	Project Costs	0	0	0	663	847	0	1,509
	Contingency	0	0	0	63	79	0	143
	Total	**0**	**0**	**0**	**726**	**926**	**0**	**1,652**
Total Release	Project Costs	0	0	0	663	847	0	1,509
	Contingency	0	0	0	63	79	0	143
	Total	**0**	**0**	**0**	**726**	**926**	**0**	**1,652**
Future Release	Project Costs	0	0	0	0	0	0	0
	Contingency	0	0	0	0	0	0	0
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Project Costs		**0**	**0**	**0**	**663**	**847**	**0**	**1,509**
Contingency		**0**	**0**	**0**	**63**	**79**	**0**	**143**
Total		**0**	**0**	**0**	**726**	**926**	**0**	**1,652**

Approved 2010-2014 BP		0	0	0	0	0	0
Variance to Business Plan		**0**	**0**	**726**	**926**	**0**	**1,652**

The Darlington Refurbishment Complex Phase 3 conceptual estimates plus capitalized interest and contingency were included in the Darlington Refurbishment Campus Plan submitted 2011-2015 Business Plan.

APPENDIX J: Project Variance Analysis

The following summarizes the variances from previous release:

Phase 2 Partial Release Estimate					
Capital ($000)	**LTD Oct 2010**	**Last BCS Feb 2010**	**This BCS Dec 2010**	**Variance**	**Comments**
Engineering Design	$33	$131	$131	$0	
Consultants/Application Fees	$0	$0	$0	$0	
Subdivision Agreement	$150	$576	$576	$0	
Construction	$0	$12,818	$12,818	$0	
Other Contracts/Costs - Hydro One WAN	$0	$1,283	$1,283	$0	
RFP Specification & Tender	$705	$800	$840	$40	Utilization of project contingency
Owner's Contingency (5%)	$0	$780	$733	-$47	Contingency reallocated to RFP
Cost Escalation (2% per year)	$0	$283	$397	$114	2010 site servicing work delayed to 2011
Interest on Capital (6%)	$10	$2,257	$1,868	-$389	Delay of work to 2011
Total Phase 2 Project Costs	**$898**	**$18,927**	**$18,645**	**-$283**	

Phase 3 Full Release Estimate					
Capital ($000)		**Last BCS Feb 2010**	**This BCS Dec 2010**	**Variance**	**Comments**
Design & Construction		$53,000	$60,000	$7,000	Warehouse increased by 30K sq-ft; Added 10K sq-ft loading bay and 10K sq-ft aisleways & corridors; Prescribed CEC requirements in external finishes and storm water location, and unexpected site conditions.
Commissioning		$100	$130	$30	Higher costs due to larger footage
LEED Consultant		$200	$350	$150	Higher costs due to larger footage
Other Contracts		$500	$690	$190	Higher costs due to larger footage
Capitalized IT & Furniture		$0	$7,572	$7,572	Reclassification of NR IT & Furniture Costs
Owner's Contingency		$8,070	$9,933	$1,863	Higher contingency due to higher direct costs
Cost Escalation (2% per year)		$2,530	$853	-$1,677	Escalation included in current D&C Costs
Interest on Capital (6%)		$3,766	$4,778	$1,012	Higher interest due to higher direct costs
Total Capital Costs		**$68,166**	**$84,306**	**$16,140**	
OM&A ($000)		**Last BCS Feb 2010**	**This BCS Dec 2010**	**Variance**	**Comments**
IT & Furniture for Offices		$11,000	$1,428	-$9,572	Reclassification of NR IT & Furniture Costs
Owner's Contingency (10%)		$1,100	$143	-$957	Lower contingency due to lower direct costs
Cost Escalation (2% per year)		$626	$82	-$544	Lower escalation due to lower direct costs
Total OM&A Costs		**$12,726**	**$1,652**	**-$11,074**	
Total Phase 3 Project Costs		**$80,892**	**$85,958**	**$5,066**	

Note: The Feb 2010 BCS represents a total release of $19.7M including $0.8M for Phase 1, Land Development and $18.9M for Phase 2, Site Servicing and Contract Tendering of this project.

APPENDIX K: Financial Model Assumptions

Following are the key assumptions used during the modelling of the Project:

Project Cost Assumptions:

1. The total area of the complex is estimated at 280,000 square-feet; 448 staff.
2. The total design & construction costs for Phase 3 equates to $259 per square-feet at 2010$ for non-warehouse and $100 per square-feet for warehouse & loading bay, based on the gross building area of 280,000 square-feet.

Financial Assumptions:

3. The discount rate is 7% (Regulated Nuclear asset) for this strategic investment decision.
4. The Ontario CPI (2% per year) is used to convert the cost estimates in 2010$ to "Dollars of the year".
5. CCA Rate 6% or Class 1* is being used for new non-residential buildings.

Project Life Assumptions:

6. The Phase 2 Municipal Site Servicing will be completed by July 1, 2013.
7. The design, construction and commissioning of the DRC at the CEC will take about 2 1/2 years.
8. The DRC at the CEC will be in-service by July 1, 2013.

Operating Cost Assumptions:

9. Annual operating costs for the DRC is estimated at $5.3M in 2010$ including utility costs, realty taxes, facilities and IT services costs, commencing July 1, 2013. It equates to $10 per square-feet for warehouse/Mock-ups/Shops and $29 per square-feet for offices, Information Centre and other miscellaneous facilities, based on the gross building area of 280,000 square-feet.

Other Assumptions:

10. The following are not included in the cost estimates:
    - Reactor mock-ups Including the design, construction, delivery and installation will be procured under a separate agreement and project. Costs to service the property after construction and potential increased electrical service, until further defined, to house & support the mock-up.
    - Floor work (trenches, conduits) to support the internal of the mock up area or the warehouse.
    - Racking, carousels or storage units in the warehouse or support infrastructure.
    - Equipment such as; forklifts, carts, welders, security x-ray machines, relocation changes for equipment or requirements of the x-ray machine & equipment, and tools and devices to support specific work group needs.
    - Information Centre custom artwork or decals.
    - Internet Wireless service in the building.
    - Staff relocation costs, incremental travel costs or warehouse transportation costs.
    - Office moving costs of affected organizations such as Nuclear Refurb, Information Centre & Security
11. Potential cost recovery of some of the servicing costs if other developers build within the CEC is not included in this evaluation.
12. Incremental travelling time and costs are not included in the NPV calculation for the leased office space alternatives.

APPENDIX L: Indicative Schedule – Darlington Refurbishment Complex (Recommended Alternative)

Darlington Refurbishment Complex

ID	Task Name	Start	Finish	2010				2011				2012				2013			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	Phase 2: Site Services and RFP Spec																		
2	**Muncipal Services**	Mar-10	Jun-13																
3	Finalize Regional Subdivision & Servicing Agreement		Oct-10																
4	Award Tender for Site Servicing - Clarington		Jan-11																
5	Award Tender for Site Servicing - Durham Region		Jan-11																
6	Site Servicing	Feb-11	Jun-13																
7	**Darlington Refurbishment Complex RFP**	Mar-10	Dec-10																
8	Prepare DRC Specification (Completed)		Sep-10																
9	Full Release BCS Approved		Dec-10																
10	Select EPC Contractor		Jan-11																
11	Phase 3: Design , Construct & Commission DRC																		
12	Award EPC Contract		Mar-11																
13	Design Complete	Mar-11	Jun-11																
14	Construction Start	Jul-11	Jul-13																
15	In-Service		Jul-13																

Numbers may not add due to rounding.

Filed: 2016-05-27
EB-2016-0152
Exhibit D2
Tab 2
Schedule 10
Table 1

Table 1
Capital Expenditures Summary - Darlington Refurbishment Program ($M)

Line No.	Description	2013 Actual	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
	Darlington Refurbishment									
	Darlington Refurbishment Unit Refurbishment [1]									
1	Darlington Refurbishment Program - Definition Phase	318.0	463.1	485.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Darlington Refurbishment Program - Execution Phase	0.0	0.0	0.0	1,011.6	1,070.3	1,121.0	978.9	858.3	1,194.8
3	**Total Darlington Refurbishment Unit Refurbishment**	318.0	463.1	485.0	1,011.6	1,070.3	1,121.0	978.9	858.3	1,194.8
4	Facilities and Infrastructure Projects	100.6	152.0	148.2	164.1	19.6	0.4	0.3	0.0	0.0
5	Safety Improvement Opportunities	11.7	79.2	72.6	55.2	4.8	(0.0)	0.0	0.0	0.0
6	**Total Darlington Refurbishment**	430.3	694.3	705.8	1,230.9	1,094.6	1,121.4	979.2	858.3	1,194.8

Notes:
1 The DRP Unit Refurbishment includes the Unit 2, Unit 3, Unit 1, Unit 4, and early in-service projects.

Numbers may not add due to rounding.

Table 2
Capital Project Listing - Darlington Refurbishment Program
Projects ≥ $20M Total Project Cost [1,2]

Line No.	Facility	Project Name	Project Number	Category	Start Date	Final In-Service Date	Total Project Cost ($M)	Partial/Devmt Release ($M)	Initial Full Release ($M)	Superceding Full Release ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
		ONGOING PROJECTS FROM EB-2013-0321														
1	DN	Darlington Refurbishment - Unit Refurbishment - Unit 2	Various	Unit Refurb - Unit 2	2010	Feb-20	4,800.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,799.8	0.4
2	DN	R&FR - Tooling for Removal Activities	73112	Unit Refurb - Early In-service	Feb-12	May-16	87.0	0.0	0.0	0.0	87.0	0.0	0.0	0.0	0.0	0.0
3	DN	Heavy Water Storage Facility [3]	31555	F&IP	Nov-06	May-17	381.1	0.0	110.0	381.1	0.0	365.9	0.0	0.0	0.0	0.0
4	DN	Water & Sewer Project [3]	73802	F&IP	Jun-10	Nov-15	57.7	0.0	40.6	57.7	3.7	0.0	0.0	0.0	0.0	0.0
5	DN	Darlington Energy Complex [3]	73803	F&IP	Mar-10	Jul-13	105.4	0.0	105.4	0.0	0.9	0.0	0.0	0.0	0.0	0.0
6	DN	Retube Feeder Replacement Island Support Annex [3]	73810	F&IP	Sep-11	Oct-15	40.7	0.0	40.7	0.0	40.4	0.0	0.0	0.0	0.0	0.0
7	DN	Refurbishment Project Office [3]	73815	F&IP	Sep-11	Jan-16	99.9	0.0	99.9	0.0	7.6	0.0	0.0	0.0	0.0	0.0
8	DN	Electrical Power Distribution System [3]	73821	F&IP	Nov-10	Oct-15	20.8	0.0	16.9	20.8	2.4	0.0	0.0	0.0	0.0	0.0
9	DN	Third Emergency Power Generator [4]	73360	SIO	Apr-12	Oct-16	120.4	0.0	77.2	120.4	105.3	0.0	0.0	0.0	0.0	0.0
10	DN	Containment Filtered Venting System [4]	73365	SIO	Aug-13	Aug-16	80.3	0.0	80.6	0.0	80.1	0.5	0.0	0.0	0.0	0.0
11		**Subtotal**					5,793.5				327.4	366.4	0.0	0.0	4,799.8	0.4
		COMPLETED PROJECTS FROM EB-2013-0321														
12		No projects in this category					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13		**Subtotal**					0.0				0.0	0.0	0.0	0.0	0.0	0.0
		PROJECTS NOT IN EB-2013-0321														
14		No projects in this category					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15		**Subtotal**					0.0				0.0	0.0	0.0	0.0	0.0	0.0
16		**Total - Projects ≥ $20M Total Project Cost**									327.4	366.4	0.0	0.0	4,799.8	0.4

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period.
2 In-Service forecasts reflect RQE.
3 For F&IP, Total Project Cost and release information reflect approved Business Case Summary.
4 For SIO, Total Project Cost and release information reflect approved Gate Progression Form or Change Control Form.

Numbers may not add due to rounding.

Filed: 2016-05-27
EB-2016-0152
Exhibit D2
Tab 2
Schedule 10
Table 3

Table 3
Capital Project Listing - Facilities & Infrastructure / Safety Improvement Opportunities Projects
Projects $5M - $20M Total Project Cost [1,2]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project Cost ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		ONGOING PROJECTS FROM EB-2013-0321												
1	DN	Fuel Handling - IFB Heat Exchanger Plate Replacement	73164	Unit Refurb - Early In-service	Replace the plate packs for all 8 heat exchangers of the irradiated fuel bay system to restore cooling capacity and mitigate margin management issue	Mar-14	Jul-15	6.4	0.2	0.0	0.0	0.0	0.0	0.0
2	DN	Balance of Plant - Negative Pressure Containment	73471	Unit Refurb - Early In-service	Provide a redundant monitoring capability in Unit 3 for negative pressure containment parameters used in three safety related systems	Apr-12	Oct-16	5.1	4.0	1.1	0.0	0.0	0.0	0.0
3	DN	Balance of Plant - Heavy Water Islanding Modifications	73472	Unit Refurb - Early In-service	Provide isolation valves and a redundant pressure relief path for the headers used to transfer moderator and primary heat transport heavy water between units and the heavy water processing facility	Apr-12	Aug-16	5.6	5.6	0.0	0.0	0.0	0.0	0.0
4	DN	Balance of Plant - Low Pressure Service Water	73514	Unit Refurb - Early In-service	Re-orient a valve to allow a hose connection to be attached as part of the low pressure service water temporary modifications during Unit 2 refurbishment	Oct-14	Feb-18	6.4	0.0	0.0	6.4	0.0	0.0	0.0
5	DN	GM Facility Interim Office Leasehold Improvements [3,5]	73806 / 73814	F&IP	Make leasehold improvements for the Nuclear Refurbishment Interim Office Facility at 1908 Colonel Sam Drive "GM Facility" that will accommodate the Nuclear Refurbishment organization and some delegated support staff for the period between the fall of 2010 until the fall of 2013 when the Darlington Energy Complex is ready for use	Mar-10	Feb-20	9.3	0.0	0.0	0.0	0.0	8.5	0.0
6	DN	Vehicle Screening Facility [3]	73817	F&IP	Build an extension to the vehicle screening infrastructure at the DNGS Sally Port to increase throughput of vehicles entering/exiting the Darlington Protected Area at the Sally Port from the refurbishment and Campus Plan projects	Jun-13	Oct-14	6.6	2.4	0.0	0.0	0.0	0.0	0.0
7	DN	Powerhouse Steam Venting System Improvements [4]	73370	SIO	Increase nuclear safety margins by the addition of a second redundant control loop in the Powerhouse Steam Venting System initiation logic	Oct-12	Oct-15	5.6	0.5	0.0	0.0	0.0	0.0	0.0
8	DN	Shield Tank Overpressure Protection [4]	73380	SIO	Install relief devices to the Shield Tank Cooling System in each Darlington Unit to prevent shield tank failure from over-pressureization under Beyond Design Basis Accidents	Jan-13	Jul-17	13.5	6.9	6.9	0.3	0.0	0.0	0.0
9	DN	Emergency Service Water Buried Services [4]	73398	SIO	Replace the buried Emergency Service Water Piping L6 due to extensive corrosive pitting observed during inspection	Jul-13	Nov-15	14.6	1.3	0.0	0.0	0.0	0.0	0.0
6		**Subtotal**						73.1	21.0	8.0	6.7	0.0	8.5	0.0
		COMPLETED PROJECTS FROM EB-2013-0321												
7		No projects in this category						0.0	0.0	0.0	0.0	0.0	0.0	0.0
8		**Subtotal**						0.0	0.0	0.0	0.0	0.0	0.0	0.0
		PROJECTS NOT IN EB-2013-0321												
9		No projects in this category						0.0	0.0	0.0	0.0	0.0	0.0	0.0
10		**Subtotal**						0.0	0.0	0.0	0.0	0.0	0.0	0.0
11		**Total - Projects $5M - $20M Total Project Cost**							21.0	8.0	6.7	0.0	8.5	0.0

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period.
2 In-Service forecasts reflect RQE.
3 For F&IP projects, Total Project Cost and release information reflect approved Business Case Summary.
4 For SIO projects, Total Project Cost reflect approved Gate Progression Form or Change Control Form.
5 These are temporary F&IP Projects that will continue to attract interest until the in-service date of the first refurbished unit.

Numbers may not add due to rounding.

Table 4
Capital Project Listing - Facilities & Infrastructure / Safety Improvement Opportunities Projects
Projects <$5M Total Project Cost[1,2]

Line No.	Project Name	Number of Projects	Total Project Cost ($M)	Average Cost Of All Projects ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	**Unit Refurbishment - Early In-service**	4	5.4	1.4	2.0	0.0	2.2	0.0	0.0	0.0
2	**Facilities & Infrastructure Projects**	1	0.9	0.9	0.0	0.0	0.0	0.0	0.9	0.0
3	**Total - Projects <$5M Total Project Cost**	5	6.3	2.2	2.0	0.0	2.2	0.0	0.9	0.0

Notes:
1 Projects with expenditures during Test Period, or In-Service Amounts in Bridge or Test Period.
2 Total Project Costs and In-Service forecasts reflect RQE.

Numbers may not add due to rounding.

Table 5
Comparison of In-Service Capital Additions - Darlington Refurbishment Program ($M)

Line No.	Business Unit	2013 Budget	(c)-(a) Change	2013 Actual	(g)-(c) Change	2014 OEB Approved	(g)-(e) Change	2014 Actual	(k)-(g) Change	2015 OEB Approved	(k)-(i) Change	2015 Actual
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1	**Darlington Refurbishment - Unit Refurbishment - Unit 2**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	**Darlington Refurbishment - Unit Refurbishment - Early I/S**	0.0	0.0	0.0	0.0	2.1	(2.1)	0.0	7.4	11.1	(3.7)	7.4
3	**Subtotal**	0.0	0.0	0.0	0.0	2.1	(2.1)	0.0	7.4	11.1	(3.7)	7.4
4	**Facilities & Infrastructure Projects**[1]	104.2	(5.0)	99.2	(55.7)	16.6	26.8	43.5	68.1	89.6	21.9	111.6
5	**Safety Improvement Opportunities**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.2	42.7	(14.5)	28.2
6	**Total In-Service Capital Additions**	104.2	(5.0)	99.2	(55.7)	18.7	24.8	43.5	103.7	143.4	3.7	147.1

Line No.	Business Unit	2015 Actual	(c)-(a) Change	2016 Budget	(e)-(c) Change	2017 Plan	(g)-(e) Change	2018 Plan	(i)-(g) Change	2019 Plan	(k)-(i) Change	2020 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
7	**Darlington Refurbishment - Unit Refurbishment - Unit 2**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,799.8	4,799.8
8	**Darlington Refurbishment - Unit Refurbishment - Early I/S**	7.4	91.4	98.8	(97.7)	1.1	7.5	8.6	(8.6)	0.0	0.0	0.0
9	**Subtotal**	7.4	91.4	98.8	(97.7)	1.1	7.5	8.6	(8.6)	0.0	4,799.8	4,799.8
10	**Facilities & Infrastructure Projects**	111.6	(54.1)	57.4	308.4	365.9	(365.9)	0.0	0.0	0.0	9.4	9.4
11	**Safety Improvement Opportunities**	28.2	166.0	194.1	(186.7)	7.4	(7.2)	0.3	(0.3)	0.0	0.0	0.0
12	**Total In-Service Capital Additions**	147.1	203.3	350.4	24.0	374.4	(365.5)	8.9	(8.9)	0.0	4,809.2	4,809.2

Line No.	Business Unit	2020 Plan	(c)-(a) Change	2021 Plan
		(a)	(b)	(c)
13	**Darlington Refurbishment - Unit Refurbishment - Unit 2**	4,799.8	(4,799.8)	0.4
14	**Darlington Refurbishment - Unit Refurbishment - Early I/S**	0.0	0.0	0.0
15	**Subtotal**	4,799.8	(4,799.8)	0.4
16	**Facilities & Infrastructure Projects**	9.4	(9.4)	0.0
	Safety Improvement Opportunities			0.0
17	**Total In-Service Capital Additions**	4,809.2	(4,809.2)	0.4

Notes:
1 2015 OEB approved for FIP was reduced by $66.0 million, the amount for the AHS and OSB projects that are now in the Nuclear Operations Portfolio.