PICKERING REFURBISHMENT PROGRAM OVERVIEW

1.0 SUMMARY

The Pickering Refurbishment Program ("Pickering Refurbishment" or "PRP") is a multi-year, multi-phase program at the Pickering Nuclear Generating Station ("Pickering") to enable the replacement or rehabilitation of life-limiting critical components and the completion of upgrades to meet regulatory requirements within Units 5-8. When completed, the PRP will allow Units 5-8 to continue safe and reliable operation for an expected additional 38 years based on 300,000 equivalent full power hours of pressure tube life.

OPG's Pickering Refurbishment planning efforts included reviews of operating experience and lessons learned from the Darlington Refurbishment Program ("DRP") and prior hydroelectric projects, as well as past CANDU and other nuclear refurbishments. Without refurbishment, Pickering Units 5-8 would cease commercial operation in 2026. Pickering Units 1-4 have ceased commercial operation.[1]

The PRP will be conducted in phases. OPG began the Feasibility Phase in 2022 following the Province of Ontario's (the "Province") request for OPG to update its feasibility assessment for refurbishing Pickering Units 5-8. In this phase, OPG assessed whether the refurbishment would be technically, economically, and operationally viable. In August 2023, OPG's Board of Directors approved the feasibility assessment. Subsequently, the Province announced their support in January 2024 for OPG to proceed with the next steps toward refurbishing Units 5-8. Next, the PRP began the Initiation Phase. In November 2024, with the OPG Board of Directors' approval, this phase was completed and the PRP transitioned into the Definition Phase. The Province also announced its support for the Definition Phase in January 2025. The detailed planning conducted by OPG and its contractors during the Definition Phase has enabled the development of a four-unit budget and schedule for the successful execution of

[1] Pickering Units 2 and 3 were laid up in 1997 and have been placed into a safe store condition for eventual dismantling. Pickering Units 1 and 4 have ceased operations in 2024 (October and December, respectively) and are in the process of lay-up, for safe store and eventual dismantling.

the PRP. Based upon this work, OPG prepared a detailed four-unit budget and schedule release quality estimate ("RQE"), which was approved by OPG's Board of Directors in November 2025.

Under the RQE, refurbishment of all four Pickering units will be completed in July 2034, with defueling starting in September 2026 and execution starting in January 2027. The first unit, Unit 5, is planned to be completed with a return to service date of May 2031. Unlike the DRP, OPG will be refurbishing all four units at the same time, with a staggered return to service schedule for each subsequent unit.

Based on the significant effort undertaken to develop the RQE, OPG has a high level of confidence in the four-unit PRP cost estimate of $26.84B, which includes contingency, interest and escalation. The RQE establishes a four-unit, program-level control budget that serves as the baseline against which the success of the PRP will be measured. A simplified breakdown showing PRP components included in RQE and their budget is provided in Chart 1 below. Life to date expenditures (to the end of September 2025) are $1.44B, inclusive of interest and escalation.

Chart 1 – Simplified Breakdown of Total PRP Release Quality Estimate[2]

#	Bundles / Category	RQE Total Cost ($B)	%
1	Retube, Feeder, & Boiler Replacement	7.85	29
2	Turbine Generators	3.27	12
3	Balance of Plant	1.75	7
4	Operations & Maintenance	2.26	8
5	Facilities & Infrastructure	0.41	2
6	Deep Water Intake	0.93	3
7	**Sub-Total Major Work Bundles**	**16.46**	**61**
8	Functional and Program Support	2.56	10
9	**Sub-Total Function and Program Support**	**2.56**	**10**
10	Contingency[1]	3.76	14
11	**Sub-Total before Interest**	**22.79**	**85**
12	Interest	4.05	15
13	**Total Release Quality Estimate**	**26.84**	**100**

[1] Contingency includes associated escalation.

On November 26, 2025, the Province announced that it had approved OPG's plan to refurbish Units 5-8 at Pickering, which will support the government's plan to protect Ontario workers and the province's long-term energy security.[3] In addition, the Province noted:

> Once completed, Pickering will generate an increased capacity of up to 2,200 megawatts (MW) of electricity, equivalent to powering 2.2 million homes. This will ensure Ontario has the energy it needs to power more homes and a strong, self-reliant and resilient economy.

[2] The PRP RQE does not include non-capital costs incurred mainly in 2023 related to conducting the feasibility assessment for the Pickering Units 5-8 refurbishment. These costs were recorded in the Capacity Refurbishment Variance Account and are sought for clearance in this Application (see Ex. H1-1-1, Section 5.6).

[3] Province of Ontario, News Release: *Ontario Greenlights Pickering Nuclear Generating Station Refurbishment to Create Nearly 37,000 Jobs*, November 26, 2025 <https://news.ontario.ca/en/release/1006772/ontario-greenlights-pickering-nuclear-generating-station-refurbishment-to-create-nearly-37000-jobs>.

> The project is expected to create approximately 30,500 jobs during refurbishment, while sustaining 6,700 jobs throughout the station's operation. With a final budget of $26.8 billion, more than 90 per cent of the project cost will be spent in Canada to support local businesses and deliver economic benefits across the province. Refurbishment and ongoing operation will increase Canada's GDP by $41.6 billion. OPG will deliver the project using the same disciplined planning, oversight, and partnership model that has kept the Darlington refurbishment on-time and on-budget. OPG has also committed to investing $100 million with Indigenous-owned companies over the life of the refurbishment project, ensuring that First Nations hosting nuclear facilities share directly in the economic benefits.[4]

OPG is currently completing the remaining major deliverables under the Definition Phase, with the plan to transition into the Execution Phase in January 2027.

The federal government has proposed a 15% refundable Clean Electricity investment tax credit ("CEITC") for certain clean electricity investments, including eligible refurbishment works, that could be available to OPG. At the time of filing, no legislation implementing this credit is in place and the CEITCs are not reflected in OPG's 2025-2031 Business Plan. OPG will account for such credits as a reduction in the capital costs of the underlying projects. As discussed elsewhere in the evidence, the Application proposes to return to customers the revenue requirement of the CEITCs through a series of variance accounts, including the Capacity Refurbishment Variance Account ("CRVA"). The CEITCs are discussed further in Ex. F4-2-1, Section 3.6.1.

The Application describes the progress and planning of the PRP to date and provides evidence to support its request for approval of the forecast PRP in-service amounts through 2031, OM&A expenditures during the IR term and, pursuant to Ontario Regulation 53/05 ("O. Reg. 53/05"), the recovery of interest amounts on capital expenditures for the PRP prior to the underlying

[4] *Ibid*.

assets being placed in service under the concurrent cost recovery ("CCR") framework.[5] OPG's pre-filed evidence demonstrates that:

- OPG has successfully performed detailed planning, including reviewing operating experience and lessons learned from the DRP and other projects, to determine the PRP scope and to establish high-confidence schedule and cost estimates for safely executing the Program, including the return to service of refurbished Unit 5 in the IR term; and
- The project has in place the resources, organization and processes necessary to execute the PRP in its entirety, safely, on time, on budget, and with the required quality level.

2.0 APPROVALS SOUGHT

This Application seeks approval for the following in respect of the PRP:

- In-service additions to OPG's rate base of: (i) $159.3M in the 2026 bridge year, and (ii) for the IR term, $20.6M in 2027; $0.0M in 2028; $0.0M in 2029, $0.0M in 2030, and $9,688.0M in 2031, all on a forecast basis. These amounts reflect the addition to rate base of $8,474.1M related to the Unit 5 in-service addition as well as $1,213.9M related to the Deep Water Intake in 2031, and $159.3M in 2026 and $20.6M in 2027 for Early In-Service Facilities and Infrastructure Projects. If actual additions to rate base or their timing are different from forecast amounts and their timing, the revenue requirement impact of the difference will be recorded in the CRVA and any amounts greater than the forecast amounts added to rate base will be subject to a prudence review in a future proceeding.
- OM&A expenditures of $100.3M in 2027, $94.1M in 2028, $84.9M in 2029, $52.7M in 2030, and $46.5M in 2031 (see Ex. F2-8-1).
- PRP CCR interest amounts on a forecast basis totaling $2,923.3M over the 2027-2031 period as described in Ex. I1-1-3 and calculated in Ex. I1-1-1, Table 7. If actual CCR interest amounts are different from the forecast amounts, the difference will be recorded in the Pickering B Refurbishment Project Variance Account for future disposition.

[5] As discussed in Ex. I1-1-3, O. Reg. 53/05 has established a framework for recovery of interest amounts for capital expenditures on the PRP prior to such assets being placed in service, effective January 1, 2026. The Application refers to this framework as concurrent cost recovery.

As discussed in Ex. H1-1-1, the CRVA will capture and return to customers the revenue requirement impact of any CEITCs received for the PRP during the IR term.

3.0 EVIDENCE ROADMAP

The evidence related to PRP is organized as follows:

- **Ex. D2-3-1 (PRP Overview)** – provides a summary of the PRP, the approvals sought, this evidence roadmap and a description of the relevant regulatory framework.
- **Ex. D2-3-2 (PRP Structure)** – describes OPG's overall commercial strategy for the PRP, which establishes OPG as the Program owner and defines OPG's relationships with its external contractors. This schedule also describes how OPG has structured itself as the Program owner as well as the management system structures used by OPG to exercise its role as owner.
- **Ex. D2-3-3 (PRP Major Work Bundle Structure and Contracts)** – describes how OPG has structured the major work bundles, as well as the contracting approaches that OPG has used for each of the major work bundles.
- **Ex. D2-3-4 (PRP Planning)** – describes the work undertaken during the planning process to develop an accurate scope, schedule and cost estimate for the PRP, including the incorporation of lessons learned from prior projects.
- **Ex. D2-3-5 (PRP Scope)** – describes the steps taken during the Definition Phase to define PRP scope, explains the importance of a well-defined scope to successful execution, provides an overview of the scope, and provides a scope comparison between the PRP and the DRP.
- **Ex. D2-3-6 (PRP Schedule)** – describes how the PRP schedule was developed, including how risks to the schedule were considered in the planning process.
- **Ex. D2-3-7 (PRP Contingency)** – describes the process by which the contingency amounts were determined and why the use of a contingency estimate is important to accurate costing.
- **Ex. D2-3-8 (PRP Costs and In-Service Amounts)** – describes the process by which the PRP Class 3 RQE was developed. It also provides a breakdown of these estimates by major work bundle and information on in-service amounts.

- **Ex. D2-3-9 (PRP Execution)** – describes how the execution of work will be managed with the goal of delivering PRP safely, on time, on budget, and with the required quality.
- **Ex. D2-4-10 (Independent Studies)** – provides a summary of Pegasus Global Holdings, Inc.'s independent and objective assessment of OPG's plan and approach to execution of the PRP. The final report is provided as an attachment to that schedule.
- **Ex. F2-8-1 (PRP OM&A)** – describes the OM&A amounts forecasts over the IR term.

A detailed breakdown of the PRP evidence structure is included in Attachment 3.

OPG has also engaged independent experts to review and verify key aspects of the PRP. The following independent expert reviews are provided in support of the evidence:

- KPMG review of the governance and processes to develop the RQE (Ex. D2-3-8, Attachment 1);

4.0 REGULATORY AND PLANNING FRAMEWORK

This section describes the key regulatory instruments, documents and frameworks that apply to the PRP.

4.1 Ontario Regulation 53/05 and Financing Mechanisms

Following the Province announcing its support for OPG to proceed with the Definition Phase for the PRP (discussed below) in January 2025, O. Reg. 53/05 was amended to allow OPG to record, in the now Pickering B Variance Account, costs that OPG is incurring for preserving resources and supporting infrastructure to enable potential refurbishment and subsequent operation of the units beyond September 30, 2026. As part of this amendment, the Province explicitly defined "Pickering B Refurbishment Project" in O. Reg. 53/05 to refer to "the work undertaken by Ontario Power Generation Inc. in respect of the refurbishment, in whole or in part, of some or all of the generating units of the Pickering B Nuclear Generating Station".

In December 2025, O. Reg. 53/05 was further amended, effective January 1, 2026, to introduce provisions for the recovery of interest amounts in respect of the PRP prior to the underlying assets being placed in-service. Further details are provided in Ex. I1-1-3.

4.2 Government Support

As discussed above, in September 2022, and in conjunction with its support for Pickering Units 5-8 extended operations into September 2026, the Province asked OPG to update its feasibility assessment for refurbishing Pickering "B" units at the Pickering Nuclear Generating Station, based on the latest information:

> Further operation of Pickering Nuclear Generating Station beyond September 2026 would require a complete refurbishment. The last feasibility study was conducted between 2006 and 2009. With significant economic growth and increasing electrification of industry and transportation, Ontario has asked OPG to update its feasibility assessment for refurbishing Pickering "B" units at the Nuclear Generating Station, based on the latest information, as a prudent due diligence measure to support future electricity planning decisions. Refurbishment of Pickering Nuclear Generating Station could result in an additional 30 years of reliable, clean and zero-emissions electricity from the facility.[6]

Pursuant to this request, in August 2023, OPG's Board of Directors approved OPG's Pickering Units 5-8 feasibility assessment, which was submitted to the Province. OPG's Board of Directors also decided to commence initial planning and early works on a limited basis for the PRP.

In January 2024, the Province announced its support for OPG to proceed with the next steps toward refurbishment. This included the PRP proceeding with the Project Initiation Phase, which includes engineering and design work as well as securing long-lead components that can require years for manufacturing.

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[6] Pickering "B" refers to Pickering Units 5-8. See: Province of Ontario, News Release: *Ontario Supports Plan to Safely Continue Operating the Pickering Nuclear Generating Station*, September 29, 2022 <https://news.ontario.ca/en/release/1002338/ontario-supports-plan-to-safely-continue-operating-the-pickering-nuclear-generating-station>.

In October 2024, the Minister of Energy and Electrification released *Ontario's Affordable Energy Future: The Pressing Case for More Power*, which confirmed the Province's continued support for refurbishing Ontario's nuclear facilities, including Pickering Units 5-8.[7]

In January 2025, the Province announced it is advancing plans to refurbish Pickering Units 5-8 by approving OPG's plan to proceed with the Project Definition Phase, the next step toward refurbishing Pickering Units 5-8.[8] As part of the preparation for refurbishment, the Province authorized OPG to sign a $2.1B contract with CanAtom for early engineering and procurement to prepare for the execution of the Retube Feeder and Boiler Replacement Program, creating more than 2,400 jobs across Ontario. It additionally noted its support for OPG's $4.1B budget for this phase of work, bringing the total investment to date in the project to $6.2B. As part of this announcement, the Province cited the Conference Board of Canada's ("CBoC") economic assessment of the PRP, noting that the full refurbishment project would create 11,000 jobs per year while contributing $19.4B to Ontario's GDP over 11 years.

The CBoC has subsequently updated its economic impact assessment in September 2025, which identified that the refurbishment and operation of Pickering Units 5-8 is expected to increase Ontario GDP by $38.2B (2024 dollars) over the project's lifespan.

In November 2025, the Province announced that it approved OPG's plan to refurbish Units 5-8 at Pickering. As part of the announcement, the Minister of Energy and Mines stated that, "For more than 50 years, nuclear power has been the backbone of Ontario's energy grid, with the Pickering Nuclear Generating Station as one of the best-performing and continuously operating nuclear stations in the world".[9] In addition, the announcement recognized that:

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[7] Province of Ontario, News Release: *Ontario's affordable energy future: The pressing case for more power,* October 2024 <https://www.ontario.ca/files/2024-11/energy-ontarios-affordable-energy-future-en-2024-11-07.pdf>, p. 8.

[8] Province of Ontario, News Release: *Ontario Advancing Plan to Refurbish Pickering Nuclear Generating Station*, January 23, 2025 <https://news.ontario.ca/en/release/1005620/ontario-advancing-plan-to-refurbish-pickering-nuclear-generating-station>.

[9] Province of Ontario, News Release: *Ontario Greenlights Pickering Nuclear Generating Station Refurbishment to Create Nearly 37,000 Jobs*, November 26, 2025 <https://news.ontario.ca/en/release/1006772/ontario-greenlights-pickering-nuclear-generating-station-refurbishment-to-create-nearly-37000-jobs>.

> Refurbishing Ontario's nuclear fleet is a key pillar of Energy for Generations, the province's first-ever integrated energy plan to ensure Ontario has the reliable, affordable power it needs to power new homes and drive economic growth. The government's integrated approach and record investments in energy infrastructure are also providing the certainty needed for Indigenous communities, municipalities, businesses and industry partners to invest confidently in Ontario's future. With a clear path forward, the plan is not only meeting the demands of today, but it is protecting jobs, supporting workers and powering economic growth for generations to come.[10]

4.3 CNSC Regulatory Framework

Nuclear power plants in Canada are subject to ongoing regulatory oversight by the Canadian Nuclear Safety Commission ("CNSC"), including periodic licence renewal. OPG must adhere to the requirements of the *Nuclear Safety and Control Act*, all associated regulations, and all license conditions. Approval for the return to service of Pickering Units 5-8 after refurbishment is contingent upon the licensee demonstrating that all license conditions are met. Furthermore, continued operation of a nuclear power plant largely depends on the work required to ensure its long-term safe operation, as described in the CNSC's Regulatory Document REGDOC-2.3.3: Periodic Safety Reviews ("PSR") (Attachment 1).

To support the *Nuclear Safety and Control Act* environmental protection review, a Predictive Environmental Risk Assessment (Attachment 2) for the project was submitted to the CNSC on June 20, 2025. Overall, the Predictive Environmental Risk Assessment concludes that the activities associated with Pickering Units 1-8 and the Pickering Waste Management Facility are not predicted to result in adverse effects to human health nor the environment with implementation of the recommended monitoring and mitigation measures.

To support the refurbishment of Pickering Units 5-8, OPG is conducting a comprehensive PSR, which includes an assessment of station design and operation against applicable current

[10] *Ibid.*

safety standards and operating practices, and ensures a continued high level of safety throughout the station's operating life.

OPG is currently preparing the Integrated Implementation Plan, as required by the PSR, for the refurbishment of Pickering Units 5-8, which will be submitted to the CNSC on August 31, 2027. OPG has also submitted a consolidated Pickering license renewal application, the Power Reactor Operating License and Waste Facility Operating License, to the CNSC on June 30, 2025, and the new license is expected by the end of 2026. The new license, if approved, will allow OPG to execute the refurbishment and continue to operate Pickering Units 5-8 for an additional 30-plus years, assuming all license conditions and regulatory obligations are met. The PSR will be completed before any of the units return to service following refurbishment. See Ex. D2-3-5 for further information.

LIST OF ATTACHMENTS

Attachment 1:	CNSC Regulatory Document REGDOC-2.3.3: Periodic Safety Reviews
Attachment 2:	Predictive Environmental Risk Assessment for Pickering Refurbishment, Decommissioning, and Continued Operations (P-REP-07701-00014)
Attachment 3:	Detailed Breakdown of Evidence Structure

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Exhibit D2-3-1
Attachment 1
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Canada's Nuclear Regulator

Operating Performance
Periodic Safety Reviews

REGDOC-2.3.3

April 2015

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

Operating Performance: Periodic Safety Reviews
Regulatory Document REGDOC-2.3.3

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Preface

This regulatory document is part of the CNSC's operating performance series of regulatory documents, which also covers commissioning, construction and severe accident management. The full list of regulatory document series is included at the end of this document and can also be found on the CNSC's website.

Regulatory document REGDOC-2.3.3, *Periodic Safety Reviews*, sets out the CNSC's requirements for the conduct of a periodic safety review (PSR) for a nuclear power plant (NPP). It is consistent with the International Atomic Energy Agency's Safety Standards Series, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants* [1]. REGDOC-2.3.3 supersedes RD-360, *Life Extension of Nuclear Power Plants*, published in February 2008.

A PSR involves an assessment of the current state of the plant and its performance to determine the extent to which it conforms to applicable modern codes, standards and practices, and to identify any factors that would limit safe long-term operation.

Operating experience in Canada and around the world, new knowledge from research and development activities, and advances in technology, are taken into account. This enables the determination of reasonable and practical improvements that should be made to structures, systems and components, and to existing programs, to ensure the safety of the facility to a level approaching that of modern nuclear power plants, and to ensure continued safe operation. A PSR is a rigorous safety assessment that is complementary to, and does not replace, routine and non-routine regulatory reviews, inspections, mid-term reports, event reporting and investigations, or other CNSC compliance and verification activities.

Conduct of a PSR is intended to be a requirement that can be aligned with licence renewals and form part of the licensing basis for a regulated facility or activity within the scope of this document. It is intended for inclusion in licences, either as part of the conditions and safety and control measures in a licence, or as part of the safety and control measures to be described in a licence application and the documents needed to support that application.

For existing nuclear power plants, the requirements contained in this document do not apply unless they have been included, in whole or in part, in the licence or licensing basis.

An applicant or licensee may put forward a case to demonstrate that the intent of a requirement is addressed by other means and demonstrated with supportable evidence.

The requirements and guidance in this document are consistent with modern national and international practices addressing issues and elements that control and enhance nuclear safety.

Guidance contained in this document exists to inform the applicant, to elaborate further on requirements or to provide direction to licensees and applicants on how to meet requirements. It also provides more information about how CNSC staff evaluate specific problems or data during their review of licence applications. Licensees are expected to review and consider guidance; should they choose not to follow it, they should explain how their chosen alternate approach meets regulatory requirements.

A graded approach, commensurate with risk, may be defined and used when applying the requirements and guidance contained in this regulatory document. The use of a graded approach is not a relaxation of requirements. With a graded approach, the application of requirements is commensurate with the risks and particular characteristics of the facility or activity.

Important note: Where referenced in a licence either directly or indirectly (such as through licensee-referenced documents), this document is part of the licensing basis for a regulated facility or activity.

The licensing basis sets the boundary conditions for acceptable performance at a regulated facility or activity, and establishes the basis for the CNSC's compliance program for that regulated facility or activity.

Where this document is part of the licensing basis, the word "shall" is used to express a requirement to be satisfied by the licensee or licence applicant. "Should" is used to express guidance or that which is advised. "May" is used to express an option or that which is advised or permissible within the limits of this regulatory document. "Can" is used to express possibility or capability.

Nothing contained in this document is to be construed as relieving any licensee from any other pertinent requirements. It is the licensee's responsibility to identify and comply with all applicable regulations and licence conditions.

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Periodic Safety Reviews

1. Introduction

REGDOC-2.3.3, *Periodic Safety Reviews*, sets out the CNSC's requirements for the conduct of a periodic safety review (PSR). A PSR is a comprehensive evaluation of the design, condition and operation of a nuclear power plant (NPP, plant). It is an effective way to obtain an overall view of actual plant safety and the quality of the safety documentation, and to determine reasonable and practical improvements to ensure safety until the next PSR or, where appropriate, until the end of commercial operation.

PSRs have been effective in achieving improvements in safety. Adopting PSRs in support of licence renewal will ensure the continued improvement of NPP safety. Past experience with life-extension projects gives the CNSC and the Canadian nuclear industry a large degree of familiarity with the PSR process. As such, the application of a PSR in Canada represents an evolution of a current practice, as opposed to the adoption of a new one.

1.1 Purpose

This regulatory document sets out the CNSC's requirements for the conduct of a PSR. Guidance is also provided on how these requirements may be met.

1.2 Scope

This document is intended for nuclear power plants. However, it can be used by other nuclear facilities applying a graded approach.

1.3 Relevant regulations

The following provisions of the *Nuclear Safety and Control Act* (NSCA) and regulations made under the NSCA that are relevant to this regulatory document:

1. Subsection 24(4) of the NSCA states that "No licence shall be issued, renewed, amended or replaced − and no authorization to transfer one given − unless, in the opinion of the Commission, the applicant (*a*) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and (*b*) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed"
2. Subsection 24(5) of the NSCA states that "A licence may contain any term or condition that the Commission considers necessary for the purposes of this Act…"
3. Section 3 of the *General Nuclear Safety and Control Regulations* states the general licence application requirements
4. Paragraphs 12(1)(*c*), (*f*) and (*i*) of the *General Nuclear Safety and Control Regulations* state that "Every licensee shall
   (*c*) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security of nuclear facilities and of nuclear substances; …
   (*f*) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity; …
   (*i*) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;"

5. Sections 3 and 6 of the *Class I Nuclear Facilities Regulations* state the general licence application requirements specific to Class I nuclear facilities and the information required to apply for a Class I nuclear facility operating licence

1.4 National and international standards

Key principles and elements used in developing this regulatory document are consistent with national and international standards, guides and practices. In particular, this regulatory document is consistent with the International Atomic Energy Agency's (IAEA) Safety Standards Series, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants* (SSG-25) [1].

2. General Requirements

The licensee shall conduct a PSR in accordance with this regulatory document for the period until the next PSR or, if applicable, until the end of commercial operation of the plant. The PSR shall be conducted according to the following four phases:

1. preparation of a PSR basis document
2. conduct of the safety factors reviews and identification of findings
3. analysis of the findings and their integral impact on the NPP's safety (global assessment)
4. preparation of a plan of safety improvements (integrated implementation plan)

Guidance

The objectives of a PSR are to determine:

1. the extent to which the facility conforms to modern codes, standards and practices
2. the extent to which the licensing basis remains valid for the next licensing period
3. the adequacy and effectiveness of the programs and the structures, systems and components (SSCs) in place to ensure plant safety until the next PSR or, where appropriate, until the end of commercial operation
4. the improvements to be implemented to resolve any gaps identified in the review and timelines for their implementation

The PSR approach is outlined in SSG-25. The complex process of conducting a PSR can be facilitated by subdividing it into tasks that are identified as safety factors. These safety factors are intended to cover all aspects that are important to the safety of an operating nuclear power plant. The terms "safety factor" and "safety factor reports" are an adoption of the SSG-25 terms, with the addition of a safety factor for radiation protection. Safety factor reports are discussed further in sections 3 and 4.

The licensee first prepares the PSR basis document which defines the scope and methodology for the PSR. This is then used to conduct the review, prepare the safety factor reports, and the global assessment report. The results of the PSR are used to establish the corrective actions and safety improvements to be included in the integrated implementation plan.

The documentation submitted to the CNSC includes:

1. PSR basis document
2. reports on the review of each safety factor (safety factor reports)
3. global assessment report (GAR)
4. integrated implementation plan (IIP)

In accordance with SSG-25 and international practice, 10 years is considered an appropriate interval between PSRs to identify any factors that would limit the NPP's continued safe operation and determine the extent to which it conforms to applicable modern codes, standards and practices. The next PSR interval may deviate from 10 years when it includes the end of commercial operation. The licensee may propose an alternative interval when the proposed operating strategy includes the end of commercial operations within or shortly after the 10-year interval.

It is expected that the effort necessary to carry out a second (or subsequent) PSR of an NPP will often be considerably less than for the first. In general, subsequent PSRs will focus on changes in requirements, facility conditions, operating experience and new information, rather than repeating the activities of previous reviews.

The PSR is complementary to, and does not replace, regulatory activities required and/or performed by the CNSC, including routine and non-routine regulatory reviews and inspections, mid-term reports, event reporting and investigations, or any other CNSC licensing and verification activities.

3. Periodic Safety Review Basis Document

The PSR basis document is an essential instrument that governs the conduct of the PSR. It ensures that the licensee and the CNSC have the same expectations for the PSR's scope, methodology and outcomes.

The PSR basis document shall be submitted to CNSC staff for acceptance. The required elements of the PSR basis document are:

1. statement of current licensing basis, including exemptions and acceptable deviations
2. statement of the proposed operating strategy of the facility
3. description of scope of the PSR
4. description of the methodology for the performance of the PSR, including the period for which the PSR is valid
5. statement of applicable modern codes, standards and practices
6. description of the methodology for the identification, dispositioning and tracking of gaps
7. description of the methodology for the global assessment
8. PSR governance

3.1 Current licensing basis

The licensee shall provide a description of the current nuclear power plant licensing basis at the time of initiation of the PSR, which will be used as a baseline for the conduct of the PSR.

3.2 Proposed operating strategy of the nuclear power plant

In the PSR basis document, the licensee shall state the proposed operating strategy of the plant.

Guidance

The PSR is performed to assess the condition of the NPP and the adequacy of the programs, including aging management programs, which are in place to maintain reactor safety. The review is forward-looking and the operating strategy of the plant should be considered to identify potentially lifetime-limiting features of the plant. The licensee is expected to identify whether the operating strategy is operation beyond the next 10-year interval or the end of commercial operations.

The operating strategy is expected to be reflected in the methodologies described in the PSR basis document.

3.3 Scope of the periodic safety review

The licensee shall describe the scope of the PSR in the PSR basis document. The licensee shall:

1. address all safety factors of the NPP including any interdependencies
2. identify all facilities and associated SSCs to be covered by the PSR
3. address unit-specific and site-specific issues
4. for multi-unit NPPs, address interdependencies on common SSCs not covered by item 1
5. consider all expected modes of operation; for a multi-unit facility, taking into consideration the operational state of each unit
6. include a comprehensive review of current licensing issues applicable to the safety factors

Guidance

The scope of the PSR should include a review of each of the following safety factors:

1. plant design
2. actual condition of SSCs important to safety
3. equipment qualification (environmental and seismic)
4. aging
5. deterministic safety analysis
6. probabilistic safety assessment
7. hazard analysis
8. safety performance
9. use of experience from other NPPs and research findings
10. organization, the management system and safety culture
11. procedures
12. human factors
13. emergency planning
14. radiological impact on the environment
15. radiation protection

SSG-25 describes 14 safety factors that have been selected on the basis of international experience and are intended to cover all factors important to NPP safety. The scope, tasks and methodologies of these 14 safety factors are considered to meet the CNSC's expectations for corresponding safety factors 1–14 listed above. The CNSC has included an additional safety factor on radiation protection; the licensee should refer to Appendix A for guidance on the scope and tasks for the review of this safety factor. The PSR basis document should include, in the scope and tasks, how the intent of each task listed for a safety factor will be addressed.

It is expected that the required effort to carry out a subsequent PSR of an NPP will often be considerably less than for the first; however, the subsequent PSR should consider explicitly if the earlier PSR conclusions remain valid (for example, in light of the time elapsed since it was performed).

3.4 Methodology for the performance of the periodic safety review

The licensee shall specify the methodology for:

1. conducting assessments that confirm that the plant will continue to meet its licensing basis until the next PSR cycle or, where appropriate, the end of commercial operation
2. conducting assessments against applicable modern codes, standards and practices
3. conducting a global assessment of facility safety in view of all PSR gaps and strengths
4. identifying any corrective actions and safety improvements that are necessary to address PSR findings to improve the level of safety

Guidance

The methodologies that will be applied for the PSR should be described in the PSR basis document to show how the licensee plans to achieve the PSR objectives as stated in section 2. The methodologies outlined in SSG-25 for performing safety factor reviews provide an acceptable approach.

Since processes and programs have many levels of interdependencies and interrelationships, the reviews should be conducted using internal documents that correctly represent these dependencies and relationships. To ensure this, a freeze date should be established for the internal documents used in the safety factor reviews. The reviews are then carried out using documents that are applicable to the document freeze date.

3.5 Applicable modern codes, standards and practices

The licensee shall state what modern national and international codes, standards and practices will be used in the reviews, including their effective dates, as well as:

1. the criteria for their selection
2. the PSR cut-off date beyond which changes to codes and standards and new information will not be considered
3. the type of review to be performed (clause-by-clause, high level or alternative)

Guidance

An integral element of the PSR is the assessment of the extent to which the NPP would satisfy requirements and expectations set out in applicable modern codes, standards and practices. A list of modern codes, standards and practices with their cut-off dates, should be established before any work is carried out. This ensures a common and consistent expectation for the reviews.

Modern codes, standards and practices should be selected, taking into consideration CNSC's regulatory documents as well as modern international practices and operational experience. Primary consideration for selection of codes and standards should rest with those referenced in licences and applicable CNSC regulatory documents. IAEA documents and other appropriate international standards should also be considered. If an appropriate Canadian code or standard is not available, the licensee should propose a reasonable substitute.

It is expected that all mandatory clauses in a code or standard will be reviewed to determine if the identified requirements are met. Any applicable sub-tier referenced sections in the mandatory clauses to other codes, standards and licensee documentation should also be reviewed and addressed. A clause-by-clause type review should also be performed for new versions of codes and standards referenced by the licence and licence condition handbook. For other codes and standards, licensees may propose other types of reviews.

3.6 Methodology for the identification, dispositioning and tracking of gaps

The licensee shall describe the process and methodology for identifying, categorizing, prioritizing and dispositioning gaps. The licensee shall state what decision-making process will be used to evaluate and decide on the various alternatives to disposition the gaps.

To the extent practicable, the licensee shall resolve identified gaps with respect to applicable modern codes, standards and practices. The licensee shall use established processes to resolve identified gaps with the current licensing basis. The licensee shall track dispositioning and resolution of all gaps identified during the PSR through to their resolution.

Guidance

The PSR review should identify the following types of findings:

- **strengths** – current practices are equivalent to or better than those established in modern codes and standards, practices
- **gaps –** current practices are not equivalent to those established in modern codes and standards practices, or do not meet the current licensing basis, or are inconsistent with the operational documentation for plant

The rationale behind identifying the findings and their disposition should be justified using valid arguments and supporting evidence. All gaps should be categorized and prioritized according to their safety significance. While assessing gaps for safety significance, the licensee should consider deterministic and probabilistic safety analyses, engineering judgment or a combination thereof. Suitability for assessment via selected means should be determined by the nature of the finding.

Depending on the nature of the gaps, the licensee may also include considerations such as public radiation safety, plant operability, occupational radiation safety, emergency preparedness, and the environment when prioritizing gaps. The overall priority of a gap should inform the course of action to be taken to establish its recommended disposition. Any gaps representing the plant's non-compliance against the current licensing basis may be resolved through the existing plant programs. The licensee should establish and maintain a database of all gaps identified during the PSR.

3.7 Methodology for the global assessment

The methodology for performing the global assessment shall be described in the PSR basis document. The methodology shall address and include:

1. results of the safety factor reviews, in particular, the findings (both gaps and strengths) of NPP design and operation
2. the interdependencies between gaps and the significance of their aggregate effects
3. recommended corrective actions and safety improvements to address individual and consolidated gaps
4. the extent to which the safety requirements of defence in depth are fulfilled
5. an estimate of global risk associated with facility operation with any unresolved gaps

The results from the global assessment shall be documented in the global assessment report.

Guidance

The objective of the global assessment is to present an overall evaluation of facility safety taking into account a balanced assessment of all findings identified in the PSR. The global assessment should

take into account all the strengths and gaps from the PSR, and the corrective actions and/or safety improvements proposed to improve the overall level of safety.

The review of individual safety factors may indicate that the NPP's safety is acceptable; however, when a review of the interactions, overlaps and gaps between safety factors is performed, new findings may be identified that have an impact on overall level of safety.

3.8 Periodic safety review governance

In the PSR basis document, the licensee shall establish, and describe governance for the conduct of the PSR.

Guidance

The licensee's governance for the conduct of PSR should address that:

1. the PSR team is qualified to carry out the review
2. provisions have been made for peer or independent review of work done
3. controls are in place to ensure that information and data are used consistently across the review
4. requirements for the preparation and verification of documentation are satisfied
5. results are recorded in a systematic and auditable manner

The licensee should develop a project plan for the conduct of the PSR that includes established project management processes and quality management provisions.

4. Performance of the Periodic Safety Review

The licensee shall conduct the PSR in accordance with the accepted PSR basis document following its acceptance by CNSC staff.

Guidance

It is recommended that the licensee does not undertake substantive work on the PSR until such time as CNSC staff has accepted the PSR basis document.

4.1 Safety factor reports

Upon completion of the safety factor reviews, the licensee shall prepare reports for submission to CNSC staff in accordance with the accepted PSR basis document. The licensee shall ensure that each safety factor report documents:

1. objective, scope, tasks and methodology for the review
2. applicable codes , standards and practices
3. overview of applicable facility programs and processes
4. findings of the review which identify gaps and strengths
5. categorized and prioritized gaps
6. interfaces with other safety factor report findings
7. options for corrective actions for each gap

Guidance

The safety factor reports document the findings for specific review tasks. The findings of the assessments and the comparison against applicable modern codes, standards, and practices are included. Any gaps are identified, recorded, categorized, prioritized and dispositioned.

The overall structure of each report should be a summary of the review followed by detailed reporting and conclusions. The report should:

1. clearly indicate the type of review conducted for each review element: a clause-by-clause review, a high-level review or a combination thereof, and provide the rationale for selecting the type of review
2. provide systematic coverage of the expected review tasks with detailed analysis of how the licensee addressed requirements to fulfill licensing bases, as well as the expectations for satisfying applicable, modern codes, standards and practices set out in the basis document
3. clearly indicate the licensee's acceptance of any work done by an outsourced contractor
4. provide enough information to allow CNSC staff to make a regulatory determination based on the information contained in the report

The licensee should prepare the safety factor reports to be as self-contained as practicable, avoiding excessive referencing. Where a code, standard or practice addresses more than one review element, the findings of such reviews should be cross-referenced.

Safety factor reports should be submitted concurrently or in a single package because some reports may be inter-related. For example, the report for aging may be inter-related with the reports on the actual condition of SSCs important to safety and deterministic safety analysis.

5. Global Assessment Report

The licensee shall prepare a report that documents the results of the global assessment. The global assessment report (GAR) shall present the findings of the PSR, both strengths and gaps, to provide an overall assessment of the safety of plant. The GAR shall document the overall conclusions, corrective actions and safety improvements to be considered. It shall be submitted to CNSC staff for review.

Guidance

The GAR should provide a living database that captures the current state of the gaps. The database should be fully traceable so that a change in a gap, or in the assessment of a gap, can be easily tracked to its resolution. The GAR should include the following elements:

1. summaries of the safety factor reports and identified gaps and strengths
2. overlaps, omissions, and interface issues of the findings from the safety factor reports
3. consolidation of gaps into global issues where appropriate
4. safety significance and risk ranking of all gaps (individual and consolidated)
5. corrective actions, safety improvements and appropriate dispositions proposed for all gaps and global issues
6. a global assessment based on the aggregate effect of the findings resulting from all safety factor reports, taking the proposed corrective actions and safety improvements into account, and defence in depth
7. statement of the licensee's assessment of the overall acceptability of operation of the NPP

6. Integrated Implementation Plan

The licensee shall develop an integrated implementation plan (IIP) that addresses the results of the global assessment. The IIP shall be submitted to CNSC staff for acceptance.

In the IIP, the licensee shall:

1. list the corrective actions and safety improvements (including necessary physical NPP modifications) that will address all gaps identified in the PSR, and findings
2. specify the schedule for implementing the corrective actions and safety improvements

Guidance

An overview of the acceptability of safe operation of plant in view of the proposed changes should be included in the IIP, to demonstrate that the outcome of safety improvements serves the intended purpose of the PSR.

In the IIP, the licensee should:

1. demonstrate traceability and provide references to the GAR
2. specify the processes used for determining the detailed scope, including prioritization and scheduling of corrective actions and safety improvements
3. schedule and implement corrective actions and safety improvements commensurate with their safety significance
4. specify processes for identification and management of project risks and controls
5. specify the process to be used to track the progress and completion of the corrective actions and safety improvements

It is encouraged to organize the IIP according to the CNSC's safety and control areas so as to facilitate the CNSC's review. See Appendix B for more information on CNSC's safety and control areas.

To ensure the IIP's success, the licensee should have the following in place:

1. a project organization, structured to execute the IIP
2. governance for IIP delivery
3. scope, schedules and dependencies, at least for the earlier tasks
4. definition of resources and a resourcing plan
5. a mechanism for overall integration, peer or independent review and oversight

Appendix A: Safety Factor for Radiation Protection

As stated in section 3.3 of this document, the scope of the PSR should address the following 14 safety factors set out in the International Atomic Energy Agency's Safety Standards Series, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants* (SSG-25) [1]:

1. reactor facility design
2. actual condition of structures, systems and components important to safety
3. equipment qualification
4. aging
5. deterministic safety analysis
6. probabilistic safety assessment
7. hazard analysis
8. safety performance
9. use of experience from other plants and research findings
10. organization, the management system and safety culture
11. procedures
12. human factors
13. emergency planning
14. radiological impact on the environment

SSG-25 does not address radiation protection (RP) as a separate safety factor because it is considered as a review element of several other safety factors. It is expected that RP-related elements will be integrated into the relevant safety factor reports as described in SSG-25, including safety factors 8 (safety performance), 10 (organization, the management system and safety culture) and 11 (procedures).

Based on experience from previous CNSC reviews, the licensee should address four RP-related review elements separately. These elements are outlined in the following text.

A.1 Objective

The objective of the review of RP is to determine:

- the extent to which RP has been accounted for in the design and operation of the reactor facility
- whether RP provisions (including design and equipment) provide adequate protection of persons from the harmful effects of radiation, and ensures that contamination and radiation exposures and doses to persons are monitored and controlled, and maintained as low as reasonably achievable (ALARA)

A.2 Scope and tasks

The scope of this review will depend on the extent of changes in standards and/or the licensing basis since the previous PSR or the start of operation. The review of RP should include the following tasks:

- reactor design features for RP
- RP equipment and instrumentation for radiation monitoring
- RP aspects during nuclear emergencies
- RP operating experience

A.3 Methodology

The review should be performed systematically by reviewing national and international requirements and standards listed in the PSR basis document and other requirements and standards identified as relevant during the course of the review.

A.3.1 Review of the reactor design features for radiation protection

The review should identify all sources of radiation and radiation exposure pathways, with an evaluation of radiation doses that could be received by workers at the facility with consideration of contained and fixed sources, and potential sources of airborne radioactive material. The review should demonstrate that the ALARA principle has been incorporated in the reactor design and operational programs and arrangements, in order to minimize the number and locations of radiation sources and the radiation fields associated with them.

The review should determine that the design and layout of the reactor facility meets CNSC regulatory requirements and expectations for reactor facilities in the area of RP (e.g., REGDOC-2.5.2, *Design of Reactor Facilities: Nuclear Power Plants* and RD/GD-369, *Licence Application Guide: Licence to Construct a Nuclear Power Plant*). The review should include RP principles, and how they are incorporated into the reactor design and are of a sufficient depth to demonstrate the following:

- suitable provisions have been made in the design and layout of the reactor facility to keep occupational radiation doses below regulatory limits and ALARA, including:
  - classification of areas (zoning) and access control
  - aging of all materials and obsolescence of technology that could impair the radiological safety functions of SSCs
  - radiological hazard control
  - decontamination of personnel, equipment and structures
  - radiological monitoring (in-plant)
- SSCs have been adequately designed so that radiation exposures during all activities are optimized and justified

A.3.2 Review of radiation protection equipment and instrumentation for radiation monitoring

The review of RP equipment and instrumentation for radiation monitoring should demonstrate adequate provisions for monitoring all significant radiation sources, in all activities throughout the lifetime of the reactor facility. These should cover operational states and accident conditions and, as practicable, beyond-design-basis accidents, including severe accidents. The review of the physical condition of RP instrumentation and equipment should be confirmed by walk downs where practicable to verify continued utility and functionality.

A.3.3 Review of radiation protection aspects for nuclear emergencies

The review of RP aspects for nuclear emergencies should demonstrate the effectiveness of RP measures during a nuclear emergency. These measures may be significantly impacted by facility configuration and controls; or for example, the review should consider access controls, habitability controls, communications systems, adequate radiation monitoring capabilities, portable emergency response RP equipment, and radiation personnel protective equipment.

A.3.4 Review of radiation protection related to operating experience

The review of RP-related operating experience (OPEX) should identify OPEX reports from other reactor facilities and relevant national and international experience and research findings. The review should verify that this information has been properly considered in the routine evaluation of OPEX and research developments and that appropriate action has been taken. The review of OPEX should seek to identify good practices and lessons learned elsewhere, and to take advantage of improved knowledge derived from research, in the area of RP.

Appendix B:CNSC Safety and Control Areas

Safety and Control Area	Description
Management system	The framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.
Human performance management	The activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
Operating performance	This includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.
Safety analysis	Maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.
Physical design	The activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.
Fitness for service	The activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.
Radiation protection	The implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored and controlled, and maintained as low as reasonably achievable (ALARA)
Conventional health and safety	The implementation of a program to manage workplace safety hazards and to protect personnel and equipment.
Environmental protection	The programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.
Emergency management and fire protection.	The emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.
Waste management	The internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.
Security	The programs required to implement and support the security requirements stipulated in the regulations, in the license, in orders, or in expectations for the facility or activity.
Safeguards and non-proliferation	The programs required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons.*
Packaging and transport	The programs that manage the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

Glossary

aging management
Engineering, operations, inspection, and maintenance actions to control, within acceptable limits, the effects of physical aging and obsolescence of structures, systems and components.

ALARA (as low as reasonably achievable)
A principle of radiation protection that holds that exposures to radiation are kept as low as reasonably achievable, social and economic factors taken into account. Section 4 of the *Radiation Protection Regulations* stipulates licensee requirements with respect to ALARA.

corrective actions
Measures taken to eliminate the cause of a detected nonconformity or other undesirable situation to prevent reoccurrence.

global assessment
An overall risk judgment on the acceptability of continued operation of a nuclear facility.

integrated implementation plan (IIP)
A plan that considers the scope and schedule of safety improvements to support continued operation of a facility, based on the results of a periodic safety review.

licensing basis
A set of requirements and documents for a regulated facility or activity comprising:

- the regulatory requirements set out in the applicable laws and regulations
- the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence
- the safety and control measures described in the licence application and the documents needed to support that licence application

management system
A set of interrelated or interacting elements (system) for establishing policies and objectives and enabling the objectives to be achieved in an efficient and effective way. The management system integrates all elements of an organization into one coherent system to enable all of the organization's objectives to be achieved. These elements include the structure, resources, and processes. Personnel, equipment, and organizational culture as well as the documented policies and processes are parts of the management system. The organization's processes have to address the totality of the requirements on the organization as established in, for example, IAEA safety standards and other international codes and standards.

nuclear power plant
A nuclear facility consisting of any nuclear fission reactor installation that has been constructed to generate electricity on a commercial scale.
Note: An NPP may include more than one nuclear reactor.

periodic safety review (PSR)
A comprehensive assessment of nuclear power plant design and operation that deals with the cumulative effects of aging, modifications, operating experience, technical developments and siting factors, and aims at ensuring a high level of safety throughout the operating life of plant.

periodic safety review (PSR) basis document
The information that sets out the scope and methodology for the conduct of the periodic safety review.

safety improvements
Measures taken that result in more effective implementation of the safety objectives of a nuclear power plant.

safety significance
The significance of a situation, event or issue with respect to the impact on meeting the nuclear safety objectives as defined by the IAEA in document No. SF-1 *Fundamental Safety Principles* [2]. In general, a situation, event or issue has safety significance if it denotes a deviation from the safety case accepted in the licence, in a direction detrimental to safety, such as but not limited to:

- reducing margins to (or exceeding) the accepted limits
- increasing risk to the health, safety and security of persons and the environment
- impairments (various degrees) of the special safety systems or of the safety functions for accident mitigation
- reduction in defence in depth
- events causing radioactive releases and spills of hazardous substances, injuries to workers or the public, etc.

structures, systems and components (SSCs)
A general term encompassing all of the elements (items) of a facility or activity that contribute to protection and safety. Structures are the passive elements: buildings, vessels, shielding, etc. A system comprises several components, assembled in such a way as to perform a specific (active) function. A component is a discrete element of a system. Examples are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks, and valves.

References

1. International Atomic Energy Agency (IAEA), Safety Standards Series, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants*, Vienna, Austria, 2013.
2. IAEA, Safety Standards Series, Safety Fundamentals No. SF-1, *Fundamental Safety Principles*, Vienna, Austria, 2006.

Additional Information

1. Canadian Nuclear Safety Commission (CNSC), REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, Ottawa, 2014.
2. CNSC, REGDOC-2.6.3, *Aging Management*, Ottawa, 2014.
3. CNSC, P-242, *Considering Cost-benefit Information*, Ottawa, 2000.
4. IAEA, Safety Reports Series No. 57, *Safe Long Term Operation of Nuclear Power Plants*, Vienna, Austria, 2008.
5. IAEA, Safety Standards Series, Safety Guide NS-G-2.12, *Ageing Management for Nuclear Power Plants*, Vienna, Austria, 2009.
6. IAEA, Safety Standards Series, Safety Guide NS-G-2.6, *Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plants*, Vienna, Austria, 2002.
7. IAEA, INSAG 12, *Basic Safety Principles for Nuclear Power Plants*, 75-INSAG-3 Rev.1, A report by the International Nuclear Safety Advisory Group, Vienna, Austria, 1999.

CNSC Regulatory Document Series

Facilities and activities within the nuclear sector in Canada are regulated by the Canadian Nuclear Safety Commission (CNSC). In addition to the *Nuclear Safety and Control Act* and associated regulations, these facilities and activities may also be required to comply with other regulatory instruments such as regulatory documents or standards.

Effective April 2013, the CNSC's catalogue of existing and planned regulatory documents has been organized under three key categories and twenty-five series, as set out below. Regulatory documents produced by the CNSC fall under one of the following series:

1.0 Regulated facilities and activities

Series
- 1.1 Reactor facilities
- 1.2 Class IB facilities
- 1.3 Uranium mines and mills
- 1.4 Class II facilities
- 1.5 Certification of prescribed equipment
- 1.6 Nuclear substances and radiation devices

2.0 Safety and control areas

Series
- 2.1 Management system
- 2.2 Human performance management
- 2.3 Operating performance
- 2.4 Safety analysis
- 2.5 Physical design
- 2.6 Fitness for service
- 2.7 Radiation protection
- 2.8 Conventional health and safety
- 2.9 Environmental protection
- 2.10 Emergency management and fire protection
- 2.11 Waste management
- 2.12 Security
- 2.13 Safeguards and non-proliferation
- 2.14 Packaging and transport

3.0 Other regulatory areas

Series
- 3.1 Reporting requirements
- 3.2 Public and Aboriginal engagement
- 3.3 Financial guarantees
- 3.4 Commission proceedings
- 3.5 Information dissemination

Note: The regulatory document series may be adjusted periodically by the CNSC. Each regulatory document series listed above may contain multiple regulatory documents. For the latest list of regulatory documents, visit the CNSC's website.

ONTARIO POWER GENERATION

Report

Public Information	
Document Number: P-REP-07701-00014	
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Title:
Predictive Environmental Risk Assessment for Pickering Refurbishment, Decommissioning, and Continued Operations

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Predictive Environmental Risk Assessment for Pickering Refurbishment, Decommissioning, and Continued Operations

P-REP-07701-00014 R000

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Public Information

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PREDICTIVE ENVIRONMENTAL RISK ASSESSMENT FOR PICKERING REFURBISHMENT, DECOMMISSIONING, AND CONTINUED OPERATIONS

P-REP-07701-00014 R000

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PREDICTIVE ENVIRONMENTAL RISK ASSESSMENT FOR PICKERING REFURBISHMENT, DECOMMISSIONING, AND CONTINUED OPERATIONS

P-REP-07701-00014 R000

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Revision Number	Date	Comments
R000	07 April 2025	Initial Issue of report.

LAND ACKNOWLEDGEMENT

The lands and waters on which the Pickering Nuclear Generating Station (PNGS) is situated are the treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

The PNGS is within the territory of the Johnson-Butler Purchase/Gunshot Treaty (1787-1788) and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the Treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

EXECUTIVE SUMMARY

Ontario Power Generation (OPG) plans to pursue refurbishment and continued operation of Pickering Nuclear Generating Station (PNGS) Units 5 to 8, as well as decommissioning of PNGS Units 1 to 4, herein referred to as the Project. This report presents the Predictive Environmental Risk Assessment (PERA) for the Project. The PERA supports the renewal of the existing licence for PNGS to include refurbishment activities for PNGS Units 5-8, decommissioning of PNGS Units 1-4, as well as the Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF) waste licence.

Refurbishment and continued operation of PNGS Units 5-8 will help OPG meet its mission to build a sustainable future powered by our electricity, our ideas, and our people. This supports OPG's vision to electrify life in one generation.

The focus of the PERA is on the activities that will potentially occur up to and including the re-licensing period from 2027 to 2037; activities and Project phases that will occur after the end of 2037 are discussed at a more general level of detail. The Project includes the following phases:

PNGS Units 1-4

- **Stabilization Phase:** Initiated in October 2024, a 3-year Stabilization Phase for Unit 1 and Unit 4 includes the arrangements and activities that ensure a safe and efficient transition from the end of commercial operation to the Storage with Surveillance (SWS) state for the transitioning units. PNGS Unit 2 and Unit 3 are not included in the assessment of this phase as the Stabilization Phase of Unit 2 and Unit 3 is complete and the units have been in SWS since 2010.

- **Storage with Surveillance:** Starting in 2028, and projected to end by approximately 2090, a 50-70-year Storage with Surveillance Phase will be initiated (for Unit 1 and Unit 4) to allow for natural decay of radioactivity. Unit 2 and Unit 3 have been in SWS since 2010 and will continue in SWS until approximately 2090 as well. Activities during this phase include the ongoing operation of the Irradiated Fuel Bays (IFBs) and the continued transfer of spent fuel to dry storage containers (DSCs). Consistent with CNSC REGDOC-2.11.2 "Decommissioning" (CNSC, 2021), risk reduction activities will be initiated during this phase to remove and remediate non-nuclear equipment and buildings/facilities.

- **Dismantle and Demolish:** From 2034 to approximately 2100, the Dismantle and Demolish Phase will be initiated for Units 1-4 with details to be provided in subsequent Detailed Decommissioning Plan (DDP) updates.

PNGS Units 5-8

- **Refurbishment:** Starting in 2027 (pending approvals) preparation for refurbishment of PNGS Units 5-8 will be initiated, including defueling and dewatering of reactors, relocation and/or

removal of structures and equipment, construction of buildings and temporary laydown areas. Starting in 2027, the first unit will enter refurbishment which involves replacing reactor components including: fuel channels and calandria tubes, inlet and outlet feeders from end fittings to the reactor inlet/outlet headers, replacement of steam generators, refurbishment of various systems including reactor auxiliary systems and feedwater systems, and normal upgrade and maintenance activities. The unit will then be refuelled and restarted.

- **Continued Operations:** At the end of refurbishment, all units at PNGS Units 5-8 will be returned to service and operation will then continue for approximately 30 years.

- **Decommissioning:** At the end of life for PNGS Units 5-8 the facility will enter a Stabilization Phase, followed by SWS, and Dismantle and Demolish phases. At this stage, decommissioning of PNGS Units 5-8 is only conceptually developed, and is consistent with its preliminary decommissioning plan (PDP) (OPG, 2025).

Objectives

This PERA was conducted to meet the requirements of CSA N288.6:22 "Environmental Risk Assessments at Nuclear Facilities and Uranium Mines and Mills" (CSA, 2022a) and also meets the requirements for an Environmental Risk Assessment (ERA) outlined in Section 4.1 of REGDOC-2.9.1 "Environmental Protection: Environmental Principles, Assessments and Protection Measures" (CNSC, 2020). The objectives of the PERA are to:

- Identify whether any proposed Project activities are likely to result in environmental emissions or other stressors potentially exceeding those in previous assessments;

- Predict and assess the risk of effect to representative human and ecological receptors resulting from exposure to radiological and non-radiological substances and physical stressors expected to be released during refurbishment, decommissioning, and continued operations of PNGS;

- Inform prioritization of monitoring and mitigation measures.

OPG is committed to open and transparent communication on our operations and projects and adheres to the guidance outlined in CNSC REGDOC 3.2.1, Public Information and Disclosure, and CNSC REGDOC 3.2.2, Indigenous Engagement, in accordance with the PNGS Licence Condition Handbook (CNSC, 2018, 2022).

Methodology

The general approach to this PERA included the following key steps:

1. Review and update existing conditions. This is primarily conducted through review of the 2022 Pickering Nuclear ERA and additional data collected to support an update to existing conditions.

2. Identify proposed PNGS Units 1-4 decommissioning activities and PNGS Units 5-8 refurbishment activities.

3. Perform a qualitative assessment to identify future activities that are not bound by existing conditions or assumptions in previous assessments (Tier 1 assessment). For those interactions bound by existing conditions or previous assessments, no further action is required other than documenting the rationale.

4. Conduct quantitative assessment (Tier 2) for those interactions not bound by existing conditions or assumptions in previous assessments. This is primarily a quantitative risk assessment with estimation of dose and hazard quotients (as applicable).

5. Identify mitigation measures and recommendations for monitoring programs.

The evaluation of Project-environment interactions also utilizes the previous assessments referred to above, which include the 2022 PN ERA (Ecometrix, 2023a), the 2017 Safe Storage Predictive Effects Assessment (PEA) and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017), and the Pickering Component Storage Structure (PCSS) PERA (Ecometrix, 2024).

Tier 1 Assessment

PNGS Units 1-4 Decommissioning and PNGS Units 5-8 Refurbishment proposed activities were evaluated for interactions with environmental pathways and receptors in the Tier 1 assessment. In general, interactions associated with project activities during the Stabilization and SWS phases of PNGS Units 1-4 are considered sufficiently bounded by the findings of the 2017 Safe Storage PEA and the 2022 PEA Addendum, or the 2022 PN ERA, and do not warrant further evaluation. Although PNGS Units 1-4 risk reduction and removal activities were not evaluated in previous assessments, these activities are not anticipated to result in significant environmental effects as construction best practices and applicable mitigation plans will be implemented to ensure impacts are minimized. Environmental effects of future dismantle and demolish activities planned to start in 2034 will be detailed in subsequent DDP updates and PERA updates when more detailed work packages are defined.

Refurbishment activities for PNGS Units 5-8 including islanding the unit, refurbishment of reactor auxiliary systems, and other upgrades are determined in the Tier 1 assessment to have negligible interaction with the environment. Some activities, such as the construction of the PCSS, are evaluated as part of a separate PERA. Other activities, such as defueling and dewatering the units, are bounded by the 2017 Safe Storage PEA and the 2022 PEA Addendum, while still others, such as management of tritium emissions, are bounded by the 2022 PN ERA. These activities bounded by other assessments do not warrant further evaluation in the Tier 2 assessment.

One of the major design modifications/activities not previously evaluated is the potential construction of an offshore lake bottom water intake structure for PNGS Units 5-8 that will replace the current shoreline surface water intake. The proposed deep water intake (DWI) will draw deeper

cooler water from Lake Ontario which is expected to significantly reduce fish impingement and entrainment as well as reduce potential biofouling events with attached algae. The construction of the intake structure could also potentially involve shoreline modifications such as a dock, infill, and material disposal. The Tier 1 screening identified that aquatic habitat impacts from the DWI construction and thermal effects, especially as they relate to climate change, require further assessment. As such, these project-environment interactions are comprehensively evaluated in the Tier 2 quantitative assessment to characterize the potential for adverse impacts.

To support this PERA, predictive air quality and noise modelling was completed to assess potential impacts to human and ecological receptors resulting from the planned PNGS Units 1-4 Decommissioning and PNGS Units 5-8 Refurbishment. The modelling was developed as a conservative "worst-case" bounding scenario for the planned Project activities.

No long-term human health effects are expected to occur as a result of the predicted ambient air quality or noise conditions for the bounding scenario. Exceedances of the selected ambient air quality criteria were predicted for total suspended particulates (TSP), inhalable and respirable particulates (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2, representative of nitrogen oxides [NO_X]), and benzo(a)pyrene (BaP, representative of polycyclic aromatic hydrocarbons [PAHs]) for at least one of the human receptor locations assessed. No health risks are anticipated for the bounding scenario since air quality criteria exceedances are predicted to occur infrequently (i.e., only a few days to a few weeks in the year), or at receptor locations where people stay for short periods of time (i.e., the Sport Fisher). For noise, predicted exceedances of human health noise guidelines are modelled to only occur at locations where people stay for short periods of time (i.e., the Sport Fisher, Industrial/Commercial Worker), limiting the overall exposure to elevated noise levels.

No long-term ecological health effects are expected to occur as a result of the predicted ambient air quality for the bounding scenario. Some exceedances of the selected ambient air quality criteria were predicted for TSP, PM_{10}, $PM_{2.5}$, NO_2, and BaP for at least one of the ecological receptor locations assessed. No effects are expected since exceedances are largely localized to the PN site where mitigation measures (e.g., dust suppression measures) will be utilized to further minimize dust and particulate emissions. Project-related exceedances of short-term 24-hr TSP and PM_{10} criteria off-site at Frenchman's Bay are predicted to occur relatively infrequently (i.e., exceedances on a few days up to a few weeks in a year). It is expected that Frenchman's Bay will continue to provide suitable habitat for local terrestrial and riparian biota over the course of the Project.

No noise impacts to receptors at Hydro Marsh and Frenchman's Bay are expected since predicted noise levels are less than the 10 dB guideline for incremental change above existing conditions. Exceedances of noise guideline are localized to the PN site. It is presumed that wildlife currently inhabiting the PN site are well adjusted to noise levels characteristic of an urban/semi-urban environment and are relatively tolerant of human activity. Increased noise levels above the 10 dB guideline are predicted at the Bank Swallow Fixed Face Earthen Embankment. As such, mitigation measures should be considered to reduce noise levels during the breeding season (approximately April 1st to August 31st). Additionally, the conservative assumptions in the noise model can be re-evaluated once Project planning is further underway to provide more realistic predictions.

While air quality and noise were not assessed further for any human or ecological receptors in the Tier 2 assessment, recommendations are included to protect breeding birds on-site including species at risk from elevated noise levels (see recommendations section below). Barn swallow, bank swallow, and peregrine falcon are known to breed on the PN site.

General feedback from the Williams Treaties First Nations indicates that it would be beneficial to include a Harvester receptor in the PERA, to more specifically reflect Indigenous people who may live and work near the facility and consume traditional foods harvested near the facility. As such, assessment of a Harvester is considered in the Tier 2 quantitative assessment.

Following refurbishment, PNGS Units 5-8 will operate in a manner consistent with existing operations (4 operating units). Consequently, the potential effects of the Continued Operation Phase on most environmental components are bounded by those previously assessed in the 2022 PN ERA for 6 operating units and comparable to current conditions with 4 units (PNGS Units 5-8) operating.

In summary, the following potential effects are evaluated in the Tier 2 assessment:

- Inclusion of a Harvester in the Predictive Human Health Risk Assessment (HHRA) to assess radiation dose from exposure to releases of tritium, carbon-14, and beta/gamma to the atmospheric and surface water environment.
- Evaluation of aquatic habitat loss and potential changes to habitat quality in the Predictive Ecological Risk Assessment (EcoRA) from construction of the proposed DWI and associated lake infill areas and dock.
- Evaluation of changes to thermal effects on indicator fish species in the Predictive EcoRA due to operation of the DWI, with consideration of long-term climate change.

Tier 2 Quantitative Assessment

Predictive HHRA

The Tier 1 assessment concluded that the radiological emissions to air and water assessed in the 2017 Safe Storage PEA remain conservative estimates of radiological emissions for current Project planning for PNGS Units 1-4 Stabilization and SWS, as well as for PNGS Units 5-8 Refurbishment.

Using the conservative estimates for emissions, the predictive HHRA provides the predicted radiation dose for the Harvester, and also provides an updated dose prediction for the other human receptors evaluated in the 2017 Safe Storage PEA based on more recent meteorological data from PN (2017 to 2021).

The incremental radiation dose from the Project to all human receptors evaluated is predicted to be well below the regulatory public dose limit of 1 mSv/a. The predicted dose to the Harvester is 1.24 µSv/a which is 0.12% of the regulatory public dose limit (1,000 µSv/a). The predicted doses to all human receptors are well below the public dose limit and a small fraction of the natural background

dose of 1,400 µSv/a; therefore, no health effects are anticipated due to exposure of potential critical groups to radiological releases from the PN Site during the Project phases.

Predictive EcoRA

The predictive EcoRA evaluated the potential impacts of the construction and operation of the DWI on aquatic habitat loss and thermal effects.

Based on the habitat assessment results, the construction of the proposed DWI and associated lake infill areas and dock could result in the destruction of approximately 17.5 ha of fish habitat utilized by species for potential spawning, foraging and migration, and 4.8 ha of habitat alteration from dredging and potential bridge over the PNGS Units 5-8 CCW outfall. Additionally, the construction of the intake channel (a bored tunnel running from the intake cap to PNGS) could result in temporary disruption of approximately 2.5 ha of fish habitat.

Although the substrate and depth in the nearshore area meet the spawning requirements of some fish species, high wave energy along the shoreline makes it unsuitable for spawning. Furthermore, the DWI and nearshore aquatic environment lack unique habitat features, as they are typical of other areas found throughout Lake Ontario. Therefore, while construction activities will result in habitat loss, no rare or unique habitats will be lost.

The thermal impact of the PNGS Units 5-8 discharge during operation of the DWI was evaluated. It is anticipated that once the DWI is in operation the discharge temperature will be the same or lower than the existing PNGS Units 5-8 discharge temperatures. Thus, the PNGS Refurbishment activities are not expected to add any additional thermal load to the aquatic environment, and may even result in an improvement relative to current thermal conditions. When considering the additional influence of climate change over time, lake water temperatures are expected to increase over the long-term. However, this increase is not expected to occur uniformly across the water column, with surface waters warming at a faster rate than deeper layers. The effects of lake warming are anticipated to impact all fish in varying degrees. Some fish species may have to shift to different habitats to remain within their optimal temperature range or acclimate as climate change continues to progress. Over the long-term, thermal contributions from PNGS Units 5-8 are expected to be similar or slightly less than current conditions.

Cumulative Effects

The PERA encompasses all existing and known future activities on the PN site including evaluation of: previous PNGS operations (for 6 operating units), PNGS Units 1 and 4 Stabilization, PNGS Units 1-4 SWS and dismantle/demolish activities, PNGS Units 5-8 Refurbishment (including construction and operation of the DWI), PNGS Units 5-8 Continued Operations, the NSS-PWMF including construction of an additional Storage Building #5, the PCSS, and construction of other planned buildings.

The air, noise, and surface water modelling performed to support the PERA conservatively evaluate bounding scenarios where Project activities occur during the same timeframe. As such, cumulative effects on the PN site have been considered in this PERA.

Cumulative effects from other OPG projects near the PN site were considered. Environmental monitoring at PN includes contributions from Darlington Nuclear Generating Station (DNGS), and in the future, Darlington New Nuclear Project (DNNP). Since the PN site is approximately 34 km west of the DN site, the influence from DNGS and DNNP at PN would be small.

Overall Conclusions

Based on the results of the PERA, most activities associated with PNGS Units 1-4 Decommissioning, PNGS Units 5-8 Refurbishment, and Continued Operations are not predicted to result in adverse effects to human and/or ecological receptor groups evaluated. Some aquatic habitat will be disturbed or removed from DWI construction – OPG will meet all Fisheries and Oceans Canada (DFO) authorization requirements including implementation of fish habitat compensation measures to offset the loss of habitat and associated productivity. As such the effect of aquatic habitat loss should be minimal with implementation of mitigation measures. While some individual exceedances of air quality or noise guidelines were identified, monitoring and mitigation measures identified below will be implemented to confirm no adverse effects.

Recommendations for Monitoring and Mitigation

Based on the results of this PERA, recommendations and/or mitigation measures are identified in **Table ES-1** below.

Table ES-1: Recommendations for Monitoring and Mitigation

Environmental Component	Recommendation for Monitoring and Mitigation
Atmospheric Environment	• Air Quality: Air monitoring of existing conditions should continue so that at least 6 months of air quality data are available to characterize the existing environment. The additional air monitoring data should be included in the next iteration of the PERA. • Air Quality: Implementation of a dust management plan that could involve mitigative measures such as the application of dust suppressants, stabilization of completed soil surfaces, and suspension of dust-generating activities during periods of inclement weather. This is expected to reduce dust and particulate emissions and deposition on to vegetation surfaces, limiting pollution of local wildlife habitat. • Noise: The development and implementation of a Noise Management Plan will outline best construction practices and available mitigation measures for controlling noise generation.

Environmental Component	Recommendation for Monitoring and Mitigation
	• Noise: Mitigation measures should be explored to reduce noise levels to species at risk during the breeding season, including Bank Swallow, Barn Swallow, and Peregrine Falcon (known to nest on the PN site). Mitigation measures may include alternate truck routes, revisiting assumptions in noise model to reduce conservatism.
Surface Water Environment	• No additional recommendations beyond continuing to implement surface water quality monitoring through OPG's ongoing environmental monitoring program. • OPG will employ best practices for stormwater management that would meet Ontario Ministry of Environment, Conservation and Parks (MECP) requirements and industrial sewage works rules.
Aquatic Environment	• Aquatic monitoring studies were completed to support this PERA based on current Project planning for the DWI at the time of study design. As the design of the DWI evolves, it presents some uncertainty in the study area size and location. As such, further data (fish community, benthic macroinvertebrate community, microzooplankton community) should be collected for the aquatic environment to reflect changes to DWI planning since the Project was initiated. The additional aquatic environment data should be included in the next version of the PERA. • Aquatic Habitat: To mitigate impacts of habitat loss from DWI construction, measures should be taken to limit the spread of aquatic invasive species, such as cleaning, draining, and drying any equipment used in the water, and avoiding the transfer of organisms or water between bodies of water. Additionally, OPG will replace and restore disturbed habitat features, as well as remediate any impacted areas, in accordance with DFO authorization requirements, if applicable. • Aquatic Habitat: An Erosion and Sediment Control Plan should be developed to minimize the mobilization of suspended materials into the water during DWI construction. Mitigation measures may include conducting in-water works in isolation of open or flowing water to reduce sediment introduction into the watercourse, regular inspection and maintenance of erosion controls, monitoring for signs of sedimentation, and ensuring the proper disposal of dredged materials. Similarly, a spill response plan should be implemented to prevent spills of deleterious substances. • Impingement and Entrainment: The reduction of impingement and entrainment once the DWI is operational should be confirmed through monitoring programs.

Environmental Component	Recommendation for Monitoring and Mitigation
	• Thermal Effects: The assumption that PNGS Units 5-8 discharge temperatures post-DWI implementation will be the same or slightly lower than previous operational conditions (with 6 operating units) should be confirmed through evaluation of lake water temperatures in terms of hazard quotients to key indicator fish species, as well as evaluation of the influence of climate change over time. This evaluation should be included in routine PN ERA updates. Additionally, monitoring of lake bottom temperatures within the thermal plume, once the DWI is operational is recommended to improve the understanding of habitat conditions.
Geological and Hydrogeological Environment	• During construction of the PCSS, Storage Building #5, Retube and Feeder Replacement Service Island Support Annex (RFRISA), and other planned buildings, any dewatering during excavation should be completed with the necessary permissions following MECP regulations intended to be protective against discharge or re-infiltration of collected groundwater. • A geotechnical investigation should be completed to determine if dewatering is required for the RFRISA or any other planned building. A geotechnical investigation has already been completed for the PCSS and is discussed in the PCSS PERA.
Terrestrial Environment	• See atmospheric environment row for recommendations on reducing noise levels for species at risk. • As much as its possible to do so, construction activities should be adjusted as needed to minimize impacts, such as modifying work schedules or implementing noise and activity restrictions near nesting sites. To further reduce disturbance, heavy construction activity should be avoided during key breeding periods. Furthermore, work could be planned to occur during daytime hours to minimize disruption of nocturnal wildlife. • OPG will comply with the species and habitat protection provisions of the Endangered Species Act, Species at Risk Act, and Migratory Birds Convention Act during all project activities. • OPG will continue to monitor breeding birds and conduct broader biodiversity monitoring on an annual basis to support conservation efforts and regulatory compliance.
Radiation and Radioactivity (Gamma Radiation)	• Future iterations of the PN ERA (based on the time period they encompass) should consider the new NSS-PWMF layout with inclusion of the transferred Dry Storage Modules (DSMs) from the Phase I to the Phase II NSS-PWMF site. Data from thermoluminescent dosimeters surrounding the DSMs as well as

Environmental Component	Recommendation for Monitoring and Mitigation
	quarterly catch basin stormwater monitoring can be used to verify the conclusion that doses remain acceptable.

OPG recognizes that the PERA, while it satisfies assessment of environmental impacts from a Western science perspective, may not fully address the impact of the Project on Aboriginal and Treaty rights as they are understood today. This is particularly true in light of the 2018 settlement agreement between the seven members of the Williams Treaties First Nations (WTFN) with the Governments of Canada and Ontario. The Settlement (Government of Canada, 2018) pertains to the lands of the PN site and reaffirms the rights of WTFN citizens, which has fundamentally shifted how WTFN is engaged and consulted on site development. OPG recognizes the importance of furthering our knowledge and understanding, in ongoing meaningful engagement with the WTFN. OPG endeavors to continue to work with the WTFN to appropriately identify the rights impacted by the Project and to achieve feasible mitigation measures and/or accommodation.

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LIST OF ACRONYMS AND SYMBOLS

Acronyms

AAQC	Ambient Air Quality Criteria
AAWS	Advanced Algae Warning System
ACB	Air Contaminants Benchmarks
AIFB	Auxiliary Irradiated Fuel Bay
ALARA	As Low as Reasonably Achievable
ALW	Active Liquid Waste
AQM	Air Quality Monitoring
ASB	Auxiliary Services Building
BaP	Benzo(a)pyrene
BOD	Biochemical Oxygen Demand
BPUE	Biomass Per Unit Effort
BSM	Broadscale Monitoring
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAAQS	Canadian Ambient Air Quality Standards
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CCW	Condenser Cooling Water
CLFN	Curve Lake First Nation
CNSC	Canadian Nuclear Safety Commission
CO	Carbon monoxide
COD	Chemical Oxygen Demand
COG	CANDU Owners Group
COPC	Contaminant of Potential Concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
COSSARO	Committee on the Status of Species at Risk in Ontario
CPUE	Catch Per Unit Effort
CSA	Canadian Standards Association
CSB	Common Services Building
CSM	Conceptual Site Model
CTU	Combustion Turbine Unit
CWQG	Canadian Water Quality Guidelines
D_2O	Heavy Water (Deuterium oxide)
DDP	Detailed Decommissioning Plan
DFO	Fisheries and Oceans Canada
DGR	Deep Geologic Repository
DNGS	Darlington Nuclear Generating Station
DNNP	Darlington New Nuclear Project

DRL	Derived Release Limit
DSC	Dry Storage Container
DSM	Dry Storage Module
dw	Dry weight
DWI	Deep Water Intake
EA	Environmental Assessment
EC	Environment Canada
ECA	Environmental Compliance Approval
ECCC	Environment and Climate Change Canada
Eco CV	Ecological Component Value
EcoRA	Ecological Risk Assessment
EMP	Environmental Monitoring Program
EPG	Emergency Power Generator
EPRI	Electric Power Research Institute
ERA	Environmental Risk Assessment
ERT	Emergency Response Team
ESA	Endangered Species Act
ESDM	Emissions Summary and Dispersion Modelling
EXP	Experimental
FAA	Fisheries Act Authorization
FCSAP	Federal Contaminated Sites Action Plan
FDS	Fish Diversion System
FEQG	Federal Environmental Quality Guideline
FFEE	Fixed Face Earthen Embankment
FNFNES	First Nations Food, Nutrition and Environment Study
GHG	Greenhouse Gas
GLM	Generalized Linear Model
GTA	Greater Toronto Area
GWMP	Groundwater Monitoring Program
GWPP	Groundwater Protection Program
%HA	Percent Highly Annoyed
HADD	Harmful Alteration, Destruction, and Disruption
HC	Health Canada
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
HTO	Tritium Oxide
HU	Hydrostratigraphic Unit
IA	Impact Assessment
IARC	International Agency for Research on Cancer
IBI	Indices of Biological Integrity
IEP	Indigenous Engagement Plan

IFB	Irradiated Fuel Bay
ILCR	Incremental Lifetime Cancer Risk
ILW	Intermediate Level Waste
ISO	International Organization for Standardization
ISQG	Interim Sediment Quality Guidelines
LAeq	Equivalent sound levels (A-weighted)
L&ILW	Low and Intermediate Level Waste
LEL	Lowest Effect Level
LLW	Low Level Waste
LPL	Lowest Practical Level
MECP	Ministry of Environment, Conservation and Parks
MISA	Municipal Industrial Strategy for Abatement
MNA	Monitored Natural Attenuation
MNRF	Ontario Ministry of Natural Resources and Forestry
MOE	Ontario Ministry of Environment
MOECC	Ontario Ministry of Environment and Climate Change
MOEE	Ontario Ministry of Environment and Energy
MSB	Main Security Building
MSIFN	Mississaugas of Scugog Island First Nation
MWAT	Maximum Weekly Average Temperature
NEW	Nuclear Energy Worker
NO_2	Nitrogen Dioxide
NO_x	Nitrogen oxides
NPC-300	Environmental Noise Guideline
NSCA	Nuclear Safety and Control Act
NSS-PWMF	Nuclear Sustainability Services – Pickering Waste Management Facility
NSS-WWMF	Nuclear Sustainability Services – Western Waste Management Facility
NWTP	New Water Treatment Plant
OBT	Organically Bound Tritium
OPEX	Operating Experience
OPG	Ontario Power Generation
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCSS	Pickering Component Storage Structure
PDP	Preliminary Decommissioning Plan
PE	Planning Envelope
PEA	Predictive Effects Assessment
PERA	Predictive Environmental Risk Assessment
PEL	Probable Effects Level
PHC	Petroleum Hydrocarbons
PM_{10}	Inhalable particulates

$PM_{2.5}$	Respirable particulates
PN	Pickering Nuclear
PNGS	Pickering Nuclear Generating Station
PNIC	Pickering Nuclear Information Centre
POI	Point of Impingement
POW	Plane of Window
PSQG	Provincial Sediment Quality Guideline
PWQO	Provincial Water Quality Objective
Q25	First Quartile
Q75	Third Quartile
QA	Quality Assurance
RAB	Reactor Auxiliary Bay
RBSW	Reactor Building Service Water
RCM	Regional Climate Model
RCP	Representative Concentration Pathway
RCS	Retube Component Storage
RCSF	Retube Component Storage Facility
RFRISA	Retube and Feeder Replacement Service Island Support Annex
RLWMS	Radioactive Liquid Waste Management System
RMA10	Hydrodynamic surface water model
SARO	Species at Risk in Ontario
SB	Storage Building
SCS	Site Condition Standards
SDSE	Shutdown System Enhancement
SEL	Severe Effects Level
SG	Standby Gas Generator
SHA	Safe Harbour Stewardship Agreement
SLM	Sound level meters
SO_2	Sulfur dioxide
SPM	Suspended Particulate Matter
SQG	Soil Quality Guideline
SS	Storage Structure
SSC	Structures, Systems, and Components
STDM	Short Term Daily Maximum
SWS	Storage with Surveillance
TAB	Turbine Auxiliary Bay
TH	Turbine Hall
TKN	Total Kjeldahl Nitrogen
TLD	Thermoluminescent dosimeter
TOC	Total Organic Carbon
TRC	Total Residual Chlorine

TRCA	Toronto and Region Conservation Authority
TRV	Toxicity Reference Value
TSD	Technical Support Document
TSP	Total suspended particulates
U.S. EPA	United States Environmental Protection Agency
UCLM	Upper Confidence Limit of the Mean
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VBRS	Vacuum Building Ramp Sump
VOC	Volatile Organic Compound
WHO	World Health Organization
WNW	West-North-West
WSP	Water Supply Plant
WTFNs	Williams Treaties First Nations
ww	Wet weight

1.0 Introduction

The Pickering Nuclear (PN) site is located in the City of Pickering on the north shore of Lake Ontario at Moore Point, about 32 km east of downtown Toronto and 21 km west of Oshawa (**Figure 1-1**). The PN site is comprised of the PN Generating Station (PNGS), with four operating CANada Deuterium Uranium (CANDU) pressurized heavy water reactors, and two units in Storage with Surveillance (SWS). The Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF) is also located on the PN site and is comprised of two sites. The NSS-PWMF Phase I site is located southeast of PNGS Unit 8, adjacent to the east side of the station security fence, and the NSS-PWMF Phase II site is located approximately 500 m north-east of the power generating facilities in the East Complex.

By the late 1700s, the Indigenous peoples in southeastern Ontario were compelled to cede their lands along the northern shore of Lake Ontario to the Crown. Two Treaties and agreements between the Crown and First Nations have historically been related to the lands comprising the PN site: the Johnson/Butler Purchase (1787-1788) (also known as the Gunshot Treaty), and the Williams Treaties (1923). Presently, the PN site remains within the territory of the 1923 Williams Treaties.

Ontario Power Generation (OPG) plans to pursue refurbishment and continued operation of PNGS Units 5-8 (PNGS Units 5-8), as well as decommissioning of PNGS Units 1-4), herein referred to as the Project. Refurbishment and continued operation of PNGS Units 5-8 will help OPG meet its mission to build a sustainable future powered by our electricity, our ideas, and our people. This is in support of OPG's vision to electrify life in one generation.

The existing PNGS licence allows for continued operation of PNGS Units 5-8 until the end of 2026. PNGS Units 1 and 4 were shutdown in 2024 and PNGS Units 2 and 3 have been in SWS since 2010. The existing licence is being renewed early to include refurbishment activities for PNGS Units 5-8, decommissioning of PNGS Units 1 to 4, as well as incorporating the NSS-PWMF waste licence.

To support the licence renewal, this predictive environmental risk assessment (PERA) was prepared. This PERA evaluates the proposed Project activities to ensure there will not be any significant risks to people or the environment, and to determine any areas requiring additional mitigation, monitoring, or study. This PERA complies with Canadian Standards Association (CSA) N288.6:22, Environmental Risk Assessment at Nuclear Facilities and Uranium Mines and Mills (CSA, 2022b) and Canadian Nuclear Safety Commission (CNSC) REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures (CNSC, 2020). OPG is committed to open and transparent communication on our operations and projects and adheres to the guidance outlined in CNSC REGDOC 3.2.1, Public Information and Disclosure, and CNSC REGDOC 3.2.2, Indigenous Engagement, in accordance with the PNGS Licence Condition Handbook (CNSC, 2018, 2022).

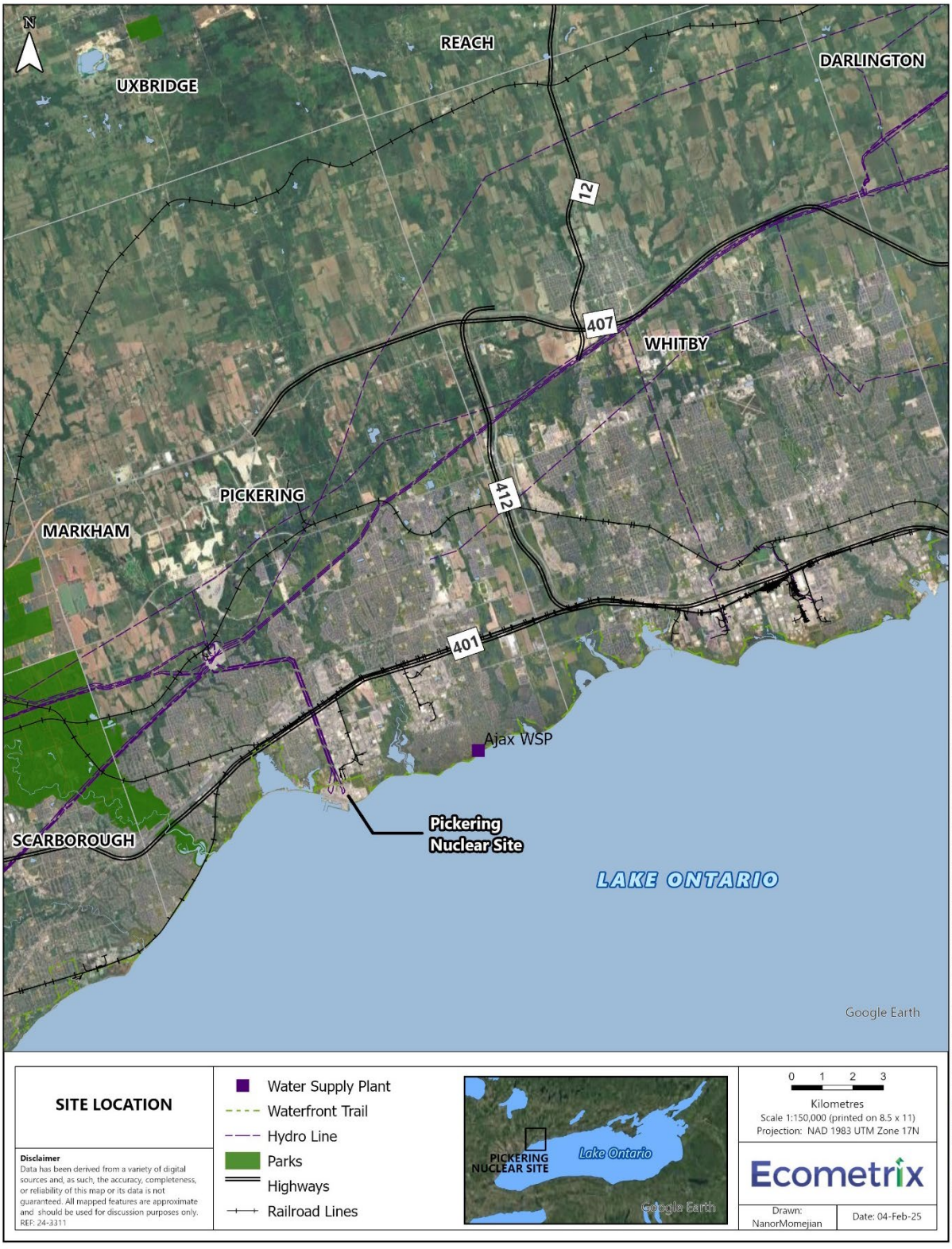


Figure 1-1: PN Site Location and Vicinity

1.1 Project Overview and Schedule

This section provides a brief overview of the Project and associated timelines based on current planning at the time of preparing this PERA. As the Project progresses the timelines may shift; however, conceptual timelines are provided here for planning purposes, and are shown in **Figure 1-2**. The assumptions considered in the PERA are specific to activities which are expected to occur during the Project phases considered and are generally independent of exact timelines unless otherwise noted within the assessment.

The focus of the PERA is on the activities that will occur up to and including the re-licensing period from 2027 to 2037; however, activities and Project phases that will occur after the end of 2037 are discussed at a more general level of detail.

PNGS Unit 1 was permanently shut down on October 1, 2024 and Unit 4 was permanently shut down on December 31, 2024. PNGS Units 2 and 3 were previously shut down in 1997 and were declared to be in SWS in 2010 (Note: for the purposes of this PERA, the term Safe Storage is equivalent to SWS). Stabilization activities were initiated in 2024 for PNGS Unit 1 and in early 2025 for PNGS Unit 4 and are expected to be completed by 2028. SWS Activities (Start of Decommissioning[1]) for Unit 1 and Unit 4 will begin in 2028.

- **Stabilization Phase:** Initiated in October 2024, a 3-year Stabilization Phase for Units 1 and 4 includes the arrangements and activities that ensure a safe and efficient transition from the end of commercial operation to the SWS state for the transitioning units. Stabilization activities include defueling and dewatering reactor Units 1 and 4. PNGS Units 2 and 3 are not included in assessment of this phase as the Stabilization Phase of Units 2 and 3 is complete and the units have been in a SWS state since 2010. The stabilization activities are captured in the PNGS Stabilization Activity Plan (OPG, 2024a), and were previously assessed from an environmental impact perspective in the 2017 Safe Storage Predictive Effects Assessment (PEA) and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017).

- **Storage with Surveillance (SWS):** Starting in 2028 to approximately 2090, a 50- to 70-year SWS Phase for Units 1 and 4 will begin to allow for natural decay of radioactivity. Units 2 and 3 have been in SWS phase since 2010. Activities during this phase include the ongoing operation of the Irradiated Fuel Bays (IFBs) and the continued transfer of spent fuel to dry storage containers (DSCs). Current planning anticipates that used fuel transfer to DSCs will be completed within 10 years of PNGS Units 1 and 4 transitioning to SWS. Monitoring the natural decay of radioactivity within the remaining reactor systems will continue to approximately 2050. Risk reduction and removal activities will be initiated to remove and remediate non-nuclear equipment and buildings/facilities. These

[1] Decommissioning actions are the procedures, processes and work activities (e.g., storage with surveillance, decontamination, dismantling or cleanup) that are taken to retire a facility, location or site from service with due regard for the health and safety of people and the environment.

risk reduction and removal activities are distinct from Dismantle and Demolish activities. Risk reduction and removal activities will only occur for structures, systems, and components (SSCs) that have been end-stated and are no longer required to support SWS activities. This is consistent with CNSC REGDOC-2.11.2 "Decommissioning" (CNSC, 2021). SWS activities were previously assessed from an environmental impact perspective in the 2017 Safe Storage Predictive Effects Assessment (PEA) and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017) – the SWS period was 25 to 30 years in previous assessments; with the focus on the first 10 years as bounding for the rest of the phase. While the duration of SWS is now longer, the bounding assumption for the first 10 years of SWS is still valid. Risk reduction and removal activities were not considered in the 2017 Safe Storage PEA or 2022 PEA Addendum, but are assessed in this PERA.

- **Dismantle and Demolish:** From 2034 to approximately 2100, the Dismantle and Demolish Phase will be initiated for PNGS Units 1-4. The specific Dismantle and Demolish activities, along with their associated work packages, will be detailed in subsequent Detailed Decommissioning Plan (DDP) updates.

For PNGS Units 5-8, refurbishment licensed activities are planned to start in 2027; however, prerequisites will start earlier. The units are planned for shutdown in 2026. The first unit from PNGS Units 5-8 is expected to come back online in 2031 and the last of the four units is expected to come back online by the end of 2034. The PNGS Units 5-8 Project phases are described below, and the conceptual timeline is shown in **Figure 1-2**.

- **Refurbishment:** Starting in 2027 (pending approvals), preparation for refurbishment of PNGS Units 5-8 will be initiated, including defueling and dewatering of reactors, relocation and/or removal of structures and equipment, construction of buildings and temporary laydown areas. Starting in 2027, the first unit will enter refurbishment which includes replacing reactor components including: fuel channels and calandria tubes, inlet and outlet feeders from end fittings to the reactor inlet/outlet headers, replacement of steam generators, refurbishment of various systems including reactor auxiliary systems and feedwater systems, and normal upgrade and maintenance activities. The unit will then be refuelled and restarted. Each unit will undergo refurbishment in a staged manner.

- **Continued Operations:** At the end of Refurbishment all units at PNGS Units 5-8 will be returned to service where operation will then continue for approximately 30 years. Continued Operations of the refurbished reactors will be very similar to current operations for PNGS Units 5-8 and will include ongoing maintenance until end of life of the reactors.

- **Decommissioning:** At the end of life for PNGS Units 5-8 (approximately 2070), the facility will enter a Stabilization Phase, followed by SWS, and Dismantle and Demolish phases. At this stage, decommissioning of PNGS Units 5-8 is only conceptually developed, and is consistent with its preliminary decommissioning plan (PDP) (OPG,

2025). Prior to the transition of PNGS Units 5-8 to SWS, the PDP will be further developed into a DDP to include all details of decommissioning, and the associated environmental effects will be evaluated. It is assumed, based on growing international decommissioning experience and the protection strategies outlined in the PDP, that effective mitigation measures will be available for decommissioning. Additionally, Stabilization and SWS activities for PNGS Units 5-8 were previously assessed from an environmental impact perspective in the 2017 Safe Storage PEA and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017), as these documents assessed both PNGS Units 1-4 and PNGS Units 5-8.

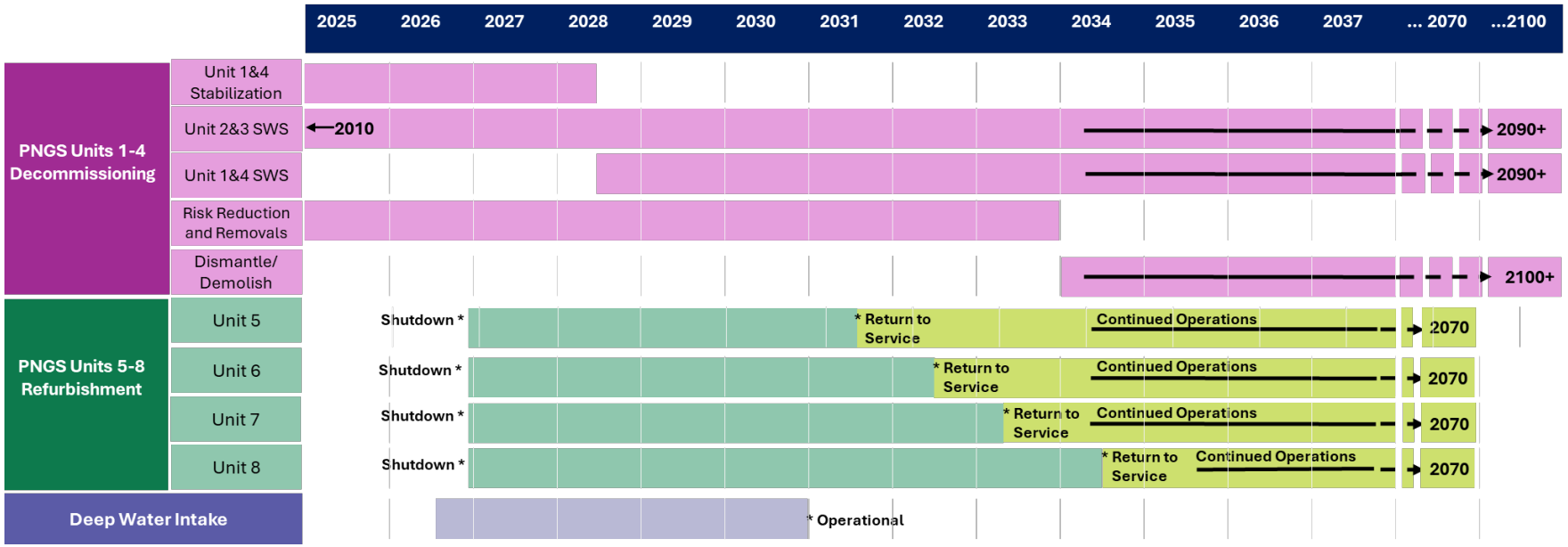


Figure 1-2: Pickering NGS Timeline Overview

1.2 Regulatory Context

The *Nuclear Safety and Control Act* (NSCA) mandates the CNSC to regulate the nuclear industry in a manner that prevents unreasonable risk to the environment and makes adequate provision for environmental protection, in conformity with international obligations. This mandate is reflected in the General Nuclear Safety and Control Regulations under the NSCA, and in the CNSC Regulatory Document REGDOC-2.9.1 "Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2" (CNSC, 2020).

REGDOC-2.9.1 outlines the CNSC's environmental protection framework, including the environmental protection measures a licensee would take for a given project or licence application. The refurbishment of PNGS Units 5-8 and the decommissioning of PNGS Units 1-4 is not a designated project under the *Impact Assessment Act* (2019). However, the Project does have potential for interactions with the environment, which requires the CNSC to conduct an Environmental Protection Review under the NSCA. This PERA will become part of the supporting technical documentation to be submitted to the CNSC in support of the licence application for these activities, which will help inform the CNSC's Environmental Protection Review.

This PERA has been prepared following the guidance of CSA N288.6:22 (CSA, 2022b) and CNSC REGDOC-2.9.1 (CNSC, 2020).

OPG is committed to open and transparent communication on our operations and projects and adheres to the guidance outlined in CNSC REGDOC 3.2.1, Public Information and Disclosure, and CNSC REGDOC 3.2.2, Indigenous Engagement, in accordance with the PNGS Licence Condition Handbook (CNSC, 2018, 2022).

1.3 Objectives

The objectives of this PERA are to:

- Identify whether any proposed Project activities are likely to result in environmental emissions or other stressors potentially exceeding those in previous assessments;
- Predict and assess the risk of effect to representative human and ecological receptors resulting from exposure to radiological and non-radiological substances and physical stressors expected to be released during refurbishment, decommissioning, and continued operations of PNGS;
- Inform prioritization of monitoring and mitigation measures.

The most recent ERA for PN was completed in 2022 and focused on the five-year period from 2016 to 2020 (Ecometrix, 2023a). The 2022 PN ERA should be consulted for detailed information on prior operational conditions on the PN Site (for 6 operating units); as well as the systems and structures in operation at PNGS. Additionally, the 2017 Safe Storage PEA and 2022 PEA

Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017) should be consulted for assessment of the environmental risks from stabilization and SWS activities.

To support this PERA, additional field data were collected on existing conditions in 2024 and 2025. These data supplement the ongoing annual environmental monitoring program (EMP), effluent and emissions monitoring programs, biodiversity monitoring programs, and any supplementary environmental field studies previously conducted. Existing conditions are described at a summary level in Section 4.0.

1.4 Scope

1.4.1 Spatial Boundaries

For the predictive human health risk assessment (HHRA), the spatial scale is consistent with that in the 2022 PN ERA, the 2017 PN PEA, 2022 PN PEA Addendum, and EMP, and includes identified human receptors (including a Harvester receptor not considered in previous assessments, see **Section 6.1.1.2**) within 10 km of the PN site, as shown on **Figure 1-3**. This area includes lands within the city of Pickering, the town of Ajax, and the eastern part of the city of Toronto (Scarborough).

For the predictive ecological risk assessment (EcoRA), the spatial scale is consistent with that in the 2022 PN ERA, the 2017 PN PEA and 2022 PN PEA Addendum and includes those ecological receptors identified on the PN site and within the immediate PNGS boundary, as well as within the 914-m exclusion zone and the near-field receiving waters, including Frenchman's Bay. However, for this assessment the nearshore Lake Ontario has been expanded to include the area of the proposed DWI, as shown on **Figure 1-4**.

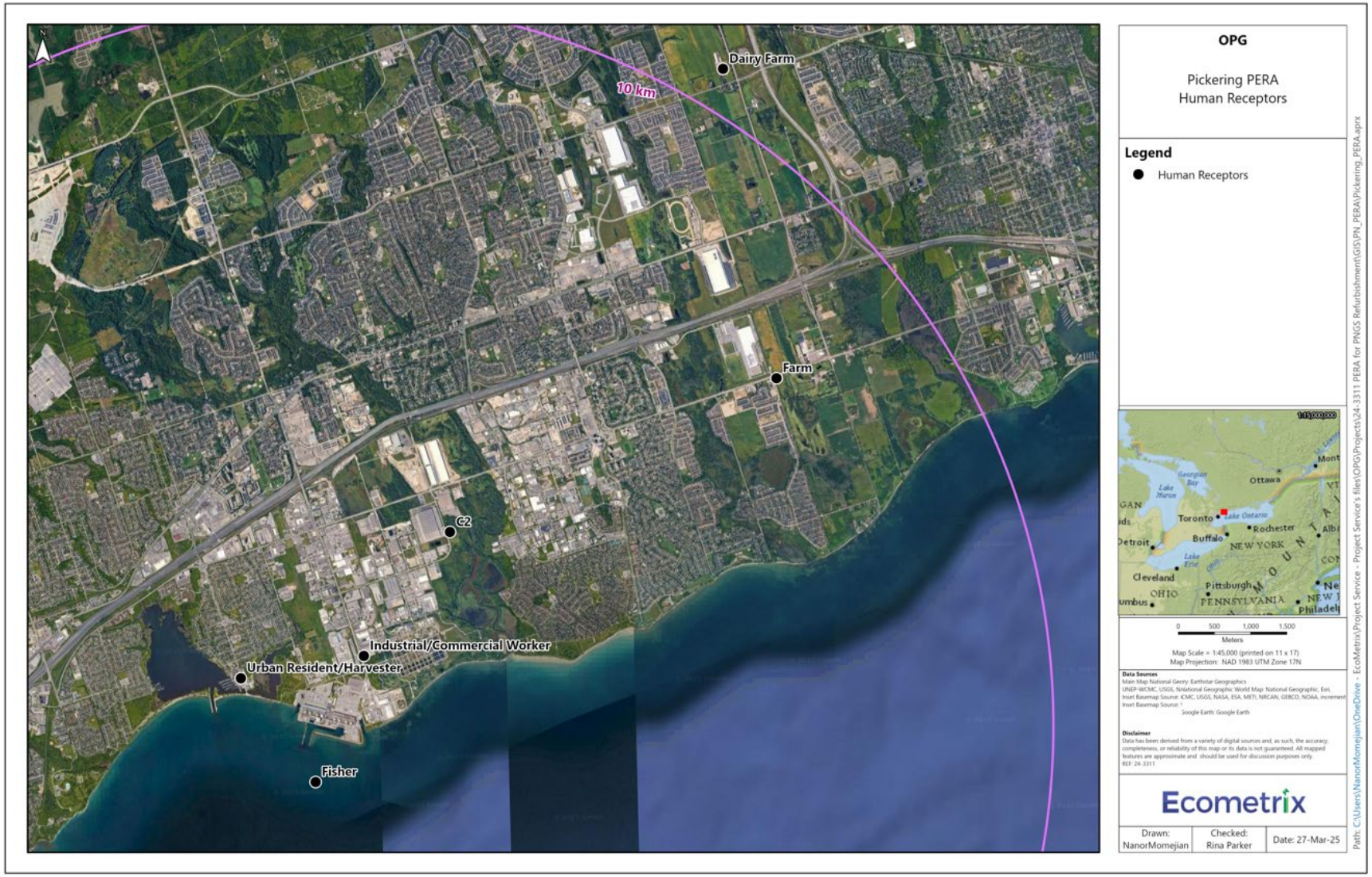


Figure 1-3: Area of Assessment for Human Receptors

Figure 1-4: Areas of Assessment for Ecological Receptors

1.4.2 Temporal Boundaries

The temporal boundaries of the Pickering PERA include the existing licence period which expires at the end of August 2028, as well as the re-licensing period to align with the start of refurbishment activities. This includes PNGS Units 1 and 4 Stabilization (3 years), PNGS Units 1-4 SWS (including risk reduction and removal activities that will occur during this timeframe), as well as PNGS Units 5-8 refurbishment and the start of continued operations (see **Figure 1-2**). This Pickering PERA covers the timeframe of 2025 to 2037.

At this stage, future Dismantle and Demolish activities for PNGS Units 1-4 are in the planning stages. The specific Dismantle and Demolish activities, along with their associated work packages, will be detailed in subsequent DDP updates.

At the end of commercial operation of PNGS Units 5-8, the facility will enter a Stabilization Phase, followed by SWS, and Dismantle and Demolish. At this stage, decommissioning of PNGS Units 5-8 is only conceptually developed, and is consistent with its PDP (OPG, 2025). Prior to the transition of PNGS Units 5-8 to SWS, the PDP will be further developed into a DDP to include all details of decommissioning, and the associated environmental effects will be evaluated. It is assumed, based on growing international decommissioning experience and the protection strategies outlined in the PDP, that effective mitigation measures will be available for decommissioning.

1.5 Summary of Past Assessments

This section provides a summary of past assessments that were relied on to support the assessment of PNGS Units 1-4 decommissioning and PNGS Units 5-8 refurbishment and continued operations in this PERA. The 2022 PN ERA provides the most up to date assessment of previous conditions at the PN site for 6 operating units. It is important to understand these existing and previous conditions in order to assess future conditions during PNGS Units 1-4 decommissioning and PNGS Units 5-8 refurbishment and continued operations. This section also provides a summary of predictive assessments that have been completed including the 2017 Safe Storage PEA and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017), as well as the 2007 environmental assessment (EA) for the refurbishment and continued operations of PNGS Units 5-8.

1.5.1 Environmental Risk Assessment for Pickering Nuclear

The most recent ERA for PN (i.e., the 2022 PN ERA) (Ecometrix, 2023a) was completed in accordance with CSA N288.6-12 (CSA, 2012) and REGDOC-2.9.1. It assesses the conditions at the PN site focused on the five-year period from 2016 to 2020. The scope looked at the potential effects of nuclear and hazardous substances released from the PN site on the human and ecological environment, as well as potential effects from physical stressors.

Potential risks to human receptors were characterized quantitatively in the HHRA, which concluded that there was limited risk to human receptors from inhalation of nitrogen oxides

(NO_X) and ingestion of hydrazine via drinking water. While the Incremental Lifetime Cancer Risk (ILCR) to sport fishers from ingesting fish containing hydrazine exceeded the acceptable risk level, this estimate was based on the highly conservative assumption that 100% of the fish consumed were collected within 500 meters of the Condenser Cooling Water (CCW) discharge. During the 2016 to 2020 period, the annual radiological dose to the critical group (Urban Resident) ranged from 1.2 to 2.1 µSv/a (0.0012 to 0.0021 mSv/a), which is approximately three orders of magnitude lower than the regulatory public dose limit of 1 mSv/a. Since the critical group is the receptor that receives the highest dose from PN, their protection implies that other receptor groups near PN are also protected.

The ERA suggested that there were minimal effects of the PN site on aquatic or terrestrial ecosystems near the site, in Frenchman's Bay, and surrounding areas. No significant adverse effects are expected from sulfur dioxide (SO_2) emissions to ecological receptors at the PN site. Based on 2015 Emissions Summary and Dispersion Modelling (ESDM), elevated concentrations of SO_2 were predicted to be released in 2016, resulting in an exceedance of the annual ambient air quality criteria (AAQC) that is protective of vegetation; however, from 2017 to 2020 no exceedances were identified. The adjusted annual SO_2 concentration did not exceed the no-effect level from the World Health Organization (WHO, 2000); therefore, no long-term effects to vegetation are expected.

At the outfall, Upper Confidence Limit of the Mean (UCLM) concentrations of morpholine, hydrazine, copper, and total residual chlorine (TRC) were below benchmark levels for aquatic receptors.

At Frenchman's Bay, water concentrations of hydrazine, morpholine, TRC, and sodium did not exceed their respective benchmarks for the ecological receptors evaluated. The maximum and UCLM measured iron concentrations in water at Frenchman's Bay were above the benthic invertebrate benchmark, but the maximum and UCLM measured iron concentrations in sediment at Frenchman's Bay did not exceed the sediment benchmarks for benthic invertebrates; therefore, adverse effects are not expected since benthic invertebrates live in the sediment.

While the Hazard Quotients (HQs) based on the maximum and UCLM concentrations of aluminum and iron exceeded the acceptable level of 1 for certain riparian mammals and birds in Frenchman's Bay, many of these species are unlikely to be impacted at a population-level as they do not reside exclusively in the area. The Least Bittern, a species at risk, is likely not at risk from exposure to iron in Frenchman's Bay, since based on UCLM exposure, the HQ does not exceed the acceptable risk level of 1. Birds are mobile and would be exposed to concentrations closer to UCLM than the maximum.

In general, soils on the PN site that exceeded benchmark concentrations are localized, suggesting the influence of past industrial operations rather than deposition from atmospheric sources. As such, accumulation of contaminants of potential concern (COPC) in soil over time is not expected.

Although localized effects to individual earthworms/plants may occur, the earthworm community and terrestrial plant population on the site as a whole are not expected to be affected. Risks to mammals and birds on the PN site are considered unlikely. Acceptable risk levels were not exceeded for mammals or birds exposed to UCLM concentrations in soil, except for the Red-winged Blackbird for zinc. The terrestrial receptors, except for the Meadow Vole which has a small home range, are highly mobile and are unlikely to be exposed to the maximum concentrations for the entire year. Residency at the PN site has been conservatively assumed to be 1, even though soil is inaccessible at most areas of the site due to the existing infrastructure. Any effects to individual mammals or birds on the PN site are localized, and the populations on the site as a whole are not expected to be affected.

The impacts of physical stressors, such as temperature, entrainment, and impingement, were also assessed for fish at the PN site. It was found that the thermal plume released from PNGS does not adversely affect the development of Round Whitefish embryos. Additionally, biomass lost to impingement in 2016 was reduced by 88% relative to baseline levels (i.e., prior to the installation of the fish diversion system in 2009), surpassing the 80% impingement reduction target set by the CNSC in 2009.

In terms of radiological impacts, there were no exceedances of the radiation dose benchmarks for aquatic, riparian, and terrestrial biota at any locations for the ecological receptors assessed.

1.5.2 Predictive Effects Assessment for Pickering Nuclear Safe Storage

A predictive effects assessment (PEA) for PN Safe Storage was completed in 2017 to identify changes from the years 2011 to 2015 (identified as existing conditions at the time of the assessment) environmental and human health conditions that would result from activities associated with the Stabilization Phase and the SWS Phase of PNGS Units 1-4 and PNGS Units 5-8 (Golder and Ecometrix, 2017). Based on the screening assessment, further quantitative assessment of air quality (radiological and non-radiological), and surface water flow and quality were conducted. The conclusion of the 2017 Safe Storage PEA was that there were no predicted potential adverse effects to humans nor to ecological receptors from the activities proposed to take place during the Stabilization and the SWS Phases.

To support the mid-term operating licence review that occurred in 2023, a PEA Addendum Report was prepared to document and demonstrate that human health and the environment would continue to be protected during PNGS Units 1 and 4, and PNGS Units 5-8 shutdown, based on updated existing environmental conditions and current operational assumptions for the Stabilization and SWS Phases (Ecometrix, 2023b). The 2017 Safe Storage PEA assumed continued operations of PNGS until 2024; whereas in the PEA Addendum Report, continued operations of PNGS Units 5-8 was assumed until 2026. Based on changes to assumptions for Safe Storage (equivalent to SWS) at the time when the PEA Addendum Report was being prepared, the PEA Addendum Report re-assessed predicted effects to future ecological receptors in the PN forebay as well as potential entrainment and impingement effects due to increased flows through the intake, compared to the 2017 Safe Storage PEA. The conclusion of

the 2022 PEA Addendum was consistent with 2017 in that there were no predicted potential adverse effects to humans nor to ecological receptors from the activities proposed to take place during the Stabilization and the SWS Phases. No further mitigation measures were identified.

Based on current planning, the 2017 Safe Storage PEA and 2022 PEA Addendum are still valid for PNGS Units 1-4 for the Stabilization and SWS Phases. Note the SWS period in the 2017 Safe Storage PEA and 2022 PEA Addendum was 25 to 30 years; with the focus on the first 10 years as bounding for the rest of the phase. While the duration of SWS is now longer, the bounding assumption for SWS is still valid. For PNGS Units 5-8, OPG now plans to pursue refurbishment.

1.5.3 Pickering B Refurbishment Environmental Assessment

In 2007 OPG conducted an EA study for the refurbishment of one or more of the PNGS Units 5-8 reactors. The scope of the EA included the construction and operation of additional waste storage structures to accommodate wastes resulting from reactor refurbishment activities, and from continued operation of the reactors.

The EA study report and nine technical supporting documents (TSDs) were submitted to the CNSC in December 2007 (OPG, 2007). After considering the screening report, the mitigation measures, and comments filed from the public, the CNSC accepted that the project would not cause significant adverse effects (CNSC, 2009).

In early 2024, OPG announced that it plans to pursue refurbishment of PNGS Units 5-8 to help meet Ontario's growing electricity demand and reduce emissions by supporting the electrification of the province's overall economy (OPG, 2024b).

1.6 What OPG has heard through Indigenous Engagement Feedback

In early 2024, OPG initiated support for the Michi Saagiig Nations of the WTFN to carry out an Indigenous Knowledge study, including aspects of Rights impact assessment (IA), cumulative effects assessment, and augmented monitoring, as determined by the Nations. This work will be scoped by the Michi Saagiig Nations, and when completed, the Nations will determine if and what portions may be shared with OPG, which can help inform future ERAs.

This section describes engagement activities and meetings with Indigenous Nations and communities related to the PERA, relevant discussion and feedback, and how it has been considered in the PERA.

OPG has a site wide Indigenous Engagement Plan (IEP) for the PN site which covers ongoing and proposed initiatives, including the PERA. The IEP distinguishes between rights holders (WTFNs) and Indigenous Nations and communities that express interest in OPG's PN site.

Currently, OPG is engaging with the Michi Saagiig Nations on a regular basis on various OPG projects, including activities that are planned at the PN site. OPG also continues to share information and provide opportunities for engagement with the Chippewa Nations. With respect

to Indigenous Nations and communities who have expressed interest in Pickering NGS, OPG conducts outreach and engages at the request of the Nations. Engagement on the PERA has primarily focussed on the WTFNs. The list below summarizes feedback received and topics discussed related to the Pickering PERA through various engagements with the Michi Saagiig Nations.

- In 2023, OPG received comments from the Mississaugas of Scugog Island First Nation (MSIFN) on the 2022 PN ERA and 2022 PEA Addendum. A number of issues were raised related to terminology, questions on environmental monitoring data, and explanation of ERA results. OPG has addressed those comments that are also applicable to this PERA.
    - Moved away from using the term "baseline" to describe the current environmental conditions. Have preferred the term "existing conditions", "current operational conditions", "existing operational conditions", or "previous operational conditions" if referring to 6 operating units.
    - Inclusion of text to describe how adaptive management is considered (Section 2.0).
    - Initiated collection of environmental monitoring data in 2024 and 2025 to address concerns that existing conditions at PNGS were relying on old data. Environmental data collected included air quality data, noise levels, surface water and sediment quality, soil quality, fish tissue, and aquatic habitat characterization.
- In May 2024, OPG met with the Nations to present an overview of the PERA, including plans for field studies and opportunities to participate.
- In June 2024, sampling plans were shared with the Nations as well as dates for upcoming monitoring as opportunities for participation.
- In Fall 2024, a Michi Saagiig representative of MSIFN participated in the fish community studies in the deepwater intake study area. On that day a Lake Sturgeon was captured and released back into the lake. Follow up discussions with the Michi Saagiig Nations identified lessons learned regarding communications between OPG and the Michi Saagiig Nations when a notable event occurs.
- In November and December 2024 OPG received comments on the Darlington New Nuclear Project (DNNP) PERA from the Curve Lake First Nation (CLFN) and the MSIFN, respectively. Comments from the CLFN on the DNNP PERA that may be relevant to this PERA are assessment of the thermal plume and its impact on aquatic biota, as well as the accuracy of the Harvester receptor characterized in the DNNP PERA. OPG is making efforts to seek additional information to update the characteristics of the new Harvester receptor over time, and engaging with the Michi Saagig Nations along the way. While at the time of preparation of this report comments from the MSIFN on the DNNP PERA are

still being addressed, those comments that may be relevant to this PERA include: ensuring direct input from the WTFNs into the PERA, formalizing a plan to incorporate input from the WTFNs into the ERA process and ensuring characteristics are accurately represented in exposure models, prioritizing monitoring and validation of emissions, addressing cumulative effects, consideration of adaptive management, and clarifying waste management, among others.

- In early 2025, OPG received comments from CLFN on the PCSS PERA, requesting a Harvester receptor be added to the assessment. The Harvester has been added to this PERA (see Section 6.0). Subsequently, in April 2025, OPG received comments from MSIFN on the PCSS PERA. OPG is still reviewing these comments and will formally address these comments through the PCSS PERA process. OPG has taken action to address a few comments in this PERA, including:
    - Removing the word "discernable" from "no discernable health effects" and removing the word "adverse" from "no adverse radiological effects to ecological receptors" when presenting the results of the PCSS PERA;
    - Adding reference to CNSC REGDOC 3.2.1, Public Information and Disclosure, and CNSC REGDOC 3.2.2, Indigenous Engagement (CNSC, 2018, 2022).
- In March 2025, OPG met with the Nations to provide an overview of the PERA's timelines, to understand engagement opportunities leading up to its submission to the CNSC.

OPG will continue to facilitate engagement on this and other PERAs and ERAs, which will broaden OPG's understanding of surrounding land use and receptor selection. OPG endeavors to continue to work with Indigenous Nations and communities to strengthen ongoing engagement around ERAs and PERAs. OPG has shared this PERA report as a draft for review and comments by the Michi Saagiig Nations. However, it does not at this time include the voices of the Nations. As the PERA is an iterative process, OPG continues to engage and welcomes input and feedback that may be incorporated into this and/or future assessments.

1.7 Quality Assurance and Quality Control

This PERA made use of environmental monitoring data. These data are derived from chemical and radiochemical analyses of samples collected from effluent streams and environmental media around the PN site. The environmental data provided by OPG were collected by qualified staff and analyzed by qualified laboratories under the Environmental Monitoring Program (EMP), such as the station chemistry laboratory and the Whitby Health Physics Laboratory. The EMP has

its own quality assurance (QA) program that encompasses activities such as sample collection, laboratory analysis, laboratory quality control, and external laboratory comparison (OPG, 2019a).

Environmental samples collected in 2024 and 2025 to characterize existing conditions at the PN site, such as water, sediment, soil, fish tissue, air and noise were collected and analyzed in accordance with CSA N288.4:19. Samples collected were analyzed for non-radiological constituents by Bureau Veritas Laboratories and radiological constituents by Kinectrics, which are both accredited by the Standards Council of Canada as conforming to the quality assurance requirements of International Organization for Standardization (ISO) Standard 17025. In order to achieve desired detection limits, hydrazine analysis was performed by Eurofins Lancaster Laboratories Environmental in Lancaster, Pennsylvania, which is accredited to the ISO Standard 17025 as well as the United States National Environmental Laboratory Accreditation Program Standard.

Throughout the planning and preparation of the PERA, all staff worked under an ISO 9001:2015 certified Quality Management System. All work was internally reviewed and verified. Reviews included verification of data and calculations, as well as review of report content and formatting. Comments have been dispositioned and addressed as appropriate by report revisions. The review process has been documented through an electronic paper trail of review comments and dispositions.

2.0 Methodology

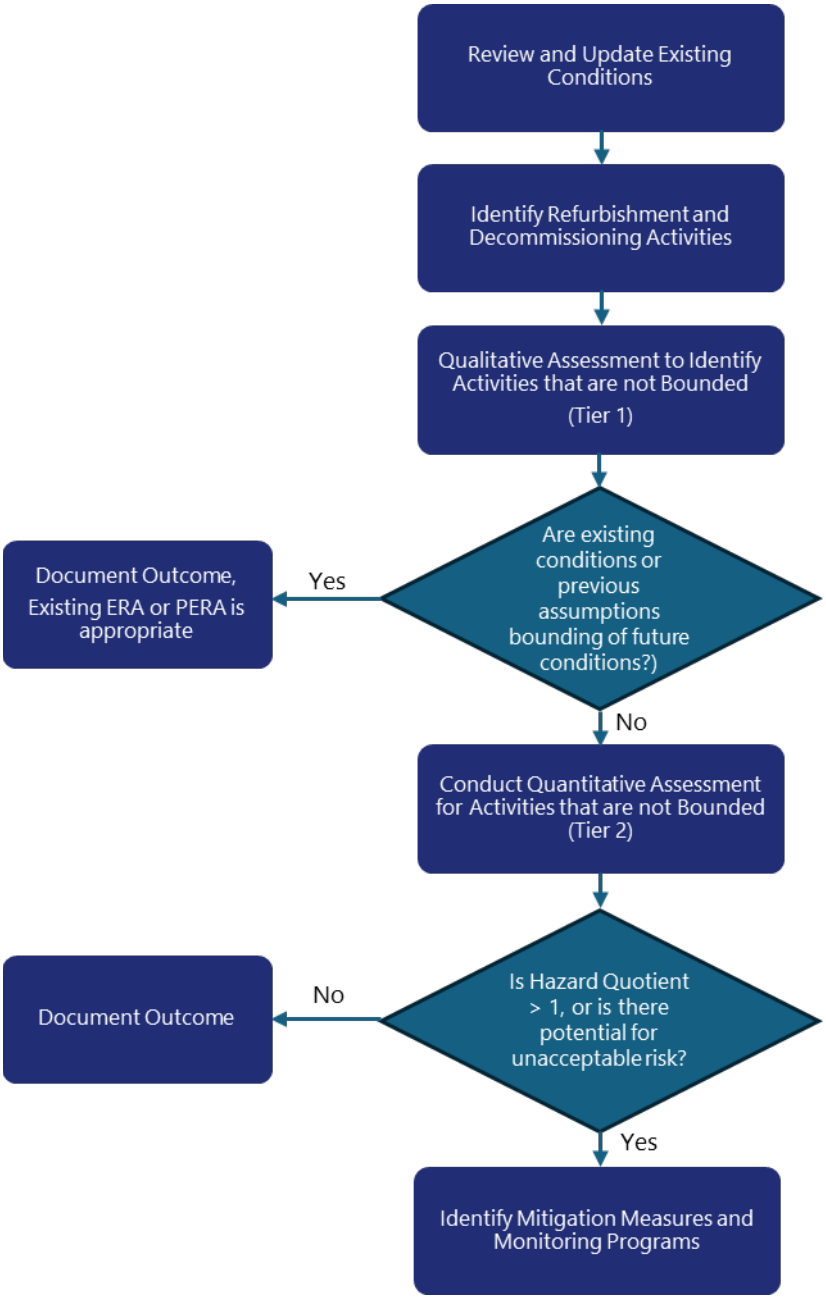
The methodology for the PERA is based on general guidance from CSA N288.6:22 (CSA, 2022b). Specific guidance on predictive ERAs is not provided in the CSA guidance; therefore, ERA guidance was modified from Figure 5.1 in CSA N288.6:22 to apply to this assessment. This methodology is generally consistent with that identified in the 2017 Safe Storage PEA and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017) and is shown on **Figure 2-1**.

The PERA focuses on identifying and assessing decommissioning and refurbishment activities that were not previously considered and found acceptable in other assessments (the 2017 Safe Storage PEA and 2022 PEA Addendum) and are not bounded by previous conditions at the PN site as described in the 2022 PN ERA (for 6 operating units) and updated existing conditions (**Section 4.0**). Those activities that are not bounded by existing or previous conditions are those that may potentially increase environmental emissions or other stressors, and which therefore warrant further assessment of human health or ecological risk.

A qualitative assessment (Tier 1 assessment) is performed to identify which project activities are not bounded by existing conditions and previous assessments. A quantitative assessment (Tier 2 assessment) is performed for those environmental interactions and project activities that are not bounded. The outcome of the quantitative assessment will inform if additional monitoring or mitigation measures are recommended.

OPG integrates adaptive management into its environmental management system. Specifically, adaptive management is fundamental to the EMP to ensure that the monitoring activities remain valid, and to enable OPG to appropriately identify and address any adverse findings or areas of risk. EMP design reviews, self-assessments and audits are regularly conducted to confirm effectiveness of environmental monitoring activities and to practice continual improvement. The ERA process is also a means for adaptive management as it is undertaken every 5 years and considers changes to site activities and environmental conditions to identify any areas where changes in mitigation or monitoring may be needed. Through the existing processes, if a risk to the environment is identified or predicted through the ERA, it can trigger changes to the EMP, supplementary studies and/or mitigation measures, as required.

As the Project is in its planning phase, the PERA has been conducted as a bounding conservative assessment to ensure that potential environmental effects are adequately characterized. As part of adaptive management, an updated PERA may be prepared, if warranted based on CSA N288.6:22 to incorporate future Project changes.



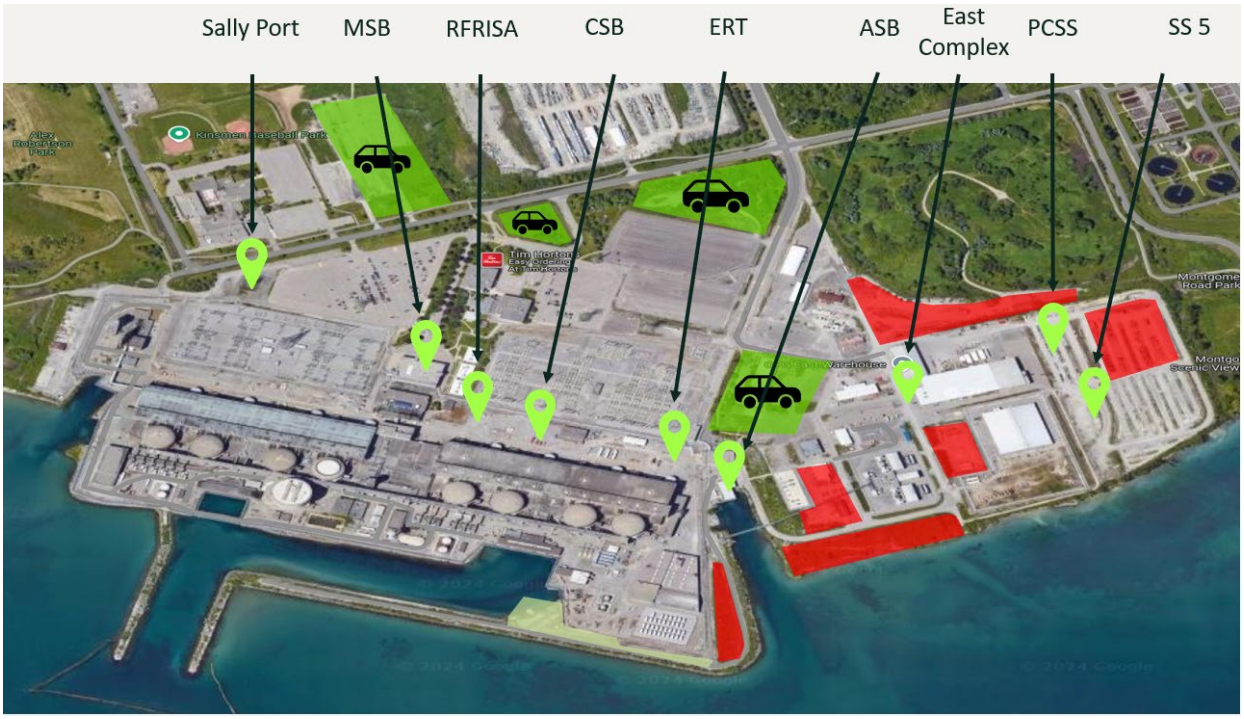
Note: A hazard quotient is a numerical representation of a potential for effects due to exposure to constituents. A hazard quotient greater than 1 indicates that there is potential for adverse effects and there is a need for further, more detailed assessment. In some situations (i.e., physical stressors) a hazard quotient may not be applicable, but the overall tiered approach still applies.

Figure 2-1: Methodology for the PNGS PERA

3.0 Project Activities

This section provides the current understanding (at the time of preparing this PERA) of the overall activities for the Decommissioning of PNGS Units 1-4 and the Refurbishment and Continued Operation of PNGS Units 5-8. As identified in **Section 1.1**, permanent shutdown of PNGS Units 1 and 4 occurred in Q4 2024, Stabilization Activities for Units 1 and 4 were initiated in 2025 and SWS Activities (Start of Decommissioning) for Units 1-4 will start in 2028. PNGS Units 5-8 refurbishment licensed activities will start in 2027; however, other prerequisites will begin earlier. The first unit is expected to come back online from PNGS Units 5-8 in 2031 and the last of the four units in 2034. Operation of PNGS Units 5-8 will then continue for approximately 30 years.

The PN site is shown on **Figure 3-1**, which includes existing and planned buildings, laydown areas, and parking areas. A summary of assumptions for the Project are provided in **Table 3-1** by SSC, with further detailed discussion provided by Project phase below. A background description of each SSC is provided in the 2022 PN ERA (Ecometrix, 2023a).



Note: Red shaded areas represent planned laydown areas, green shaded areas represent parking.
Existing Facilities: MSB = Main Security Building; ERT = Emergency Response Team; ASB = Auxiliary Security Building;
Proposed New Facilities: RFRISA = Retube and Feeder Replacement Service Island Support Annex; CSB = Common Services Building; PCSS = Pickering Component Storage Structure; SS = Storage Structure

Figure 3-1: Pickering Nuclear Site Plan

Table 3-1: Summary of Project Assumptions for Pickering Refurbishment and Decommissioning

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
Reactor Building Systems	• The Reactor Building systems will cease operation for nuclear fission and heat generation. Fuel will be removed, heavy water systems drained, moderator system flushed, and all other liquids, wastes and potentially hazardous transient materials will be removed. • Building ventilation and stack monitoring will remain operational. • The Reactor Building active drainage sumps will remain operational. • 1,500 Mg of the approximately 3,000 Mg heavy water that will be drained from the units will be transferred to the Darlington Heavy Water Management Building – West Annex, following the Darlington Unit 1 refurbishment per D_2O Management Plan for Pickering Safe Storage	• Surveillance will commence to ensure Reactor Building systems are maintained in a safe state. • Operation of ventilation will be reduced and run only as required for occupational safety and building integrity. • Sumps will be isolated from the active drainage system. • Heavy water storage on-site will continue, with periodic transfers off-site as required.	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• The Reactor Building systems will cease operation for nuclear fission and heat generation. Fuel will be removed, heavy water systems drained, moderator system flushed, and all other liquids, wastes and potentially hazardous transient materials will be removed. • Heavy water (D_2O) transfers from PNGS Units 5-8 dewater to Darlington Heavy Water Management Building West Annex – 150 Mg will be Low Curie, 160 Mg will be High Curie • Units will be drained – 2017 Safe Storage PEA assumptions would be bounding. • Removal of Fuel Bundles using existing fuel handling equipment • Initial dewatering may result in some increase in radiological emissions from RLWMS and reactor building ventilation. • Heavy water will be drained from moderator and heat transport systems and auxiliaries. • Systems will be dried and maybe rinsed to remove remaining heavy water, minimizing tritium emissions later during the outage. • Dewatering moderator and heat transport involves removal of ~ 242 m^3 and 139 m^3 of heavy water, respectively. • Heavy water will be reused once refurbishment is complete.
Reactor Auxiliary Bay (RAB), Irradiated Fuel Bays (IFB-A, IFB-B) and Auxiliary Irradiated Fuel Bay (AIFB*)	• The RAB systems will remain in operation to accommodate the shutdown of the reactor units, the defueling, and the removal of other equipment. • Systems no longer required will be taken out of service and left in a safe state, with the equipment remaining in place.	• SWS will commence to ensure RAB is maintained in a safe state. • IFB-A and AIFB will remain in normal operation until all contents can be transferred to dry storage. • Selected monitoring equipment will remain operational.	• In the 2025– 2037 timeframe baskets and associated frames from the IFB-A and AIFB would be removed and transferred to the NSS-PWMF (See Nuclear Sustainability Services - Pickering Waste Management Facility (NSS-PWMF) row for more details)	• Used fuel will be transferred to the IFB-B for wet storage. • Used fuel will remain in IFB-B for at least 10 years; however, OPG is authorized to process and store a maximum of 100 DSCs with used fuel that has been cooled in wet storage for a minimum of 6 years. Commissioning tests on DSCs

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
	• IFB-A and AIFB will remain in normal operation.	• Fuel will be transferred to DSCs and transportation to the NSS-PWMF will continue. • Once IFB-A is no longer required, for storage or cobalt harvest IFB-A may be drained.		have been performed and submitted to the CNSC for review. OPG will proceed with processing and storing of minimum 6-year cooled fuel once CNSC staff conclude the results are acceptable.
Turbine Hall and Turbine Auxiliary Bay (TAB)	• Electricity generating equipment (e.g., turbines and generators) associated with each reactor unit will cease operation as units are shut down. • As equipment within the PNGS Units 1-4 TAB is no longer required, it will be taken out of service and left in a safe state with equipment remaining in place (some exceptions may be made for equipment that can be resold). • PNGS Units 1-4 TAB basement sump pumps will remain in operation.	• Current steam emissions from PNGS Units 1 and 4 will no longer exist during the Surveillance Phase. • Surveillance will commence to ensure PNGS Units 1-4 TAB is maintained in a safe state. • Heating and ventilation will be provided, to the extent required. • Operation of the PNGS Units 1-4 TAB basement sumps will continue to maintain the groundwater level below the basement floor.	• Within the 2025-2037 timeframe, select Non-Nuclear Components such as turbine and generator in the Turbine Hall (PE-B-1 in Section 3.3.4.2) will be partially removed, but Turbine Hall structures remain. • Removal of electrical supply and controls In the PNGS Units 1-4 TAB (PE-B-2) will occur within the 2025 - 2037 timeline in parallel with Units 1&4 Stabilization activities. PNGS Units 1-4 TAB structure will remain intact.	• Planned modifications will be installed. • Turbine and generator controls will be upgraded. • Turbine and generator will be commissioned.
Service Wing*	• No Changes to 2017 Safe Storage PEA	• No Changes to 2017 Safe Storage PEA	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• No Changes from existing conditions for PNGS Units 5-8
Standby Generators and Emergency Power	• The generators will continue to be tested and relied on to supply back-up power and water to PN Generating Station systems while fuel remains in the reactor units.	• A single back-up power source will be required.	• Select Standby Generator (PNGS Units 1-4 in PE-A-2, see Section 3.3.4.1), Standby Generator pumphouse and fire protection system for the fuel oil tanks will be removed completely within the 2025-2037 timeframe.	• PNGS Units 5-8 Standby Generators will be upgraded and/or replaced
Building Heating and Ventilation	• Adequate building heating and ventilation will continue to be supplied. • An alternative heating source will be required during the Stabilization Phase. • Starting in 2026 the Auxiliary Boiler will not be used – transition to electric boilers	• Building heating and ventilation will be supplied to the extent necessary to satisfy occupational safety and maintain system and building integrity. • Less heat (i.e., less heating boiler use) will be required than in the Stabilization Phase. • The Auxiliary Boiler will be used during peak loads as back-up heating supply during the SWS Phase because there will be a transition to electrical heating sources with the electric boiler being the primary heat source.	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• During Refurbishment, the heating source will transition to electric boilers and the Auxiliary Boiler will be available on standby

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
Condenser Cooling Water (CCW) and Reactor Building Service Water (RBSW) Systems	• CCW pumps will be taken out of service in stages as reactor units are shut down. • A minimum of two CCW pumps will continue to operate following the shutdown of reactor units to facilitate Stabilization activities.	• The increased CCW flow between the 2017 Safe Storage PEA and the 2022 Safe Storage PEA Addendum will further reduce the temperature difference between the discharged water temperature from the outfall and the water intake temperature (i.e., ΔT) because of greater dilution of warm water. The increased CCW flow may change predicted sediment deposition patterns. • Unit 1 CCW Pumps will be made available as contingency. • For PNGS Units 5-8, the expected CCW flow rate through the PNGS-B side is 2,899 L/s (250,500m^3/day) during the SWS Phase, higher than the assumed flow rate of 578 L/s (50,000 m^3/day) in the 2017 Safe Storage PEA. With regards to water quality, the updated CCW flows are bounded by the conditions assumed for the 2017 Safe Storage PEA, because the higher flow rate will provide greater dilution, resulting in reduced discharge concentrations at the outfall. This was addressed in the 2022 Safe Storage PEA Addendum.	• Cooling water lines will be removed from the CCW supply system. CCW lines will be isolated, and segmented. • Remove CCW pipework to access points and cap per the interim end state. • Cutting and capping the CCW pipework during the 2025-2037 timeframe.	• When all units on the PNGS Units 5-8 side are shut down for refurbishment, CCW pumps on the PNGS Units 1-4 side will be operating. RBSW will be released to both the PNGS Units 1-4 and PNGS Units 5-8 discharge channels. • When one unit has completed refurbishment and the DWI is operational, water will flow into PNGS Units 5-8 through the DWI. All CCW pumps will be shutdown on PNGS Units 1-4 side. • At the end of refurbishment all units on PNGS Units 5-8 will be operational and water balance will return to existing conditions for the PNGS Units 5-8 side.
Electrical Transmission Facilities*	• Main output transformers and generating system transformers associated with each unit will be taken out of service and placed into a safe state following the shutdown of the reactor units. • Select station service transformers and switchyard equipment will remain in operation to supply power to the facility. Any transformers no longer required would be placed in SWS.	• Select station service transformers and switchyard equipment will remain in operation to supply power to the facility.	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• Replacement of the Main Power Output Transformers will occur as well as partial upgrade of the standby generators • The Auxiliary Power Supply will be used to support DWI construction power.
Oil and Chemical Storage Building*	• Waste consolidation activities and transportation off-site will increase.	• Operations will continue, though waste consolidation and transportation activities will be reduced.	• Selected oil tank and gas cylinders to be completely removed or partially removed throughout the 2025– 2037 timeframe. Those activities units include: ○ Remove Oil Tank Farm A (PE-A-1, see Section 3.3.4.1): This unit	• Waste consolidation activities and transportation off-site will increase.

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
			is already emptied and will be removed off-site along with concrete pad, and associated piping, instrumentation, and electrical connections. Pipework will need to be removed, capped, material and equipment surveyed, hoisted for transportation and off-site disposal. ○ Complete removal of internal components and structures for Gas Bottle Storage Enclose A (PE-A-2): Gas bottles would be removed before the start of decommissioning activities in 2034. During decommissioning phase, the remaining structure/building will be dismantled and removed. ○ Complete removal of internal components and structures of Standby Generator oil tanks PNGS Units 1-4 (PE-A-2): The standby generator oil tanks will be emptied in the Stabilization phase. During SWS, the remaining structure/building will be dismantled and removed.	
Administration, Engineering Services, Security Buildings and Pickering Nuclear Information Centre (PNIC)*	• The Administration building will be maintained to support the decommissioning project and to house key decommissioning staff. • The assumption of the 2017 Safe Storage PEA remains bounding.	• The Administration building will be maintained to support the decommissioning project and to house key decommissioning staff. • The 2017 Safe Storage PEA assumption that buildings will be leased to future industrial/commercial workers is bounding, because the future industrial/industrial worker was assessed as the nearest receptor to the plant (refer to Section 4.1.3 of the 2017 Safe Storage PEA). This receptor would be bounding of exposure and dose from any on-site building leased out.	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• Construction of Retube and Feeder Replacement Service Island Support Annex (RFRISA), a three-storey business and personal services building. • Based on Project planning for refurbishment leasing of buildings is no longer planned; therefore, the on-site future industrial/commercial worker is no longer applicable.

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
		Therefore, no further assessment is required. (Note: based on Project planning for refurbishment leasing of buildings is no longer planned)		
High Pressure Emergency Coolant Injection (HPECI) Facilities*	• No changes while fuel remains in the reactor units. • Once the reactor units are all defueled, the HPECI will be drained, and all associated equipment placed in an inactive safe state. • HPECI water will be discharged via an approved pathway.	• HPECI facilities will no longer be in operation and will be in an inactive safe state. • PNGS-A Pipework will be drained, but PNGS-B will remain in service	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• No changes are planned to the HPECI system.
New Water Treatment Plant (NWTP)*	• A mobile water treatment system may be used or demineralized water will be brought from off-site, and stored in tanks at the PN site. New pumps and controls will be added to hook up with the existing network to supply active loads during SWS. • The 2017 Safe Storage PEA evaluated use of a mobile water treatment system • If demineralized water brought from off-site no discharges are anticipated to be associated with water treatment to meet demineralized water requirements, and the 2017 Safe Storage PEA assumptions are bounding.	• A mobile water treatment system is no longer planned during the SWS Phase. The 2017 Safe Storage PEA considered non-radiological discharges from a mobile water treatment system during the SWS Phase and found that predicted concentrations of contaminants from water treatment are below screening levels (refer to Section 4.2.3.2.1.1 of the 2017 Safe Storage PEA). Considering that no water treatment is currently planned, the assessment of non-radiological discharges from a mobile water treatment system in the 2017 Safe Storage PEA is bounding for lake water quality. No further assessment is needed.	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• A new water treatment plant will be built and commissioned • During refurbishment a mobile water treatment plant may be used for 2.5 years (approximately October 2026 to 2029. • A temporary mobile water treatment plant may be used to support DWI construction activities such as tunnel boring and muck management (approximately 2027-2030).
Nuclear Sustainability Services - Pickering Waste Management Facility (NSS-PWMF)*	• A Licence Amendment for PWMF is being sought from CNSC to load 6- to 10-year fuel to the DSCs (from previous 10-year minimum), to free up bay space for the defueling of PNGS Units 5-8. A dose rate assessment has been completed for OPG considering the higher activity (lower aged) fuel for Storage Building 3 (SB #3).	• No changes, the NSS-PWMF will continue in full operation to receive, process and store DSCs until all the fuel has been removed from the IFBs and they have been decommissioned.	• Used fuel that has been stored in the IFBs for the required minimum cooling period will continue to be loaded into DSCs and transported to the NSS-PWMF using the existing programs and procedures for the management of used fuel. • Work will continue to be executed with existing operational procedures, leveraging established practices from previous fuel handling operations. • As fuel is removed, empty baskets and associated frames will be removed from the IFBs and disposed of using existing waste routes.	• Used fuel that has been stored in the IFBs for the required minimum cooling period will continue to be loaded into DSCs and transported to the NSS-PWMF using the existing programs and procedures for the management of used fuel. • Used fuel will be transferred to NSS-PWMF for storage. No additional storage buildings after SB #5 are planned.

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
Waste Management (radiological and non-radiological)*	• Radioactive and non-radiological solid and liquid wastes will continue to be generated and managed as they are during normal operations.	• There will be a reduction in wastes produced. • Waste will continue to be managed in accordance with accepted procedures and licence requirements.	• Waste management will continue to be managed in accordance with accepted procedures and licence requirements.	• Pickering Component Storage Structure (PCSS) will be construction in East Complex for storage of Low and Intermediate Level Waste (L&ILW). • Refurbishment waste, including fuel channel assembly waste and steam generator waste, will be stored in PCSS. • Refurbishment of fuel channel assemblies, calandria tubes and feeder piping will generate Intermediate Level Waste (ILW) and Low Level (LLW). • Volume reductions such as cutting and crushing in the Reactor Building vault will be used for pressure tubes and calandria tubes. • Feeder pipes cut into lengths to fit in standardized waste containers, and transported off site as per routine LLW generated at PNGS Units 5-8. • Total estimated volume of miscellaneous routine LLW is 4,000 m^3 (1,000 m^3 per unit). • Miscellaneous LLW and feeder pipes will be transported to NSS-WWMF. • Relocation of Dry Storage Modules (DSMs)
Site Drainage and Waterborne Emissions	• Drainage systems, including stormwater runoff, sewage, active and inactive drainage systems will remain operational. • Draining of systems may result in additional flow to the radioactive liquid waste management system (RLWMS, e.g., upgraders), but it will be discharged as in previous operations (6 operating units). • Additional materials may be generated for discharge via the inactive drainage; however, approval will be obtained for the disposal options. • The volumes of active and inactive liquid emissions generated will be gradually reduced as operations are terminated.	• All types of waterborne emissions will be reduced. • Stormwater volumes will remain the same. • All drainage systems, including stormwater runoff, sewer, and active and inactive drainage systems will remain operational to the extent necessary to meet operational and regulatory requirement. • Inactive drainage will not be re-routed to RLWMS, RBSW or the PNGS Units 5-8 discharge channel. The revised strategy for inactive drainage in the 2022 Safe Storage PEA Addendum was to discharge to the respective PNGS-A or PNGS-B CCW intake duct. As a result, less active discharges will be diverted to	• All types of waterborne emissions will be reduced. • Stormwater volumes will remain the same. • All drainage systems, including stormwater runoff, sewer, and active and inactive drainage systems will remain operational to the extent necessary to meet operational and regulatory requirement.	• During refurbishment waterbone emissions will be similar to that assessed in 2017 Safe Storage PEA. • A minimum of two CCW pumps will remain in service on PNGS Units 1-4 side while all units on PNGS Units 5-8 side are shutdown for refurbishment. RLWMS will discharge out the PNGS Units 1-4 side. • Drainage systems, including stormwater runoff, sewage, active and inactive drainage systems will remain operational.

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
	• A minimum of two CCW pumps will remain in service	the RLWMS, and the 2017 Safe Storage PEA assessment of lake water quality remains bounding. • Inactive drainage discharge to the PNGS-B CCW intake duct will be drawn back into the station along with the cooling water intake. Any potential impacted water will be diluted prior to discharge, as was the case in the 2017 Safe Storage PEA. This change does not affect the 2017 Safe Storage PEA bounding condition and the increased CCW flow between the 2017 PEA (50,000 m^3/day) and the 2022 PEA Addendum (250,500 m^3/day) will reduce predicted discharge concentrations since there is greater CCW flow available for dilution. Therefore, no further assessment is needed for inactive drainage to the PNGS-B side. • Inactive drainage discharge to the PNGS-A CCW intake duct will eventually be a source of tritium to the forebay because there is expected to be no intake flow through the PNGS-A intake duct. This was assessed in the 2022 Safe Storage PEA Addendum.		
Screenhouses, Forebay, Intake Channel, and Intake and Discharge Ducts	• All these SSCs will remain operational and continue to operate as in the current operations. • The CCW duct may not be used when the CCW pumps cease operations at the end of the Stabilization Phase.	• The forebay will continue to be an operating intake that is reduced from operational conditions but will be increased from the 2017 Safe Storage PEA assumption as discussed in the CCW and RBSW systems row (i.e. Section 3.7 of the 2017 Safe Storage PEA). Once the deepwater intake is operational the forebay will no longer be an operating intake and a cutoff wall will be constructed that allows for minimal flow to pass into the forebay and direct the operational flows through the Deep Water Intake and into the forebay. • The 2017 Safe Storage PEA predicted that the forebay would become a	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• DWI to be constructed will draw deeper cooler water from Lake Ontario which is expected to significantly reduce fish impingement and entrainment as well as reduce potential biofouling events with attached algae (see Section 3.1.1.7). • Construction of the DWI will also involve shoreline modifications including a potential dock and possible infill, and disposal of construction and dredged material (see Section 3.1.1.7). • Once the DWI is in use, a cut-off wall will be installed in the intake channel, as it will no longer be needed to supply water to the station. The cut-off wall will be designed to allow for minimal flow through the wall into the forebay.

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
		sediment depositional area (refer to Section 4.3.2 of the 2017 Safe Storage PEA). Less sedimentation in the forebay is expected to occur due to the higher expected intake flow rate. This change is considered bounded in the assessment in the 2017 PEA. No further assessment is needed. • The inactive drainage system will continue to discharge to the common PNGS Unit 1-4 or PNGS Unit 5-8 line that leads to the old water treatment plant and then directed to the sediment pond and to the common intake channel, discharge to the respective PNGS Until 1-4 or PNGS Unit 5-8 CCW intake duct after unit shut-down. However, for PNGS Unit 1-4, with no CCW flow, inactive drainage will report eventually to the forebay. See discussion in the previous row. This was assessed in the 2022 Safe Storage PEA Addendum.		• DWI and its associated cutoff wall are pending final design, construction and approvals..
Fish Diversion System (FDS)*	• The FDS will continue to be installed seasonally as necessary while any number of CCW pumps remain in operation.	• The FDS will not be removed without prior approval and discussions between OPG and Fisheries and Oceans Canada (DFO).	• The FDS will not be removed without prior approval and discussions between OPG and DFO.	• The FDS will not be removed without prior approval and discussions between OPG and DFO.
Tempering Water Duct*	• No Changes	• No Changes	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• No changes
Auxiliary Boiler (Existing steam boiler, fueled with fuel oil, which provides back-up heating steam supply for the PN site during commercial operations)*	• The existing Auxiliary Boiler will be upgraded and modified to supply steam for building heating and process steam (as a backup to meet peak demand if required) during the Stabilization Phase. The upgrades to the Auxiliary Boiler include installation of a new air dryer, replacement of the feed water pump, and a new oxygen sensor; these upgrades will not increase the air emission rate from the Auxiliary Boiler. • Operation of the Auxiliary Boiler during the Stabilization Phase is bounded by the 2017 Safe Storage PEA and previous	• Operation of the Auxiliary Boiler will be limited to during Peak Loads. • Transition to electrical heating sources with the electric boiler being the primary heat source	• No risk reduction and removal or dismantle/demolish activities in the 2025 – 2037 timeframe associated with this SSC.	• Heating source will transition to electric boilers and the Auxiliary Boiler will be available on standby

Structure, System or Component	Units 1 & 4 Stabilization Phase (Defueling/Dewatering and End Stating) (2024-2028)	Units 1-4 Storage with Surveillance Phase (Wet and Dry) (2028-2070+)	Units 1-4 Risk Reduction and Removal and Dismantle/Demolish Activities (2025-2037)	Units 5-8 Refurbishment (2026-2034)
	operational conditions assessed for the 2022 PN ERA, both of which consider full-time operation of the Auxiliary Boiler.			

Other Supporting Structures and Services*	• The East and West Annex will be used for PN Site activities and will remain.
	• The East Complex will continue to be used for PN Site activities.
	• Upgraders will continue to be used to upgrade heavy water. Necessary process steam may be supplied by the building heating boilers.
		• The East Complex, East and West Annex will be required.
		• The East Complex will be maintained for PN Site activities.
		• Upgraders will be in service as required.
			• The Helium Trailers x4 and Hydrogen (H_2) Skids (PE-A-1, see Section 3.3.4.1) will be completely removed, with the removal of internal components and structures
			• Select Off Gas System Building will be partially removed in the 2025– 2033 timeframe, while keeping the structures. The Off Gas System includes the Activated Carbon Tank, ducts, instrumentation, pump system, connected piping and electrical systems.
			• Complete removal of internal components of Sulzer-A while keeping the structure (PE-A-1).
			• Selected structures will be completely removed including:
			  ○ Scaffolding Sheds (PE-A-1): These sheds will be dismantled to be removed, transported and disposed.
			  ○ Shutdown System Enhancement (SDSE) Instrument Rooms (PE-A-2): The outer structure of the instrument rooms will be dismantled, removed and transported for disposal.
				• The East and West Annex will be used for PN Site activities and will remain.
				• The East Complex will continue to be used for PN Site activities.
				• Upgraders will continue to be used to upgrade heavy water. Necessary process steam may be supplied by the building heating boilers.

Notes:
* Indicates that the SSC provides a common service to all PNGS units.

3.1 Refurbishment of PNGS Units 5-8

Refurbishment of PNGS Units 5-8 consists of three sub-phases: preparation for refurbishment, refurbishment, and refuelling and restarting. These sub-phases are described in more detail below. Where relevant, general descriptions of refurbishment activities have been obtained from the Refurbishment and Continued Operation of Pickering B Nuclear Generating Station EA (OPG, 2007a). Additional activities such as, construction and operation of DWI are described based on current Project planning.

3.1.1 Preparation for Refurbishment

Starting in 2027, preparation for refurbishment will be initiated including procurement and mobilization of equipment and components, relocation/removal/construction of buildings, structures and equipment and temporary laydown areas, defueling and dewatering of reactors, islanding the unit, management of heavy water, and deep water intake construction.

3.1.1.1 Procurement and Mobilization of Equipment and Components

The major system components to be procured for refurbishment include steam generators, feeder piping, fuel channel assemblies and calandria tubes.

Additionally, a large amount of heavy machinery will be mobilized. This includes diesel-powered transportation equipment, including a large multiwheeled ground transporter, forklifts, tractor trailers, and other construction equipment such as cranes, earthmovers, electrical generators, etc. A large crane will be required for hoisting of the steam generators into and out of the reactor buildings, through specially prepared and approved openings in the reactor building domes. This crane will be situated on the south side of the PNGS Units 5-8 reactor buildings.

3.1.1.2 Relocation/Removal/Construction of Buildings, Structures, and Equipment

To make room for the large crane, some structures and equipment within the PNGS Protected Area will be temporarily relocated or removed. This will include fire hydrants, an equipment storage building, the gas bottle storage enclosure and the chlorine building, since they are located south of the reactor buildings. Other structures and equipment may have to be temporarily relocated or removed to facilitate the movement of refurbishment equipment, components and wastes through the station.

The majority of the temporary construction facilities and laydown areas will be located in the East Complex (**Figure 3-1**). Construction-related facilities, such as change rooms, shop facilities, construction offices, and laydown areas for equipment and machinery will be required. These land uses are similar to the existing land use in the East Complex area. Depending on the exact timing, some existing buildings and structures within the East Complex will be converted to these uses or replaced as required.

Some additional service buildings or structures may be required within the PNGS Protected Area Boundary. There may be a need for service buildings to accommodate additional personnel or additional equipment storage, which may include the Retube and Feeder Replacement Service Island Support Annex (RFRISA), Sally Port, and the Common Services Building (CSB) (**Figure 3-1**).

The RFRISA will be constructed within the PNGS Protected Area during the same timeframe as the PCSS (**Figure 3-2**). The RFRISA is expected to have an area of approximately 48,000 to 50,000 ft^2, and will be a three-story business and personal services building with offices and conference rooms. Underground services will be connected to existing site services. It is expected that construction of the RFRISA will be complete by mid to late 2026.

Any new buildings will be designed and constructed following OPG's engineering change control process.

3.1.1.3 Construction of Pickering Component Storage Structure (PCSS) and Storage Building #5

The Pickering Component Storage Structure (PCSS) will be constructed adjacent to the northern boundary of the NSS-PWMF Phase II site within the Pickering Site East Complex (**Figure 3-2**). The PCSS will be used for the storage of low and intermediate level waste, including PNGS Units 1-4 and PNGS Units 5-8 components such as steam generators, pressure and calandria tubes, calandria tube inserts, and end fittings, and concrete LLW. Based on the expected waste streams that will be produced, the PCSS is expected to have an area of approximately 41,000 ft^2. The structure will be shielded with concrete walls and enclosed with a roof. It is expected that construction of the PCSS will be complete by mid-2027. Evaluation of the environmental effects of the PCSS was part of a separate PERA (Ecometrix, 2024) as the PCSS will be incorporated into the existing NSS-PWMF operating policies and procedures and operate under an amended Waste Facility Operating Licence.

The Pickering B Refurbishment EA included the construction and operation of two additional DSC Storage Buildings (SB #5 and #6) in the PWMF Phase II Site, east of SB #4 (SENES, 2007). At this time, only SB #5 is planned, as an amalgamation of both buildings, with an in-service date of Q3 2027 (see **Figure 3-1**). SB #5 will be designed to accommodate up to 1040 loaded DSCs.

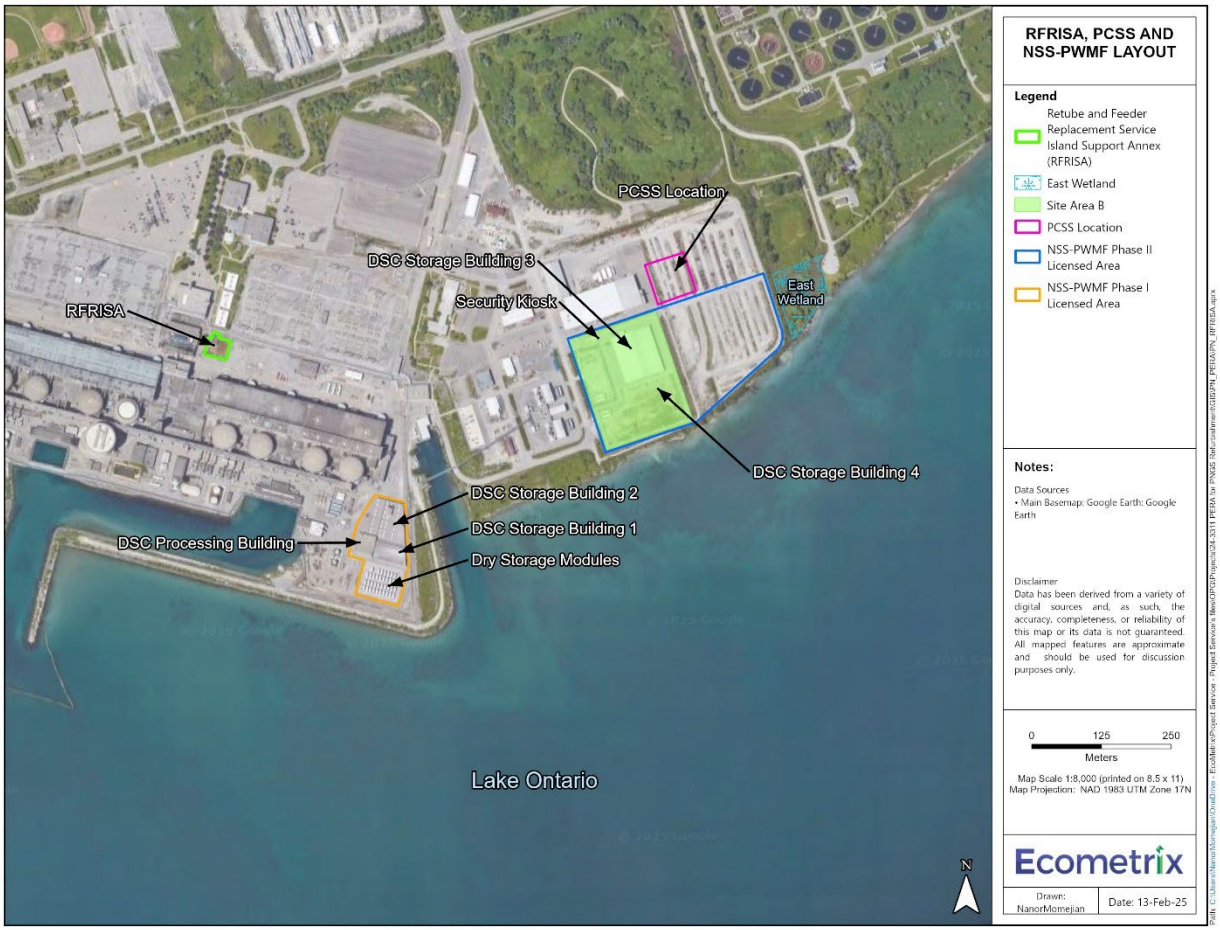


Figure 3-2: Planned Locations for the PCSS and RFRISA

3.1.1.4 Defuel and Dewater

The Reactor Building systems for Units 5-8 will cease operation for nuclear fission and heat generation. Used fuel will be removed from the fuel channels of those reactors, using fuelling machines and transferred using the existing irradiated fuel transfer and conveyor systems, to the Unit 5-8 irradiated fuel bay (IFB) for wet storage. Currently, the used fuel will remain in the IFB-B for at least ten years prior to transfer to dry storage at the NSS-PWMF. OPG is authorized to process and store a maximum of 100 DSCs with used fuel that has been cooled in wet storage for a minimum of 6 years. OPG has performed commissioning tests on DSCs and submitted dose results to the CNSC for review and can proceed with processing of minimum 6-year cooled fuel once CNSC staff conclude the results are acceptable.

Heavy water will be drained from the moderator and heat transport systems and auxiliaries. Initial dewatering may result in some increase in radiological emissions from Radioactive Liquid Waste Management System (RLWMS) and reactor building ventilation exhaust. The units (Units

5-8) will be drained. The moderator and heat transport systems will be dried and may be rinsed to remove the remaining heavy water to minimize tritium emissions later in the refurbishment process.

3.1.1.5 Islanding the Unit

The unit undergoing refurbishment will be isolated from the other operating units, to facilitate the refurbishment work and create a safe working environment for reactor activities. This is referred to as "islanding the unit", and involves physical separation of the unit to be refurbished from the common negative pressure containment system by sealing the transition duct between the boiler room and the containment pressure relief duct. It will also involve isolation of the unit's portion of some shared systems and potentially involve equipment logic or operational changes to support the needs of the remainder of the station. Operationally, the islanded unit will be supported separately from the remainder of the station and in a manner that benefits safe and efficient access for construction staff.

3.1.1.6 Management of Heavy Water

Heavy water (D_2O) removed will be collected, upgraded and stored n accordance with existing plans. Heavy water will be stored on-site, with some transferred to the Darlington Heavy Water Management Building – West Annex. Heavy water will be reused once refurbishment is complete.

If the heavy water is to be detritiated prior to reuse, it will be shipped to the Darlington Tritium Removal Facility in specially designed containers called Tritiated Heavy Water Transportation Packages, as per current practice. OPG has heavy water storage facilities on the PN site, and storage of heavy water is within PNGS Units 5-8's current operating licence (PROL 48.03/2028).

Heavy water is reusable and interchangeable between units. However, heavy water used for moderator and heat transport systems is kept separated as the isotopic composition and chemical characteristics of the heavy water in the two systems are slightly different.

3.1.1.7 Construction of Deep Water Intake

One of the major design modifications/activities related to the Project is the construction of an offshore lake bottom water intake structure for PNGS Units 5-8 that will replace the current shoreline surface water intake. The proposed deep water intake (DWI) will draw deeper cooler water from Lake Ontario which is expected to significantly reduce fish impingement and entrainment as well as reduce potential biofouling events with attached algae. The construction of the intake structure will also involve shoreline modifications including a potential dock, bridge, and possible West Infill, shoreline erosion mitigation area east of the PNGS Unit 5-8 outfall, and disposal of construction and dredged material.

The site modifications to support the DWI tunneling encompass several key activities being considered. Infrastructure enhancements may include constructing a bridge over the outfall and road widening on Dike Road. Preparatory activities include clearing/grubbing and

leveling/laydown area preparation. The infill design has not been finalized. However, a potential infill is being considered, with input from Indigenous Nations and communities and regulators, adjacent to the existing forebay groyne structure, as well as a dock and associated harbor along the Eastern quadrant of the infill.

The new intake cap will be located approximately 1.5 km offshore out from the east end of the existing forebay (**Figure 3-3**). Construction of the DWI will begin in mid-2026 and will include tunnel boring. The DWI will be operational by 2030.

During tunneling activities, a large volume of spoils will be excavated. OPG is currently evaluating spoil management options, including: lake infill, open aquatic disposal location, onsite landfill or offsite disposal facility. Based on preliminary planning it is anticipated that much of the rock could potentially be disposed of in a lake infill, near surface materials will be sent for inland disposal and overburden materials may be sent for open aquatic disposal. OPG is working with the Indigenous Nations and communities to seek input, feedback, identify the best option and identify mitigation measures. A comprehensive spoil management plan will be developed in accordance with regulatory requirements during the site preparation phase for the DWI once the DWI constructor has been selected.

Once the DWI is in use, a cut-off wall will be installed in the intake channel, as it will no longer be needed to supply water to the station. The cutoff wall is expected to be constructed using a combination of concrete, steel reinforcement, and various fill types. This structure will serve two primary functions: to separate the lake from the forebay and to provide an emergency service water supply to the station. The cut-off wall will have small holes to allow for minimal flow through the wall into the forebay. The specific flow through the structure, such as a pipe or sluice gate will be determined based on safety case and environmental requirements. The cutoff wall will be designed with environmental considerations such as minimizing risk of fish impingement/entrainment and biofouling.

The total estimated project footprint and associated impacts on aquatic habitat are outlined in **Section 6.2.2.1**. Briefly, the completed intake cap is projected to cover up to 1 ha, based on current design specifications of a 100 m x 100 m intake cap. However, to accommodate the temporary disruption caused by dredging and construction activities associated with the intake cap, a boundary of 150 m x 150 m (~2.5 ha) has been considered for total intake cap area. As the intake tunnel spanning from PNGS to the Intake cap is expected to be a bored tunnel that is several metres below the lake bed, it is not expected to result in a measurable footprint on the aquatic environment. Lake infilling will primarily be conducted in three areas: the West Infill area (11.5 ha), the Shoreline Erosion Mitigation Area (4.0 ha), and in the forebay dredge (0.2 ha). Navigational channel dredging as a part of the dock will result in a footprint of 4.5 ha. A bridge allowance of 0.6 ha is also being considered for a potential bridge over the PNGS Units 5-8 CCW outfall. Finally, the cut-off wall, which is planned to be constructed in the forebay once the DWI is operational, is expected to span up to 0.5 ha.

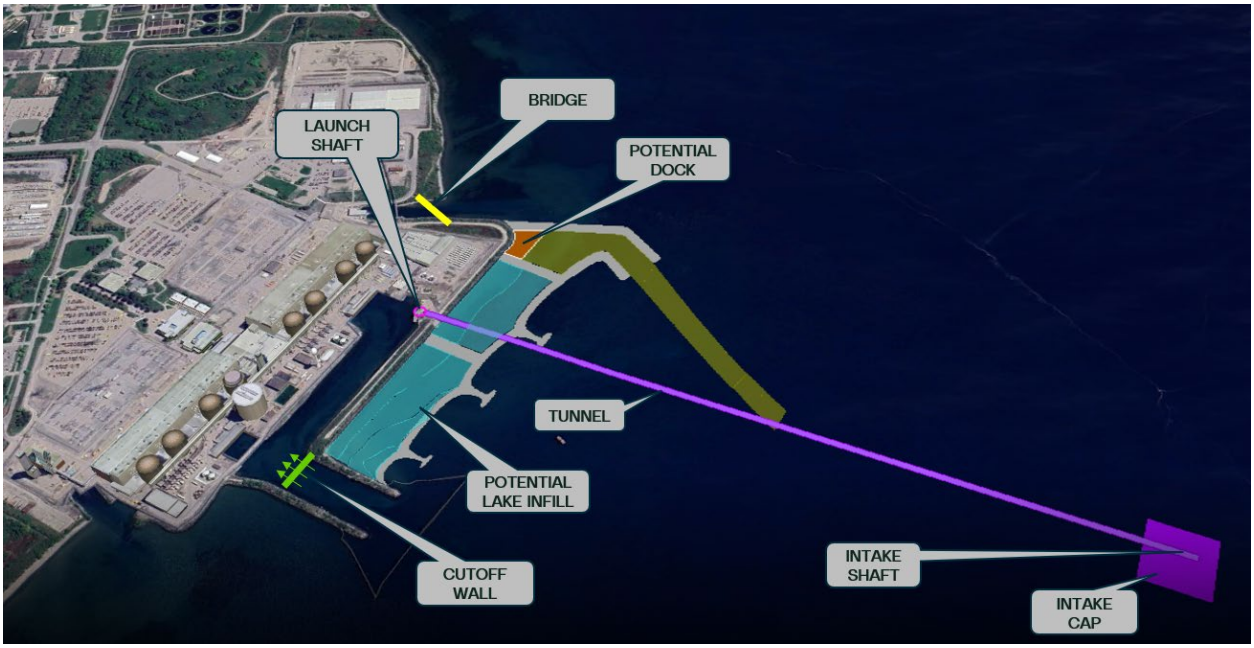


Figure 3-3: DWI and Associated Site Preparation Modifications

To accommodate equipment, space allocation, and construction activities for the DWI, OPG plans to relocate a portion of the Protected Area security fence northwards from Dike Road. Security fence relocation will be completed by Q2 2026. This would also require relocation in Q3 2025 of the Dry Storage Modules (DSMs) from which contain intermediate level waste from PNGS Units 1 to 4 Refurbishment that occurred in the mid-1980s and early-1990s and is located in the Retube Component Storage (RCS) Facility (approximately 36 DSMs). The DSMs are categorized as Intermediate Level Waste (ILW) and will need to be moved to an alternative location onsite within the NSS-PWMF Phase II site. New concrete pads will be constructed near DSC Storage Building #4 to store the relocated DSMs, and the old concrete pads where the DSMs are currently stored will be removed.

OPG also plans to relocate the NSS-PWMF fence to allow for road widening that will be used to reduce traffic on-site and connect the construction site to the East Complex.

3.1.2 Refurbishment

Starting in 2027 the first unit will enter refurbishment which includes replacing reactor components, replacement of steam generators, refurbishment of various systems including reactor auxiliary systems and feedwater systems, and normal upgrade and maintenance activities.

3.1.2.1 Replacement of Reactor Components

The following components will be replaced during refurbishment: pressure tubes, fuel channels, calandria tubes, end fittings, shield plugs, closure plugs, spacers, feeder coupling hardware,

feeder tubes (up to the headers), feeder tube supports, feeder cabinet insulation, and positioning assemblies. The work will include the following activities:

- **Vault Preparation**: removal of feeder cabinet and reactor face insulation, installation of shielding, and installation of additional services to support the work.
- **Removal of Fuel Channels, Calandria Tubes and Feeders**: feeder pipes will be removed. Shielding and automated tooling will be used where feasible to reduce worker dose. All of the components of the fuel channel assemblies (including pressure tubes) and calandria tubes will be removed.
- **Installation of New Fuel Channels, Calandria Tubes and Feeders**: New fuel channel assemblies and calandria tubes will be installed in the reactor core. New feeder piping will be installed. The reactor vaults will be returned to operational status through removal of all the temporary services, removal of temporary shielding and tooling, and reinstallation of feeder cabinet and reactor face insulation.
- **Waste Handling**: Refurbishment of fuel channel assemblies, calandria tubes and feeder piping is expected to generate low and intermediate level waste (L&ILW). ILW resulting from refurbishment will primarily include fuel channel assembly wastes (i.e., pressure tubes, calandria tubes and related components collectively referred to as "retube waste"). Pressure and calandria tubes, calandria tube inserts, and end fittings will be processed (e.g. volume reduced, packaged, etc.) before transfer to the PCSS for secure storage. Feeder pipes will be cut into lengths to fit in standardized waste containers, and transported off site as per routine LLW generated at PNGS Units 5-8. The total estimated volume of miscellaneous routine LLW is 4,000 m^3 (1,000 m^3 per unit). The estimated volume of ILW from fuel channel assembly waste is approximately 3,000 m^3.

3.1.2.2 Removal and Replacement of Steam Generators

During refurbishment, all of the steam generators (also referred to as boilers) will be replaced. Each PNGS Units 5-8 unit has 12 steam generators, each approximately 14 m in length and 2 m wide, weighing approximately 90,000 kg per steam generator. Replacement of the steam generators will include the following activities:

- **Building and Equipment Preparation**: Specially prepared and approved openings will be created in the reactor building dome to provide crane access. A wet-cutting technique will be used to minimize dust. The holes will be temporarily covered to prevent precipitation from entering the reactor building. A large heavy lift crane will be placed on the south side of the reactor building that will be used to remove the steam generators. The crane will meet stringent safety requirements such as being seismically qualified and having a significant safety factor in terms of lifting capacity.
- **Removal of Steam Generators**: Steam generator removal includes removal of insulation, cutting or disconnecting all piping and equipment attached to the steam

generators, capping of all openings to prevent release of loose radioactive contamination. The exterior of steam generators will be shielded and coated to fix loose contamination.

- **Installation of Steam Generators**: New steam generators will be shipped to site. Steam generator installation will be carried out by reversing the procedure for removal. Connections to process piping and instrumentation will be made and insulation installed. When all new steam generators are installed, equipment will be returned to operational status by removing temporary services and lifting rigs and reinstalling any temporarily removed equipment. The holes in the reactor building dome will be restored to meet design requirements. Appropriate testing will be performed to confirm containment system integrity.

- **Waste Handling**: Steam generator replacement will generate liquid waste, LLW and ILW, including the steam generators themselves, insulation materials and miscellaneous components.

    - The liquid waste (i.e., light water) from the secondary heat transport system will be drained from the steam generators. The water will be monitored to ensure it is within Environmental Compliance Approval (ECA) limits for non-radionuclides before being released to the lake. Water will also be monitored for radionuclides. If contamination is detected during the monitoring, the water will be sent to the RLWMS for processing.

    - The removed steam generators will be shielded, sealed and loose contamination on the exterior surfaces will be coated and fixed prior to removal from the reactor building. This will ensure that neither loose contamination nor radioactivity releases will be present during loading onto and unloading from the transfer vehicle. The steam generators may be placed temporarily in a laydown area prior to being transferred to the PCSS for storage. The estimated volume of the 48 steam generators is 2,500 m^3.

    - The concrete and dry solids from the cutting slurry used to cut the reactor dome would be checked to confirm that they are not radioactive and then disposed of as landfill waste or sent for recycling. If radioactive, the concrete and dry solids would be handled as LLW in a similar manner to other LLW.

3.1.2.3 Refurbishment of Other Plant Systems

Refurbishment/upgrades of the reactor auxiliary systems and feedwater systems includes normal maintenance and repair to be undertaken during each refurbishment outage, and normal maintenance activities required for the refuelling and restart of any reactor unit.

During refurbishment outages of PNGS Units 5-8, there may be opportunities to undertake normal repair, maintenance and upgrades of components. While these activities are undertaken

as part of normal operations and maintenance during typical unit outages, they are noted here to indicate the likelihood that ongoing repair and maintenance may also occur during the major refurbishment outages. This work may generate small volumes of LLW and non-radioactive waste. The wastes will be managed in a manner similar to current practice.

Replacement, upgrades, maintenance and commissioning of the majority of Turbine and Generator drive train and auxiliary equipment will be performed.

- A total of 12 low pressure turbine spindles (3 per unit), and 2 high pressure turbine spindles (Unit 6 and 8) will be replaced.
- The generator stator cores and windings will be replaced.
- The generator rotors will be refurbished and the windings will be replaced.
- The majority of the large turbine valves will undergo major maintenance with some components of the assembly being replaced.
- Moisture separator & Re-heater internals will be replaced.
- Turbine/Generator auxiliary equipment (stator cooling water, seal oil, hydrogen, lubrication oil, fire resistant fluid, glands) will undergo significant upgrades
- The turbine/generator controls system will undergo a significant upgrade.

Replacement of the Main Power Output Transformers will also occur as well as partial upgrade of the standby generators.

3.1.3 Refuelling and Restarting

Following completion of major component refurbishment activities, the reactor fuel channels will be loaded with new fuel bundles. Each reactor requires 4,560 bundles (385 tonnes of fuel for all 4 units). New fuel will be brought into the reactor building to a fuel receiving area. New fuel will likely be loaded into new fuel channels manually as per past practice for initial fuel load.

The moderator and heat transport systems will be filled with heavy water. Refilling the moderator and primary heat transport systems involves the transfer from storage of 242 m^3 and 139 m^3, respectively, of heavy water into the reactor systems.

Restarting reactors consists of system start up and testing, raising power and generating electricity for the electrical grid. The refurbished unit will be connected to the electrical grid and the reactor will be brought up to full power in a series of steps, meeting certain condition and performance criteria.

Refuelling and restarting is expected to generate LLW and ILW typical of maintenance outages. Returning the reactors to full power will produce used nuclear fuel and purification wastes, such

as filters and ion exchange (IX) resins, as well as other LLW. At the end of the Refurbishment Phase, all four reactors will be operational.

3.2 Continued Operations of PNGS Units 5-8

At the end of Refurbishment PNGS Units 5-8 will be returned to service and enter the Continued Operations phase. Continued Operations of the refurbished reactors will be similar to previous operations (6 operating units) and will include ongoing maintenance until end of life (an additional 30 years) of the reactors. More specifically, it is expected that three general areas of maintenance will be performed; namely, preventative maintenance, corrective maintenance, and improvement or upgrade activities. Additionally, during Continued Operations, radiological and non-radiological waste will need to be transported similar to previous operations (6 operating units).

During Continued Operations, used fuel will continue to be stored in the NSS-PWMF. Based on current planning, there are no future waste storage buildings planned beyond SB #5 for used fuel. DSCs currently stored at the NSS-PWMF will be transferred to a future deep geological repository for the safe, long-term management of used nuclear fuel.

3.3 Decommissioning of PNGS Units 1-4

Stabilization and SWS activities were previously assessed from an environmental impact perspective in the 2017 Safe Storage Predictive Effects Assessment (PEA) and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017). As such, the detailed activities for Stabilization and SWS are not presented below.

The focus below is on additional activities that were not previously considered in the 2017 Safe Storage PEA or 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017).

One of the major changes in assumptions since the 2017 Safe Storage PEA and 2022 PEA Addendum is that dismantling of non-nuclear systems and outbuildings[2] to ground level will occur during the SWS Phase. This is done through the allowance given in REGDOC-2.11.2 to implement such risk reduction and removal activities during SWS. Previously, it was assumed that outbuildings would remain in place and demolition and dismantling would occur following completion of the SWS Phase. Additionally, in alignment with OPG's risk reduction strategy, OPG will initiate some dismantling activities in the irradiated fuel bays (IFB-A and AIFB) during the SWS Phase.

3.3.1 Decommissioning Timeline

The Pickering PERA covers the re-licensing timeframe up to 2037; however, the full PNGS Units 1-4 decommissioning timeline is identified below based on the Detailed Decommissioning Plan (DDP) Plan Overview document:

- Since 2010: Unit 2 and Unit 3 are currently in SWS.
- 2024-2028: Unit 1 and Unit 4 cease operations (defueled and dewatered) and Stabilization activities begin. Irradiated Fuel Bay (IFB-A) and Auxiliary Irradiated Fuel Bay (AIFB) remain in service.
- 2025-2034: Initiate Risk Reduction and removal strategy and transition Unit 1 and 4 to SWS.
- 2030s: Post Refurbishment separation between PNGS Units 1-4 and PNGS Units 5-8 complete.
- 2034: PNGS Units 1-4 IFB-A fuel removal complete by 2034.
- 2034 to 2058: Major Decontamination, Dismantling and Demolition of all SSCs except Reactor Buildings.

[2] Outbuildings refers to SSCs within the PNGS Units 1-4 protected area, but not part of the main Powerhouse structure.

- 2039: Fuel removed from AIFB.
- Post 2070: Reactor Building Structure removal and Site Restoration. This can be completed after PNGS Units 5-8 has reached the end of its commercial operations.

3.3.2 Separation of PNGS Units 1-4 and PNGS Units 5-8

Since PNGS Units 1-4 and PNGS Units 5-8 will be in different lifecycle phases, there will be a need to separate the two facilities to differentiate between the decommissioning side and the operational side. The separation of PNGS Units 1-4 and PNGS Units 5-8 is established by the AB Gate[3] (**Figure 3-4**) which is defined based on the following criteria:

- Systems on the PNGS Units 1-4 side are to support SWS activities, while the systems on the PNGS Units 5-8 side are to support refurbishment and continued operations of PNGS Units 5-8.
- Terminal points to be established if required for energy sources crossing the AB gate barrier.
- At the appropriate point in decommissioning, the PNGS AB Gate may become a physical barrier to separate the operating island (PNGS Units 5-8) from the active decommissioning island (PNGS Units 1-4).

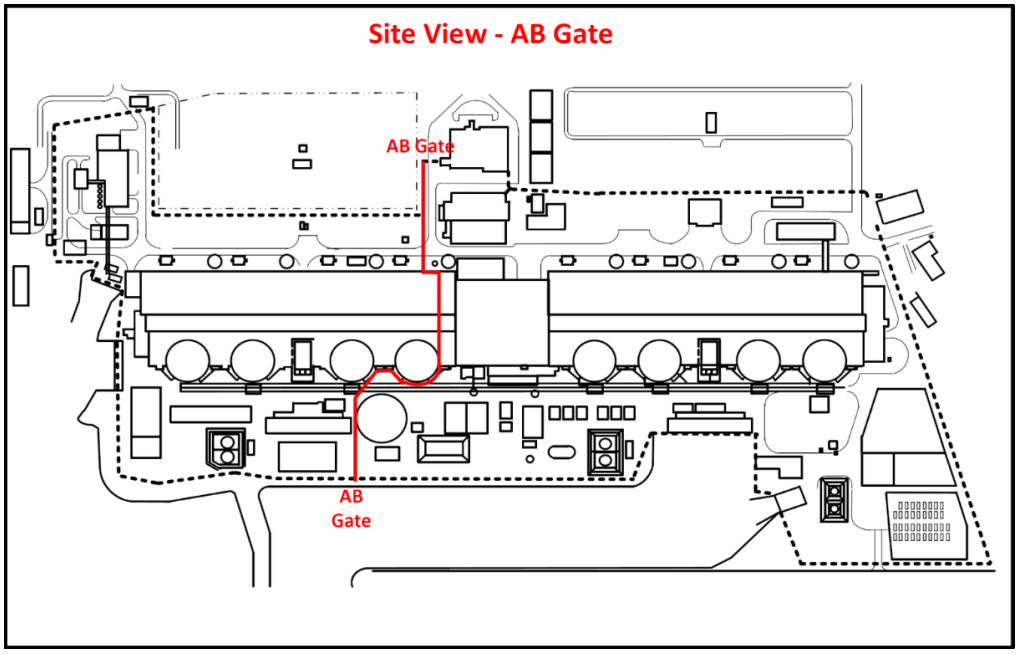


Figure 3-4: PNGS AB Gate

[3] A conceptual and physical boundary established to separate the operational and decommissioning areas of a nuclear power plant site during concurrent activities.

3.3.3 Stabilization and Storage with Surveillance Activities

Stabilization is the period following end of commercial operations where activities are performed to transition the unit from permanent shutdown to SWS (commencement of decommissioning). The Stabilization activities are captured in the PNGS Stabilization Activity Plan (OPG, 2024a), and were previously assessed from an environmental impact perspective in the 2017 Safe Storage PEA and 2022 PEA Addendum (Ecometrix, 2023b; Golder and Ecometrix, 2017).

The Stabilization Activity Plan encompasses:

- Procedures for the ongoing maintenance and monitoring required to ensure the SSCs retain their integrity and do not compromise safety.
- Identification of critical SSCs that must be kept available (i.e. not end-stated) for future use in Decommissioning activities.
- Steps taken to progress from permanent shutdown of a unit to SWS.
- Stabilization for Units 1 and 4 will be complete by the end of 2028, and Units 1 and 4 will transition to SWS.

The SWS Plan details systems that are expected to remain active or partially active post Stabilization, and are necessary for the SWS period, planned continued operation of PNGS Units 5-8, or anticipated to be required for decontamination and dismantling activities at PNGS

3.3.3.1 Irradiated Fuel Bays

Following shutdown of Units 1 and 4, used fuel was transferred to the IFB-A and AIFB for a cooling period. Fuel in the AIFB is stored in modules and fuel in the IFB-A is stored in baskets. The modules and baskets are stacked in the bays using frames. Used fuel that has been stored in the AIFB or IFB-A for the required minimum cooling period will continue to be loaded into dry storage containers (DSCs) and transported to the NSS-PWMF using the existing programs and procedures for the management of used fuel; the removal of used fuel from the AIFB and IFB-A was most recently assessed in the 2022 PEA Addendum (Ecometrix, 2023b). As fuel is removed, empty baskets and associated frames will be removed from the AIFB and IFB-A and disposed of using existing waste routes. This work is being done to create space for installing equipment necessary for inspecting damaged fuel.

The sorting, segregation, and canning of damaged and defective fuel is a first-of-its-kind operation for OPG, expected to commence in 2029. OPG will notify CNSC before proceeding with these activities to ensure compliance with regulatory requirements and safety standards.

The IFB-A will be drained by 2034 and the AIFB will be drained by 2041. The draining of the bays is the final steps in preparing the AIFB and IFB-A for subsequent decommissioning and dismantling phases. Water drained from the AIFB and IFB-A will be released to Lake Ontario in a

controlled manner that keeps tritium concentrations at the Water Supply Plants within existing tritium levels and well below regulatory limits.

3.3.4 Risk Reduction and Removal Activities

In parallel with the Stabilization Phase of Unit 1 and Unit 4, the station will commence limited risk reduction and removal activities focused on PNGS Units 1-4. These activities will include dismantling non-nuclear systems and outbuildings. The risk reduction and removal activities are planned to begin in 2025. This approach is consistent with Section 8.1 of REGDOC-2.11.2 (CNSC, 2021), which allows OPG to initiate risk reduction and removal activities during the SWS phase in accordance with its licence and consultation with the CNSC. These risk reduction and removal activities from REGDOC-2.11.2 may include:

- reduction or removal of combustibles;
- removal and recycling of non-contaminated or slightly contaminated equipment;
- reduction or isolation of asbestos;
- demolition of non-nuclear buildings or facilities, provided that there are no safety impacts to the remainder of the site;
- removal of accumulated radioactive waste to an offsite licensed storage or disposal facility, location or site;
- reduction or removal of hazardous wastes.

The scope of the dismantling and demolishing activities is organized into planning envelopes (PEs)[4] which are identified in detail in the DDP. The PEs that are considered in this PERA are execution of elements of PE-A (mostly non-nuclear buildings or facilities on site that are no longer required to support PNGS Units 1-4 operations or SWS) as well as PE-B (non-nuclear components and systems located within the TH and TAB). Risk reduction and removal activities will commence in 2025 and continue to 2037 and only occur on SSCs which have completed the Stabilization Phase and are end-stated.

The PEs are structured to facilitate sequencing of PNGS Units 1-4 decommissioning beginning with demolition of outbuildings and removal of non-nuclear systems, followed by dismantling and demolition of nuclear systems and reactor components, and finally removal of building structures and subsequent site remediation.

3.3.4.1 Activities Associated with Planning Envelope A

Activities associated with PE-A include the dismantling and removal of end-stated, abandoned, or retired structures within the PNGS Units 1-4 protected area, excluding the main powerhouse

[4] A definable part or area of a facility that is sufficiently removed from, or otherwise independent of, other parts or areas such that the strategic approach to decommissioning that part or area can be planned in a relatively independent manner

structure. The PE-A is categorized into three groups and each includes SSCs that will no longer be required to support PNGS Units 1-4 (OPG, 2024c).

- Group A-1: Post PNGS Units 1 and 4 shutdown, Outbuildings and SSCs not required after shutdown **(Figure 3-5**).
    - Scaffolding Shed Buildings,
    - Oil Tank Farm A,
    - Off Gas System Building,
    - Old Water Treatment Plant,
    - Helium Trailers,
    - Hydrogen Skids,
    - Sulzer-A.
- Group A-2: Post separation of PNGS Units 1-4 and PNGS Units 5-8, Outbuildings and SSCs not required after common systems are separated along the AB Gate (**Figure 3-6**).
    - Gas Bottle Storage Enclosure 'A',
    - SDSE Instrument Rooms 1-2, SDSE Instrument Rooms 3-4,
    - PNGS Units 1-4 Standby Generator,
    - Standby Generator oil tanks PNGS Units 1-4,
    - Standby Generator Pumphouse PNGS Units 1-4
- Group A-3: Post IFB Empty, Outbuildings and SSCs not required after IFB-A and AIFB are emptied, drained, and dried (IFB-A will be drained by 2034 and the AIFB will be drained by 2041) (**Figure 3-7**). Group A-3 is planned to start in 2034 as part of Dismantling and Demolition. Activities are in the preliminary planning stage and will be developed further through future DDPs, including a safety assessment to be completed by the end of 2025.
    - Heavy Water Upgrading Plant,
    - Heavy Water UPPA Upgrading Towers,
    - UPP Expansion Feed Storage Area,
    - UPP Expansion Area, UPP Area,
    - PNGS-A Screenhouse,
    - Demineralized Water Tanks.

As part of PE-A, select SSCs will undergo complete removal of the internal components and the structures, including gas trailers, a standby generator, oil tanks and gas cylinders. Meanwhile, other selected SSCs will undergo partial removal of internal components leaving only the structures such as the off-gas system buildings, and the old water treatment plant. There are other non-operational components such as sheds and instrument rooms that will be removed completely which includes the internal components as well and the outbuilding structures.

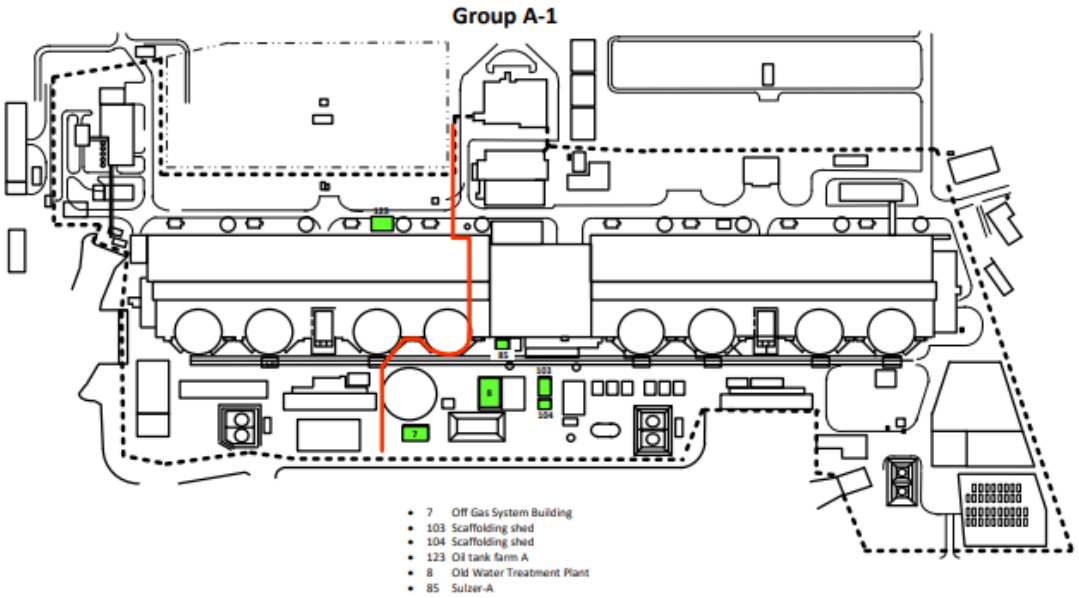


Figure 3-5: Planning Envelope A-1 – Outbuildings in Green

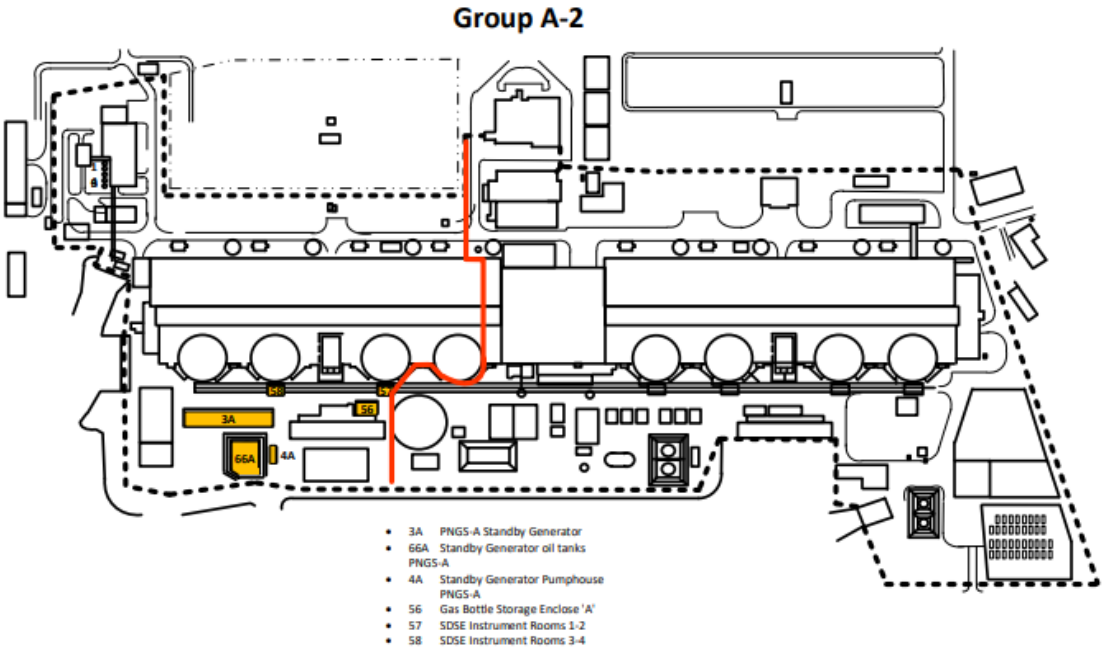


Figure 3-6: Planning Envelope A-2 – Outbuildings in Orange

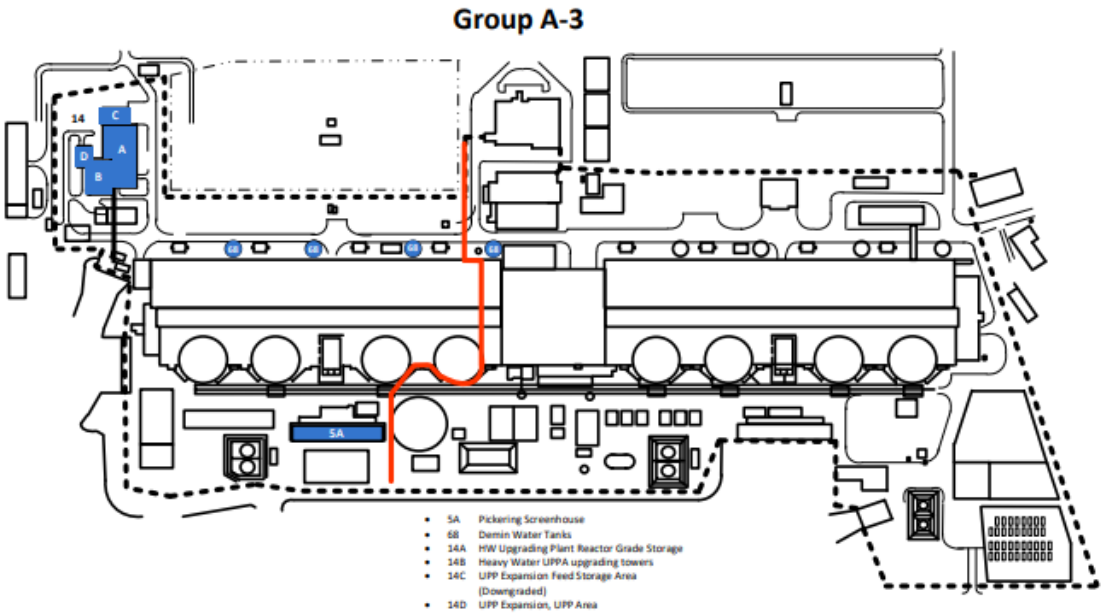


Figure 3-7: Planning Envelope A-3 – Outbuildings in Blue

3.3.4.2 Activities Associated with Planning Envelope B

The decommissioning process of PE-B includes the dismantling and removal of SSCs considered to be non-nuclear that are located within the TH and TAB. Components included in PE-B have been end-stated, abandoned or retired, and do not support PNGS Units 1-4 SWS, PNGS Units 5-8 refurbishment, or continued operations of PNGS Units 5-8. The PE-B is categorized into two groups based on location and the type of systems to be decommissioned and is described in detail in the DDP Program Volume 2:

- Group B-1: SSCs such as the turbine and generators located within the TH of PNGS Units 1-4 (**Figure 3-8**)
- Group B-2: SSCs such as the electrical supply and controls, located within the TAB of PNGS Units 1-4 (**Figure 3-9**)

The components included in this envelope are not anticipated to be radiologically contaminated. The decommissioning process in PE-B also includes removal of all equipment from the work area, such as tanks, valves, pumps, motors, heat exchangers, instrumentations and pipework. Selected SSCs in PE-B will undergo risk reduction and removal activities following these steps for both Groups B-1 and B-2:

- Clear work area to access the target equipment (e.g. pumps, heat exchangers, pipework).
- Dismantle/segment larger tanks/containers/gas cylinders/pipes.

- Electrical connections disconnected from the remaining instrumentation and removed to terminal points.
- Capping and sealing the remaining pipework (for those that are partially removed). Underground metal and concrete piping will be excavated for survey and removed, if necessary. Non-contaminated materials beyond one meter will be left in place. Any contaminated materials exceeding clearance levels will be removed and disposed of appropriately.
- Material/equipment will be characterized, surveyed, classified, and transported to an approved offsite disposal facility.
- Clear up work area and make safe.

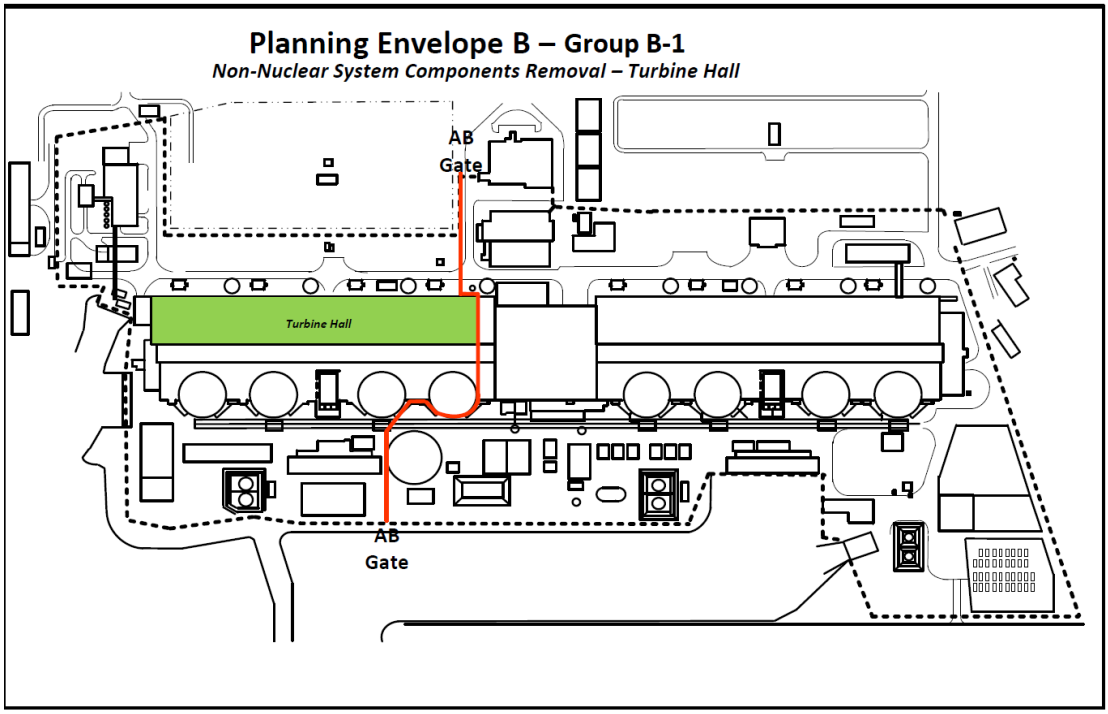


Figure 3-8: Planning Envelope B-1 – Turbine Hall

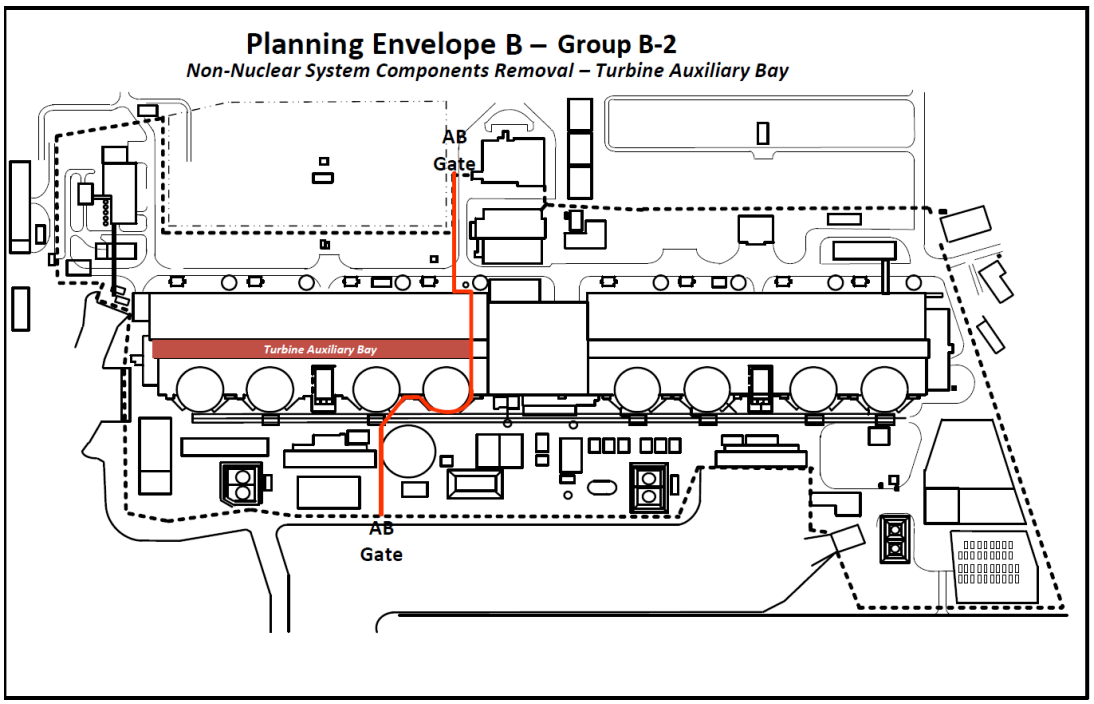


Figure 3-9: Planning Envelope B-2 – Turbine Auxiliary Bay

3.3.4.3 Waste Management

As the outbuildings in PE Group A-1 and Group A-2 are mostly considered non-nuclear, it is assumed that all waste generated will be non-radioactive. The exception is for the Sulzer-A building which will generate LLW.

For PE Group B-1 and Group B-2, all waste generated are expected to be non-radioactive except for the head tanks in Group B-2 which may be potentially contaminated. Characterization and surveying of SSCs in Group B-1 and Group B-2 will be completed to verify waste classifications. All waste will be managed in accordance with accepted procedures and licence requirements.

4.0 Summary of Existing Conditions

A concise summary of existing and previous conditions is provided in this section based on the data presented in the 2022 Pickering ERA (Ecometrix, 2023a) which focused on the five-year period from 2016 to 2020. Updated information on existing conditions is also provided based on any new data collected since the 2022 Pickering ERA through ongoing annual environmental monitoring programs, as well as the supplementary environmental field studies conducted in 2024 and 2025 that were completed to support this PERA. A summary of the 2024 and 2025 environmental field studies is presented in **Table 4-1**, with a detailed description of each program provided in the sections below.

Table 4-1: Summary of 2024-2025 Environmental Field Studies conducted in support of the PERA

Sampling/Monitoring program	Data collected	Locations sampled	Parameters Analyzed	Sampling Frequency
Air quality and noise monitoring program	Continuous air measurements Noise levels including A-weighted energy-equivalent sound levels (Leq), statistical sound-level measurements (e.g., Ln values including L10 and L90), and octave band sound levels	Air: PN site (1 location; **Figure 4-1**) Noise: PN site (4 locations; **Figure 4-1**)	Air samples: Suspended particulate matter (SPM), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), volatile organic compounds (VOC) as represented by acrolein) and polycyclic aromatic hydrocarbons (PAH; as represented by benzo[a]pyrene).	One continuous sampling event each for Air Quality and Noise: Air quality: Winter (January 2025) to Spring (May 2025) Noise: Winter (2-week event in October 2024)
Surface water sampling program	Surface water samples In-situ water quality measurements (Conductivity, dissolved oxygen, pH, temperature, turbidity)	Lake Ontario (4 locations in nearshore and 4 locations in proposed DWI area; **Figure 4-3**) Frenchman's Bay (6 locations; **Figure 4-4**)	General chemistry parameters, metals, petroleum hydrocarbons (PHC) fractions F1 to F4, hydrazine, morpholine, radionuclides microbiological parameters, volatile organics, and petroleum hydrocarbons	Three sampling events: Spring (May 2024), Summer (July 2024), Fall (October 2024)
Sediment sampling program	Sediment samples	Proposed west infill area and shoreline erosion mitigation area (7 locations; **Figure 4-6)** Frenchman's Bay (16 locations; **Figure 4-5**)	General chemistry and physical parameters, metals, methylmercury, radionuclides, polychlorinated Biphenyls (PCBs), pesticides, herbicides, polycyclic aromatic hydrocarbons and petroleum hydrocarbons	One sampling event each: Frenchman's Bay: Summer (August 2024) Proposed west infill area and shoreline erosion mitigation area: Fall (November 2024)
Soil sampling program	Soil samples	PN site (8 locations; **Figure 4-20**)	General chemistry and physical parameters, metals, petroleum hydrocarbons, volatile organics, and radionuclides	One sampling event: Fall (September 2024)
Benthic Macroinvertebrate Community sampling program	Benthic macroinvertebrates samples In-situ water quality measurements (Conductivity, dissolved oxygen, pH, temperature, turbidity)	Proposed DWI area (Samples collected from lake bottom at 17-19 m depths; one location within each of the following sampling grids S4, S7, S8, and S9; **Figure 4-7** Proposed west infill area and shoreline erosion mitigation area (0-3 m depth; **Figure 4-6**)	Total macroinvertebrate density, Invertebrate taxonomic richness (lowest practical level; LPL), Simpson's Evenness, Simpson's Diversity, Density of major taxonomic groups, Relative density of major taxonomic groups.	One sampling event each: Proposed DWI area: Fall (November 2024) Proposed west infill Area and shoreline erosion mitigation area: Fall (October 2024)
Macrozooplankton community sampling program	Macrozooplankton samples In-situ water quality parameters (e.g., Conductivity, dissolved oxygen, pH, temperature, turbidity) at the bottom, mid-depth, and 0.5 m below the surface	Proposed DWI area (12-14, 14-16 and 16-18 m depths; 6 locations with two locations at each depth; **Figure 4-7**)	Identification and enumeration of all microzooplankton, Biovolume calculations for dominant microzooplankton species.	Three sampling events: Spring (May 2024), Summer (July 2024), and Fall (October 2024)

Sampling/Monitoring program	Data collected	Locations sampled	Parameters Analyzed	Sampling Frequency
	Temperature profiles before and after each net set (Water temperature in °C at 1 m intervals)			
Deepwater Fish Community sampling program	Species and number of fish caught In-situ water quality measurements (Conductivity, dissolved oxygen, pH, temperature, turbidity) Temperature profile before and after each net set (Water temperature in °C at 1 m intervals) Fish tissue from up to eight individuals from up to three species in each of the spring and fall season	Proposed DWI area (12-14, 14-16 and 16-18 m depths; fixed-sequential-random design of three grids each; **Figure 4-7**)	Species composition and species richness, Catch per unit effort (CPUE; # fish/24h) by species and combined, Biomass per unit effort (BPUE; grams/24h) by species and combined, Morphometric summary (lengths and weights) of fish captured. Fish tissue was analyzed for metals and radionuclides.	Three sampling events: Spring (May 2024), Summer (July 2024), and Fall (October 2024)
Nearshore Fish community sampling program	Species and number of fish caught In-situ water quality measurements (Conductivity, dissolved oxygen, pH, temperature, turbidity) Fish tissue from up to eight individuals from up to three species in each of the spring and fall season	Proposed west infill area and shoreline erosion mitigation area (0-3 m depths depending on lake depth; 3 locations; **Figure 4-10**)	Species composition and species richness, Catch per unit effort (CPUE; # fish/24h) by species and combined, Morphometric summary (lengths and weights) of fish captured Fish tissue was analyzed for metals and radionuclides.	Three sampling events: Spring (May 2024), Summer (July 2024), and Fall (October 2024)
Aquatic Habitat Assessment program	Proposed DWI area: Sidescan sonar Proposed west infill area and shoreline erosion mitigation area: Underwater Transect video collection	Proposed DWI area (14 transects; **Figure 4-7**) Proposed west infill area and shoreline erosion mitigation area (5 transects; **Figure 4-18**)	Substrate information including substrate type and coverage, macrophyte presence, algae coverage, dreissenid mussel coverage, and fish observations	One sampling event: Proposed DWI area: Summer (July 2024) Proposed west infill area and shoreline erosion mitigation area: Spring (May 2024)

4.1 Atmospheric Environment

4.1.1 Air Quality

The atmospheric environment at the PN site is typical of a southern Ontario airshed within the Windsor-Québec corridor, with local air quality being dominated by traffic and industrial emissions released throughout the Greater Toronto Area (GTA) and the long-range transport of airborne pollutants from neighbouring Canadian provinces and the United States. Substances that dominate air quality impacts include carbon monoxide (CO), nitrogen oxides (NO_X), sulfur dioxide (SO_2), total suspended particulates (TSP), inhalable particulates (PM_{10}) and respirable particulates ($PM_{2.5}$). Environment and Climate Change Canada (ECCC) and the Ministry of the Environment, Conservation and Parks (MECP) measure air quality at several locations between Toronto and Oshawa, though there are no ambient air quality stations located in close proximity to PNGS. The nearest ECCC/MECP Air Quality Monitoring (AQM) stations are the Oshawa (ID# 061703) and Toronto East (ID# 060410) stations. The PNGS emits relatively low quantities of chemical and radiological constituents to the atmosphere during the course of normal operations, overall, the PN site does not significantly contribute to air quality emissions at a regional level (OPG, 2003).

4.1.1.1 Radiological Air Emissions

The PN site emits relatively low quantities of radiological contaminants to the atmosphere during normal operations; routinely monitored parameters include tritium oxide (HTO), iodine-131 (I-131), carbon-14 (C-14), and radioactive noble gases and particulates.

OPG maintains an Environmental Monitoring Program (EMP) in the vicinity of PN in accordance with operating licence requirements. The program scope encompasses protection of both the public and the environment from nuclear materials, hazardous substances, and physical stressors resulting from PN site operations, including on-site waste management activities.

As described in the recent 2023 EMP report (OPG, 2024d), atmospheric HTO emissions within the last 10-years peaked during 2016 and 2017; since then, HTO emissions decreased over time until 2020, following improved management of airborne HTO. In 2020, HTO emissions increased due to a heat transport system leak in Unit 1 and a moderator purification valve leak on Unit 6. These leaks have since been repaired and HTO emissions have continued to decline from 2021, to 2023. In October 2020, a microscrubber was installed on Unit 4 and it was placed into service in 2021. The microscrubber removes a significant portion of the tritium from airborne emissions and converts it into waterborne tritium effluent, which is directed to the Active Liquid Waste Tanks (ALW) for controlled release to the CCW within acceptable limits. Overall, emissions of HTO have gradually decreased between 2020 and 2023 following the noted increase in 2020.

Atmospheric C-14 emissions have gradually increased between 2020 and 2023, but remain lower than the emissions recorded in 2018 which represent the 10-year high. C-14 emissions were elevated in 2018 due to work associated with the moderator purification system on Units 1 and 6. In 2023, elevated C-14 emissions were attributed to the removal of the Unit 6 moderator

purification system in preparation of a planned Unit 6 outage in Q1 and moderator gas purging on Unit 4 in Q2 (OPG, 2024d).

As described in the recent 2023 EMP report, radioactive noble gas stack emissions are often measured below instrument detection limits; thus, measurements taken from environmental noble gas monitors located outside of PNGS are used to trend PN noble gas emissions. Argon-41 is the predominant radionuclide measured in noble gas around PN and is associated with operation of PNGS Units 1 and 4. A Mann-Kendall trend analysis indicates Ar-41 emissions have increased over the last 10 years. In 2020, a notable decrease in Ar-41 emissions was attributed to a decrease in the operating time of Units 1 and 4. In 2021, Ar-41 emissions increased again but have gradually decreased in 2022 and 2023 (OPG, 2024d). Xenon-133 is occasionally measured above the detection limit at PN, though this radionuclide composes a relatively small percentage of noble gas emissions compared with Ar-41. Xe-135 and Iridium-192 were not detected in noble gas emissions at the PN site between 2021 and 2023 (OPG, 2024d). Additionally, radioactive particulates and radioiodine emissions are noted to have a minimal contribution to public dose (OPG, 2024d).

Overall, radiological air emissions from the PN site (**Table 4-2**) remain at a very small fraction of the site Derived Release Limits (DRLs) (OPG, 2024e). The DRLs represent radionuclide release rates that correspond to an exposure at the legal public dose limit of 1 millisievert per year (mSv/a) for the most affected critical group.

Table 4-2: Radiological Air Emissions from PN (2021-2023)

Parameter	Units	Average [1] (2016-2020)	Year [2]			Average (2021-2023)	Average (2021-2023) as % of DRL [3]
			2021	2022	2023		
Tritium Oxide	Bq/a	6.40E+14	5.20E+14	4.90E+14	4.80E+14	4.97E+14	0.49%
Noble Gas	γBq-MeV/a	1.14E+14	1.40E+14	1.00E+14	1.20E+14	1.20E+14	0.45%
Iodine-131	Bq/a	1.27E+07	9.70E+06	1.10E+07	1.00E+07	1.02E+07	0.0004%
Particulate	Bq/a	5.11E+07	1.10E+07	1.10E+07	1.20E+07	1.13E+07	0.003%
Carbon-14	Bq/a	2.72E+12	2.60E+12	2.40E+12	3.20E+12	2.73E+12	0.010%

Notes:

[1] Average from the 2022 PN ERA (Ecometrix, 2023a) is the average of emissions from 2016 to 2020.

[2] Data for 2021, 2022 and 2023 obtained from the 2021, 2022 and 2023 PN EMP reports, respectively (OPG, 2023a, 2023b, 2024d)

[3] The DRL used for comparison to 2021-2023 average emissions is obtained from the 2016 PN DRL report (OPG, 2024e).

4.1.1.2 Non-Radiological (Chemical) Air Emissions

The PN site emits low levels of chemical contaminants to the atmosphere during normal operations. The main sources of atmospheric emissions result from boiler chemical emissions and fossil fuel combustion associated with the testing of on-site standby generators. Chemicals associated with the treatment of boilers include hydrazine, morpholine and other degradation products (e.g., ammonia), which are used within the feedwater system to prevent corrosion of the boilers. These chemicals are released to the atmosphere through controlled boiler venting. Combustion emissions occur during testing of the standby generators and other minor sources, such as the on-site use of vehicles or motorized equipment. These sources can release CO, NO_X, and trace amounts of volatile organic compounds (VOCs), metals, and polycyclic aromatic hydrocarbons (PAHs). Emissions of SO_2 and TSP are relatively minor compared with other atmospheric emissions due to the use of low-sulphur diesel during testing of the standby generators.

4.1.1.2.1 Emission Summary and Dispersion Modelling Reports

The Emission Summary and Dispersion Modelling (ESDM) process uses dispersion modelling to predict the maximum air concentration at the property line (Point of Impingement; POI) for each chemical constituent. ESDM reports from 2015 (Golder, 2015) and 2017-2020 (Ortech, 2019a, 2019b, 2020, 2021) were consulted to aid in the selection of airborne chemical COPCs in the 2022 PN ERA (Ecometrix, 2023a) and the 2022 PEA and PEA Addendum for PN Safe Storage (Ecometrix, 2023b; Golder and Ecometrix, 2017). This PERA considers the most recent ESDM reports prepared for 2020, 2021, 2022 and 2023 (Ortech, 2021) to characterize previous conditions (with 6 operating units) relating to chemical emissions from PNGS.

Three operating scenarios are evaluated annually in the 2020-2023 ESDM reports. Scenario 1 represents a worst-case emission scenario, reflecting operations related to the production of electricity, and considers transitional operations associated with equipment start-up and shutdown. Scenario 2 considers potential additive effects of nitrogen oxide emissions related to testing of emergency standby equipment. Scenario 3 considers operation of the auxiliary steam boilers as the primary heating source for the PN site during the planned shutdown of nuclear power generation.

Contaminant emissions are assessed within the ESDM reports by comparing POI concentrations estimated from PNGS emission rates to POI exposure benchmarks listed in the MECP publication, *Air Contaminants Benchmarks (ACB) List: Standards, guidelines and screening levels for assessing point of impingement concentrations of air contaminants* (the 'ACB list'). The ACB list encompasses the air standards set out in O. Reg. 419/05, as well as a broader list of additional benchmarks intended to aid facilities in preparing ESDM reports. As of 2018, the modelling of all ESDM-reported contaminants transitioned to AERMOD, with POI concentrations provided for 1-hour, 24-hour, or annual averaging periods depending on the MECP POI limits.

Between 2020 and 2023, the ESDM reports indicated that the PN site was operating in compliance with s. 19 of O. Reg. 419/05. All contaminants with MECP POI standards that are

emitted from the PN site were found to have POI concentrations less than their respective MECP POI limits. Since 2020, modelled emissions of NO_X were routinely found to result in the highest maximum POI concentrations relative to the MECP standard, though no exceedances of the standard were modelled. As part of the ESDM reporting, hydrazine is the subject of a site-specific Maximum Ground Level Concentration (MAXGLC) approval. Between 2020 and 2023, hydrazine was found to have POI concentrations below the approved MAXGLC value.

4.1.1.2.2 Updated 2025 Air Quality Monitoring

As part of the supplementary environmental field studies completed to support this PERA, an air quality monitoring program was initiated in January 2025 to characterize existing atmospheric site conditions at the PN site. Overall, the program was designed and implemented following regulatory and guidance documents from federal and provincial agencies including the Canadian Council of Ministers of the Environment (CCME), ECCC, Health Canada (HC), and the Ontario Ministry of the Environment, Climate and Parks (MECP). Additionally, as is common practice for Canadian ambient air monitoring programs, the selection of monitoring instrumentation relied upon guidance provided by the U.S. Environmental Protection Agency (EPA).

Past air monitoring studies and the data requirements of this PERA provided the basis for the selection of airborne COPCs for the monitoring program. Several COPCs were identified as relevant to the program, including total suspended particulates (TSP), particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), volatile organic compounds (VOC; as represented by acrolein) and polycyclic aromatic hydrocarbons (PAH; as represented by benzo[a]pyrene). Measurements of these airborne COPCs were compared against applicable ambient air quality criteria, namely the Canadian Ambient Air Quality Standards (CAAQS) provided by the CCME (ECCC, 2023a) and the Ambient Air Quality Criteria (AAQC) provided by the Ontario MECP (MECP, 2023). Of note, acrolein and benzo(a)pyrene were selected as surrogate parameters for VOCs and PAHs, respectively, as these chemicals each have the lowest (i.e., most conservative) AAQC values within their respective chemical groups.

One monitoring station, named AQ1, was established for the air quality program as shown in **Figure 4-1** below. This location was selected by considering various parameters including location within the PN site, exposure to PN-associated air emissions, local obstructions, meteorological conditions, and site accessibility, maintenance and security considerations. The optimal placement of the monitoring station was determined by considering the inlet height, horizontal and vertical distances from the inlet to support structures and the distance from the inlet to nearby airflow obstructions.

Air sampling commenced in Q1 2025 and will continue for approximately five (5) months until the end of May 2025. In general, the operation of monitoring instrumentation followed a

schedule consistent with the National Air Pollution Surveillance (NAPS) program[5]. Over the course of the program, continuous monitors collected data on an hourly basis for PM_{10} and $PM_{2.5}$, nitrogen oxides (NO_X), and SO_2. The intermittent sampling was conducted to coincide with the intermittent samples collected under the NAPS schedule of 1-in-6 days for TSP and the Ontario MECP schedule of 1-in-12 days for PAHs and VOCs.

Many air quality parameters require sufficiently large datasets to thoroughly characterize existing conditions for the purpose of air quality modelling and comparison against ambient air quality criteria, particularly those with annual averaging periods. As of March 2025, not enough site-specific air quality data has been collected to sufficiently characterize existing atmospheric conditions at the PN site. For the air quality parameters of interest, existing conditions were characterized by using regional atmospheric concentrations from the Darlington Nuclear (DN) West Station (for SO_2 and BaP) or the MECP's Oshawa air monitoring station (for $PM_{2.5}$ and NO_2). Background concentrations of TSP and PM_{10} were estimated using the MECP Oshawa station's monitoring data for $PM_{2.5}$. As CO is not measured at the DN and Oshawa MECP monitoring stations, available CO concentrations measured at the PN site were used to characterize existing conditions. Existing air quality concentrations used for the air quality modelling are presented in **Table 4-3**. It should be noted that air quality concentrations obtained from the DN and Oshawa MECP monitoring stations likely represent an overestimate of existing air quality conditions at PN as these monitoring locations are influenced by local industrial emission sources (e.g., St Marys Cement and the Durham York Energy Centre) that are considerably closer to the DN site compared to the PN site.

Summary statistics of the air quality data available to date from the PN monitoring station (AQ1) are provided in **Table 4-4** below for informational purposes only, as data collection remains ongoing. Air quality monitoring continues to be conducted at the PN site and the summary statistics presented here are subject to change as new data is collected. An analysis of the air quality modelling supporting this PERA is provided in **Section 5.1.1**; the air quality concentrations used to characterize existing conditions in the modelling are shown in the results tables (see **Table 5-4** to **Table 5-11**).

[5] The National Air Pollution Surveillance (NAPS) Program, established in 1969 and coordinated by Environment and Climate Change Canada (ECCC), aims to provide robust and long-term ambient air quality data of a uniform standard across the populated regions of Canada.

Table 4-3: Summary of Existing Conditions Air Concentrations Used In AQ Modelling

COPC	Averaging Period	Measured Concentration (µg/m^3)	Source
TSP	24-hr (90th percentile)	44.2	Estimated from MECP Oshawa $PM_{2.5}$ data
	Annual (average)	25.5	Estimated from MECP Oshawa $PM_{2.5}$ data
PM_{10}	24-hr (90th percentile)	22.1	Estimated from MECP Oshawa $PM_{2.5}$ data
$PM_{2.5}$	24-hr (90th percentile)	11.1	MECP Oshawa AQ Monitoring Station
	24-hr (98th percentile)	18.6	MECP Oshawa AQ Monitoring Station
	Annual (average)	6.7	MECP Oshawa AQ Monitoring Station
NO_2	1-hr (90th percentile)	14.5	MECP Oshawa AQ Monitoring Station
	1-hr (98th percentile)	25.6	MECP Oshawa AQ Monitoring Station
	24-hr (90th percentile)	12.6	MECP Oshawa AQ Monitoring Station
	Annual (average)	6.7	MECP Oshawa AQ Monitoring Station
SO_2	1-hr (90th percentile)	3.6	Darlington New Nuclear Baseline Program
	1-hr (99th percentile)	51.5	Darlington New Nuclear Baseline Program
	Annual (average)	4.2	Darlington New Nuclear Baseline Program
CO	1-hr (90th percentile)	753.4	PN On-site AQ Data (Jan-Feb 2025)
	8-hr (90th percentile)	738.0	PN On-site AQ Data (Jan-Feb 2025)
BaP	24-hr (90th percentile)	6.85E-05	Darlington New Nuclear Baseline Program (2021-2022)
	Annual (average)	3.58E-05	Darlington New Nuclear Baseline Program (2021-2022)

Table 4-4: Summary of PN Air Quality Monitoring Data (Jan. 6 to Feb. 18, 2025)

COPC	Averaging Period	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Average (µg/m^3)	Standard Deviation (µg/m^3)	90th Percentile (µg/m^3)	98/99th Percentile
PM_{10}	24-hr	20.8	42.3	29.3	5.7	36.9	NA
$PM_{2.5}$	24-hr	15.2	31.9	20.6	3.9	27.2	29.4 (98th)
NO_2	1-hr	0.02	62.2	12.5	11.8	29.2	51.9 (98th)
	24-hr	2.9	32.6	13.1	7.0	22.6	NA
SO_2	1-hr	0.01	151.1	4.8	5.547	8.9	9.7 (99th)
CO	1-hr	319.4	1150.6	617.4	104.6	753.4	NA
	8-hr	351.2	873.9	617.7	95.9	738.0	NA

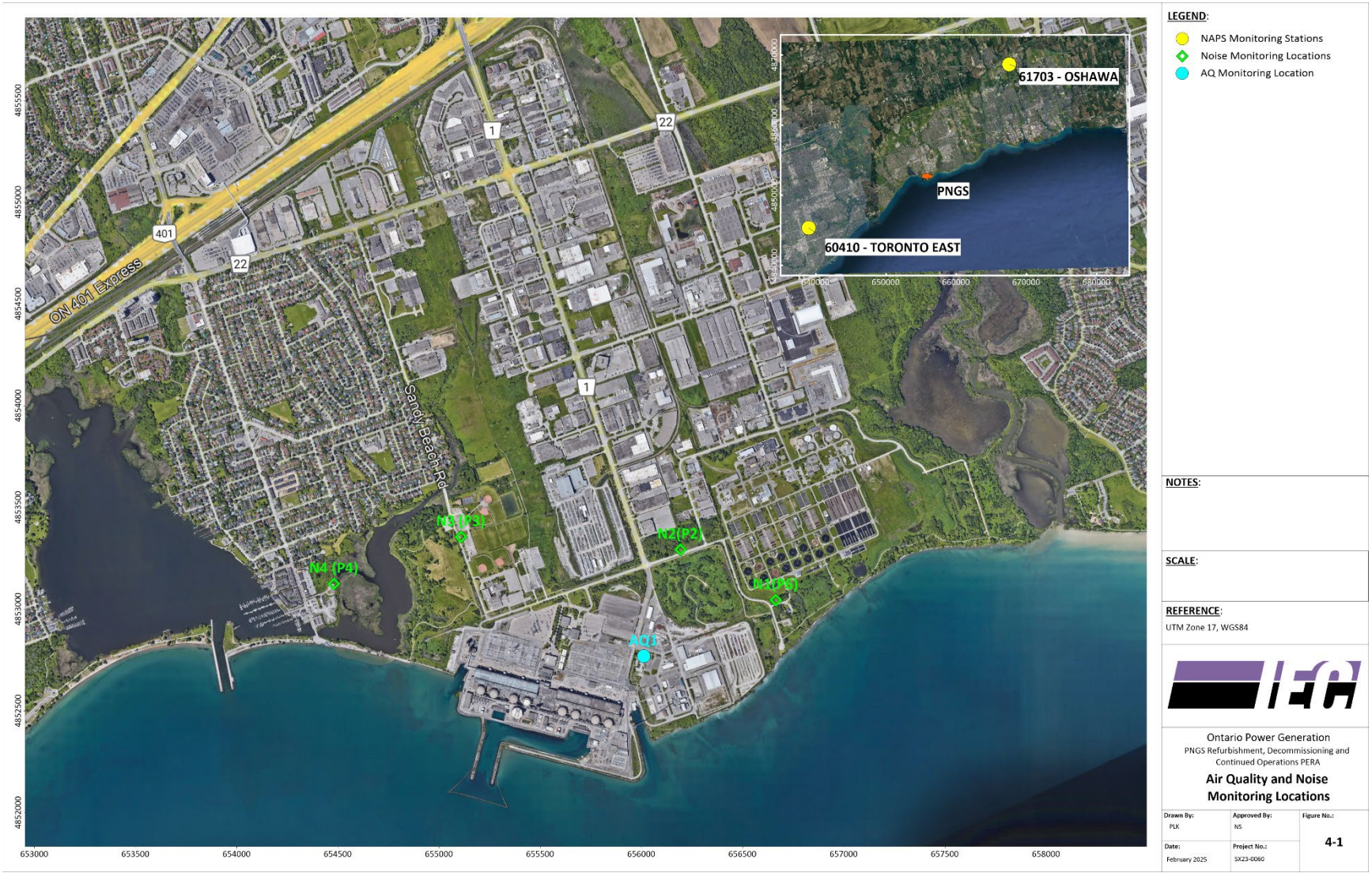


Figure 4-1: Monitoring Locations for the 2025 Air Quality and 2024 Noise Monitoring Program

4.1.2 Noise

Noise emissions from the PNGS originate from a wide variety of on-site sources. During the 2016-2020 period, the PN site operated under amended ECA No. 4766-A3YMB9, issued on December 2, 2015. This was replaced in 2019 by amended ECA No. 2372-BESHSC, issued October 17, 2019. The ECA application includes an assessment of on-site noise sources (OPG, 2023c). Past acoustic assessments have identified numerous on-site sources of noise emissions, including the following:

- Standby gas generators (SGs) for both PNGS Units 1-4 and U5-8;
- Emergency power generators (EPGs);
- Auxiliary Diesel Generators;
- Building exhaust and ventilation systems;
- Chillers and air conditioning units;
- Combustion turbine units (CTUs); and
- Emergency pumps.

The most significant sources of noise at the PN site are the SGs, EPGs, CTUs and other emergency equipment, such as pumps operated only during emergency situations (OPG, 2023c). Prior acoustic assessments, including those conducted annually since 2018 at receptor locations within the vicinity of the PN site, concluded that overall noise levels were compliant with applicable MECP Noise & Vibration Guideline (NPC-300 & NPC-207) sound level limits (OPG, 2011, 2019b, 2020a, 2021a, 2022a, 2023c, 2024f).

Although there are times when recorded maximum sound levels periodically exceed the MECP Class 1 (i.e., urban) and Class 2 (i.e., suburban) sound level limits (MECP, 2013), on-site monitoring has indicated that these exceedances are unlikely to be the result of PNGS activities and are more likely the result of localized events consistent with the surrounding populated urban environment (e.g., road traffic). Overall, the PNGS is compliant with noise limits and does not significantly contribute to noise levels experienced by local human and ecological receptors, which tend to be dominated by other sources consistent with an urbanized environment.

4.1.2.1 Updated September 2024 Noise Monitoring

As part of the supplementary environmental field studies completed to support this PERA, a noise monitoring program was conducted in September 2024 to characterize existing atmospheric site conditions at the PN site. As part of this program, various noise measurements, including A-weighted energy-equivalent sound levels[6] (LAeq) and statistical sound-level

[6] LAeq represents the equivalent continuous sound level, measured in A-weighted decibels (dBA)

measurements (e.g., Ln values[7] including L10 and L90) were recorded at four monitoring locations around the PN site, shown in **Figure 4-1**.

Health Canada provides recommendations for criteria that may be adopted to evaluate the predicted effect of a project in terms of its potential to lead to noise-associated health effects in its 2017 publication *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (HC, 2017). These include recommended limits for impulse noise (e.g., blasting) that are protective against hearing loss, night-time sound level limits for indoor locations where people sleep, indoor and outdoor limits for the preservation of speech comprehension, and limits to evaluate the probable community annoyance. Regarding the latter, Health Canada relies on the results of socio-acoustic research that illustrates that the percentage of a community reported to be "highly annoyed" increases as noise levels in the community increase. These studies have resulted in a dose-response curve that relates sound levels to "percentage highly annoyed" (%HA).

The MECP Publication *NPC-300 Environmental Noise Guideline: Stationary and Transportation Sources – Approval and Planning* (MECP, 2013) outlines sound level limits for outdoor and plane of window (POW) points of reception. These are the default limits that are applied in the absence of any other information regarding the actual background sound environment (i.e., without any contribution from the Project). If it can be demonstrated that the minimum 1-hr background noise level in each of the set periods (i.e., day, evening, night) are higher than the exclusionary limits, then the site-specific background levels may be applied as the sound level limits for future assessment purposes. Consistent with the guidance document, a "Class 1 area" refers to an acoustic environment typical of a major urban population centre where background sound levels are dominated by human activities, such as road traffic. Comparably, a "Class 2 area" refers to an acoustic environment that has qualities of a Class 1 area during daytime hours (7:00 a.m. to 7:00 p.m.) and qualities of a Class 3 area during nighttime hours (7:00 p.m. to 7:00 a.m.). A "Class 3 area" refers to an area dominated by natural sounds typical of a wilderness or agricultural area, or a small community with minimal road traffic (MECP, 2013).

Larson Davis Class 1 integrating sound level meters (SLM) were used for the collection of sound level data. Instrumentation and procedural guidelines for the measurement of sound as part of the recent noise monitoring program were consistent with the Ontario MECP's NPC-102 (Instrumentation) and NPC-103 (Procedures) publications (MOE, 1978).

Noise monitoring stations were strategically placed in close proximity to sensitive receptors to ensure that exposures to existing noise levels may be sufficiently characterized. The SLMs were positioned such that they remained a minimum of 3 m away from any adjacent buildings or

[7] Ln values are statistical noise measurements used to assess noise levels from fluctuating noise sources over time. L10 is the noise level exceeded for 10% of the measurement period; for 10% of the time, the sound pressure level is above this value. Similarly, L90 is the noise level exceeded for 90% of the measurement period; for 90% of the time, the sound pressure level is above this value. For this reason, the L90 is used to represent background or ambient noise levels of an environment.

structures and a minimum of 1.5 m above the ground surface. Consistent with the MECP NPC-103 guidance document, any noise data deemed to be negatively influenced by weather and poor meteorological conditions (e.g., high winds) were discarded from the dataset to ensure an accurate representation of existing noise conditions without interference from weather-related events. Noise monitoring was completed over a 2-week period in September 2024 using an averaging period of 1-hour for the collection of sound level measurements. A summary of the noise monitoring data and a comparison against the Class 1 and Class 2 sound level limits is provided in **Table 4-5**.

Consistent with previously completed noise monitoring programs, existing conditions at the PN site continue to be dominated by sound sources typical of a developed, urban environment. Although there are periodic exceedances of the MECP Class 1 (i.e., urban) and Class 2 (i.e., suburban) sound level limits (MECP, 2013), it is understood that these exceedances are not the result of PN site activities. In populated urban areas, it is common for sound level limits to be occasionally exceeded due to localized events, such as traffic (e.g., car alarm) or other human activity near the area of monitoring. Periodic exposure to sound levels in excess of the MECP sound level limits are not associated with human health effects and are considered a common occurrence in urban and semi-urban areas.

Table 4-5: PN Existing Conditions Noise Data Summary (September 2024)

Location ID	LAeq		LA90		Full Day		Min 1-hr LAeq		Data Count (Hours)		
	Day	Night	Day	Night	LAeq	LA90	Day	Night	Day	Night	Total
Class 1	50	50	50	50	50	50	50	50	-	-	-
Class 2	50	45	50	45	50	45	50	45	-	-	-
P2	**60.1**	**57.2**	47.7	46.9	**59.5**	47.5	49.4	45.3	97	40	137
P3	**61.0**	**53.5**	48.4	46.9	**59.8**	48.0	47.3	44.5	119	49	168
P4	49.1	**50.9**	47.3	50.0	49.7	48.4	44.0	47.7	121	54	175
P6	**50.8**	**50.8**	48.7	49.5	**50.8**	49.0	47.1	47.9	121	50	171

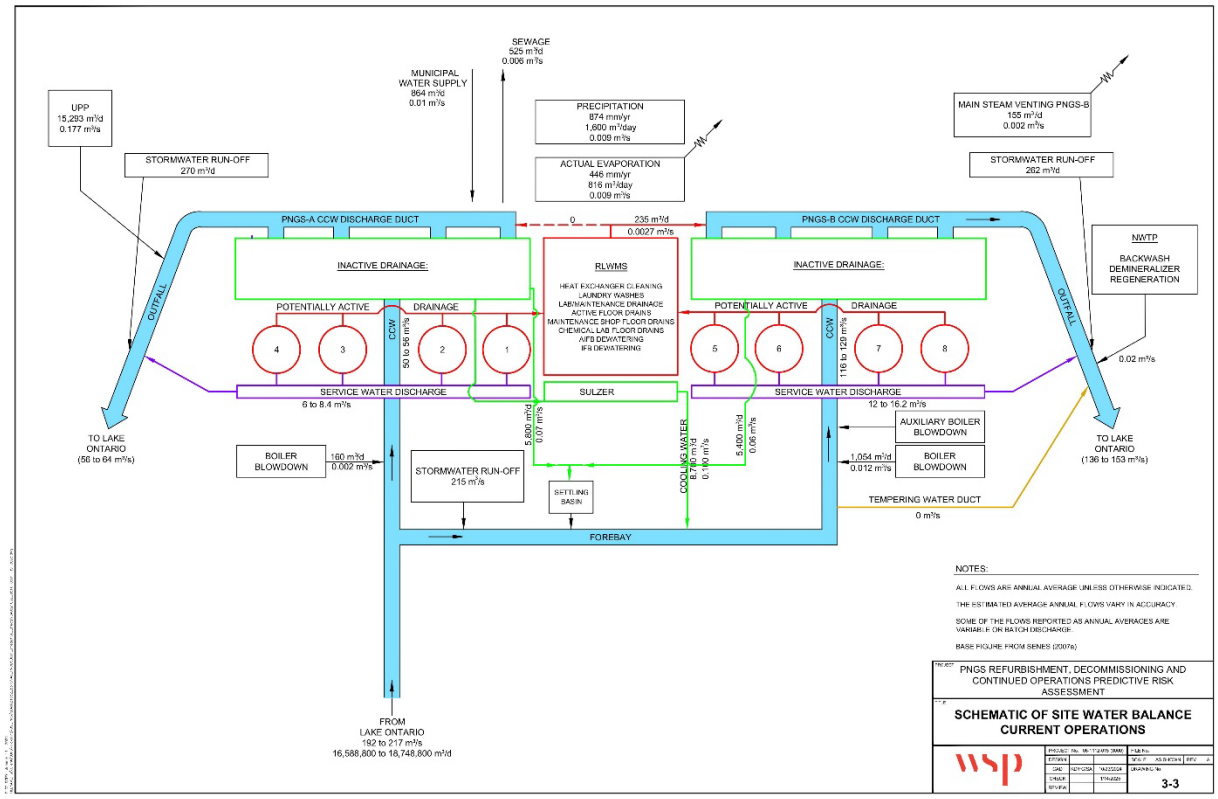
Notes:
Values are presented as A-weighted decibels (dBA).
"Class 1" and "Class 2" refer to the 1-hour sound level limits for outdoor points of reception in Table B-1 of the NPC-300 noise guidance document (MECP, 2013). Consistent with the guidance, "Day" refers to the hours of 7:00 a.m. to 7:00 p.m. and "Night" refers to the hours of 7:00 p.m. to 7:00 a.m.
Bold indicates an exceedance of the Class 1 sound level limit; underline indicates an exceedance of the Class 2 sound level limit.

4.2 Surface Water Environment

4.2.1 Flow and Hydrology

The PN Site is situated on the north shore of Lake Ontario. Lake-wide circulation is primarily driven by wind and by seasonal temperature effects. The frequency of lake current flowing toward each direction and the maximum speed that occurred in each direction has been documented from 2011 to 2020; Ecometrix, 2023c). The average easterly and westerly current speeds were approximately 24 cm/s and 17 cm/s respectively.

Nearshore lake currents are affected by the PNGS operations via the condenser cooling water (CCW) discharge. The current water balance at the PN site, reflecting six functional units as assessed in the 2022 PN ERA (i.e., prior to the permanent shutdown of PNGS Units 1 and 4 at the end of 2024 and the pre-refurbishment state of PNGS Units 5-8), is depicted in **Figure 4-2**. The flow from the PNGS Units 1-4 CCW discharge duct is estimated at approximately 56-64 m^3/s, and the flow from the PNGS Units 5-8 CCW discharge duct is 136-163 m^3/s. Thus, localized effects are observed near these discharge points. Similarly, localized changes in flow can also be seen in the vicinity of intake groynes that are directed toward the plants and a zone of in-flowing water can be seen around the intake. Under the previous operational conditions (with 6 operating units), typical water withdrawal between the intake groynes and into the plant via the intake channel is estimated at 192-217 m^3/s based on rated condenser CCW pump capacities and service water demand.



Note: Figure reflects previous operational conditions as presented in the 2022 PN ERA with 6 operating units.

Figure 4-2: Water Balance at PNGS under Previous Operational Conditions in 2022 PN ERA

4.2.2 Water and Sediment Quality

4.2.2.1 Water Quality

PNGS currently interacts with the surface water quality of Lake Ontario as all liquid effluent (except for sewage, which goes to into the Regional Municipality of Durham sewage mains) and some stormwater drainage is discharged into the CCW discharge duct, the outfall structures or the forebay. All effluent collected through drainage systems is analyzed by OPG (and treated if necessary) to ensure it meets radiological and non-radiological limits prior to discharge to Lake Ontario.

Frenchman's Bay is a provincially significant wetland west of PNGS. To characterize conditions around the PN site in Frenchman's Bay, an environmental sampling program was conducted in the summer of 2015 in support of the 2017 ERA (Ecometrix and Golder, 2018). Surface water samples were collected from Lake Ontario and Frenchman's Bay during one sampling event to evaluate the quality of the water in these areas. Samples were analyzed for general chemistry parameters, metals, petroleum hydrocarbons (PHC) fractions F1 to F4, morpholine, radionuclides including tritium, carbon-14 (C-14), and cobalt-60 (Co-60), cesium-134 (Cs-134), and cesium-137 (Cs-137). The ERA also utilized hydrazine concentration determined from a supplementary EMP study conducted in 2014 (Ecometrix, 2015).

In 2024, water samples were collected from Lake Ontario and Frenchman's Bay to update the current understanding of existing conditions and to support this PERA. Samples were collected in the spring, summer, and fall to capture seasonal variability. The sampling stations are depicted in **Figure 4-3** and **Figure 4-4** and were based on locations sampled in 2015, with the addition of four locations (LW2401, LW2402, LW2403, and LW2404) in offshore Lake Ontario, to consider the location of the planned DWI. LWE-1, located offshore of the stormwater location M5-1 and previously sampled in 2015, was not included in the 2024 sampling program. As with previous sampling programs, a control location (LWC-1) on Lake Ontario near Cobourg WSP was included in the sampling. For the Lake Ontario stations, water samples were collected near the surface (0.5 m depth) and at the bottom (0.5 m off bottom) of the water column to capture the vertical profile. Mid-depth samples were collected in Frenchman's Bay, as thermal stratification is unlikely in the shallow depths observed in this area. The list of parameters evaluated in 2024 was expanded to include microbes, volatile organics, and radionuclides such as Iodine-131, Thorium-series, and Uranium-series. Results from this program were compared against relevant water quality guidelines, including the CCME Canadian Water Quality Guidelines (CWQG) (CCME, 2024), Ontario Provincial Water Quality Objectives (PWQO) and interim PWQO (MOEE, 1994), and Health Canada's Drinking Water Quality Guidelines (HC, 2024).

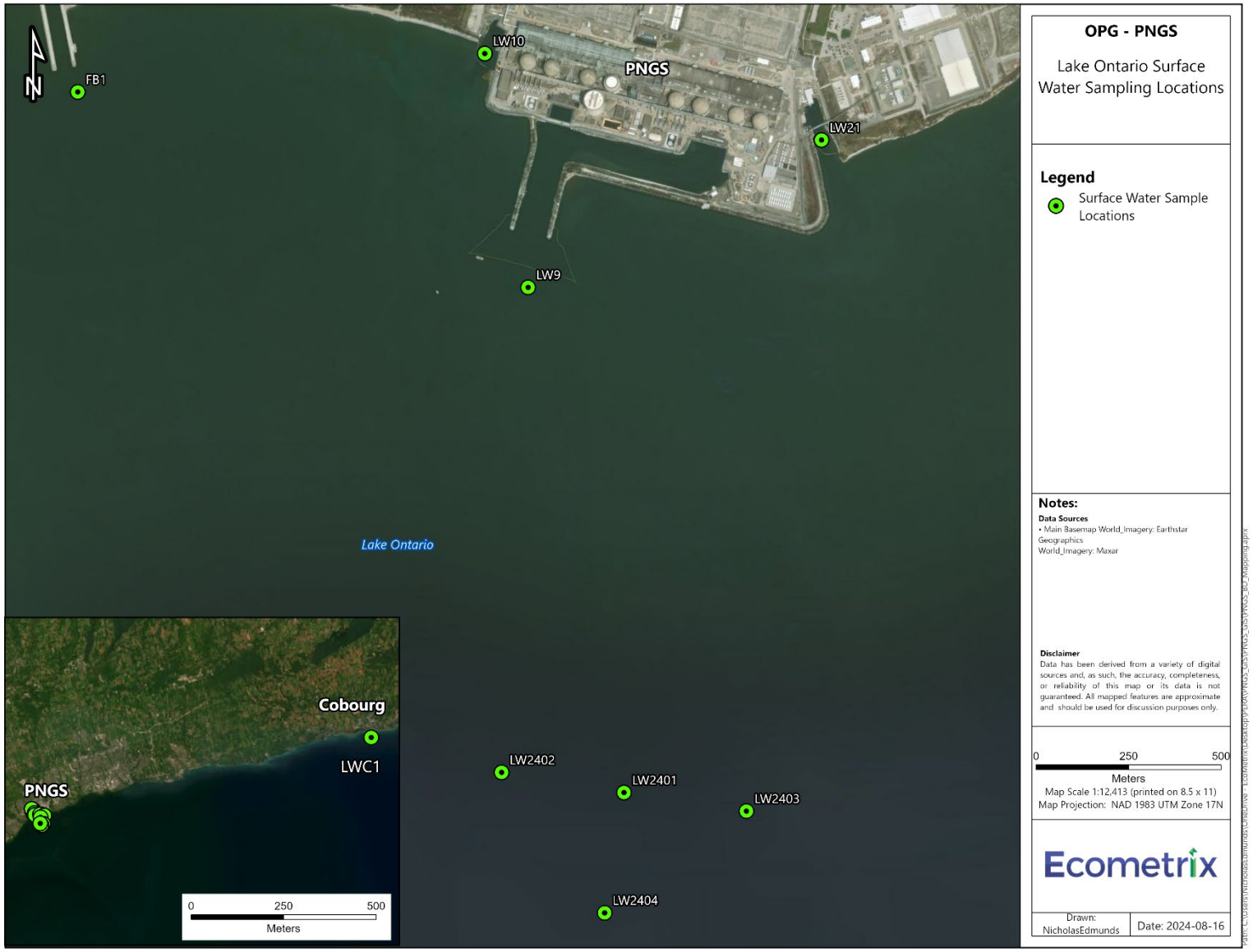


Figure 4-3: Lake Ontario Surface Water Sampling Locations, 2024

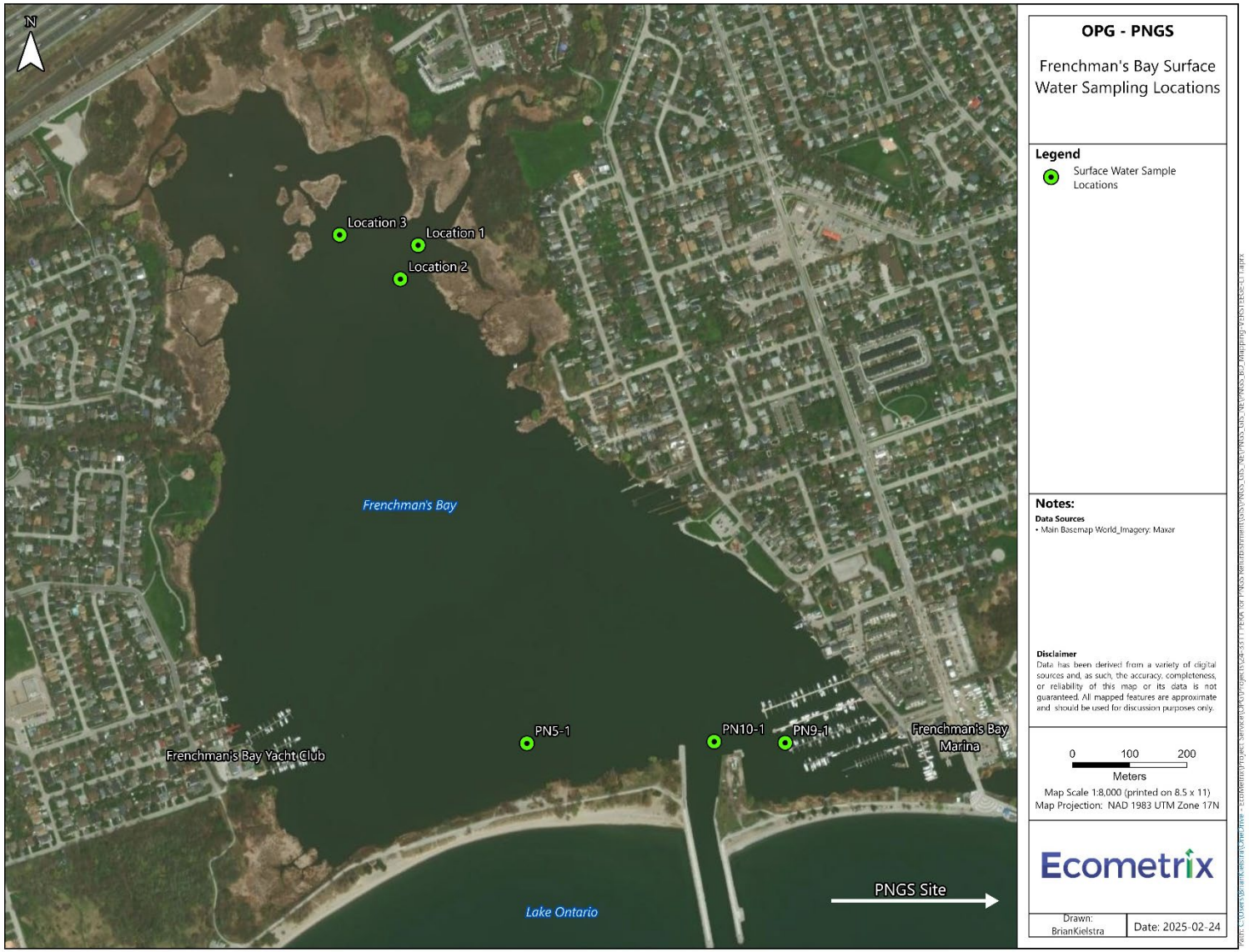


Figure 4-4: Frenchman's Bay Surface Water Sampling Locations, 2024

4.2.2.1.1 Lake Ontario

Of the non-radiological parameters evaluated in the 2015 program, hydrazine and morpholine exceeded their respective water quality guidelines in Lake Ontario (Ecometrix and Golder, 2018). However, modeling the associated risk to human receptors from exposure to these COPCs indicated no threat to public health, based on the conclusions of the 2022 PN ERA.

Across the spring, summer, and fall sampling events as a part of the 2024 surface water sampling program, pH, ammonia (total and un-ionized), cobalt (total), copper (total), silver (total), total coliforms and *Escherichia coli* (*E. coli*) levels in Lake Ontario exceeded at least one of the water quality guidelines (**Table A-1**, **Table A-2**, **Table A-3**). It should be noted that the pH was 1.5% above the PWQO guideline in two samples from LW9 and one from LW2402 (see **Figure 4-3**) during the summer sampling event. While pH is not considered a chemical contaminant, it is measured as the MECP considers freshwater bodies with a pH between 6.5 to 8.5 to be the most bio-productive. Surface waters with pH above the upper limit of the PWQO may be less productive. However, Lake Ontario is a well-documented productive habitat for aquatic biota, as demonstrated by numerous aquatic biota studies (Barbiero et al., 2001; EC, 2009a; Golder, 2007a; OPG, 2016, 2023d), including the 2024 deepwater and nearshore fish community, macroinvertebrate, and microzooplankton studies (see Section 4.3). Given this, the slight exceedance is likely due to natural spatial variability and is not a cause for concern. Additionally, the CCME CWQG for pH ranges from 6.5 to 9.0 for the protection of freshwater biota, a standard also recommended by the International Joint Commission (IJC, 1977) and the U.S. EPA (US EPA, 1986). This range is considered protective of fish and benthic invertebrates, though pH changes within it may influence the toxicity of other contaminants, such as ammonia. Since all surface water samples collected fell within the CCME guideline range and Lake Ontario remains highly productive, the minor exceedances in pH are not expected to have any adverse impacts on aquatic biota in the lake.

Exceedances of the CCME guidelines for total and un-ioinized ammonia were found in samples take from the PN intake (LW9), mouth of Frenchman's Bay (FB1), and in the potential DWI area (LW2401, LW2402, LW2403, LW2404; **Figure 4-3**) during the summer sampling event. While ammonia can be a toxicant, it is also a key component of the nitrogen cycle and a source of bioavailable nitrogen. The occurrence of exceedances exclusively during the summer suggest the possibility that elevated water temperatures in this season contributed to increased decomposition of organic matter and enhanced biological activity, resulting in greater production of nitrogenous waste in the form of ammonia. Additionally, certain cyanobacterial genera associated with algal blooms are capable of nitrogen fixation, converting atmospheric nitrogen into various forms including ammonium (Favot et al., 2023). Adverse health effects for humans as well as birds and mammals are not expected, as ammonia is naturally produced and efficiently metabolized in healthy individuals from these groups (HC, 2013). All sample concentrations were below the 1.5 mg/L odor threshold which induces avoidance behaviors for birds and mammals, thereby limiting ingestion of surface water. Potential risks to aquatic biota in these areas will be assessed further in the 2027 ERA. However, the absence of exceedances near the outfalls and in all lake sampling locations during the spring and fall events, along with

waterborne ammonia emissions from PN consistently being below regulatory limits (as detailed **Section 4.2.2.1.3**), suggests that the elevated concentrations reflect a seasonal effect rather than an impact of PN operations.

The concentrations of cobalt, copper, and silver exceeded their respective guidelines in a single sample collected at the bottom of the water column at LW9 (i.e., LW9-B) from the fall surface water sampling event in 2024. In contrast, the concentrations of cobalt and silver were below detection limits in the samples from 2015, while the maximum copper concentration in 2015 was considerably lower than that of LW9-B in 2024. However, since these metal exceedances were not detected in any other samples near the PN outfall or the corresponding surface sample (LW9-S), and were absent in the spring and summer sampling events, they likely represent sporadic variations in nearshore water quality not related to PN operations.

The total coliform and *E. coli* levels in certain Lake Ontario surface water samples exceeded the Health Canada guideline that stipulates these microbial parameters must not be detectable (i.e., below method detection limit). However, it should be noted that, total coliforms, whose counts do not correlate well with the incidence of gastrointestinal illness, exceeded this guideline in many more locations than *E. coli*, which does. Ultimately though, both total coliforms and *E. coli* are naturally-occurring in the environment and are not released in the course of normal operations at PNGS. Thus, these levels are not considered hazardous and do not represent a risk from the PNGS.

Hydrazine exceeded the CCME screening guideline of 2.6 µg/L at the sampling station near the PNGS Units 5-8 outfall (LW-21) in the spring sampling event with a concentration of 4.2 µg/L. Hydrazine is added to feedwater for oxygen removal and is discharged into the aquatic environment through boiler blowdown and flushing to the intake forebay. Boiler blowdown is generally continuous and intermittent at PNGS Units 5-8 and intermittent at PNGS Units 1-4. As such, hydrazine concentrations in the CCW discharges from PNGS Units 1-4 and PNGS Units 5-8 are monitored weekly as a part of the ECA requirements for PNGS. Monitoring data indicated that during the week of the spring 2024 sampling event, the concentration of hydrazine in the CCW discharge from PNGS Units 5-8 was above the detection limit of 2 µg/L, measuring at 3 µg/L. However, concentrations fell below the detection limit in the following week. Additionally, 85% of samples from the PNGS Units 5-8 outfall were non-detect over the 2024 monitoring period, as were subsequent samples from LW-21 in the 2024 surface water sampling program. Taken together, this suggests that the exceedance observed in spring 2024 was transient and infrequent, with no sustained risk.

Hydrazine is also classified by the International Agency for Research on Cancer (IARC) as a Group 1A carcinogen and the US EPA as a Group B2 carcinogen (probable human carcinogen), and by the European Commission as Category 2 for carcinogenicity (should be regarded as if it is carcinogenic to man). Although there is no Health Canada drinking water guideline for hydrazine, the US EPA estimated that a hydrazine concentration of 0.00001 mg/L corresponds to a cancer risk level of one in one million ($1x10^{-6}$) (EC and HC, 2011; US EPA, 1988), based on a

drinking water intake rate of 2 L/day and no exposure amortization. The concentration at LW-21 in the spring 2024 sampling event exceeds the drinking water value of 0.00001 mg/L.

The exceedance at LW-21 is unlikely to pose a risk to the public for two key reasons. First, hydrazine has a short chemical half-life, ranging from 0.6 to 1.31 days (EC and HC, 2011), and degrades rapidly. Second, conditions during water treatment at nearby water supply plants (WSPs) such as Bowmanville and Oshawa WSPs further promote its degradation. The treatment process involves multiple chlorination steps using sodium hypochlorite, which increases pH, followed by pH adjustment with sulfuric acid (Durham Region, 2022a, 2022b). Hydrazine degradation is highly influenced by pH; alkaline conditions favour its degradation (Choudhary and Hansen, 1998). Additionally, degradation of hydrazine occurs through oxidation in the presence of oxygen; the reaction tends to be catalyzed (i.e., sped up) in the presence of certain compounds like Copper (II) and phosphate ions, which are likely to be present in some amount in drinking water. Hydrazine degradation is also favoured in the presence of organic matter, which also is likely to be present in drinking water. Hydrazine was found to decrease by more than 90% when added to chlorinated, filtered county water after 1 day (Choudhary and Hansen, 1998).

Therefore, the hydrazine concentration detected at LW-21 poses a minimal risk to ecological and human receptors in the vicinity. Nevertheless, the potential risk associated with this exceedance will be quantitatively evaluated in the 2027 ERA.

4.2.2.1.2 Frenchman's Bay

Results from the 2015 study showed that aluminum, copper, iron, and sodium in Frenchman's Bay exceeded screening guidelines. While concentrations of these metals exceeded toxicity benchmarks for some ecological receptors, such exceedances are expected as the bay receives a substantial amount of urban runoff. Modelling performed to estimate PNGS's contribution to these concentrations indicated that PNGS only accounted for 0.3-22% of COPC levels at Frenchman's Bay (Ecometrix and Golder, 2018).

In comparison, the 2024 sampling program at Frenchman's Bay found exceedances of relevant water quality guidelines for aluminum (total and dissolved), iron (total), pH, ammonia (total and un-ionized), total phosphorus, total coliforms, and *E. coli* (**Table A-1**, **Table A-2**, **Table A-3**).

As in 2015, aluminum and iron exceeded toxicity benchmarks in 2024 surface water samples from Frenchman's Bay. This is not uncommon for an area like Frenchman's Bay, which is heavily influenced by urban runoff. Based on the maximum concentrations of these parameters in the 2015 surface water and sediment samples, the 2017 and 2022 PN ERAs found that the HQs for aluminum and iron exceeded the acceptable risk level of 1 for certain receptors (Aluminum: Muskrat, Bufflehead; Iron: Bufflehead, Trumpeter Swan, Common Tern, and Ring-billed Gull). The ERA concluded that as most of these receptors do not reside exclusively in Frenchman's Bay, the HQs presented were conservative, and the overall communities were not expected to be affected. Additionally, HQs calculated for ecological receptors using a surface water model to

estimate aluminum and iron concentrations attributable to PN releases were all below 1. Since the maximum concentrations of aluminum and iron in surface water samples from 2024 are lower than those in 2015, and were below the relevant guidelines in the associated sediment samples (see Section 4.2.2.2.2), the conclusions from the 2017 ERA still remain applicable.

As with Lake Ontario, the maximum pH detected across all sampling locations and events at Frenchman's Bay was slightly above the PWQO guideline (1% above in this case), but does not exceed the CCME guideline, which is protective of aquatic receptors. Additionally, the exceedance of the total phosphorus guideline in surface water samples from 2024 likely does not pose a risk to ecological receptors, as it presents in the aquatic environment as phosphate which acts as a nutrient rather than a toxicant. Similarly, ammonia (un-ionized and total) also exceeded the associated CCME guidelines in samples from the summer and fall sampling event. As such, it is evident that Frenchman's Bay is nutrient enriched. However, as with the metal exceedances, the exceedances of ammonia and phosphorus are likely due to urban runoff rather than operations at the PN site.

Finally, the estimated total coliform and *E. coli* bacteria concentrations in surface water samples from Frenchman's Bay in 2024 did not meet the associated Health Canada screening criteria which stipulates that these bacteria must not be detectable. However, as highlighted earlier, *E. coli* and other coliform bacteria are naturally-occurring in the environment and not considered to be hazardous. Though the levels of these bacteria were higher in surface water samples from Frenchman's Bay compared to those from Lake Ontario, this is expected as Frenchman's Bay and other coastal wetlands along the lake's shoreline have been shown to act as reservoirs for *E. coli* (Harrow-Lyle et al., 2024). This is likely due to internal sources such the increased presence of waterfowl and other wildlife, as well as environmental conditions (pH, temperature, moisture) that promote microbial growth. These total coliform and *E. coli* exceedances do not result from normal PNGS operations, and they are not deemed a risk to human health.

4.2.2.1.3 Waterborne Emissions

Non-radiological emissions

Aqueous liquid effluent, except for domestic sewage and some stormwater drainage, from PN is discharged into the CCW discharge duct, the outfall structures, or the forebay. The majority of stormwater drainage is directed to Lake Ontario, and domestic sewage is directed to the York-Durham Water Pollution Control Plant. Non-radioactive liquid emissions are controlled in accordance with the provincial ECA requirements. OPG also operates under the Municipal Industrial Strategy for Abatement (MISA) program under O. Reg. 215/95 (Effluent Monitoring and Effluent Limits – Electric Power Generation Sector).

To meet these regulatory requirements, OPG monitors and reports the concentrations of ammonia, hydrazine, morpholine, pH, and total residual chlorine (TRC) in the final station discharge. Reports from 2016-2020 were consulted to aid in the selection of non-radiological waterborne COPCs in the 2022 PN ERA (Ecometrix, 2023a) and the 2022 PEA Addendum for PN

Safe Storage (Ecometrix, 2023b). This PERA considers the most recent reports prepared from 2021-2023 (OPG, 2022b, 2023e, 2024g) to characterize previous operational conditions (with 6 operating units) relating to waterborne chemical emissions from PNGS. During this time period, there were no regulatory non-compliances associated with the measured concentrations of Ammonia, Hydrazine, Morpholine, pH, or TRC in the effluent from PN.

Radiological emissions

During normal operations, the PN site releases small amounts of radiological contaminants into Lake Ontario. As a part of its annual effluent monitoring program, OPG monitors the total waterborne emissions of tritium oxide (HTO), C-14, and gross beta/gamma.

HTO emissions from the PN site were slightly elevated between 2018 and 2020 compared to historical emissions due to increased processing of Active Liquid Waste (ALW) (OPG, 2024d). These elevated levels persisted in 2021, and could be attributed to the installation of a microscrubber designed to reduce airborne tritium emissions. The microscrubber converts a portion of the tritium into waterborne effluent, which is then directed to the ALW tanks for controlled release within acceptable limits. Emissions of HTO decreased in 2023, following the peak in 2022 due to the extended operation of Units 1 and 4. Overall, waterborne tritium oxide emissions from 2020 to 2023 showed no significant deviation from the last 10 years of emissions data.

The gross beta-gamma water emissions peaked from 2016 and in 2020 due to spontaneous releases of concentrated, entrained active lake sediment materials from the Reactor Building Service Water (RBSW) system. The shallow surface intake for station cooling water allows suspended particulates from the lake to enter the station. Cs-137 is strongly attracted to clay minerals, which are easily suspended in the water column and can subsequently deposit on internal surfaces of station systems (e.g. in pipe work of the systems). As Cs-137 in the sediment originates from past nuclear weapons testing, the peak in gamma emissions in 2016 and 2020, does not represent a station generated source of activity. The results were also biased high in 2021 due to residue in the sampler. Gross beta-gamma emissions were reduced back to pre-2016 levels in 2022 and 2023. Waterborne carbon-14 emissions contribute minimally to the overall public dose, and the 2020 to 2023 emissions remained consistent with historical levels based on 10 years of longitudinal data. Overall, radiological water emissions from the PN site represent a very small fraction of the site's DRLs.

Radiological emissions to water are shown in **Table 4-6** below.

Table 4-6: Radiological Water Emissions from PN (2021-2023)

Parameter	Units	Average [1] (2016-2020)	Year			Average (2021-2023)	Average (2021-2023) as % of DRL [2]
			2021	2022	2023		
Tritium Oxide	Bq/a	3.96E+14	4.80E+14	5.00E+14	3.80E+14	4.53E+14	0.06%
Gross Beta-Gamma	Bq/a	1.05E+11	1.20E+11	2.00E+10	2.20E+10	5.40E+10	2.89%
Carbon-14	Bq/a	2.60E+09	4.60E+09	1.40E+09	3.30E+09	3.10E+09	0.008%

Notes:

[1] Average from the 2022 PN ERA (Ecometrix, 2023a) is the average of emissions from 2016 to 2020.

[2] The DRL used for comparison to 2021-2023 average emissions is obtained from the 2016 PN DRL report (OPG, 2024e). The DRL for gross-beta gamma assumes conservatively that all of the gross beta-gamma is comprised of the most radiotoxic beta-gamma emitter.

4.2.2.1.4 Radionuclide Concentrations in Lake water

In the 2015 surface water sampling program, the concentrations of radionuclides of interest, including tritium, C-14, Co-60, Cs-134, and Cs-137, were measured in lake water samples collected from a single event. The same radionuclides, along with potassium-40 (K-40), iodine-131 (I-131), Thorium-series, and Uranium-series radionuclides were analyzed in lake water samples on a quarterly basis in 2024 (**Table A-1**, **Table A-2**, **Table A-3**) consistent with the locations identified in **Figure 4-3** and **Figure 4-4**. Across both years, the concentrations of C-14, Co-60, Cs-134, and Cs-137 were below detection limits in most samples. Tritium was detected in some samples with levels ranging from 20 to 40 Bq/kg, which were comparable to those observed in 2015. K-40, which is environmentally abundant and is not associated with station operations, was also detected at levels ranging from 0 to 22.3 Bq/kg. Finally, Lake water for recreational use is sampled from three beaches in the vicinity of PN on a monthly basis and analysed for HTO. This data is used as an input to estimate public dose. In 2023, the average HTO concentration in lake water samples collected from beaches near the PN area was 21.9 Bq/L. A statistically significant trend was observed over the last 10 years, aligning with slight increases in HTO waterborne emissions over the same period (see **Section 4.2.2.1.3** for details). However, in 2023, a decrease in waterborne HTO emissions was observed relative to the peak in 2022, which was reflected in lower HTO concentrations in lake water compared to 2022 levels.

4.2.2.2 Sediment Quality

Current available data indicates that substrate in nearshore Lake Ontario is comprised of coarse sand which is transient and non-depositional due to high wave energy. As a result, appropriate material (i.e., fine-grained sediments) required for analysis of sediment quality is scarce in this area (Hart and Petersen, 2013). Additionally, the invertebrate community in this area is primarily epifaunal, i.e., residing on the surface of the substrate rather than within it. As such, invertebrates in the area have limited exposure to contaminants in the sediment, further restricting the applicability of sediment assessments here. Therefore, Frenchman's Bay, which is characterized by the presence of fine-grained sediments and relatively high concentrations of TOC is the nearest depositional area for sediment that is suitable for analysis.

As a part of the sediment sampling program conducted in 2015, sediment samples were collected from the north and south areas of Frenchman's Bay and were analyzed for metals and radionuclides. Water-to-sediment partitioning coefficients were used to estimate concentrations of parameters in the sediment near the PN outfall area of Lake Ontario (Ecometrix and Golder, 2018).

In the 2024 sediment sampling program, sediment was collected in the fall from locations used in the current PNGS EMP and in the 2015 sediment sampling program in support of the 2017 ERA (**Figure 4-5**). This included 8 north locations (i.e., in the interior of the bay) and 8 south locations (near the entrance of the bay). The chosen number of samples is considered appropriate for the assessment and quantification of sediment spatial heterogeneity. The range of parameters analyzed was expanded to include Polychlorinated Biphenyls (PCBs), pesticides, herbicides, PAHs, and petroleum hydrocarbons. Seven locations in nearshore Lake Ontario were

also sampled to assess the proposed areas for the construction of the west infill area and shoreline erosion mitigation area (**Figure 4-6**), with analyses focused solely on particle size and metals. Sediment samples were collected from these locations to assist in the interpretation of other field investigations (i.e., aquatic habitat assessment for fish and macroinvertebrates) and provide an understanding of the existing conditions in these areas prior to construction. Concentrations of parameters in sediment samples were compared against the CCME Interim Sediment Quality Guidelines (ISQGs), Ontario MECP Provincial Sediment Quality Guidelines (PSQG), and other applicable screening criteria.

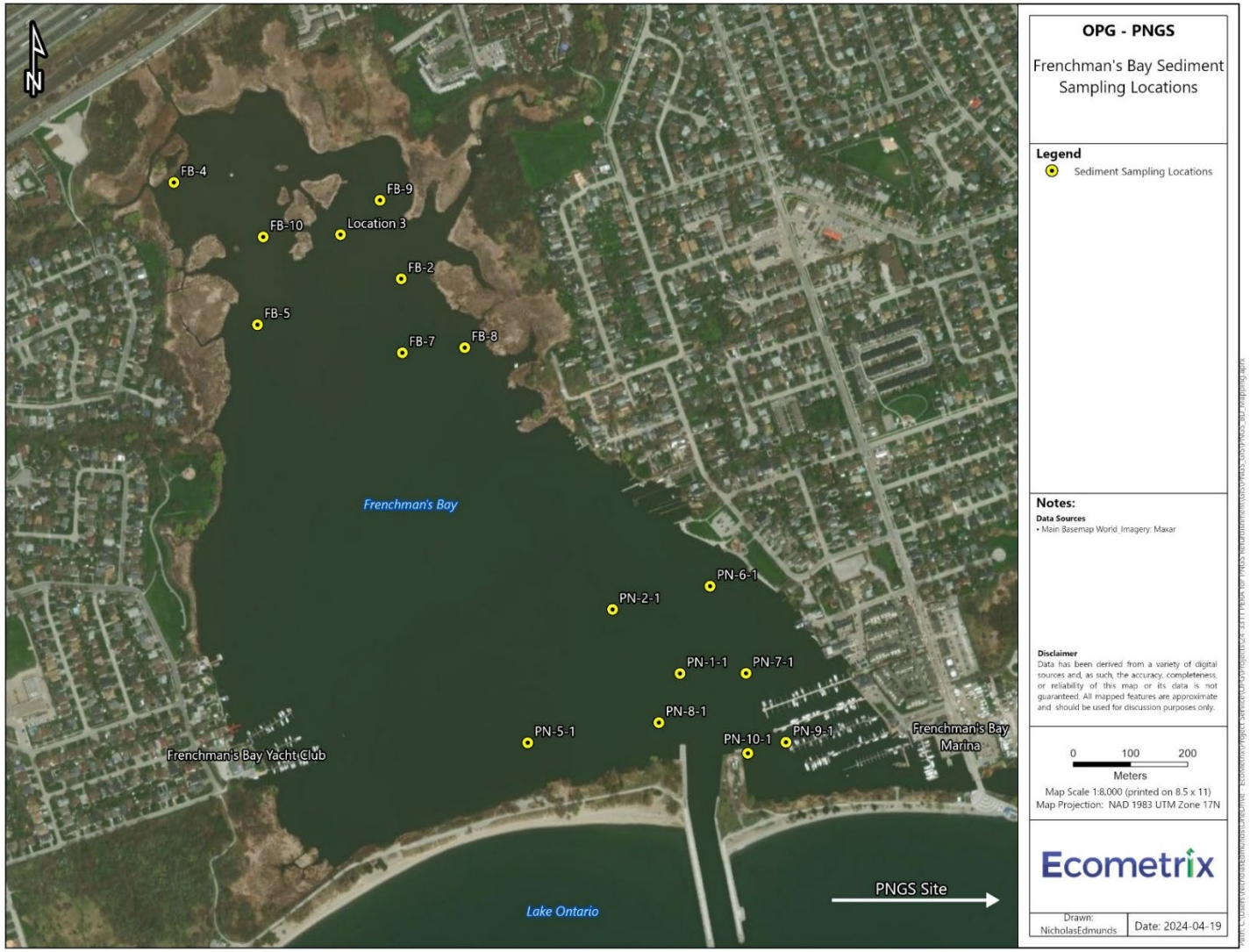


Figure 4-5: Frenchman's Bay Sediment Sampling Stations, 2024

Figure 4-6: Nearshore Lake Ontario Sediment and Benthic Macroinvertebrate Community Sampling Stations, 2024

4.2.2.2.1 Nearshore Lake Ontario

Estimated maximum copper concentrations in sediment near the PN outfall based on water concentrations in 2015 slightly exceeded benthic invertebrate benchmarks, though mean concentrations did not. However, this exceedance was not anticipated to impact the invertebrate community and should be interpreted with caution as the substrate in the area is transient and primarily comprised of coarse sand (Hart and Petersen, 2013). Both maximum and mean sediment concentrations of other parameters were below their respective ecological benchmarks.

The only parameter to exceed its associated screening guideline from the sediment samples collected in 2024 was total phosphorous (**Table A-4**). The Ontario Sediment Quality Guideline (600 mg/kg) was exceeded at two locations (Infill-03 and Infill-06; **Figure 4-6**). However, this guideline is not based on toxic effects to ecological receptors, but rather represents a nutrient effect on benthic community composition (MECP, 2008). Additionally, the elevated levels of phosphorus are probably a result of agricultural and urban inputs into Lake Ontario. Therefore, these exceedances most likely do not indicate facility-related impacts and are not associated with adverse impacts on aquatic invertebrates. The results from this sampling program cannot be directly compared to the 2015 estimates as the sampling stations were not in proximity to the outfall.

4.2.2.2.2 Frenchman's Bay

The concentrations of metals including aluminum, cadmium, chromium, copper, manganese, nickel, thallium, and tin in sediment samples from 2015 were found to exceed the established screening levels. These exceedances were anticipated, as Frenchman's Bay is highly influenced by urban runoff. Additionally, the levels of total organic carbon (TOC) were greater than the MECP guideline of 10,000 mg/kg (or 1%). However, as highlighted earlier, MECP guidelines for nutrients such as TOC are not based on toxic effects to ecological receptors. Additionally, wetland locations often exceed this screening criterion as organic matter content and nutrient levels may be naturally high in wetlands, which the guideline does not account for as it was established based on a Great Lakes dataset.

In 2024, the list of metals that exceeded their screening criteria (**Table A-4**) and the degree of exceedance of these criteria is comparable to the results from 2015. The only exceptions were aluminum, thallium, and tin, which exceeded screening criteria in 2015 but were below these criteria in 2024. Of the parameters that were quantified for the first time in 2024, certain PAHs and petroleum hydrocarbons, and Aroclor 1260 exceeded their respective sediment quality guidelines. As previously noted, these metal exceedances can be attributed to the ongoing impact of urban runoff. In line with the 2015 samples, TOC concentrations exceeded the MECP guideline at all locations in Frenchman's Bay. Unlike in 2015, all sediment samples collected from Frenchman's Bay exceeded the MECP guideline for Total Kjeldahl Nitrogen (TKN; 550 mg/kg). The exceedances of TOC and TKN are likely due to the naturally elevated organic content of

wetland ecosystems and are not associated with toxic effects. The elevated nutrient levels are probably a result of agricultural and urban inputs, rather than being linked to PNGS operations.

4.2.2.2.3 Radiological Parameters

Sediment samples collected from Frenchman's Bay during the 2015 sampling program were analyzed for radionuclides, including C-14, Co-60, Cs-134, and Cs-137 (Ecometrix and Golder, 2018). In 2019, additional sediment samples were collected and analyzed in support of OPG's EMP (OPG, 2020b), with K-40 included in the analysis. Sediment samples collected as a part of the 2024 sediment sampling program were also analyzed for the same radionuclides, with the addition of tritium, K-40, I-131, Thorium-series, and Uranium-series radionuclides.

Across all three sampling events (2015, 2019, 2024), the majority of sediment samples exhibited concentrations of Co-60 and Cs-134 well below detection limits. Cs-137 was generally detectable in samples from all three events, with similar results being observed. C-14 concentrations in 2019 were comparable to those from 2015, but were below detection limits in 2024 (**Table A-4**). Though tritium, K-40, I-131, Thorium-series and Uranium-series radionuclides were all detectable in the samples from the most recent 2024 monitoring program, the concentrations are low.

4.2.3 Stormwater runoff

Stormwater runoff from the PN site is collected by a drainage system and directed south to Lake Ontario. Runoff entering the discharge channels is estimated at 270 m^3/day for PNGS Units 1-4 and 262 m^3/day for PNGS Units 5-8, based on an annual precipitation of 872 mm. The 2017 ERA (Ecometrix and Golder, 2018) included results from a 2015–2016 stormwater sampling campaign to characterize the quality of stormwater. Final concentrations in the discharge channels and in Lake Ontario were compared to relevant water quality guidelines, and no exceedances of the selected benchmarks were identified.

Consistent with the requirements of CSA N288.6-12 clause 11.1 to periodically review changes to the facility, the expansion of PWMF Phase II will likely result in changes to the stormwater catchments in the East Complex. The appropriate stormwater outfalls in the East Complex should be reviewed and sampled accordingly to be representative of the catchment areas after the completion of the PWMF Phase II expansion. Gross beta-gamma in stormwater was monitored and reported quarterly over the 2016-2020 period; however, in 2021 OPG determined that no routine monitoring is required given the robust design of the used fuel dry storage containers (DSCs) and absence of liquid inside the DSCs during dry storage (OPG, 2021b). Following their review of the 2017 ERA, CNSC and ECCC recommended that a stormwater sampling plan be included in future ERA submissions. OPG plans to carry out this recommendation after the completion of the PWMF Phase II expansion and results from the stormwater sampling will be included in the subsequent routine updates of the ERA.

4.3 Aquatic Environment

4.3.1 Fish

4.3.1.1 Fish community

More than 90 species of migratory and resident fish species are known to inhabit Lake Ontario (see Ecometrix, 2023b for a complete list), with most of them utilizing nearshore waters for spawning, rearing, feeding, and migration. The three fish species at risk that have been identified at the PN site, along with their federal and provincial ranking is presented in **Table 4-7**. While the Lake Ontario population of Atlantic Salmon is listed federally as extinct, individual were last observed in 2020, likely as individuals from ongoing stocking programs (OPG, 2021c). American Eel, has been consistently recorded in annual impingement monitoring from 2016 to 2022 (OPG, 2016, 2016, 2017a, 2017a, 2018a, 2019c, 2021d, 2021c, 2022c, 2023d). OPG has an Ontario ESA Waterpower Agreement for the operation of the Saunders Generating Station on the St. Lawrence River, and as part of that ESA (Endangered Species Act) agreement, from 2006 – 2010, OPG stocked 4 million young eels (elvers) in the upper St. Lawrence and Lake Ontario. Lastly, a Lake Sturgeon was caught and released near PN in the fall of 2024 during the deepwater fish community studies, marking the first observed sighting since 2005 (OPG, 2012a; TRCA, 2022). The New York State Department of Environmental Conservation has stocked Lake Sturgeon in 13 waters within the Lake Ontario and St. Lawrence River drainage system intermittently since 1993, with the most recent program conducted from 2014 to 2019 (Great Lakes Fishery Commission, 2023; Stewart et al., 2012; Welsh et al., 2020).

While Round Whitefish is not considered a species at risk, they were considered a species of interest by regulators (OPG, 2013) as they are cold-water fish native to Lake Ontario, and because early embryonic stages are considered sensitive to thermal stressors (Eme et al., 2015; Griffiths, 1980; Petrudev, 2022). As such, this species has been the focus of several studies investigating the environmental impacts of PNGS (see **Section 4.3.1.3** for details). It was felt that absence of an effect observed for Round Whitefish embryo development would also be protective to other Great Lake fish species.

Table 4-7: Fish Species at Risk Observed in the PN Area

Scientific Name	Common Name	Federal Species at Risk Status (SARA)(1)	Provincial ESA Status (SARO)(2)	Most Recent Year Observed
Salmo salar	Atlantic salmon	Extinct	Not listed	2020
Anguilla rostrata	American Eel	No status(3)	Endangered	2022
Acipenser fulvescens	Lake Sturgeon	No status(3)	Endangered	2024

Notes:
Statuses are up to date as of January 7th, 2025.
The Provincial Species at Risk in Ontario List, Federal List of Wildlife Species at Risk (Schedule 1 of the Species at Risk Act (SARA)), and Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists are frequently revised.
(1) SARA Schedule 1 ranks species at risk as Extirpated, Endangered, Threatened Species and Special Concern. Prohibitions of the Act do not apply to species of Special Concern.
(2) The provincial Endangered Species Act (2007) came into effect on June 30, 2008 and it applies to species once they appear on the official list.
(3) The COSEWIC status of the American Eel and Lake Sturgeon were assessed as Threatened.
Source: (OPG, 2012a, 2016, 2023d; TRCA, 2022)

Fish community studies were conducted in 2024 in the planned DWI region of Lake Ontario (**Figure 4-7**) and the nearshore sections associated with the proposed west infill and shoreline erosion mitigation areas (**Figure 4-10**). The methods used and the results are discussed below.

4.3.1.1.1 Deepwater Fish Community Study

Assessment of the fish community in the proposed DWI area followed a similar approach to that used at DNNP for intake siting (Ecometrix, 2021). In the design, the 1 km^2 study area was divided into nine sampling areas based on a 333 m x 333 m grid (labelled S1 to S9 in **Figure 4-7**). The gillnets used for fish community sampling were consistent with the Ontario Ministry of Natural Resources and Forestry (MNRF) *Lake Ontario Fish Community Index Netting Protocol* (MNRF, 2018) as well as with past studies conducted for OPG at Darlington Nuclear Generating Station (DNGS) (Ecometrix, 2021). The program comprised of three sampling events in the spring, summer, and fall of 2024. During each event, net sets were deployed in one of nine sampling grids using the the fixed-sequential-random design, where three net grids were fixed (one per depth stratum 12-14, 14-16 and 16-18 m), three were sequential (one per depth stratum; randomly assigned, excluding the fixed locations), and three were set at random grid locations.

All fish caught were identified and enumerated. Weight (in grams), length (in cm or mm), sex (where external determination was possible) and external condition (e.g., fin clips, eroded fins, deformities, lamprey scars) were also assessed for up to 30 individuals per species per season. Representative photos were taken of each fish species collected in the gillnets. Live fish from

gillnet catches were released. Eight individual fish from up to three abundant species were used for tissue burden assessment in the spring and fall seasons (see **Section 4.3.1.2**).

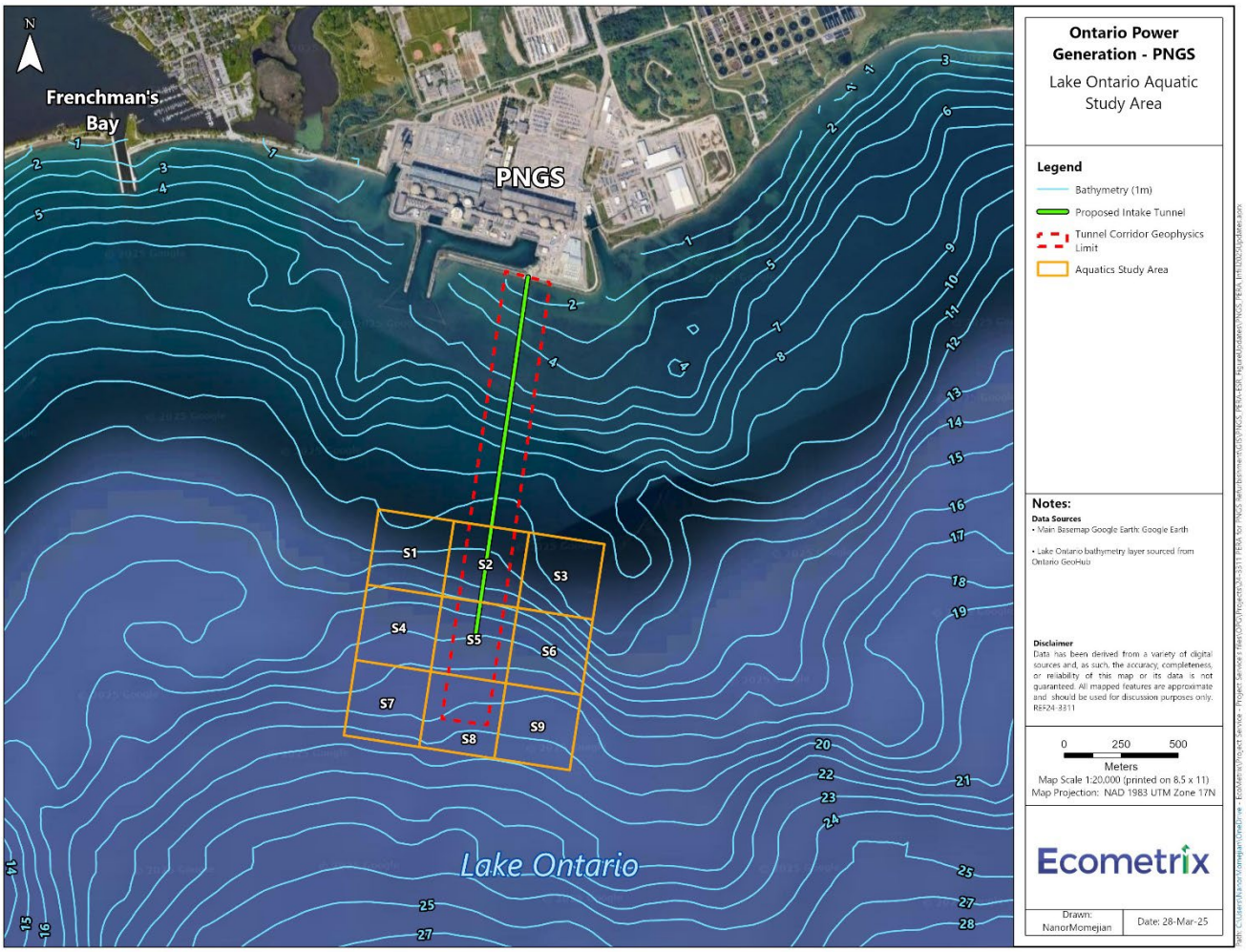


Figure 4-7: Sampling Area for 2024 PNGS Deepwater Fish Community, Benthic Macroinvertebrate Community, and Macrozooplankton Community Studies

Notes:
For the Deepwater Fish Community study, all nets set within one of the following depth stratums: 12-14, 14-16, and 16-18m. Sets followed the fixed-sequential-random design where three fixed (one per depth stratum 12-14, 14-16 and 16-18 m), three sequential (one per depth stratum; randomly assigned, excluding the fixed locations), and three random grid locations (randomly generated S1-S9) were surveyed each season. For the Benthic Macroinvertebrate Community, samples were collected at depths ranging from 17-19 m within sampling grids S4, S7, S8, and S9. For the Macrozooplankton Community Studies, samples were collected from one of the following depth stratums: 12-14, 14-16, 16-18 m. In each sampling event, six grid locations were used with two locations at each depth stratum.

Fish counts and species richness observed during the spring, summer, and fall sampling events are summarized in **Table 4-8**. Additional calculated parameters, including morphometric summaries, Mean Catch Per Unit Effort (CPUE), and Biomass Per Unit Effort (BPUE) are provided in **Table B-1**, **Table B-2**, and **Table B-3**, respectively. Across all three sampling events, 720 fish from 13 different species were captured. Species composition by season is depicted in **Figure 4-8**. Alewife comprised >92% of the catch in the spring and summer, while Lake Trout and Lake Whitefish dominated the fall catch. This seasonal shift in the dominant species captured is reflective of the migratory nature of Alewife, which make seasonal spawning migrations to the nearshore zone to spawn in the late spring. As detailed earlier, one Lake Sturgeon was caught and released during the deepwater fish community studies in the fall sampling event, marking the first observation of this species near PN in nearly two decades. Lake Sturgeon are generally uncommon in the main lake as they typically inhabit the cool, bottom waters of lakes and large streams, preferring sand and silt substrates (Holm et al., 2021). Of the nine sampling grids defined in the deepwater area for this study, S1 and S6 had the highest number of fish and species (8) collected during individual net sets across all three sampling events. In contrast, S3 had the fewest fish (49) and lowest species count (1) among sampling events.

To determine if and how deepwater fish communities varied through time or water depth, a set of generalized linear models (GLMs) were run for metrics of species richness, diversity, and abundance (CPUE and BPUE). Based on sample sizes, models could test the effects of season and depth but not their interaction (i.e., does the effect of season vary with depth). Additionally, since there was some imbalance in depth strata (overall: 8 at <14 m, 7 at 14–16 m, and 12 at >16 m depths), only the continuous measure of depth was used in the models.

Results of the GLMs are depicted in **Figure 4-9** and detailed in **Table B-4**. Based on the results, there was no influence from depth on any of the measured fish metrics, but, all metrics except for richness were significantly influenced by season. No differences were observed between spring and summer for diversity, or CPUE and BPUE considered for the entire fish community, or just small-bodied fish. However, when considering the entire fish community, the fall was found to have both significantly lower and significantly higher CPUE and BPUE, respectively, than both spring and summer. The higher CPUE observed in the spring and summer was driven primarily by the presence of Alewife in the area during those two seasons, which made up the majority of the catch. Conversely, significantly higher BPUE in the fall was driven by the higher proportions of large-bodied species, such as Lake Trout and Lake Whitefish, that were caught in the fall. These results were corroborated by the results when just considering small-bodied fish, which also showed significantly lower CPUE and BPUE in the fall relative to spring and summer.

Table 4-8: Standardized Fish Counts and Species Richness observed during the 2024 Deepwater Fish Community Study

Spring										
Grid	**2**	**3**	**3 Dup**	**4**	**4 Dup**	**5**	**7**	**8**	**9**	**Total**
Alewife	108.7	119	43	82.3	52.6	20.8	4.3	51.3	13.2	**495.1**
Lake Trout	0	0	0	0	0	1	3	3	5	**12**
Round Whitefish	0	0	0	1	0	0	0	0	0	**1**
Total	**108.7**	**119**	**43**	**83.3**	**52.6**	**21.8**	**7.3**	**54.3**	**18.2**	**508.1**
Species Richness	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**3**

Summer										
Grid	**1**	**1 Dup**	**2**	**4**	**5**	**6**	**6 Dup**	**7**	**8**	**Total**
Alewife	36.6	56	62	36	52.2	38	71.9	33	31.6	**417.3**
Brown Trout	1	0	0	0	0	0	0	0	0	**1**
Burbot	0	0	0	0	0	0	1	0	0	**1**
Lake Trout	0	0	0	0	0	0	0	0	2	**2**
Round Goby	1	1	3	0	0	0	2	0	0	**7**
Round Whitefish	0	0	0	0	1	0	0	0	0	**1**
White Sucker	0	0	0	0	0	0	3.3	0	0	**3.3**
Total	**38.6**	**57**	**65**	**36**	**53.2**	**38**	**78.2**	**33**	**33.6**	**432.7**
Richness	**3**	**2**	**2**	**1**	**2**	**1**	**4**	**1**	**2**	**7**

Fall										
Grid	**1**	**2**	**2 Dup**	**4**	**4 Dup**	**6**	**8**	**9**	**9 Dup**	**Total**
Lake Sturgeon	0	0	0	0	0	0	1	0	0	**1**
Lake Trout	0	4	6	5	0	15	16	17	1	**64**
Lake Whitefish	6	0	3	5	2	17	5	11	8	**57**
Rainbow Smelt	0	0	0	0	0	0	1	1	0	**2**
Rock Bass	0	0	1	0	0	3	0	0	0	**4**
Round Goby	0	0	0	0	0	5.3	0	0	0	**5.3**
Round Whitefish	0	2	0	2	0	0	2	1	0	**7**
Sea Lamprey	0	0	1	0	0	0	0	0	0	**1**
Walleye	0	1	0	0	0	1	0	0	0	**2**
Total	**6**	**7**	**11**	**12**	**2**	**41.3**	**25**	**30**	**9**	**148.3**
Richness	**1**	**3**	**4**	**3**	**1**	**5**	**5**	**4**	**2**	**9**

Note: Standardized fish counts are based on an extrapolated catch from the 15 m 1 ½" mesh panel to the standard 50 m length and therefore fish counts can result in partial numbers.

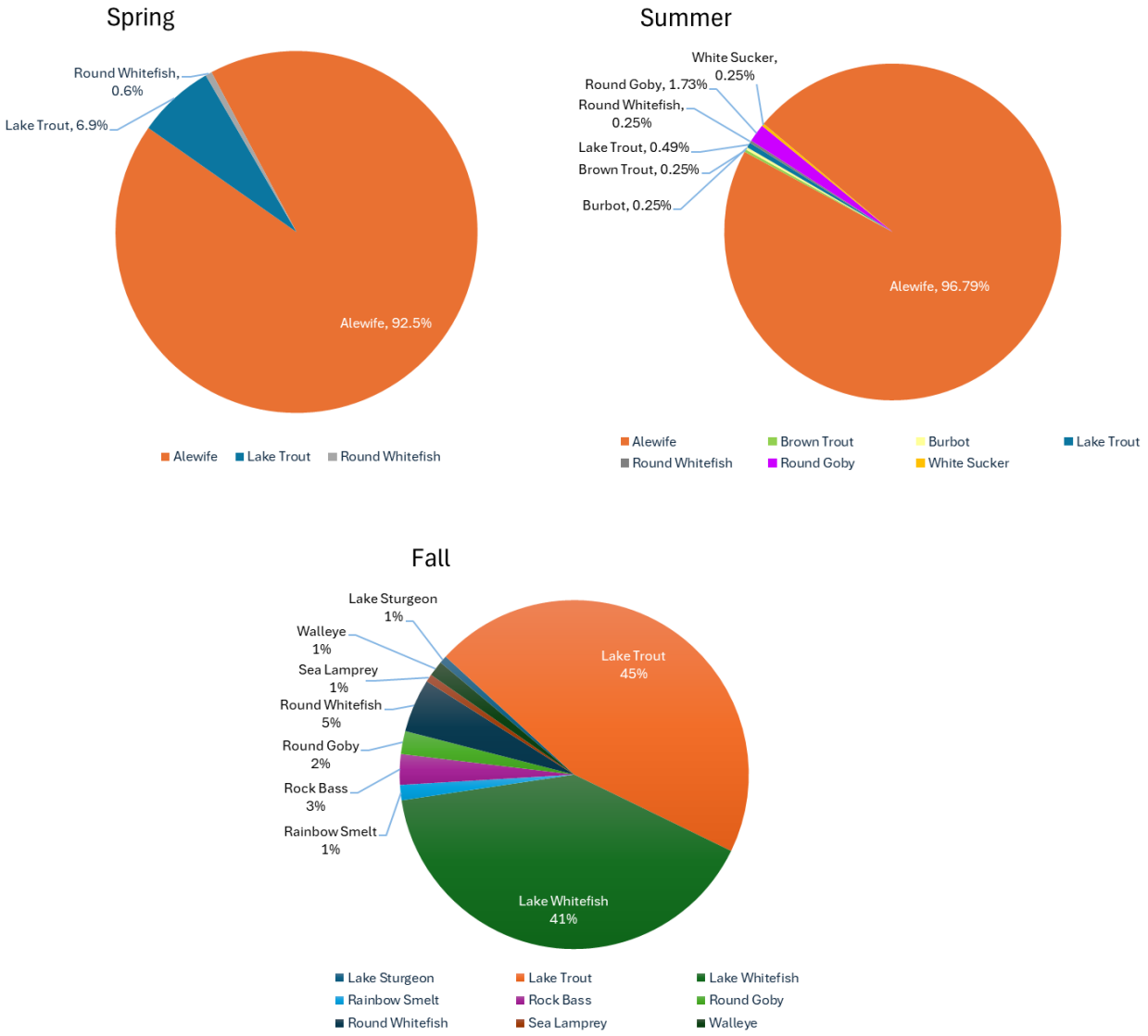


Figure 4-8: Fish Species Composition of fish caught in Monitoring Nets during the Spring, Summer, and Fall sampling events of the 2024 Deepwater Fish Community Study

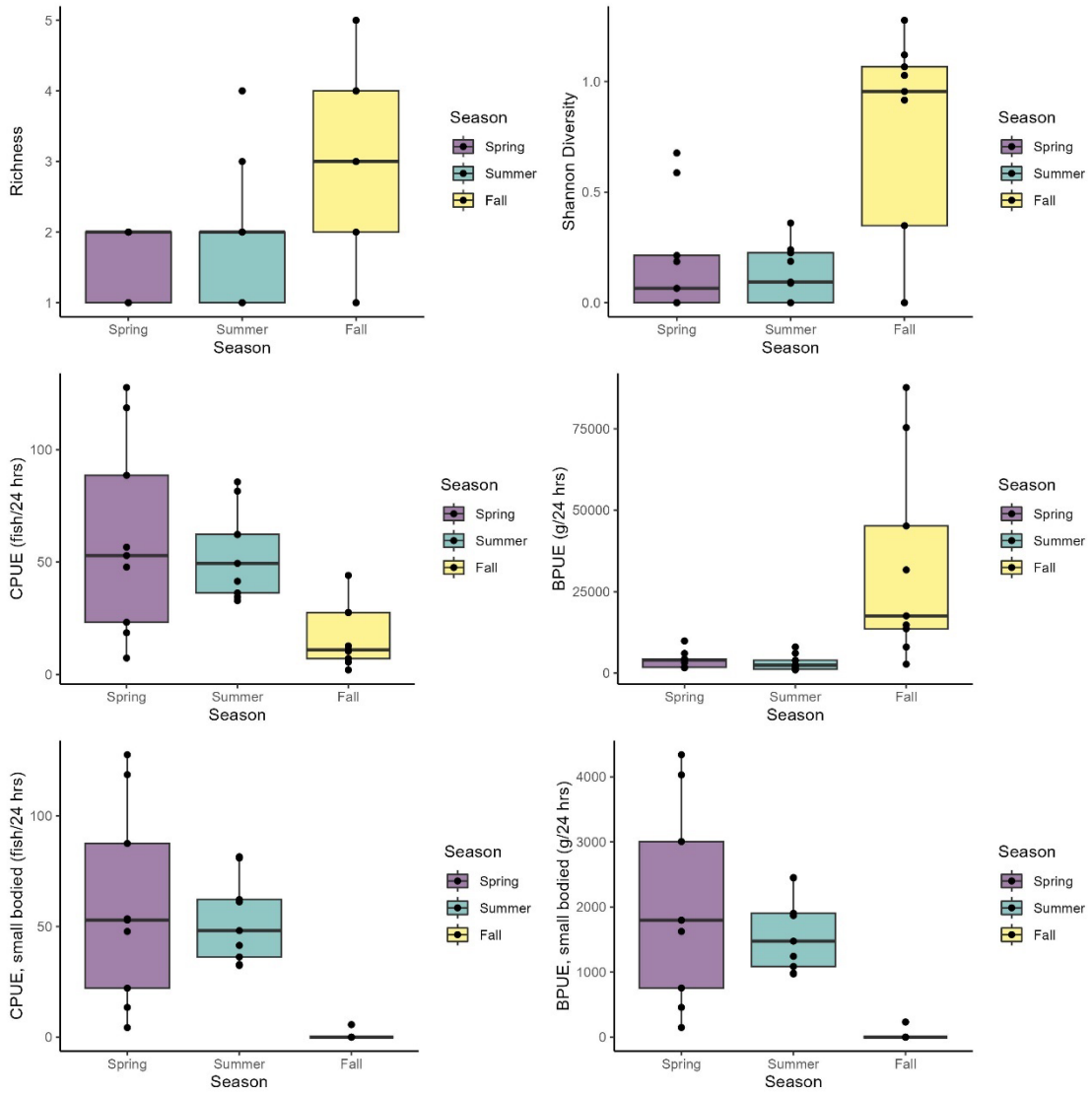


Figure 4-9: Boxplots and Raw Data (points) of Fish Endpoints Expressed by Season from the 2024 Deepwater Fish Community Study

Notes: CPUE – Catch-per-unit effort, BPUE – Biomass-per-unit effort. Boxplots are a common and useful when visually depicting variation of the raw data (black dots): the box spans the interquartile range (IQR; 25th percentile to 75th percentile), the horizontal line within the box is the median, the vertical lines extend outwards to the furthest datapoint within 1.5 x IQR, and any points outside of this vertical line are beyond 1.5 x IQR.

4.3.1.1.2 Nearshore Fish Community Study

For the nearshore fish community study, existing fish community data were collected in the proposed west infill and shoreline erosion mitigation areas during the spring, summer, and fall. Each sampling event employed two sets of MNRF small mesh broadscale monitoring (BSM) nets and one set of an experimental (EXP) long gillnet. These nets were deployed approximately perpendicular to shore, capturing depths from 0 to 3 m, depending on water depth at each location (**Figure 4-10**). Consistent with the Deepwater Fish Community Study, fish morphometrics were assessed for up to 30 individuals per species per season. Recorded parameters included weight (g), fork length (mm), total length (mm), sex (if identifiable), and general health indicators such as fin erosion, deformities, lamprey scars, and fin clips. Additionally, species composition, species richness, CPUE, and a morphometric summary were calculated.

Standardized fish counts (number of fish per net set) and species richness observed during the spring, summer, and fall sampling events are summarized in Table 4-9. Additional calculated parameters, including morphometric summaries from the BSM nets, morphometric summaries from EXP nets, as well as Catch Per Unit Effort (CPUE) are provided in **Table B-5**, **Table B-6**, and **Table B-7**, respectively. In the nearshore region, 574 fish from 20 different species were caught in the BSM and EXP nets across the spring, summer, and fall sampling events. Species composition in the spring, summer, and fall sampling events is depicted in **Figure 4-11**, **Figure 4-12**, **Figure 4-13**, respectively. Alewife and Round Goby consistently dominated the catch, accounting for >95% of the total catch in both the west infill and shoreline erosion mitigation areas in the spring and summer. Round Goby, an invasive benthic forage fish species, is abundant near the PN site and throughout Lake Ontario. Other species captured in the BSM nets included the Rainbow Trout, Brown Trout, and Atlantic Salmon, which like the Alewife, make seasonal spawning migrations into the nearshore zone. In the fall, species distributions varied more noticeably across the two net types and nearshore study areas. Round Goby continued to dominate the BSM net catch in both nearshore study areas; however, the shoreline erosion mitigation area exhibited greater species richness. Unlike the west infill area, fish captured here included benthic species such as Brown Bullhead, Yellow Perch, Logperch, Longnose Sucker, and Sculpin, all of which are common along the Lake Ontario shoreline. In the EXP nets, White Sucker and Walleye were commonly captured in the two nearshore areas.

Overall, the total number of fish caught across sampling events and net types was higher in the shoreline erosion mitigation area, Also, 7 unique species were caught in the shoreline erosion mitigation area, and 5 in the west infill area. However, these differences were not explained by species habitat preferences, foraging style and food habits. No species at risk were captured during the nearshore fish community sampling events.

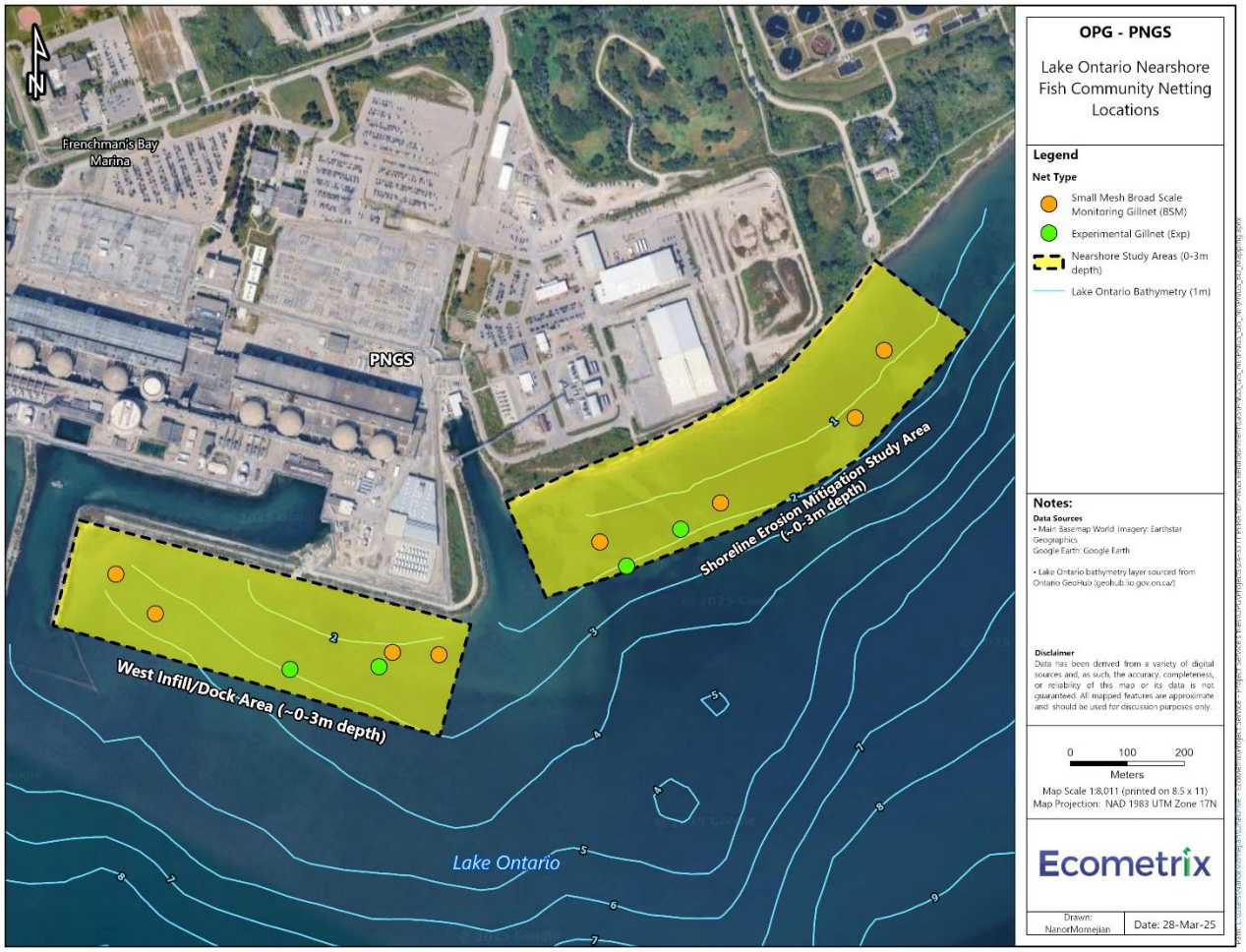


Figure 4-10: Sampling Area for the PNGS Nearshore Fish Community Study, 2024

Notes:
Net sets were set approximately perpendicular to shore at the sampling locations, resulting in sampling depth between 0-3 m depending on water depth. Sampling during each season consisted of two sets of the MNRF small mesh broadscale nets (12.5 m long, 1.8 m high) in each nearshore study area, and one set of the long gillnets (137 m, 1.8 m high, with 9 mesh panels 15.2 m long), resulting in 6 net sets per season.

Table 4-9: Fish Caught (count and %) and Species Richness in 2024 Nearshore Fish Community Study in Shoreline Erosion Mitigation Area and West Infill Area

Fish Species	EXP Nets				BSM Nets				Total
	Shoreline Erosion Mitigation Area		West Infill Area		Shoreline Erosion Mitigation Area		West Infill Area		
	Number	%	Number	%	Number	%	Number	%	
Spring									
Atlantic Salmon	-	-	2	2%	-	-	-	-	**2**
Alewife	2	33%	96	89%	8	17%	28	35%	**134**
Brown Trout	2	33%	-	-	-	-	-	-	**2**
Chinook Salmon	-	-	-	-	-		1	1%	**1**
Rainbow Trout	1	17%	1	1%	-	-	-	-	**2**
Round Goby	1	17%	9	8%	39	83%	49	62%	**98**
Threespine Stickleback	-	-	-	-	-	-	1	1%	**1**
Total Catch	**6**		**108**		**47**		**79**		**240**
Relative Total Catch	**2.5%**		**45.0%**		**19.6%**		**32.9%**		**100%**
Richness	**4**		**4**		**2**		**4**		**7**
Summer									
Alewife	48	81%	-	-	114	65%	20	48%	**182**
Brown Bullhead	-	-	-	-	1	1%	-	-	**1**
Coho Salmon	-	-	-	-	1	1%	-	-	**1**
Rock Bass	1	2%	-	-	-		-	-	**1**
Round Goby	10	17%	1	100%	59	34%	22	52%	**92**
Total Catch	**59**		**1**		**175**		**42**		**277**
Relative Total Catch	**21.3%**		**0.4%**		**63.2%**		**15.2%**		**100%**
Richness	**3**		**1**		**4**		**2**		**5**
Fall									
Alewife	-	-	-	-	3	11%	-	-	**3**
Brown Bullhead	-	-	2	18%	1	4%	-	-	**3**
Brown Trout	1	25%	-	-	-	-	-	-	**1**
Carp Sp	-	-	1	9%	-	-	-	-	**1**
Largemouth Bass	-	-	-	-	1	4%	-	-	**1**
Log Perch	-	-	-	-	1	4%	-	-	**1**
Longnose Sucker	1	25%	-	-	2	7%	-	-	**3**
Pumpkinseed	-	-	1	9%	-	-	-	-	**1**
Rainbow Trout	-	-	-	-	-	-	1	7%	**1**
Rock Bass	-	-	-	-	1	4%	1	7%	**2**
Round Goby	-	-	4	36%	15	54%	12	86%	**31**
Sculpin	-	-	-	-	3	11%	-	-	**3**
Walleye	1	25%	2	18%	-	-	-	-	**3**
White Sucker	1	25%	1	9%	-	-	-	-	**2**
Yellow Perch	-	-	-	-	1	4%	-	-	**1**

Fish Species	EXP Nets				BSM Nets				Total
	Shoreline Erosion Mitigation Area		West Infill Area		Shoreline Erosion Mitigation Area		West Infill Area		
	Number	%	Number	%	Number	%	Number	%	
Fall									
Total Catch	4		11		28		14		57
Relative Total Catch	7.0%		19.3%		49.1%		24.6%		100%
Richness	4		6		9		3		15

Notes: Total Indicates the total number of fish caught per area, per net type. Relative Total Catch indicates the proportion that the Total Catch makes up of the overall total for all areas and net types combined. Richness indicates the total number of taxa caught per area, per net type.

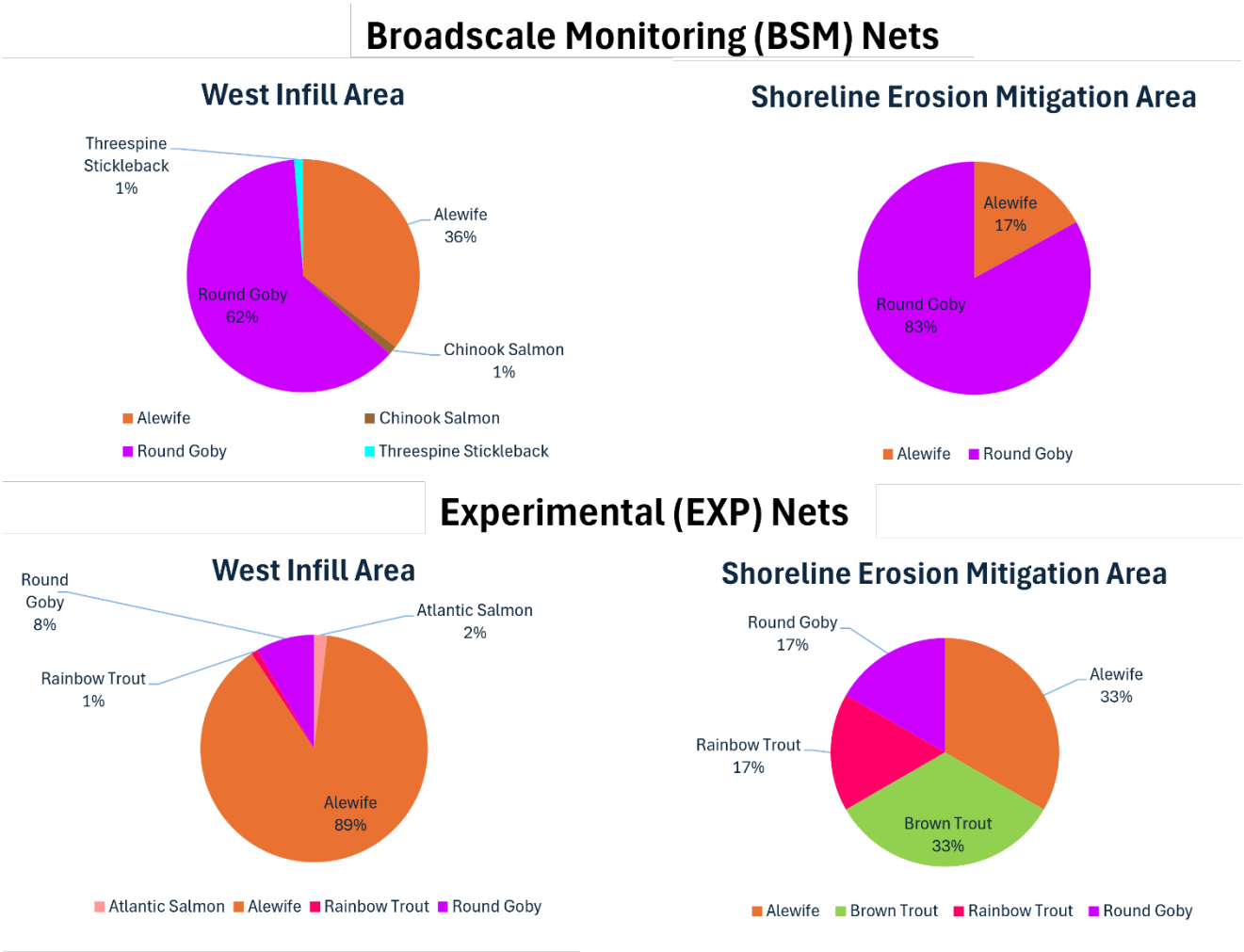


Figure 4-11: Fish Species Composition caught in Broad Scale Monitoring (BSM) and Experimental (EXP) Nets in Shoreline Erosion Mitigation Area and West Infill Area during the Spring sampling event of the 2024 Nearshore Fish Community Study

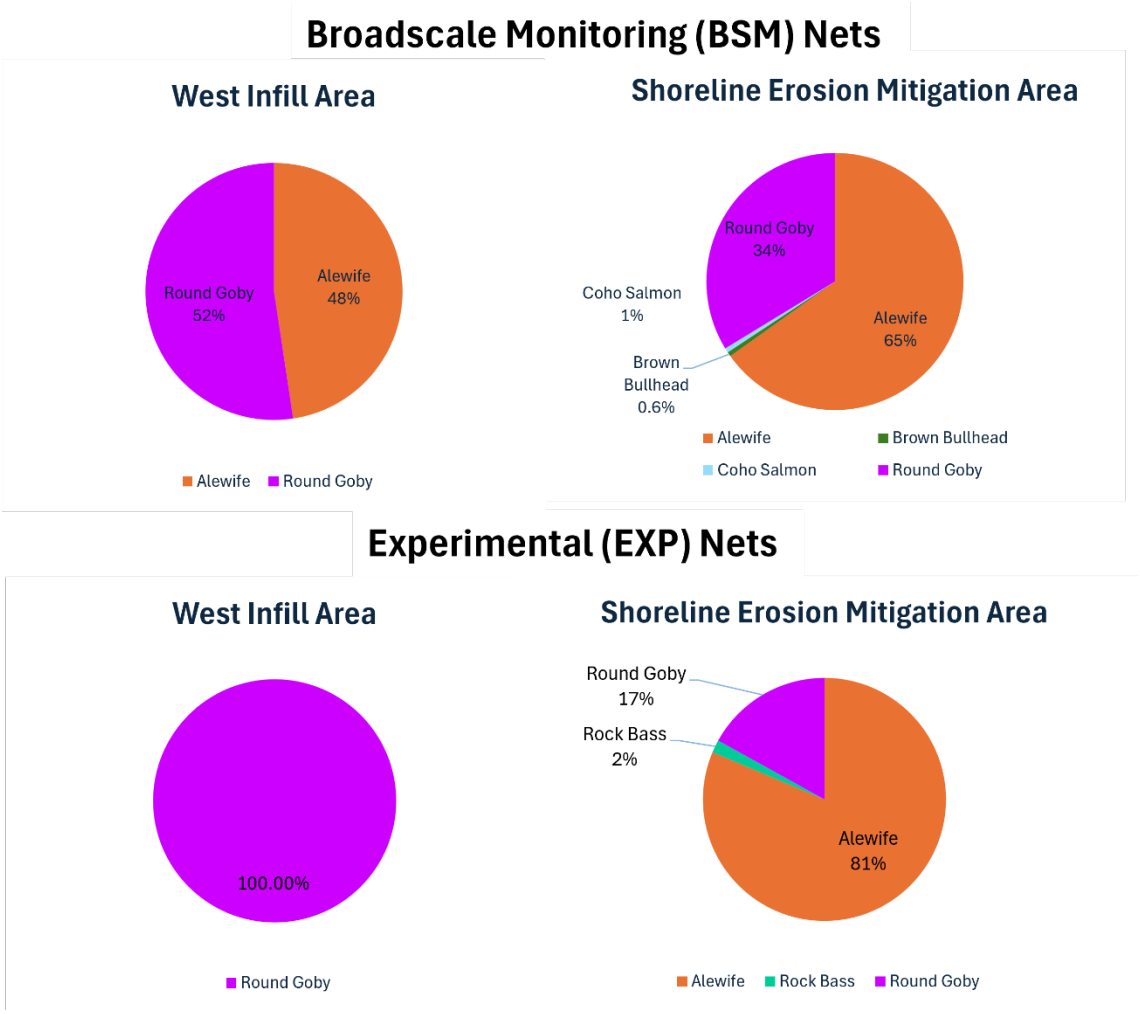


Figure 4-12: Fish Species Composition caught in Broad Scale Monitoring (BSM) and Experimental (EXP) Nets in the Shoreline Erosion Mitigation Area and West Infill Area during the Summer sampling event of the 2024 Nearshore Fish Community Study

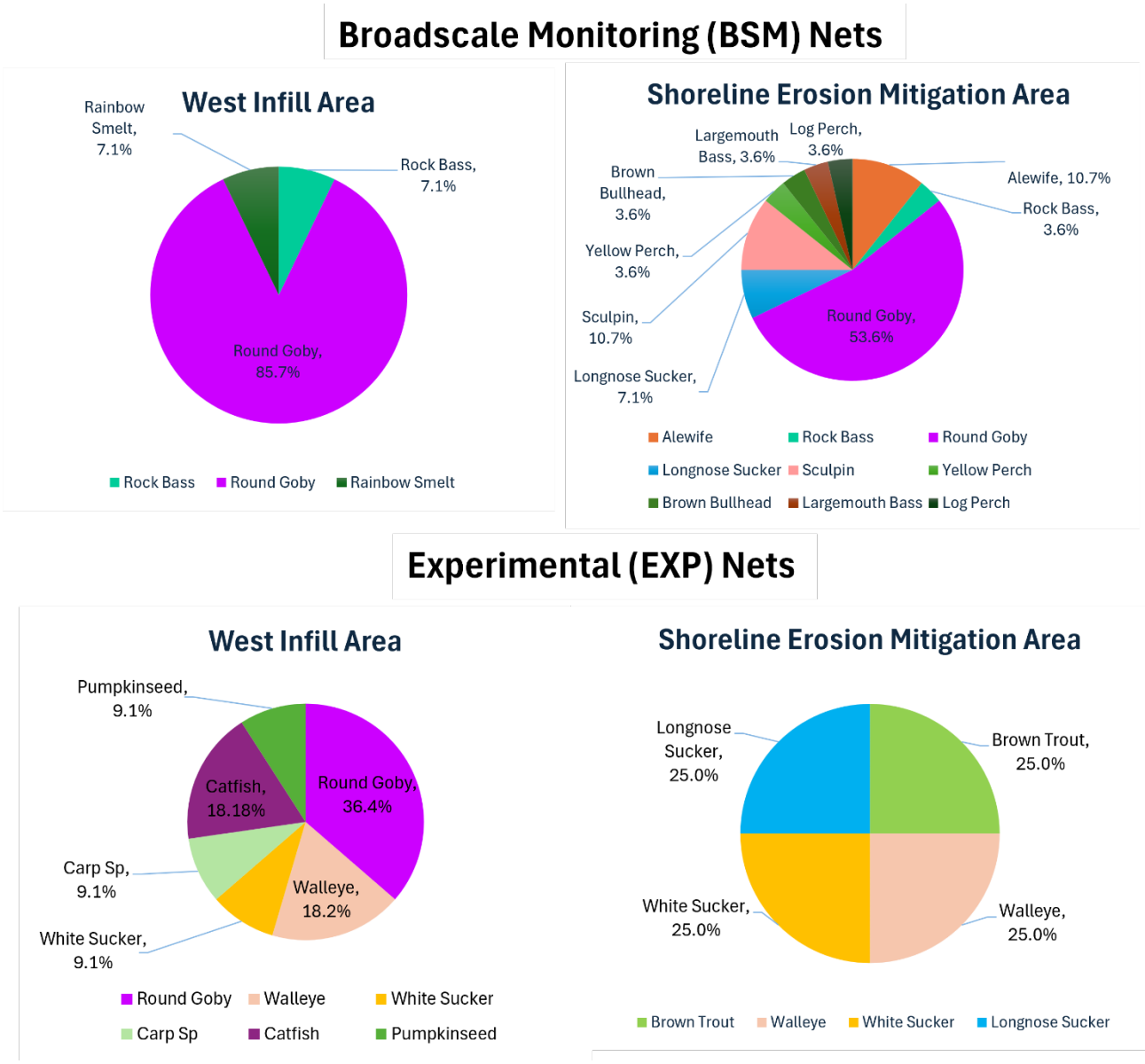


Figure 4-13: Fish Species Composition caught in Broad Scale Monitoring (BSM) and Experimental (EXP) Nets in the Shoreline Erosion Mitigation Area and West Infill Area during the Fall sampling event of the 2024 Nearshore Fish Community Study

4.3.1.2 Fish Tissue

As part of the annual EMP, White Sucker muscle tissue is analyzed for radionuclides (OPG, 2017b, 2018b, 2019d, 2020b, 2023b, 2023a, 2024d). As described in the 2023 EMP report (OPG, 2024d), the average HTO concentration in the tissue of fish from the PN outfall was 4.4 Bq/L, with no significant trend observed over the last decade. In contrast, C-14 levels in these fish averaged 283 Bq/kg-C, showing a small upward trend but remaining low. The majority of the gamma activity in fish from the PN outfall comes from naturally occurring potassium-40. This is followed by Cs-137, with an average concentration of 0.2 Bq/kg, which is consistent with data seen in the last 10 years. Cs-137 is typically present at low levels due to nuclear weapons testing in the early 1960s, and is not associated with reactor operations. Cs-134 and Co-60, which are indicative of reactor operations, were not detected in any fish samples over the last 10 years.

As part of the 2024 environmental sampling program, tissue samples from recreational species targeted and consumed by anglers and First Nations communities were collected during the fish community studies. Based on this, in the spring and fall, samples were collected from Alewife and Lake Trout caught in the planned DWI area (**Figure 4-7**), and Rainbow trout, Atlantic salmon, and Walleye caught in the nearshore regions (**Figure 4-10**). The tissues were analyzed for radionuclides and metals (**Table B-8**). Overall, there was a lot of variability in the concentrations of different parameters amongst the species, with no single species or location exhibiting a consistently higher affinity for metals or radionuclides compared to others. Mean tissue burdens of mercury, methylmercury, and selenium in each species were also compared to their respective guidelines. Mean concentrations of methylmercury in the tissue of Lake Trout and Walleye did exceed the CCME guideline for protection of wildlife consumers of aquatic biota (33 ng/g ww; CCME, 2000). Concentrations of selenium in the tissue of each species was well below the Federal Environmental Quality Guideline (FEQG; ECCC, 2022) for whole-body tissue burdens of selenium for the protection of fish i.e., 6.7 mg/kg dry weight (dw).

The average Cs-137 levels in nearshore and deepwater species are comparable with the past 10 years of data. Gamma spectrometry results are consistent with previous findings, with naturally occurring K-40 comprising most of the activity in fish from both areas (i.e. nearshore regions and deepwater intake areas), while Cs-134 and Co-60 values were below detection limits.

4.3.1.3 Thermal effects

Potential thermal effects of the PNGS thermal plume on fish near the station have been assessed across various studies considering species type (warm water vs coldwater), life stage (i.e. spawning, embryo, larval, juvenile or adult), and effect type (i.e. chronic or acute). The findings of these investigations are detailed extensively in the 2022 PN ERA. This section summarizes key results from these studies, and integrates the most recent temperature data to provide an updated characterization.

4.3.1.3.1 Thermal Plume Effects on Fish Eggs and Larvae

The potential effects of the thermal plume on the early life stages of 4 fish species were evaluated in the Aquatic Environment TSD for the EA for the refurbishment and continued operation of PNGS Units 5-8 (Golder, 2007a). The species assessed included two warm water fish species (Smallmouth Bass and Emerald Shiner) and two cold water species (Round Whitefish and Lake Trout) based on their abundance in the area, and sensitivity to thermal plume effects. A numerical model was used to delineate the thermal regime in various potential habitat areas within the receiving environment, incorporating seasonal and spatial variations in water temperature. The modelled water Maximum Weekly Average Temperatures (MWATs) within the plume were compared to species-specific Maximum Weekly Average Temperature (MWAT) criteria relevant to spawning and embryo-larval development. These criteria represent the upper bound of suitable temperatures for the biological processes under chronic exposure conditions.

In the timeframe relevant to the two warmwater species (April-May), only the discharge channels had modelled MWAT values marginally above MWAT criteria for embryo-larval development of Emerald Shiner. Given that this exceedance was limited to the discharge channels, it likely does not impact the population as a whole. In the winter period, relevant to the Lake Trout, modelled MWAT values above MWAT criteria were found in the discharge channels and at one lake location near the PNGS Units 5-8 discharge, both of which do not represent Lake Trout habitat. Therefore, it was concluded that temperatures in the thermal plume are unlikely to have adverse effects on fish embryo-larval development.

OPG continuously measures the temperatures within the discharge channels, providing data to assess the degree and frequency with which embryo-larval MWAT criteria are exceeded. In the 2022 PN ERA, the rolling 7-day average temperatures from the PNGS Units 5-8 discharge channels were calculated from the instantaneous daily maximum effluent temperatures between 2016-2020 (OPG, 2017c, 2018c, 2019e, 2020c, 2021e), and those exceeding MWAT criteria for the April-May embryo larval period for Smallmouth Bass (24.3°C) and Emerald Shiner (27°C) were counted. Over this 5 year period, there were no occurrences where the 7-day average exceeded MWAT criteria for Emerald Shiner, and only one occurrence for Smallmouth Bass. The results remained fairly consistent after incorporation of thermal data from 2021-2023 (OPG, 2022d, 2023f, 2024h) during which there were no exceedances of MWAT criteria for Emerald Shiner, and 4 exceedances for Smallmouth Bass. Additionally, the duration and degree of these exceedances remained consistent with previous years, with no exceedance persisting for more than 2 consecutive days in late May or exceeding 25.2°C. Thus, as concluded by the 2022 PN ERA, these exceedances are likely not detrimental to reproductive performance or embryo/larval development of these species because they occur infrequently, late in the embryo-larval life stages, and are localized to the discharge channel which spans a small area (0.0062 km^2).

In 2013, the potential effects of the PNGS thermal plume on fish spawning and embryo-larval development were qualitatively evaluated by comparing lake temperatures near the PNGS Units 5-8 discharge against the thermal criteria for these physiological processes of 15 species found in the vicinity of PN (Cooper, 2013). Lake temperatures in reference areas (Thickson Point and

Bonnie Brae Point, 20 km east and 26 km east of Pickering Nuclear, respectively) were also compared against these thermal criteria to provide context for natural temperature conditions. Besides MWAT criteria, this study also used Short-Term Daily Maximum (STDM) criteria, which represents upper bound temperatures considered suitable for short periods such as 24 hours. Hazard quotients (HQs) were calculated by taking the measured MWAT or STDM at each location, for the period relevant to each species, and dividing by the MWAT or STDM criterion. HQs are a useful "screening" methodology for thermal effects assessments, where a HQ equal to or greater than 1 indicates the potential for thermal effects.

Of the 15 species evaluated, nine were considered as Valued Ecosystem Components in the 2022 PN ERA. The HQ values relevant to spawning and embryo-larval development for the highest temperature location in the plume area were at least marginally above 1 for five of these species, indicating potential adverse effects from the thermal plume. However, in cases where the HQs were above 1 in the plume area, they were not substantially elevated relative to the reference area. The presence of HQ values above 1 in the reference area may not reflect potential effects in these areas, but rather suggest that some of the thermal criteria used were lower than background levels observed in the lake (possibly due to a general warming trend in the lake since the development of these criteria). Overall, these results indicated that there is no evidence of adverse chronic or acute impacts on fish reproduction and development caused by the thermal plume.

4.3.1.3.2 Thermal Increments and Embryo-larval Survival of Round Whitefish

The effects of the thermal plume on embryo survival of Round Whitefish was quantitatively evaluated in 2018 (OPG, 2018d). Round Whitefish were chosen for the study as these fish spawn nearshore on coarse substrate in late fall, with eggs hatching in early spring. The embryos of this species are also particularly sensitive to elevated water temperatures during the winter months, making them susceptible to elevated plume temperatures. Using temperature data from Round Whitefish spawning beds over the 2009-2010, 2010-2011 and 2011-2012 embryo-larval incubation periods (OPG, 2010, 2012b, 2013a), a thermal survival model was generated to estimate survival losses in Block 1 (i.e., the early incubation period) and Block 3 (i.e., the late incubation period). The estimated survival loss at the plume stations compared to the reference stations (Thickson Point and Bonnie Brae) was below the CNSC threshold no-effect level of 10% for Round Whitefish embryo survival loss in all years. Following this, data from two years of additional monitoring over the winters of 2018-2019 and 2019-2020 was also incorporated into the model (OPG, 2021f). Across both years, the largest relative survival loss observed was well below the 10% survival loss threshold. Therefore, no chronic adverse effects are expected from the thermal plume on Round Whitefish egg survival.

As mentioned by OPG (OPG, 2018b), acute threshold temperatures for Round Whitefish embryos are not available. Although not designed to develop an acute threshold, a study that continuously exposed Round Whitefish embryos to 7°C found no increases in acute mortality in either Block 1 or Block 3 (Griffiths, 1980). However, continuous exposure at 10°C did result in increased mortality in both developmental stages. The study also tested the impacts of

temperature cycles, where the embryos were exposed to 7°C for 18 hours and 10°C for 6 hours each day, which resulted in increased mortality in Block 1 (50% survival after 17 days) and Block 3 (16% survival after 30 days). Though there are limitations to interpreting these findings as the experimental thermal regimes do not necessarily reflect the behavior of the plume, it can be postulated that 50% mortality could occur between 7°C and 10°C provided that the exposure time is of sufficient duration. Accordingly, OPG has chosen a conservative value of 6°C for plume temperature above which acute temperature effects could occur. Though short-term exceedances of this temperature were found to occur between December 2018 and March 2019, they were not expected to have any effects on the Round Whitefish development as they were transient and occasional (OPG, 2020b).

4.3.1.3.3 Thermal Plume Effects on Juvenile and Adult Fish

As a part of the Aquatic Environment TSD for the EA for the refurbishment and continued operation of the PNGS Units 5-8 (Golder, 2007a), the potential effects of the thermal plume on juvenile and adult stages of the 4 species evaluated were also assessed. The modelled water MWATs did not exceed associated criteria for growth of juveniles and adults of Round Whitefish and Lake Trout at the time that they are present in the nearshore area (mid-November to early December for Round Whitefish and mid-November to April for Lake Trout). In contrast, the modelled water MWATs marginally exceeded (by less than 1°C) the criteria for Smallmouth Bass occasionally at one lake location near the PNGS Units 5-8 discharge over the period that these fish would potentially be exposed to the thermal plume. Given that these exceedances occurred only in the surface water and not in the deeper waters where the fish primarily reside, it is unlikely that they would be exposed to temperatures that would negatively impact growth.

As highlighted earlier, OPG continuously measures the temperatures in the discharge channels. The rolling 7-day average temperatures near the PNGS Units 5-8 discharge from 2016-2020 (OPG, 2017c, 2018c, 2019e, 2020c, 2021e) were compared to the MWAT criteria for Smallmouth Bass and Emerald Shiner. There were 18 occurrences between 2016 and 2020 when the 7-day average exceeded the 30°C MWAT criterion for Emerald Shiner, with an average duration of 16 days. Similarly, there were 15 occurrences when the 7-day average exceeded the 32°C MWAT criterion for Smallmouth Bass, with an average event duration of 10 days. The number of occurrences that exceeded the MWAT criteria for both species as well as the average duration of these exceedances were slightly higher between 2021-2023 (OPG, 2022d, 2023f, 2024h). Specifically, there were 10 exceedances of the Emerald Shiner MWAT criterion, with an average duration of 15.5 days. For Smallmouth Bass, there were 8 exceedances of the MWAT criterion, with the average event lasting 24 days. However, these exceedances are not considered detrimental for growth of Smallmouth Bass or Emerald Shiner because they are occasional and localized to the discharge channel. Additionally, unlike the embryonic and larval stages, juvenile and adult fish can use behavioural thermoregulatory strategies such as moving in and out of the discharge channel to optimize exposure to these temperatures.

As a part of the quantitative evaluation of the potential effects of the PNGS thermal plume on the 15 species found in the vicinity of PN, the effects on juvenile and adult growth were also

assessed (Cooper, 2013). As with the developmental stages, HQs were calculated by taking the measured water MWAT or STDM, for the seasonal period relevant to each species, and dividing by the MWAT or STDM criterion. Of the nine species considered as Valued Ecosystem Components in the 2022 PN ERA, the highest HQs were only marginally above 1 in the plume for Lake Trout. However, these values were less than or equal to the reference values. Therefore, it is unlikely that there are any chronic or acute effects arising from the thermal plume on juvenile or adult stages of any fish species.

4.3.1.3.4 Thermal Plume Contribution to Winter Cold Shock

Cold shock in fish can occur either due to natural changes in water temperature, or can be induced by a reduction in temperature when the number of operating units declines, or when fish pass through the thermal plume and encounter a high thermal gradient between plume and ambient conditions. For example, during an outage, thermal additions to receiving water can be rapidly curtailed, such that water temperature in the plume decline more rapidly than fish are able to acclimate to lower temperatures (Coutant, 1977). Unless induced by natural events, cold shock is likely to occur only during a full station outage, which occurs infrequently. However, OPG takes into consideration the effects of cold shock in the planning and scheduling of the shutdown of PNGS units and will incorporate appropriate mitigative measures if needed such that the rate of lowering water temperature is unlikely to result in any significant effects to fish. OPG is currently evaluating the potential for natural and operationally induced cold shock at PN and are in discussion with DFO on this topic.

4.3.1.3.5 Thermal stratification in Lake Ontario

During the 2024 Deepwater Fish community and Macrozooplankton community studies, temperature measurements were taken at 1 m increments throughout the water column before each net set and lift to characterize thermal stratification in the proposed DWI area.

Thermal profiles generated from data collected during all three sampling events (i.e., spring, summer, and fall) for the Deepwater Fish community are presented in **Figure 4-14**. In the spring, thermal stratification was beginning to develop. A mixed epilimnion layer generally occurred at 0 to 2 m, however the level of mixing was variable, with notable temperature differences present within this upper layer. Temperature variation within the metalimnion (2 to approximately 14 m) ranged from approximately 15.0°C to 7.5°C, however there was little evidence of a defined thermocline. The divide between the metalimnion and the hypolimnion was not clearly defined.

In the summer, thermal stratification patterns were variable due to high winds on one of the sampling days. Prior to the weather event (i.e., for samples collected in sampling matrices S1, S2, S5, and S6), a mixed epilimnion layer was present between approximately 0 to 2 m depth with a distinct thermocline present at approximately 3 m depth within the metalimnion. Temperature continued to decrease gradually within the metalimnion until approximately 10 to 12 m where the hypolimnion was observed. Following the weather event (i.e., for sampling matrices S7, S4, S8, S1 Dup, S6 Dup), temperature change throughout the water column was more constant with little distinction between the various layers.

Thermal stratification patterns observed during the fall sampling event were variable between late-October (i.e., for sampling matrices S2, S4, S6, S8, and S9) and late-November (i.e., for sampling matrices S1, S2 Dup, S4 Dup, S9 Dup). Though surface temperatures were similar between the two months, some stratification was observed in the November profiles with a distinct thermocline present at approximately 2 m depth. To the contrary, October profiles showed much weaker stratification.

The thermal profiles from the three sampling events for the Macrozooplankton community study are shown in **Figure 4-15**. In the spring sampling event, there was little evidence of a significant temperature stratification throughout the water column, with no mixing observed within the upper layers. Temperature was quite variable between 0-2 m depth, ranging from 14.5° - 10.6°C, followed by a more gradual temperature change within the remainder of the metalimnion (2-14 m). The hypolimnion was observed at depths below 14 m at temperatures in the range of 9.3°C to 9.5°C.

In the summer, there was no mixing observed within the upper layer of the water column, instead a high degree of temperature change was observed between 0 to 2 m depth. Within the remainder of the metalimnion (2-18 m) a well mixed layer was present from approximately 2 to 13 m depth, followed by a distinct deepwater thermocline observed from approximately 13 to 14 m (18 m at deepest locations). The hypolimnion was observed at depths of approximately 18 m.

In the fall, there was no evidence of temperature stratification throughout the water column, with no mixing observed within the upper layers. Temperature was quite variable between 0-3 m depth. This was by a more gradual temperature change within the remainder of the metalimnion (3-14 m) from 11.2°C to 10.5°C. The followed hypolimnion was observed at depths below 14 m.

Across all three seasons in both studies, the temperature at depths of 10.5-12 m (the proposed range for the planned DWI, with the exact depth to be determined) is 3-5°C lower than surface temperatures. The implications of the change in the temperature of water being drawn in through the intake on the thermal plume, and potential effects on aquatic biota are further evaluated in **Section 5.3.3.1.2**.

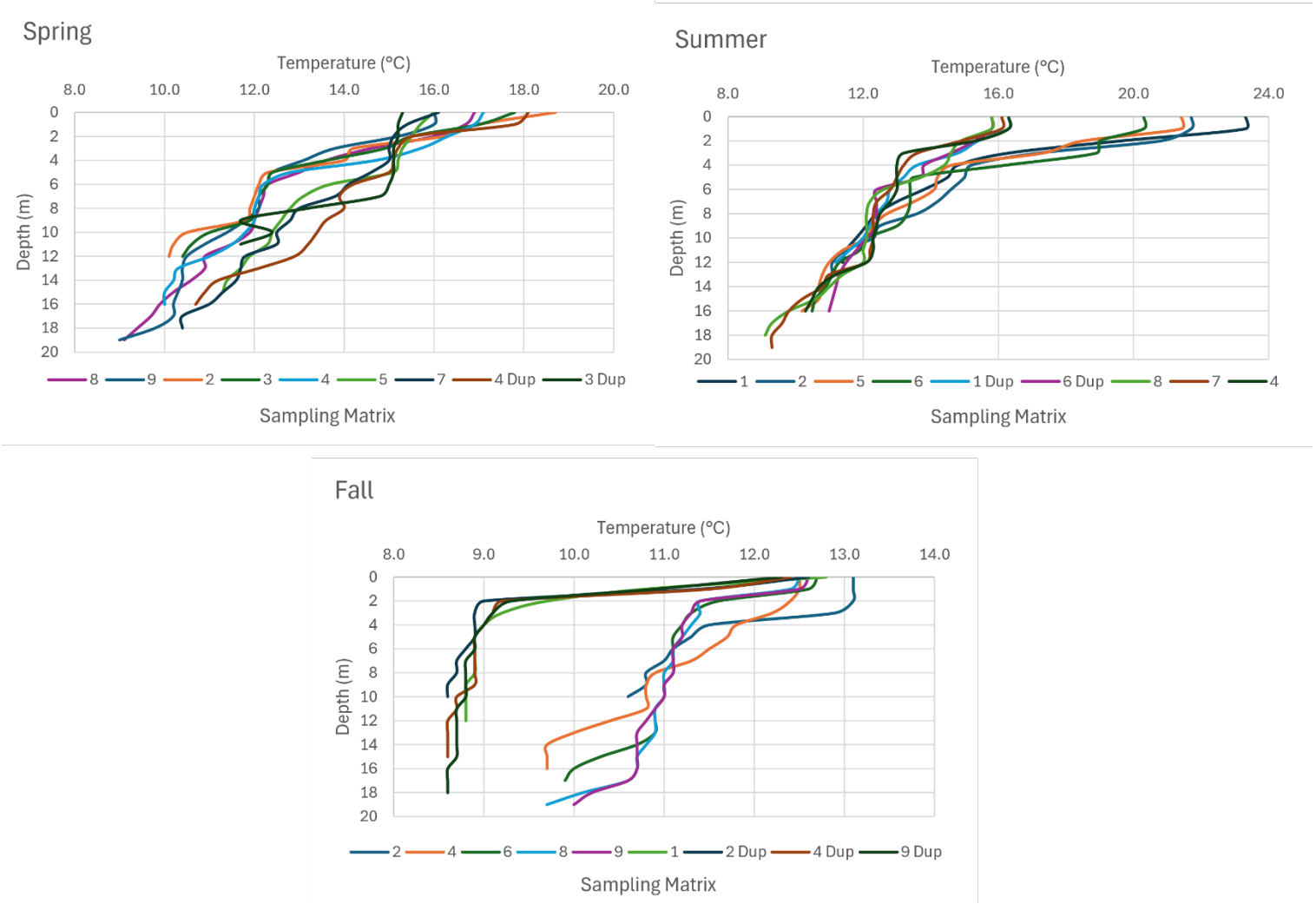


Figure 4-14: Water Temperature Profiles across the three Deepwater Fish community sampling events in 2024

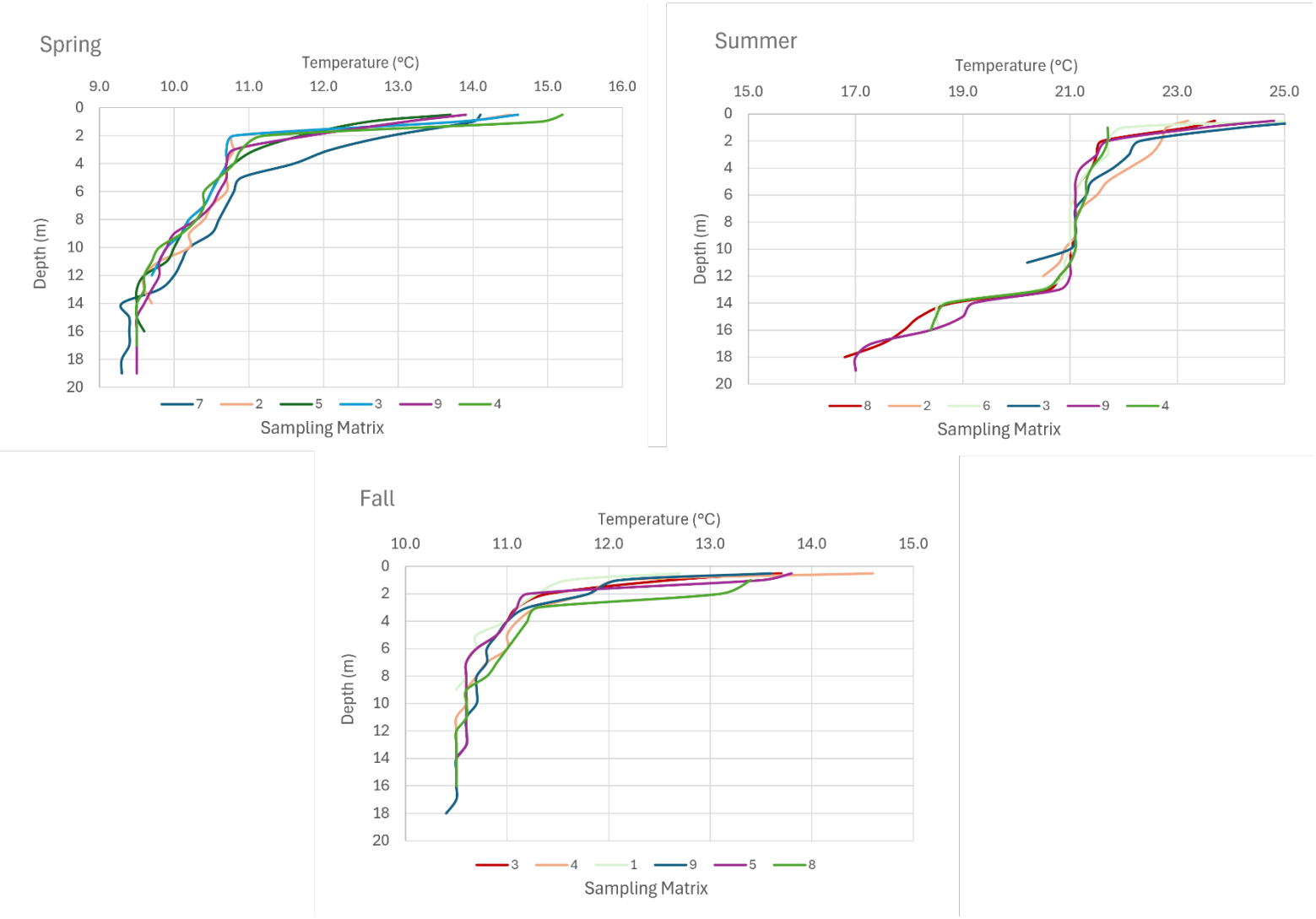


Figure 4-15: Water Temperature Profiles across the three Macrozooplankton Community sampling events in 2024

4.3.1.4 Entrainment and Impingement

In 2009, in response to an order by the CNSC to reduce impingement by 80%, OPG installed a fish diversion barrier net, which has demonstrated effectiveness in reducing fish impingement at PNGS (Patrick et al. 2014). A Fisheries Act Authorization (FAA) for PNGS operational activities was issued to OPG by DFO in 2018, requiring OPG to submit an annual impingement monitoring report to the DFO. The authorization also stipulates that consultation is required if the combined biomass of all species and ages impinged exceeds 3,619 kg/yr for two consecutive years (OPG, 2021d). In 2016, biomass lost to impingement was 88% lower than the levels recorded prior to the installation of the FDS. Exceedances of the two-year threshold were found in 2018-2019, prompting notification to DFO. However, these exceedances were likely not caused by PNGS operation but rather a cold shock event. Low temperature stress (cold shock/stress) is an often-overlooked challenge that many fish face as a result of both natural events and anthropogenic activities (Reid et al. 2022). The high impingement rate in 2018-2019 was primarily attributed to a polar vortex in January which caused water temperatures to plunge below 2°C and led to the formation of frazzle ice in the intake forebay. Primarily, Gizzard Shad were impinged during this period, and this species is known to be susceptible to "cold shock" at or below 2°C (Patrick, 2020). From 2020 to 2022, impingement estimates were below the threshold (OPG, 2021c, 2022c, 2023d). Alewife, Gizzard Shad, and Common Carp were the most commonly impinged species, consistent with prior years.

The CNSC also mandated OPG to reduce entrainment by 60% (OPG, 2012c). There is no feasible retrofit solution to achieve this; however, the proposed offshore intake location and further mitigation measures (described in **Section 5.3.2.1.2**) should reduce fish entrainment. Estimated ichthyoplankton entrainment losses at PNGS between 1975 and 2006 were summarized by (OPG, 2012d). During the most recent entrainment monitoring study at PNGS (undertaken in 2006), Alewife, Common Carp, and Freshwater Drum eggs and larvae; and Round Goby larvae were reported. All the species are invasive to Lake Ontario, with exception of Freshwater Drum (Morrison, 2019). It is acknowledged that Alewife and Common Carp entered Lake Ontario many decades ago and have since naturalized. Round Goby, however, remain a Regulated Species, and are excluded from the 2018 FAA value for the PNGS.

An updated entrainment monitoring program was initiated in October 2024 to meet Condition 3.2.3 of the 2018 FAA. The objective of the program was to quantify the impact of entrainment at PNGS with the existing shoreline intake. The 12-month program adheres to the guidelines recommended by Electric Power Research Institute (EPRI) (EPRI, 2014) and CSA for entrainment sampling at nuclear facilities in Canada including DNGS (CSA, 2018, 2024, Patrick et al. 2021). The program is comprised of 60 sampling events with both daytime and nighttime collections conducted in a 24-hour period once a week from October 2024 to April 2025. From April to August 2025, sampling will occur twice weekly from April to August 2025 to target peak entrainment periods identified from previous studies (Golder, 2005, 2007a). Entrained eggs, larvae, and fish are identified to the lowest practical taxonomic level using taxonomic keys and/or genetic barcoding. As part of the entrainment program, benthic sled surveys will be conducted in Summer 2025 to identify larval fish and eggs in the DWI area, along with vertical

tows to assess other entrainable organisms throughout the water column. Losses from entrainment are currently being offset by measures approved in the FAA. These measures include allocation of a portion of the OPG Big Island Wetland habitat bank, stocking of Atlantic Salmon in Duffins Creek, and the construction and monitoring of the Simcoe Point Wetland.

4.3.2 Benthic Macroinvertebrates

As highlighted in the 2022 PN ERA, the benthic community along Lake Ontario's north shore reflects the severe conditions of an exposed coast, and is dominated by oligochaetes and chironomids (Golder, 2007a). These taxa had higher abundances at sites within or close to the PNGS Units 1-4 thermal plume than at reference sites. Additionally, species diversity at depths of 6–10 m was lower in the plume than at reference sites. Historically, gastropods and bivalves were scarce in the nearshore due to wave abrasion and/or unsuitable substrates, but invasive species such as zebra mussels and quagga mussels have colonized these areas in the last few decades (Golder, 2007a). The aquatic macroinvertebrate communities in wetlands near PNGS were studied as part of a wetland monitoring project from 2002 to 2007 (EC, 2009a). The study used Indices of Biological Integrity (IBI) to assess and compare wetland conditions. The IBI values for macroinvertebrate communities were derived using measures of species richness and relative abundance. Durham Region's aquatic macroinvertebrate communities in wetlands were in poorer condition compared to some other Lake Ontario wetlands. Around the PN site in particular, aquatic macroinvertebrate communities at the Hydro Marsh, Frenchman's Bay and Duffins Creek Marsh were rated "poor", ''fair", and "good" respectively (EC, 2009b).

To obtain an updated characterization of the benthic macroinvertebrate community near the proposed DWI location and the nearshore study areas for this PERA, benthic samples were collected as part of the 2024 aquatic studies. Benthic macroinvertebrates were collected using standard ponar grab in the same study area used for the Deepwater Fish Community survey (**Figure 4-7**) with samples collected from grids S4, S7, S8, and S9 at depths of 17-19 m. Similarly, samples were collected from 10 stations in the nearshore areas, with the stations presented in **Figure 4-6**. Benthic macroinvertebrate Lowest Practical Level (LPL) densities at all stations are provided in **Table B-9**. Various metrics, including total invertebrate density, taxonomic richness, Simpson's Evenness, Simpson's Diversity, and relative density that were computed using the samples to provide a comprehensive assessment of the community's structure and diversity are discussed below.

4.3.2.1 Proposed DWI Area

Calculated benthic macroinvertebrate metrics are presented in **Table 4-10** for deepwater samples. Density ranged from 2,462 (S9) to 7,552 (S8) organisms/m^2. LPL richness ranged from 13 taxa in S8 to 21 taxa in S9. All stations had relatively diverse communities, with Simpson's Diversity values ranging from 0.59 in S9 to 0.84 in S4 indicating a variety of species present at all stations. The communities were not very evenly distributed with Simpson's Evenness values ranging from 0.12 at S9 to 0.45 at S4. These low evenness values are likely due to the high

proportion of crustaceans, specifically copepods belonging to Order Harpacticoida, found at each sampling station.

Communities in S9, S8, and S7 were dominated by copepods such as O. Harpacticoida, followed by worms from Phylum Nemata for S9, and Oligochaetes for S8 and S7. S4 was dominated by Oligochaetes, closely followed by O. Harpacticoida.

All Cl. Bivalvia organisms were *Dreissena bugensis*, otherwise knowns as the Quagga mussel. This invasive dreissenid mussel species was observed in three of the four deepwater samples, but only made up 4.8 to 12.8% of the overall community composition in the samples it was observed. As noted, sampling with a ponar targets finer sediments whereas mussels tend to prefer attachment to hard substrates. Consequently, the numbers of mussels noted in the samples collected are not likely reflective of the overall presence of mussels in the entirety of the deepwater study area. Sampling of the deepwater area with the benthic sled in 2025 will help provide a more complete indication of the benthic community the variety of mixed substrate habitats present.

Therefore, the deepwater benthic community was predominantly composed of O. Harpaticoida, P. Nemata, Cl. Oligochaeta, and O. Diptera (primarily Chironomidae), consistent with findings from previous studies in the area (Golder, 2007a).

Table 4-10: Benthic Macroinvertebrate Community Metrics in Samples collected from Deepwater Area, 2024

Station		SED-1	SED-2	SED-3	SED-4
Grid		S9	S8	S7	S4
Density (organisms/m^2)[a]		2,462	7,552	2,921	3,623
Richness (LPL)		21	13	18	14
Simpson's Diversity[b]		0.59	0.76	0.73	0.84
Simpson's Evenness[c]		0.12	0.33	0.21	0.45
Major Taxonomic Group (% Composition)	P. Nemata	13.99	8.78	13.97	4.23
	Cl. Oligochaeta	3.63	16.22	17.90	46.48
	Cl. Arachnida	2.33	4.05	0.44	0.70
	O. Harpacticoida	61.92	42.57	47.16	28.17
	Cl. Ostracoda	3.89	9.46	0.44	8.45
	Cl. Entognatha	0.00	0.00	0.44	0.00
	O. Diptera	7.77	6.08	14.85	11.97
	Cl. Gastropoda	0.52	0.00	0.00	0.00
	Cl. Bivalvia	5.96	12.84	4.80	0.00
Major Taxonomic Group (Density, organisms/m^2)	P. Nemata	344.45	663.38	408.23	153.09
	Cl. Oligochaeta	89.30	1224.69	523.05	1683.95
	Cl. Arachnida	57.41	306.17	12.76	25.51
	O. Harpacticoida	1524.49	3214.82	1377.78	1020.58
	Cl. Ostracoda	95.68	714.40	12.76	306.17
	Cl. Entognatha	0.00	0.00	12.76	0.00
	O. Diptera	191.36	459.26	433.75	433.75
	Cl. Gastropoda	12.76	0.00	0.00	0.00
	Cl. Bivalvia	146.71	969.55	140.33	0.00

Notes:
P. = Phylum, Cl. = Class, O. = Order
LPL = Lowest Practical Level
a - Total invertebrate density was determined as the total number of individuals of all taxonomic categories collected at a station expressed per unit area (numbers/m^2).
b - Simpson's Diversity is a measure of the diversity of a biological community. It considers both species richness (the number of different species present) and species evenness (the relative abundance of each species). Calculated at the LPL.
c - Simpson's Evenness is an expression of how equitably taxa are represented within a given sample. Evenness ranges from zero to one (one representing a sample in which all taxa have the same abundance. Calculated at the LPL.

4.3.2.2 Proposed Shoreline Erosion Mitigation and West Infill areas

Calculated benthic macroinvertebrate metrics for the ten stations sampled in the nearshore areas are presented in **Table 4-11**. Densities in these samples ranged from 19 (Infill-8) to 1,990 organisms/m^2 (Infill-1). LPL richness ranged from 2 (Infill-5) to 20 (Infill-9). Most stations had medium to high species diversity with Simpson's Diversity values greater than 0.50, apart from stations 1 (0.41), 2 (0.45), 4 (0.37), and 5 (0.49). Excluding those stations, Diversity values ranged from 0.67 to 0.91. Evenness was varied among stations, with some stations having low Simpson's Evenness values, such as station 1 (0.17) and station 4 (0.18), and some stations having very high evenness values, such as station 5 (0.97), 6 (0.84) and 8 (1.00).

Sampling stations 1, 2 and 4 had very high proportions of Oligochaetes, while stations 3 and 10 were dominated by Bivalves. Station 5's community was close to even with only two taxa present, Arachnids and Ostracods. Stations 6, 7, and 9 were dominated by Dipterans, mostly consisting of Chironomids. Station 8 only had 3 taxa present which were completely evenly distributed, consisting of Cl. Arachnida, O. Diptera, and Cl. Bivalvia.

Dreissenid mussel made up the entirety of the Cl. Bivalvia organisms identified. Only Quagga mussels were able to be identified to species level, whereas the rest of the dreissenids were identified as immature and could include both Quagga and Zebra mussel species. Dreissenids made up a higher proportion of the benthic invertebrate communities in the Infill stations compared to the deepwater stations with proportions ranging from 0.56% to 50%. This finding is supported by the aquatic habitat assessments conducted in 2024 (detailed in **Section 4.3.4**), where dreissenid mussel coverage was estimated in the nearshore region to evaluate habitat quality and quantity before the construction of shoreline erosion mitigation and west infill areas. Sparse (<25% coverage) to moderate (25–75% coverage) dreissenid mussel densities were observed in areas with larger substrate materials.

Therefore, the composition of the nearshore benthic community is consistent with previous studies in the area and reflects the habitat characteristics and severe conditions of the exposed coatline (Golder, 2007a).

Table 4-11: Benthic Macroinvertebrate Community Metrics in Samples Collected from Nearshore study areas, 2024

Station		1	2	3	4	5	6	7	8	9	10
Density (organisms/m^2)		1,990	1,129	1,301	491	38	153	249	19	549	179
Richness (LPL)		10	7	12	9	2	6	10	3	20	7
Simpson's Diversity		0.41	0.45	0.76	0.37	0.49	0.80	0.81	0.67	0.91	0.75
Simpson's Evenness		0.17	0.26	0.35	0.18	0.97	0.84	0.53	1.00	0.55	0.57
Major Taxonomic Group (% Composition)	P. Nemata	1.92	0.56	3.92	3.90	0.00	0.00	5.13	0.00	13.95	3.57
	Cl. Oligochaeta	92.95	96.61	31.37	84.42	0.00	12.50	23.08	0.00	38.37	3.57
	Cl. Arachnida	0.00	0.56	0.00	0.00	58.33	8.33	2.56	33.33	2.33	35.71
	Cl. Ostracoda	0.00	0.00	7.84	2.60	41.67	0.00	0.00	0.00	0.00	0.00
	O. Amphipoda	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00	0.00	0.00
	Cl. Entognatha	0.00	0.00	0.00	0.00	0.00	0.00	2.56	0.00	0.00	0.00
	O. Diptera	3.21	1.69	9.80	6.49	0.00	50.00	53.85	33.33	38.37	7.14
	Cl. Bivalvia	1.92	0.56	47.06	1.30	0.00	29.17	12.82	33.33	6.98	50.00
Major Taxonomic Group (Density, organisms/m^2)	P. Nemata	38.27	6.38	51.03	19.14	0.00	0.00	12.76	0.00	76.54	6.38
	Cl. Oligochaeta	1849.80	1090.74	408.23	414.61	0.00	19.14	57.41	0.00	210.49	6.38
	Cl. Arachnida	0.00	6.38	0.00	0.00	22.33	12.76	6.38	6.38	12.76	63.79
	Cl. Ostracoda	0.00	0.00	102.06	12.76	15.95	0.00	0.00	0.00	0.00	0.00
	O. Amphipoda	0.00	0.00	0.00	6.38	0.00	0.00	0.00	0.00	0.00	0.00
	Cl. Entognatha	0.00	0.00	0.00	0.00	0.00	0.00	6.38	0.00	0.00	0.00
	O. Diptera	63.79	19.14	127.57	31.89	0.00	76.54	133.95	6.38	210.49	12.76
	Cl. Bivalvia	38.27	6.38	612.35	6.38	0.00	44.65	31.89	6.38	38.27	89.30

Notes:
P. = Phylum, Cl. = Class, O. = Order
LPL = Lowest Practical Level
a - Total invertebrate density was determined as the total number of individuals of all taxonomic categories collected at a station expressed per unit area (numbers/m^2).
b - Simpson's Diversity is a measure of the diversity of a biological community. It considers both species richness (the number of different species present) and species evenness (the relative abundance of each species). Calculated at the LPL.
c - Simpson's Evenness is an expression of how equitably taxa are represented within a given sample. Evenness ranges from zero to one (one representing a sample in which all taxa have the same abundance. Calculated at the LPL.

4.3.3 Plankton Communities

As discussed in the 2022 PN ERA, plankton communities in Lake Ontario near the PN site have undergone significant changes over the past 30 years due to factors unrelated to PNGS operations (EC, 1998; Ecometrix, 2023a). Since the 1970s, phytoplankton biomass has declined considerably, presumably due to phosphorus reduction programs and the colonization of zebra mussels. Similarly, an overall decrease in algal density has been observed (Winter et al., 2012), with diatoms currently dominating the community. Zooplankton community composition has remained stable since the 1960s, and is primarily comprised of the cladocerans *Bosmina* and *Daphnia* (Barbiero et al., 2001; Barbiero and Tuchman, 2001; Lampman and Makarewicz, 1999).

As a part of the macrozooplankton community study conducted in 2024 plankton tow nets were used to collect macroinvertebrate samples from the proposed DWI area depicted in **Figure 4-7** to get an updated characterization of the existing free-floating invertebrate community in the area and identify potentially entrainable organisms (besides ichthyoplankton). The sampling program comprised of a spring, summer, and fall event, with six locations sampled per event. These six locations comprised three depth strata (12-14, 14-16 and 16-18 m), with two locations sampled at each.

Proportions of major macrozooplankton groups in samples from the spring, summer, and fall sampling events are presented in **Table 4-12**. A detailed composition of the macrozooplankton community in each sample is provided in **Table B-10**. Of the major groups identified, Cladocera were the most abundant in the spring and summer samples (>82% of total community composition), which is consistent with the findings previous studies of zooplankton communities in the area (EC, 1998; Barbiero et al., 2001). This was followed by Calanoida, and Cyclopoida. Mysida were the least abundant group in the spring (<1% of total composition) and were not recorded in any of the summer samples. Unlike spring and summer, Calanoida made up the majority of the community in the five out of six samples (56-79% of total community composition) in the fall. The most common cladoceran species in the samples included *Daphnia sp*., *Leptodora sp. Bythotrephes* sp., and *Cercopagis sp*., and the most common calanoidan species included *Skistodiaptomus sp., Leptodiaptomus sicilis* and *Epischura sp*.

A summary of parameters such as density (no. of organisms/L), BPUE, family-level taxa richness, and Simpson's Diversity from the samples collected in the spring, summer, and fall are presented in **Table 4-13, Table 4-14**, **Table 4-15**, respectively. During the summer sampling program, algal mats were present that were inhabited by three species of Cladocera (*Bythotrephes sp., Cercopagis sp., and Leptodora sp.*), which significantly influenced the abundance and biomass of the samples collected. As such, density, biomass per unit effort, and Simpson's Diversity are presented both with and without organisms found in algae in **Table 4-14**. To determine if and how the macrozooplankton community varied through time (i.e., season) or by depth within the study area, metrics of richness (lowest-practical-level, or LPL, and family-level), diversity (family-level), and abundance (Density in #/L and Biomass in mg/L) were compared using Generalized Linear Models (GLMs). Results are detailed in **Table B-11**, and presented in **Figure 4-16**.

Results indicated that, excluding organisms associated with algae, there was no influence from depth on macrozooplankton community metrics; however, all metrics were significantly influenced by season. Specifically, LPL richness was significantly different across all three sampling seasons, and was highest in the summer and lowest in the fall. For family richness, no difference was observed between spring and summer, and both seasons were had significantly greater richness than observed in fall. Although density was significantly influenced by seasonal effects and fall had the highest mean density observed, between season comparisons did not show any differences due to high variability between the replicates. Finally, diversity at the family level was significantly highest in the summer, and no difference was observed between spring and fall. The seasonal differences in diversity and richness indicate fluctuations in communities in the DWI area throughout the year, potentially due to seasonal variability in the timing of various zooplankton species peaks as well as the influence of lake currents, which are known to affect macrozooplankton distribution. When consideration of organisms associated with algae was given, similar significant seasonal effects were observed in density, biomass, and diversity; however, diversity was also significantly influenced by depth, whereby the metric increased 0.034 at every 1 m depth interval.

The seasonal differences in diversity and richness indicate fluctuations in communities in the deepwater area throughout the year, potentially due to seasonal variability in the timing of various zooplankton species peaks. In addition, lake currents, which are known to affect macrozooplankton distribution, can have a significant influence on species distributions. When consideration of organisms associated with algae was given, similar significant seasonal effects were observed in density, biomass, and diversity; however, diversity was also significantly influenced by depth. This increase in diversity at depth was driven by the presence of three additional species, and this effect was only apparent though in the summer when algal mats were observed.

Overall, the macrozooplankton community went through seasonal changes as expected, but did not appear to be influenced by depth when algal mats were not present. This would imply that the placement of the deepwater intake does not need to take depth into consideration with regard to macrozooplankton communities.

Table 4-12: Proportions of Major Macrozooplankton Groups in Samples from 2024 Macrozooplankton Community Study

Spring						
Group	**S2**	**S3**	**S4**	**S5**	**S7**	**S9**
Cladocera	87.6	95.5	83	81.6	82.1	93.1
Calanoida	11.2	4.5	14.1	15.8	14.3	4.6
Cyclopoida	1.2	0	2.2	2.5	3.2	2.3
Mysida	0	0	0.7	0	0.4	0
Total	100	100	100	100	100	100
Summer						
Group	**S2**	**S3**	**S6**	**S4**	**S8**	**S9**
Cladocera	98.7	97.8	97.7	96.5	97.5	97.1
Calanoida	1	1.2	2	3.5	2.1	1.9
Cyclopoida	0.3	1	0.3	0	0.3	1
Mysida	0	0	0	0	0	0
Total	100	100	100	100	100	100
Fall						
Group	**S1**	**S3**	**S4**	**S5**	**S8**	**S9**
Cladocera	21.43	77.49	34.76	44.3	34.59	35.94
Calanoida	78.57	22.51	65.24	55.7	65.41	64.06
Cyclopoida	0	0	0	0	0	0
Mysida	0	0	0	0	0	0
Total	100	100	100	100	100	100

Table 4-13: Summary Statistics for Calculated Macrozooplankton Metrics, Spring 2024

Station	Station Depth (m)	Richness-LPL	Richness-Family	Density (#/L)	Biomass (dw mg/L)	Simpson's Diversity-Family
S3	12.4	5	5	0.0122	0.00006	0.93
S2	14.5	7	7	0.0264	0.00019	0.81
S5	16.9	10	8	0.0423	0.00029	1.24
S4	17.4	8	8	0.0176	0.00019	1.16
S7	19.3	11	9	0.0328	0.00033	1.34
S9	19.4	7	8	0.1488	0.00095	0.79
Minimum	**12.4**	**5**	**5**	**0.0122**	**0.00006**	**0.79**
Median	**17.2**	**8**	**8**	**0.0296**	**0.00024**	**1.04**
Mean	**16.7**	**8.2**	**7.5**	**0.0467**	**0.00033**	**1.04**
Standard Deviation	**2.8**	**2.1**	**1.4**	**0.0511**	**0.00032**	**0.23**
Q25 (First quartile)	**15.1**	**7.3**	**7.3**	**0.0198**	**0.00019**	**0.84**
Q75 (Third quartile)	**18.8**	**9.5**	**8**	**0.04**	**0.00032**	**1.22**
Maximum	**19.4**	**11**	**9**	**0.1488**	**0.00095**	**1.34**

Table 4-14: Summary Statistics for Calculated Macrozooplankton Metrics, Summer 2024

Station	Station Depth (m)	Richness-LPL	Richness-Family	No Algae			With Algae		
				Density (#/L)	Biomass (dw mg/L)	Simpson's Diversity-Family	Density (#/L)	Biomass (dw mg/L)	Simpson's Diversity-Family
S3	11.4	14	10	0.1592	0.00254	1.83	0.3665	0.00462	1.17
S2	12.5	11	9	0.2274	0.00193	1.59	0.4686	0.00362	1.33
S6	16.4	15	10	0.1049	0.00092	1.62	0.1645	0.00128	1.31
S4	16.6	12	9	0.337	0.00236	1.74	0.4941	0.00319	1.71
S8	19	15	11	0.1195	0.00093	1.8	0.2022	0.00161	1.57
S9	20	13	10	0.109	0.00092	1.89	0.1752	0.00144	1.63
Minimum	**11.4**	**11**	**9**	**0.1049**	**0.00092**	**1.59**	**0.1645**	**0.00128**	**1.17**
Median	**16.5**	**13.5**	**10**	**0.1394**	**0.00143**	**1.77**	**0.2844**	**0.0024**	**1.45**
Mean	**16**	**13.3**	**9.8**	**0.1762**	**0.0016**	**1.75**	**0.3119**	**0.00263**	**1.45**
Standard Deviation	**3.4**	**1.6**	**0.8**	**0.0912**	**0.00077**	**0.12**	**0.1505**	**0.00138**	**0.21**
Q25 (First quartile)	**13.5**	**12.3**	**9.3**	**0.1116**	**0.00092**	**1.65**	**0.1819**	**0.00148**	**1.32**
Q75 (Third quartile)	**18.4**	**14.8**	**10**	**0.2104**	**0.00225**	**1.82**	**0.4431**	**0.00351**	**1.61**
Maximum	**20**	**15**	**11**	**0.337**	**0.00254**	**1.89**	**0.4941**	**0.00462**	**1.71**

Table 4-15: Summary Statistics for Calculated Macrozooplankton Metrics, Fall 2024

Station	Station Depth (m)	Richness-LPL	Richness-Family	Density (#/L)	Biomass (dw mg/L)	Simpson's Diversity-Family
S3	10.5	3	3	0.5203	0.05148	0.58
S1	10.6	5	4	0.1014	0.00514	0.75
S5	15	5	5	0.3107	0.02408	0.94
S4	16.8	4	4	0.2475	0.01462	0.82
S8	18.7	3	3	0.2285	0.01604	0.83
S9	19.7	4	4	0.1868	0.01101	0.89
Minimum	**10**	**3**	**3**	**0.1014**	**0.00514**	**0.58**
Median	**15.5**	**4**	**4**	**0.238**	**0.01533**	**0.83**
Mean	**14.7**	**4**	**3.8**	**0.2659**	**0.02039**	**0.8**
Standard Deviation	**3.9**	**0.9**	**0.8**	**0.1427**	**0.01645**	**0.13**
Q25 (First quartile)	**11.3**	**3.3**	**3.3**	**0.1972**	**0.01191**	**0.77**
Q75 (Third quartile)	**17.5**	**4.8**	**4**	**0.2949**	**0.02207**	**0.87**
Maximum	**19**	**5**	**5**	**0.5203**	**0.05148**	**0.94**

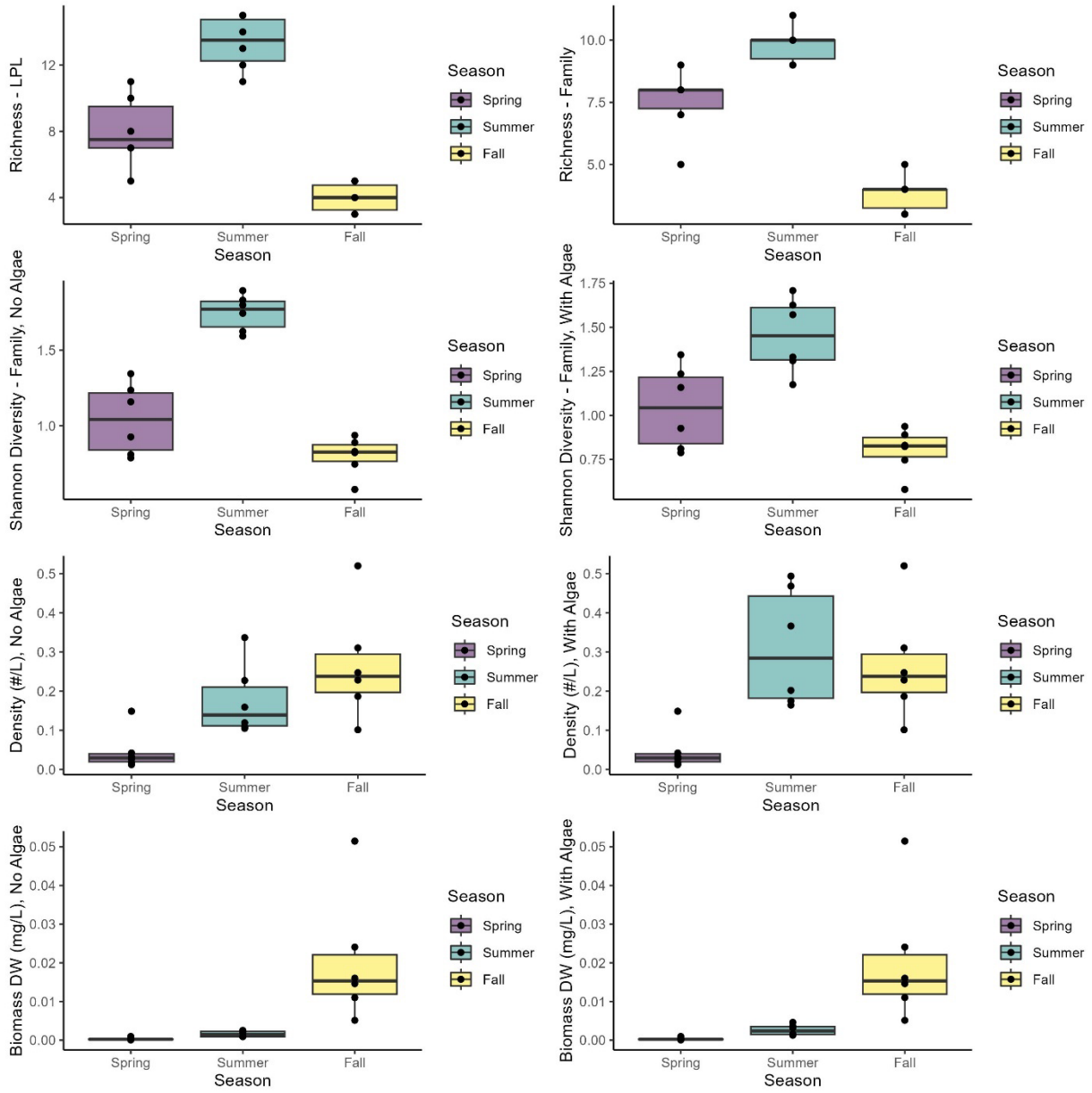


Figure 4-16: Boxplots and Raw Data (points) of Macrozooplankton Endpoints Expressed by Season

Note: "No Algae" indicates that zooplankton estimates for those trapped in dense algae were not included whereas "With Algae" indicates they were.

4.3.4 Aquatic Habitat

The aquatic habitat surrounding PNGS was discussed extensively in the Aquatic Environment TSD for the EA for the refurbishment and continued operation of the PNGS Units 5-8 (Golder, 2007a) and the 2022 PN ERA (Ecometrix, 2023a). This section integrates findings from the 2024 environmental studies to characterize existing fish habitat within the proposed DWI area and the nearshore region associated with the proposed west infill and shoreline erosion mitigation areas, informing the assessment of potential project-related impacts in Section 5. Key environmental components evaluated include water and sediment quality, substrate type, aquatic vegetation/productivity, and fish community composition. Details on water quality (**Section 4.2.2.1**), sediment quality (**Section 4.2.2.2**) are presented elsewhere in the PERA, and will be summarized below in the context of fish habitat quality in the proposed areas.

4.3.4.1 Proposed DWI Area

4.3.4.1.1 Water Quality

Concentrations of metals, petroleum hydrocarbons (PHC) fractions F1 to F4, morpholine, and volatile organics in water samples from the DWI area (i.e., LW2401, LW2402, LW2403, LW2404) were either below associated screening guidelines or below detection limits. Additionally, radionuclide levels in these samples were also either below detection limits or consistent with historical Lake Ontario levels. General chemistry parameters such as turbidity, conductivity, dissolved oxygen, and pH conditions in these samples were comparable to other habitats/environments found along the northern shore of Lake Ontario (Stephenson and Mackie, 1988; Stephenson, 1990). While one location in the DWI area exceeded the PWQO guideline for pH during the summer sampling event, the value remained within the CCME CWQG range of 6.5 to 9.0 for the protection of freshwater biota. Overall, the water quality in the DWI area is considered suitable for fish habitat.

4.3.4.1.2 Sediment Quality

As sediment in Lake Ontario is transient and sparse in offshore areas, its quality in the DWI could not be assessed. However, based on the water quality conditions in the area, there is no indication that sediment quality in the area would pose a risk to aquatic biota.

4.3.4.1.3 Physical Habitat features

As a part of the 2024 aquatic habitat assessment studies conducted in support of this PERA, Sidescan sonar was taken in 14 transects within the 9 sampling grids of the DWI area (**Figure 4-7**). Sidescan data was imported into ReefMaster v 2.2.57 (Reefmaster, 2024), where the bottom classification tool was used to characterize the substrate based on hardness estimations. These classifications were then compared to the sidescan imagery and the Aquaview substrate checks to assign representative substrate types across the area. Substrate was classified as Sand, Sand/Gravel, Sand/Gravel/Cobble, Gravel/Cobble, Gravel/Cobble/Boulder, Cobble/Boulder, or Boulder throughout the study area. Though mussel and algal/vegetation coverage was not quantified, general observations were recorded.

Overall, substrate throughout the DWI area was composed of gravel/cobble, with a tendency for coarser substrates (gravel/cobble/boulder, cobble/boulder, and boulder) to the northeast and finer substrates (sand, sand/gravel) to the south and southwest of the DWI. Areas with cobble and boulder substrate exhibited high mussel densities. Periphyton (benthic algal material) coverage was generally sparse on gravel and fine sediments, but more abundant on cobble and boulder substrates. No macrophytes were observed. Additionally, there did not appear to be any unique habitat features (e.g., rocky shoals or steep drop-offs) that would serve to concentrate fish, with the habitat likely similar to other surrounding areas of Lake Ontario. Substrate types within each sampling grid are detailed in **Table 4-16**, and are mapped in **Figure 4-17**.

S8 and S9 tended to have the highest diversity of substrate types and were two of the grid squares with substantial portions of sand and gravel/sand. Proceeding towards shore, shallower, substrates were larger and the overall diversity was reduced. It is likely that proceeding even shallower and more towards shore would like result in a reduction in fine grained sediments even further and an increase in large substrates like cobble and boulder. This is due to the increase in the potential effects of wave action and weather as the water depth decreases. Further habitat assessment in 2025 of an addition onshore row of assessment grids will help substantiate this inference.

Table 4-16: Substrate characterization in the proposed DWI area, 2024

Sampling grid	Depths (m)	Substrate characterization
S1	10-14	Substrates primarily comprised of sand/gravel/cobble. Other substrate types identified include sand/gravel/cobble, gravel/cobble, and gravel/cobble/boulder. In general, coarser substrates (cobble and infrequent boulder) were observed in the mid and northern section of the grid in depths of approximately 10 to 13m. Finer substrates were observed in deeper areas (12 to 14m), with a large patch of sand/gravel/cobble present in the southwest section of the sampling grid.
S2	11-14	Substrates primarily comprised of sand/gravel/cobble. Small sections containing larger substrates (cobble/boulder) are present to the northwest and mid grid to the east. These sections of larger substrates are generally associated with the 12m depth contours.
S3	10-13	Substrates primarily comprised of coarser substrates (gravel/cobble/boulder). Substrate size tends to increase in size from west to east in the sampling grid. The furthest eastern edge of this sampling grid is comprised primarily of cobble and boulder substrates.
S4	14-17	Substrates primarily comprised of sand/gravel/cobble. Finer substrates are found in patches located to the south and southeast between depths of 16 to 17m. Coarser substrates are present along the edge of the southeast section of the sampling grid in 16 to 17 m depths.
S5	14-17	Substrates primarily composed of gravel/cobble. These substrates are generally located throughout the northwestern section of the sampling grid. The southern/southeastern section of the sampling grid contains diverse substrate types, containing substrates ranging from sand to boulder in patches throughout the entire southeast section of the sampling grid.
S6	11-17	Substrates primarily composed of gravel/cobble and gravel/cobble/boulder. There was a general pattern of less coarse substrates in the southwest and more coarse substrates to the northeast. The largest substrates (cobble/boulder and boulder) within this sampling grid are located in the north-east section between the 11 to 14 m depth contours.
S7	16-19	Substrates primarily composed of gravel/cobble and gravel/cobble/boulder. Finer substrates are generally located to the mid-south (17 to 19 m) sections of the sampling grid, while coarser substrates tend to be located to the east and west, adjacent to the sampling grid extent.

Sampling grid	Depths (m)	Substrate characterization
S8	17-20	Substrates are variable throughout the sampling grid, with all substrate types observed. Generally, coarser substrates (gravel/cobble/boulder and cobble/boulder) are present to the west, between the 17 and 18 m depth contours, while patches of finer substrates (sand/gravel) tend to be present throughout the middle and to the east of the sampling grid across all depths.
S9	17-20	The substrate is diverse and comprised of sand/gravel, sand/gravel/cobble, and gravel/cobble, with patches of sand and gravel/cobble/boulder. The finest substrates (sand and sand/gravel) generally occur between the 18 and 19m depth contours, while coarser substrates are present throughout the eastern extent of the sampling grid across all depths.

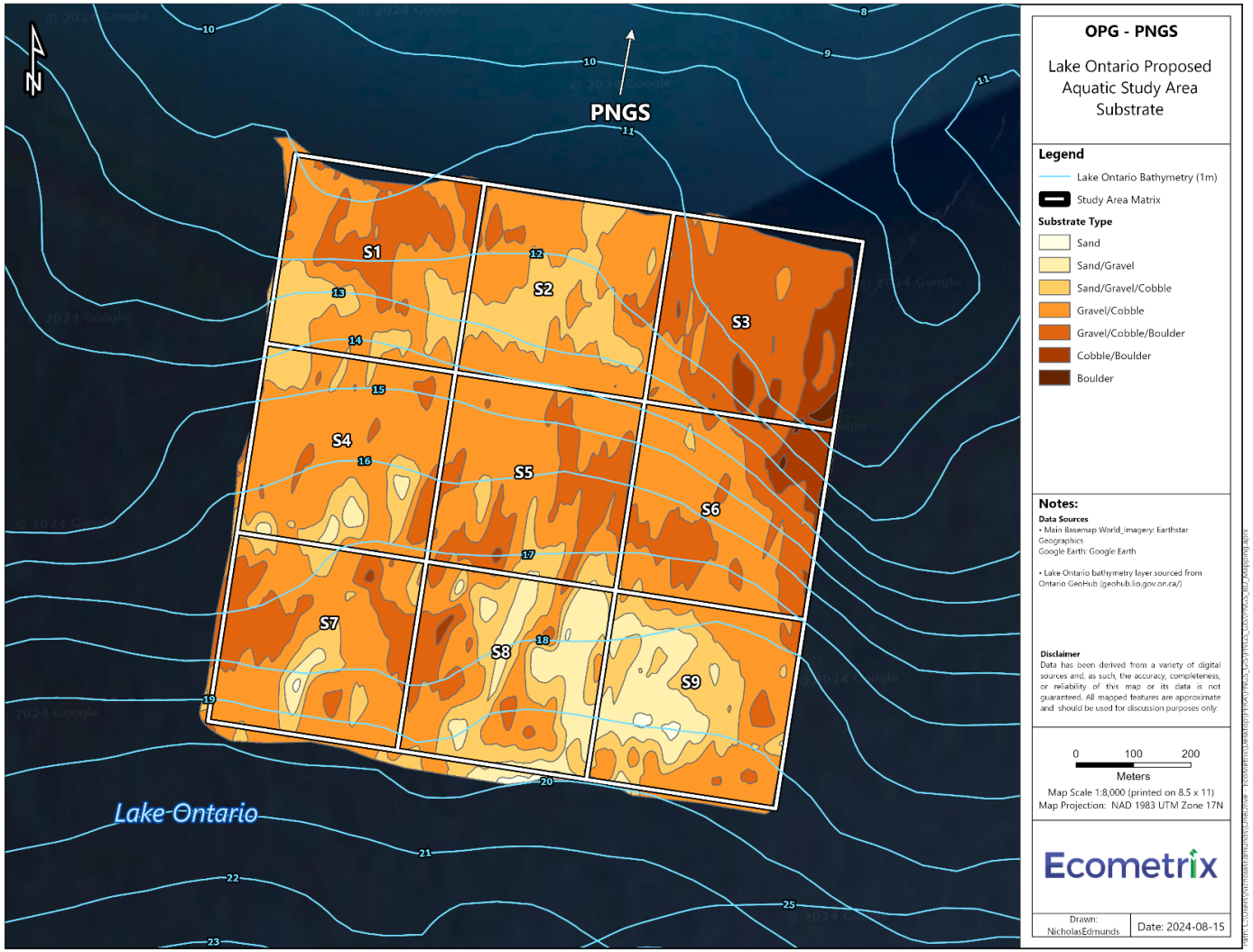


Figure 4-17: Proposed DWI Area Substrate Coverage, 2024

4.3.4.2 Proposed Shoreline Erosion Mitigation Area and West Infill Area

4.3.4.2.1 Water Quality

Although water samples were not collected directly from the nearshore region associated with the proposed shoreline erosion mitigation and west infill areas during the 2024 surface water sampling program, samples from the PN Outfalls (LW-10, LW-21) and Intake channel (LW-9) can be used to provide a conservative assessment of the water quality in these areas. This is because the outfalls and intake are expected to have the highest concentrations of contaminants and thermal inputs due to their proximity to the discharge channels and PNGS. Thus, the water quality in the shoreline erosion mitigation and west infill areas is likely to be less impacted due to natural dilution and dispersion.

The concentrations of petroleum hydrocarbons (PHC) fractions F1 to F4, morpholine, and volatile organics near the outfalls and intake channel were either below associated screening guidelines or below detection limits. Across the three sampling events, exceedances of pH and ammonia were found to exceed associated guidelines at LW9 in the summer sampling event. However, as highlighted in **Section 4.2.2**, these exceedances are likely not attributable to PN operations and do not pose a risk to aquatic biota. Similarly, exceedances of copper, cobalt, and silver were noted near the intake channel in the fall. However, as highlighted earlier, these exceedances likely represent sporadic variations in nearshore water quality not related to PN operations. Radionuclide concentrations were either below detection limits or consistent with historical Lake Ontario levels. As with the DWI area, general chemistry parameters such as turbidity, conductivity, dissolved oxygen, and pH in water samples from these locations fall within the range observed in habitats along the northern shore of Lake Ontario. Thus, the water quality in the potential shoreline erosion mitigation and west infill areas is considered suitable for fish habitat.

4.3.4.2.2 Sediment Quality

Sediment samples collected from the nearshore study areas in 2024 were analyzed for sediment size, general chemistry parameters, and metals. No exceedances of metal screening guidelines were observed. While phosphorus exceeded the guideline at one location in each nearshore area, this threshold reflects potential nutrient enrichment effects on benthic community composition rather than toxicity to ecological receptors. Overall, sediment quality in the shoreline erosion mitigation and west infill areas is considered suitable for fish habitat.

4.3.4.2.3 Physical Habitat features

As a part of the 2024 aquatic habitat assessment conducted in support of this PERA, underwater video was collected from five transects in the shoreline erosion mitigation and west infill areas each to characterize the available habitat. The transect coverage is outlined in **Figure 4-18**. Consistent with the methodology used in previous assessments (Golder and SENES, 2009; SENES, 2011a, 2011b), videos along each transect were split into 11 images and reviewed. In each image, observations regarding sediment composition (base and surficial sediment size and substrate type), macrophyte and algal coverage, dreissenid mussel coverage, and fish counts

were recorded. Basen on sediment classifications, substrates were categorized into six types: fine sediments over bedrock with patches of exposed bedrock (Type 1), Finer sediments usually with distinct ridges and or ripple (Type 2), Finer sediments with scattered gravel and cobble (Type 3), Gravel and cobble in a base of fine sediments (Type 4), Rocks ranging in size from gravel to boulders in a base of finer sediments (Type 5), and Rocks ranging in size from gravel to boulders in a base of finer sediments (Type 6). When classifying mussel and algae coverage, the terms sparse (0-25% coverage), moderate (25-75% coverage) and dense (75-100% coverage) were utilized. If fish were seen within a transect, fish presence was noted.

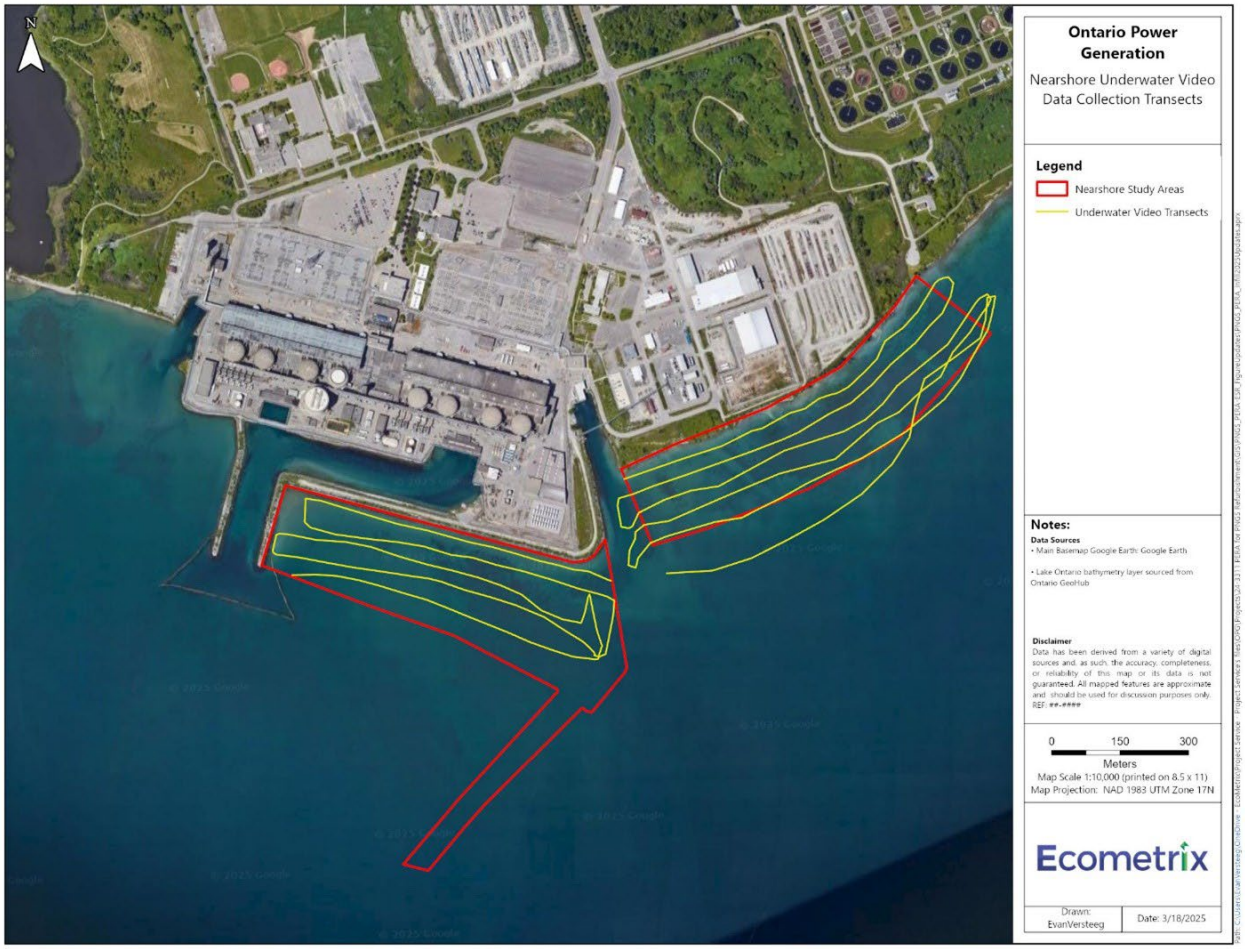


Figure 4-18: Underwater Video Data Collection Area in the Nearshore Study Areas for the Aquatic Habitat Assessment Study, 2024

Substrate classification results for each transect in the shoreline erosion mitigation and west infill areas are presented in **Table B-12**. Classification values at each point were then used in the Nearest Neighbor interpolation tool within the Spatial Analyst toolbox in ArcGIS to estimate the substrate coverage across each nearshore area, which is presented in **Figure 4-19**. In general, substrates in the shoreline erosion mitigation area consisted of five substrate types; these were Type 2, Type 3, Type 4, Type 5, and Type 6. Type 2 substrates (finer sediments usually with distinct ridges and or ripples) were the most common and Type 3 (finer sediments with scattered gravel and cobble) the least common. Finer substrates were seen closer to shore and to the west, with coarser substrates found further from shore. Overall, the dominant substrates indicate that the area is energetic and provides limited high quality fish habitat. Aquatic vegetation (including macrophytes and algae) was observed throughout most of every transect, with only six of the 55 images containing no aquatic vegetation. Nearly 100 % coverage was seen in 13 of 55 images. The majority of images within transects 2, 3 and 5 also had no observable mussels and no mussels were observed in transect 1 or 4., with mostly sparse and some moderate amounts observed occasionally. Mussel density tended to increase with substrate particle size. No fish were observed along any of the transects conducted within the shoreline erosion mitigation area.

Substrates in the west infill area consisted of three substrate types; these were Type 2, Type 5, and Type 6. The finer Type 2 substrates represented the majority of the area, especially concentrated on the west side of the area. The prevalence of sand with distinct ridges and ripples suggest poor fish habitat based on it being a high energy area. Aquatic vegetation was not observed in most of the west infill area. The east section of the study area had high levels of vegetation coverage (>90%), which tended to coincide with coarser substrates. The majority of transects 1, 2, 4, and 5 did not contain mussels, and no mussels were observed throughout transect 3. Though infrequent, areas of sparse to moderate mussel density tended to be observed coincident with areas containing larger substrates (cobble/boulder). No fish were observed along any of the transects conducted within the west infill area.

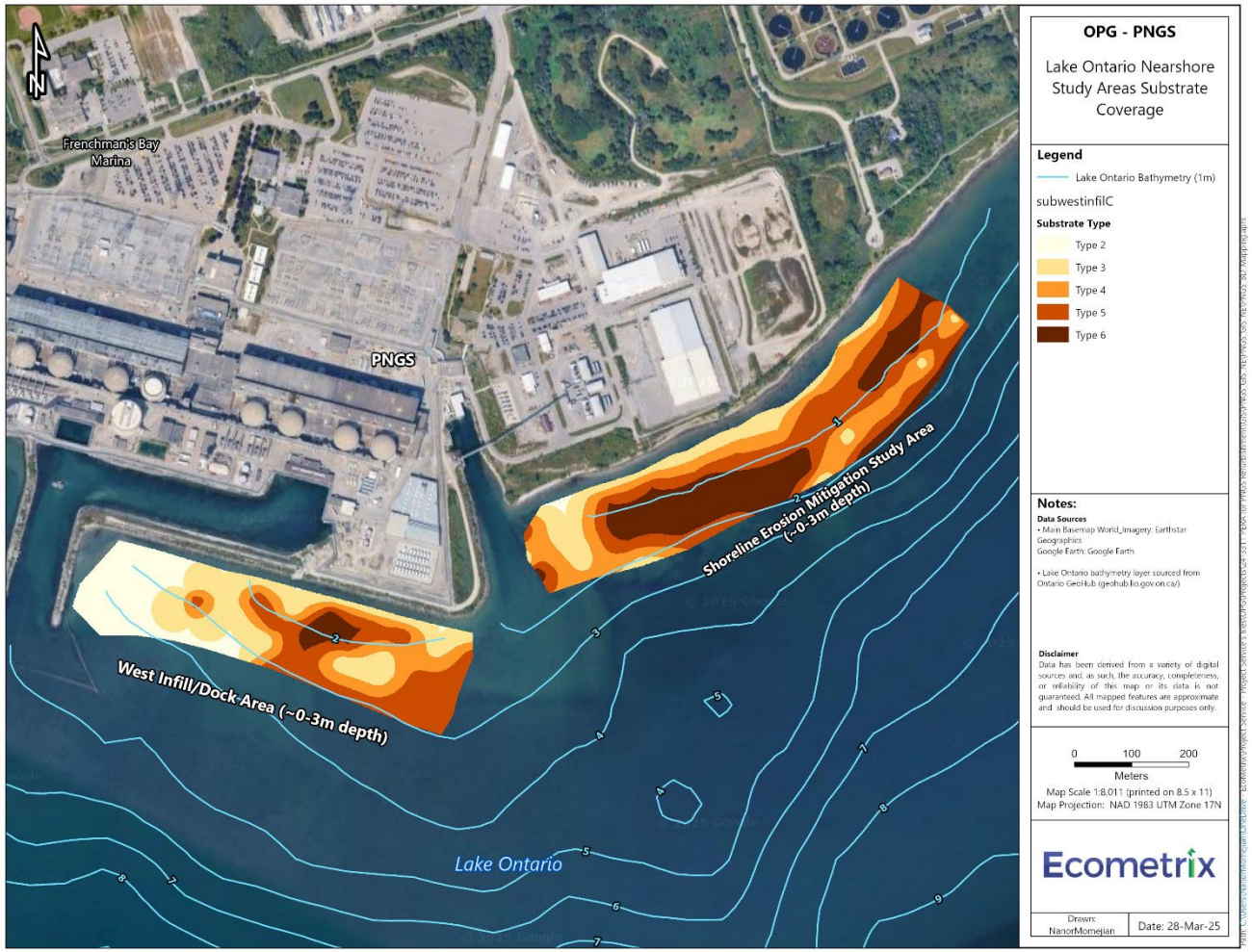


Figure 4-19: Proposed Shoreline Erosion Mitigation and West Infill Areas Substrate Coverage, 2024

4.4 Geological and Hydrogeological Environment

4.4.1 Surficial Geology and Soil

The PN site is situated between the Oak Ridges Moraine to the north and Lake Ontario to the south. The moraine is composed of thick deposits of glacial till and sand and gravel that are associated with hummocky terrain at the surface (Golder, 2007b). South of the moraine, the north shore of Lake Ontario is largely underlain by glacial till and glaciolacustrine deposits of clayey silt to silty clay composition. The underlying soil sequence at PN can be subdivided into three main layers generally comprised of construction fill materials, a recent Upper Till Complex and an older Lower Till Complex directly overlying the local bedrock (Golder, 2007b).

Historical operations at the PN site have resulted in isolated areas of chemical and radiological contamination in soil. The 2017 ERA (Ecometrix and Golder, 2018) determined that risks posed by soil contaminants to human and ecological receptors were low. Following the 2015 soil sampling program, no additional soil samples were collected for evaluation in the 2022 PN ERA (Ecometrix, 2023a).

The first site-wide soil monitoring program was initiated in 1999 to characterize soil quality at the PN site. As part of the 2014 ERA, soil samples (0-1.5 metres in depth) collected as part of the site-wide monitoring program were compared against newly issued soil standards at the time following the Ontario MECP's update to O. Reg. 153/04. The 2014 ERA had identified a short-list of metals that were found to exceed their respective soil screening criteria. Ultimately, the 2014 ERA concluded that additional monitoring was recommended in areas of the PN site where metal concentrations were found to exceed soil benchmarks to ensure the protection of plants and soil organisms. To address this recommendation, an updated soil monitoring program was conducted in October 2015 in support of the 2017 ERA, focusing on the areas of contamination identified in the 2014 ERA.

The 2017 ERA (Ecometrix and Golder, 2018) and the 2022 PN ERA (Ecometrix, 2023a) documented that surface soil samples (collected in 2015 between 0 to 20 cm in depth) were analyzed for polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), petroleum hydrocarbons (PHC) fractions F1 to F4, metals and inorganics, glycol, tritium (H-3), gamma emitters (i.e., Cs-137, Cs-134, Co-60) and C-14. Concentrations of chemical constituents were compared against soil quality guidelines from the MECP and CCME that are considered protective of various classes of ecological receptors (e.g., plants, soil organisms, birds and mammals). In the 2015 sampling program, the maximum measured on-site concentration of PHC F4 was found to exceed the selected screening criteria and was hypothesized to be related to minor historic spills and impacted surface water runoff. Cadmium, strontium, and thallium, which were assessed as soil COPCs in the 2014 ERA, did not exceed their selected screening criteria based on the 2015 site soil data and were dropped as COPCs in the 2017 and 2022 PN ERAs. As of the most recent 2022 PN ERA, the list of soil COPCs included metals (arsenic, copper, lead and zinc), free cyanide, and PHC F4. Overall, based on the soil samples collected in 2015, exceedances of soil screening criteria were found to be localized and generally limited to the

eastern portion of the PN site, suggesting that contamination was not a result of widespread atmospheric deposition and that further accumulation of contaminants in soil was unlikely to occur over time (Ecometrix, 2023a).

4.4.1.1 2024 Soil Monitoring Program

4.4.1.1.1 Chemical Soil COPCs

In mid-2024, a soil monitoring program was initiated to characterize existing soil conditions at the PN site. Soil samples from the top 15 cm of soil were collected from a variety of different sampling locations (see **Figure 4-20**), consisting of locations assessed in previous soil sampling programs and/or known areas of concern at the PN site. Consistent with previous soil monitoring programs, soil samples were analyzed for PAHs, VOCs, PHC fractions F1 to F4, metals and inorganics, and radiological parameters including tritium, gamma emitters and carbon-14. Non-radiological chemical parameters were screened against the lower of either the MECP's ecological component values (Eco CVs) (MECP, 2011), or the CCME's soil quality guidelines (SQGs) for the protection of environmental and human health (CCME, 2010). Where an Eco CV is provided for both plants and soil organisms, and for birds and mammals, the lower of the two values was retained. Where Eco CVs were unavailable, for PAHs and VOCs, the free phase threshold value was used as the screening criteria. Where SQGs were provided for both ecological protection and human health protection, the lower of the two values was retained. Where SQGs were unavailable, interim SQGs from the CCME were retained for the screening assessment. Lastly, in cases where the selected screening criterion was found to be more conservative than the MECP's Ontario background soil value, the background soil value was retained as the screening criteria since screening criteria should not be set below a reasonable upper end of background (as per Clause 7.2.5.3.2 in CSA N288.6:22).

Based on the results of the recent soil monitoring program, the maximum concentration of zinc (350 µg/g) was found to exceed its selected soil screening criterion (340 µg/g), though this occurred at only one sampling location (**Table A-5**). The maximum concentration of zinc in the 2022 PN ERA (3,200 µg/g) is approximately a full order of magnitude higher than the concentration measured during the recent 2024 sampling event. Compared with the previous ERAs, arsenic, copper and lead all met their respective soil screening criteria and would no longer be considered soil COPCs. Similarly, cyanide and PHC F4, which exceeded their respective screening criteria in 2015, met these criteria during the 2024 soil sampling event. However, in contrast to the previous soil sampling event, two general soil quality parameters, electrical conductivity and sodium adsorption ratio, exceeded their respective screening criteria at two of the assessed sampling locations.

Overall, soil quality at the PN site has remained consistent compared with previously completed ERA reports. Concentrations of historical soil COPCs (i.e., arsenic, copper, lead, PHC F4, and cyanide) have improved such that these parameters do not screen in as soil COPCs based on the results of the 2024 soil monitoring program.

4.4.1.1.2 Radiological Soil COPCs

As part of its normal operations, the PN site contributes small amounts of radiological materials to the environment. Atmospheric deposition represents the primary transport pathway of radiological COPCs to soils within and near the PN site. Historically, radiological parameters including tritium, gamma emitters (i.e., Cs-137, Cs-134, Co-60), I-131 and C-14 have been monitored in soil at the PN site.

Compared with the 2015 soil monitoring event, the maximum measured concentrations of C-14 and H-3 were found to have increased approximately 2.1- and 1.7-times, with the maximum concentrations being measured at the same sampling location (GMS-26) during both the 2015 and the recent 2024 soil monitoring program. Co-60, Cs-134 and Cs-137 were all previously reported as being measured below laboratory detection limits; more recently, these radionuclides were measured above detection in some of the 2024 soil samples. The maximum measured concentration of K-40 remains comparable between the previous and recent soil sampling events. The maximum concentration of I-131 was reported as below the laboratory detection limit. Lastly, the maximum reported concentrations for the Th-series and U-series naturally occurring radionuclides were 25.4 Bq/kg and 23 Bq/kg, respectively.

In general, K-40 is environmentally abundant and is not associated with station operations. The cesium and cobalt isotopes are included as COPCs to address potential concern about deposition of particulate activity. Only Cs-134 and Co-60 are specific to reactor operations, and these are usually not detected in PN's annual environmental monitoring program (Ecometrix, 2023a). The presence of Cs-137 is primarily due to historic atmospheric weapons test fallout and not reactor operations. However, exposure to Cs-134, Cs-137, and Co-60 in soil are included in the public dose calculations in the interest of public safety.

Figure 4-20: Monitoring Locations for the 2024 Soil Monitoring Program

4.4.2 Groundwater

4.4.2.1 Groundwater Flow

At a regional scale, the sand and gravel layers buried within and between low permeability till deposits under the PN site constitute aquifers that support groundwater flow. The tills and lower bedrock deposits of shale and limestone that underlie the surficial deposits typically have low permeability and behave as aquitards, restricting infiltration and the recharge of water to more permeable layers, weathered zones and areas with open fractures.

Historical site investigations and groundwater monitoring programs have provided an understanding of the groundwater flow system below the PN site. A hydrogeological conceptual site model (CSM) for the PN site (Ecometrix, 2023c) was presented as part of developing the 2020 Groundwater Protection Plan for the PN Site (OPG, 2023g). Groundwater flow south of the Oak Ridges Moraine, including the area where the PN site is situated, is southward toward Lake Ontario.

Eight hydrostratigraphic units (HUs) have been identified beneath the PN site. The eight HUs have been grouped into four primary groundwater flow systems. These include the "shallow groundwater system" (HU 1-3); "intermediate overburden groundwater system" (HU 6); "deep overburden groundwater system" (HU 7) and the "shallow bedrock groundwater system" (HU 8). Hydrostratigraphic units 4 and 5 are not always observed, and where they are observed, are generally thin and are grouped into the shallow groundwater system. The shallow groundwater system is an aquifer, and the intermediate overburden and bedrock groundwater flow systems are considered to be aquitards. The deep overburden groundwater system may represent an aquifer; however, contaminant migration into this HU from overlying HUs is considered to be limited due to the low permeability of the till materials in HU 6.

Continued monitoring has revealed that the predominant groundwater flow direction and water table elevation have not significantly changed over time and do not experience any meaningful seasonal variability. In general, vertical flow is downward in the overburden and upward in the bedrock, consistent with regional groundwater discharge to Lake Ontario.

Groundwater flow within the PN site is significantly influenced by the inactive Turbine Auxiliary Bay foundation drainage system located beneath the deep building foundations. The inactive Turbine Auxiliary Bay foundation drainage system is used to control groundwater beneath the building. Groundwater from the Turbine Auxiliary Bay foundation drains flows into each unit's sump and then is discharged via a monitored pathway to the intake channel via pumping. Groundwater from the granular horizons in the Lower Till and the granular foundation backfill is collected in the foundation drains. The drainage system has locally lowered groundwater levels below the level of Lake Ontario, creating a hydraulic sink that captures groundwater beneath and immediately adjacent to the PN reactor buildings (SENES, 2007). Measured flow into the Turbine Auxiliary Bay foundation drains is on the order of about 25 and 77 m^3/day for PNGS Units 1-4 and U5-8, respectively. Estimated horizontal flow velocities in groundwater across the site range from 0.3 to 11 m/y (CH2M, 2000).

The vacuum building ramp sump (VBRS) is also a hydraulic sink for the south portion of the PNGS Units 1-4 side. The VBRS is located at the bottom of a truck ramp that is installed at basement elevation of the vacuum building and collects shallow groundwater in the vicinity of the building. During operations the groundwater collected in the VBRS is also discharged via a monitored pathway to the forebay.

Other subsurface features that have the potential to influence groundwater flow at the site include the RLWMS foundation drains and the reactor building (RB) foundation drains. The RLWMS foundation drains and sumps are located at a lower elevation than the TAB foundation drains. The RB foundation drains are installed at a higher elevation and may intercept shallow groundwater.

4.4.2.2 Groundwater Quality

Numerous hydrogeological investigations have been conducted at the PN site, primarily in relation to known elevated tritium concentrations in groundwater, but also relating to other chemical COPCs such as petroleum hydrocarbons, chloride and metals (iron) in areas of the site that represent potential sources of these contaminants.

Since December 2020, the PN site has maintained a robust groundwater protection program (GWPP) and groundwater monitoring program (GWMP) compliant with CSA N288.7-15, "*Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*" (OPG, 2023g). The GWPP is a comprehensive document that defines groundwater protection goals for the PN site based on site-specific hydrogeological conditions and groundwater end uses that are presented in a CSM (Ecometrix, 2023c). Groundwater monitoring and reporting, beginning in 2021, follows the design provided in the GWMP. Prior to 2021, groundwater monitoring had been ongoing for many decades at the PN site, most recently under the Groundwater Monitoring Program Design (Ecometrix, 2012). This PERA relies on OPG's annual groundwater monitoring program reports from 2021 to 2023 (OPG, 2022e, 2023h, 2024i).

In the groundwater CSM, structures, systems, and components (SSCs) were identified in order to identify high priority SSCs (i.e., those which act as potential sources of chemicals to groundwater). Chemicals associated with the SSCs were screened as COPCS for monitoring in the GWMP on the basis of recent (primarily, 2012-2018) groundwater concentrations of those chemicals at the PN site. Tritium was identified as a COPC in groundwater at the PN site; though there are no published standards for tritium in groundwater, tritium was retained as a COPC for the GWMP because of its presence in groundwater and association with SSCs.

4.4.2.2.1 Chemical COPCs in Groundwater

Non-radiological COPCs monitored during the 2021-2023 period (OPG, 2022e, 2023h, 2024i) focused on PHC F1-F4, benzene, toluene, ethylbenzene, and xylenes (BTEX) compounds, and dissolved iron; these parameters are monitored based on the screening assessment of past monitoring events. Screening benchmarks for non-radiological COPCs included Ontario MECP Site Condition Standards (SCS), specifically Table 3 (Full Depth Generic Site Condition Standards

in a Non-Potable Ground Water Condition) or Table 9 (Generic Site Condition Standards for Use within 30 m of a Water Body in a Non-Potable Ground Water Condition) standards (MECP, 2011). For substances without MECP SCS, groundwater data were compared against screening levels based on 10 times (10x) the lowest of the Ontario Provincial Water Quality Objectives (PWQO) and the CCME water quality guidelines. The 10x factor is consistent with the MECP derivation of the groundwater to surface water pathway component values (GW3), which assumes at least 10-fold dilution of groundwater in surface water (MECP, 2011).

A monitored natural attenuation program (MNA) was implemented in the Units 1 to 4 Standby Generators (SG-A) area, SG-A Overflow area, and the Units 5 to 8 Standby Generators (SG-B) area in 2011, following remedial activities. The SG-A area is monitored annually, the other areas are monitored biennially.

In total, within the MNA areas, one (1) monitoring well was sampled in 2021 and twenty-four (24) monitoring wells were sampled in 2022. Six (6) monitoring wells were monitored in 2023; however, consistent with the PN Sampling Analysis Plan and GWMP, none of the wells were sampled as free phase product was found in all six wells. Free phase product thicknesses were measured and were found to be comparable with historical monitoring results in recent years.

Concentrations of PHC F2 and PHC F3 were found to have exceeded their respective MECP SCS in both 2021 and 2022 at three MNA monitoring well locations. Similarly, in both 2021 and 2022, maximum concentrations of dissolved iron were also found to exceed the selected screening criteria of 3,000 µg/L, derived by multiplying the Ontario PWQO value of 300 µg/L by a factor of 10 as described above. All exceedances were measured in close proximity to PNGS Units 1-4 and occurred in wells drilled to approximately the same depth (~15 m below ground surface). The localized presence of PHCs and iron at concentrations above the groundwater evaluation criteria are expected in these areas, where remediation using a natural monitored attenuation approach is ongoing.

In 2022, one monitoring well associated with each of the East and West Landfills was sampled for the analysis of dissolved iron (MW-024-20 and MW-205-35). Concentrations of iron were found to be 1,000 µg/L and 1,900 µg/L, respectively, and remained within the historical range and below the evaluation criteria of 3,000 µg/L.

Although there are exceedances reported for PHCs and dissolved iron, these chemical constituents are not expected to pose adverse effects to human health and the environment. As noted in the 2022 PN ERA, continued monitoring has shown that PHCs are not migrating from groundwater to the intake channel or Lake Ontario. Human receptors are restricted from accessing the intake channel and recreational activities would occur further out into the lake, away from any potential groundwater inputs to Lake Ontario. Furthermore, the nearest water supply plant (WSP) is situated approximately 7 km east of the PN site in Ajax, Ontario; concentrations of any COPCs in groundwater would thus be subject to considerable dilution before they could migrate to a point of water intake for human consumption. With respect to dissolved iron, no health risks are expected based on the same assumptions provided above.

Furthermore, the Ontario PWQO from which the dissolved iron screening criteria is derived is based on the protection of freshwater aquatic life and is considered extremely conservative for assessing risk to humans.

Similarly, groundwater COPCs are not expected to pose any risks to ecological receptors at the PN site. Most terrestrial ecological receptors are unlikely to be exposed to groundwater as there is no reasonable complete exposure pathway. Continued monitoring has shown that aquatic receptors most at-risk of potentially contacting discharged groundwater (e.g., benthic invertebrates, bottom-feeding and pelagic fish in Lake Ontario) are not at risk as any groundwater COPCs discharging into the lake are sufficiently diluted and COPC concentrations within sampled lake water are consistently measured below screening guidelines protective of ecological health.

4.4.2.2.2 Radiological COPCs in Groundwater

During normal operations, the PN site contributes small amounts of radiological materials to the environment. Tritium is the only radiological parameter currently measured as part of the PN GWMP consistent with the PN CSM (Ecometrix, 2023c). There is potential for tritiated groundwater to migrate to surface water (i.e., Lake Ontario); however, groundwater flux from the site into Lake Ontario is likely to be small based on the estimated groundwater velocity and influence of site infrastructure (CH2M, 2000). Therefore, any COPCs in groundwater that reach the lake are subject to considerable dilution before they can migrate to a point of water intake for human consumption. Tritium concentrations in all boundary and shoreline wells at the PN site perimeter remain substantively below groundwater evaluation criteria, demonstrating no potential for off-site impacts from tritium in groundwater at PNGS.

A groundwater evaluation criterion for tritium has been developed as part of the N288.7-compliant GWPP for the PN site that would be protective of the drinking water pathway from the Ajax WSP intake. A tritium concentration of 6.19×10^9 Bq/L in groundwater was derived to be protective of human receptors (Ecometrix, 2023d). Over the past three years of groundwater monitoring, measured tritium groundwater concentrations have remained well below the screening criterion (OPG, 2022e, 2023h, 2024i).

The on-site groundwater is not considered potable. There are no groundwater supply wells downgradient of potential source areas on-site. Off-site drinking water wells may be influenced by the atmospheric tritium and this is taken into account in the public dose calculations conducted as part of OPG's annual EMP reporting. Overall, groundwater quality results from groundwater monitoring conducted from 2021 to 2023 are consistent with previous groundwater assessments.

4.5 Terrestrial Environment

The PN site spans 105 ha and encompasses limited areas of naturalization in a generally urban setting which provides habitat for many terrestrial plant and animal species. The PN Study Area is an additional 100 ha in area and includes some of the surrounding adjacent natural and park

areas as shown in **Figure 4-21**. Biodiversity monitoring has been conducted within the PN Study Area since 2009 and continues on an annual basis (TRCA, 2009, 2009, 2013, 2015a). Specifically, the transects monitored outside the site include Hydro Marsh, Alex Robertson Park, Bay Ridges Park, PN East Landfill. A standardized program was developed in 2016 (Beacon, 2017a) and was implemented annually until 2019 (Beacon, 2017b, 2018), followed by a three-year compilation from 2019 to 2021 (Beacon, 2022), an annual report in 2022 (Beacon, 2023a), and a three-year program from 2023 to 2025 (Beacon, 2023b). The program includes monitoring of amphibians, breeding birds, and bats, as well as identification of species at risk. Vegetation communities within and in the vicinity of the PN site were initially characterized in 2004 and 2006 (Golder, 2007c), further studied from 2009 to 2015 (TRCA, 2015a, 2015b), and remapped in 2018 and 2023 (Beacon, 2018, 2023b).

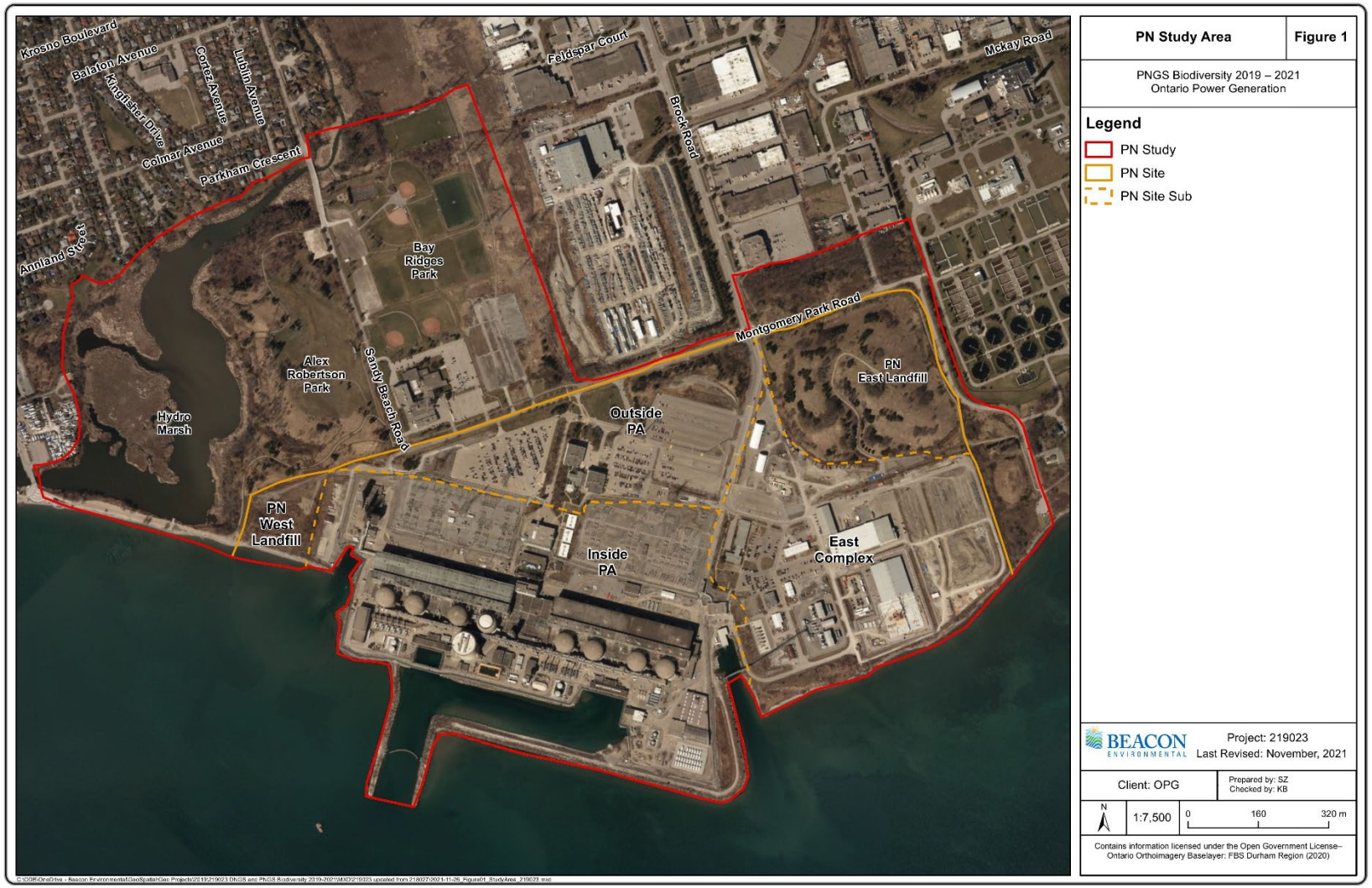


Figure 4-21: Terrestrial Monitoring Study Area (Beacon, 2022)

4.5.1 Vegetation

The vegetation around the PN site comprises a mix of terrestrial, wetland, and cultural communities. Vegetation within the site is sparse, and characterized by weeds, grasses, and small shrubs. The forested lots outside the site boundaries contain 2 ha of forested areas with a mix of native and non-native trees and shrubs (Golder, 2007c). Notably, a Butternut (*Juglans cinerea*) tree, classified as endangered under the Ontario Endangered Species Act (ESA), Schedule 1 of the Species at Risk Act (SARA) and by the Committee on the Status of Species at Risk in Ontario (COSSARO), is present in Alex Robertson Park (Beacon, 2022, 2023b). Regenerating shrublands and open fields along the Lake Ontario shoreline serve as transitional ecosystems and support a diverse range of riparian species.

The wetland communities surrounding the PN site are diverse, including swamp thickets, meadow marshes, and shallow marshes (TRCA, 2013). Key areas such as Hydro Marsh, Frenchman's Bay, and Krosno Creek feature vegetation dominated by emergent species like cattails (*Typha angustifolia*) and speckled alder (*Alnus incana*), with native species providing the majority of ground cover and species richness. Although non-native species like Common Reed (*Phragmites australis*) are present in some regions, the overall floristic quality and species diversity have remained stable (Golder, 2007c; Ecometrix, 2023a). In addition to Butternut, other species at risk recorded within the PN Study Area include Kentucky Coffee-tree (*Gymnocladus dioicus*), Red Mulberry (*Morus rubra*), and Slender Bush-clover (*Morus rubra*). However, these species have not been observed since 2000 (Beacon, 2022; OPG, 2016; TRCA, 2015a), and the Kentucky coffee-tree is thus no longer considered part of the PN Species list (Beacon, 2020).

4.5.2 Wildlife

The most recent species lists for the PN Study Area, up to and including 2023 (Beacon, 2023b), document a total of 807 species of flora and fauna, categorized into the following wildlife groups: 27 mammals, 10 reptiles and amphibians, 252 birds, 26 butterflies and moths, 18 dragonflies and damselflies, 64 fish, and 320 species of vascular plants.

The PN Study Area supports a variety of bird species, most of which are considered secure in the urban landscape of the greater Toronto region. Influenced by its location on Lake Ontario and the surrounding habitat, the area provides valuable stopover sites for migratory birds including waterfowl. As of 2023, 76 bird species were recorded as breeding within the site. Though there has been some fluctuation in the number of breeding bird species over last decade, the bird community is considered robust. Four new bird species were observed in 2023, including the American Bittern, Eastern Whip-poor-will, Red-headed Woodpecker, and Yellow-throated Vireo.

Bats were most recently surveyed in 2018 (Beacon, 2018), 2020 (Beacon, 2022)and 2022 (Beacon, 2023a). The last observation of bats on site was in 2020 (Beacon, 2022). This could be attributed to the complexity of the PN Study Area, which experiences significant anthropogenic activity throughout the day, evening, and overnight, likely discouraging bat use of the area.

Terrestrial animal species at risk that have been recorded in the PN Study Area (Beacon, 2017a, 2017b, 2018, 2022, 2023a, 2023b; OPG, 2016), along with their federal and provincial status are presented in **Table 4-17**. Since OPG inventories include incidental observations and migrants, the species listed in **Table 4-17** are not necessarily breeding within the PN site.

Most of the listed species were observed in the parklands, wetlands, and woodlands beyond the PN Site boundaries, with a few exceptions. In 2023, one Midland Painted Turtle was found in a screenhouse collection bin, and one Eastern Whip-poor will was found in the Screenhouse, likely as migrants from nearby areas. The Chimney Swift, last recorded as a group of four flying over the PN site in 2020, is not regularly observed on-site. While suitable nesting habitat may exist within site structures, this species forages widely and without additional evidence of breeding on site, these observations are considered only possible breeding records. Peregrine Falcon and Barn Swallow pairs have been confirmed to be breeding inside the Protected Area. OPG continues to monitor the presence, distribution, and breeding of species within and around the PN site and ensures compliance with federal and provincial legislation.

In 2021, the MECP issued OPG a Safe Harbour Stewardship Agreement (SHA) under Section 16(1) of the Endangered Species Act. The SHA allows OPG to test the performance and feasibility of an artificial nesting structure design for Bank Swallows. The design selected for the structure was a Fixed Face Earthen Embankment (FFEE) and was constructed to the east of the East Complex (just outside the PN Site boundary) in 2021. In accordance with the conditions of the SHA, OPG is required to undertake effectiveness monitoring of the FFEE for the duration of the conservation period, which is seven breeding seasons (i.e., 2021 – 2027). In 2023, during the third year of monitoring, Bank Swallows successfully colonized the artificial embankment for the first time. Similarly, in 2024, Bank Swallows colonized the artificial embankment. In both years, there was high occupancy and successful nesting by Bank Swallows.

Table 4-17: Terrestrial Animal Species at Risk Observed within the PN Study Area

Scientific Name	Common Name	Federal Species at Risk Status (SARA)[1]	Provincial ESA Status (SARO)[2]	Most Recent Year Observed
Amphibians and Reptiles				
Emydoidea blandingii	Blanding's turtle	Endangered	Threatened	2006
Chrysemys picta marginata	Midland Painted Turtle	Special Concern	-	2023
Birds				
Chaetura pelagica	Chimney Swift	Threatened	Threatened	2020
Contopus virens	Eastern Wood-Pewee	Special Concern	Special Concern	2022
Ixobrychus exilis	Least Bittern	Threatened[3]	Threatened	2023
Antrostomus vociferus	Eastern Whip-poor-will	Threatened[3]	Threatened	2023
Falco peregrinus	Peregrine Falcon	- [4]	Special concern	2023
Melanerpes Erythrocephalus	Red-headed woodpecker	Endangered	Endangered	2023
Hirundo rustica	Barn Swallow	Threatened[3]	Special Concern	2023
Chordeiles minor	Common Nighthawk	Special Concern	Special Concern	2010
Dolichonyx oryzivorus	Bobolink	Threatened[3]	Threatened	2006
Riparia riparia	Bank Swallow	Threatened	Threatened	2008
Butterflies and Moths				
Danaus plexippus	Monarch	Endangered	Special Concern	2023

Notes:
Statuses are up to date as of January 7th, 2025. Observations were included up to 2023.
The Provincial Species at Risk in Ontario List, Federal List of Wildlife Species at Risk (Schedule 1 of the Species at Risk Act (SARA)), and Committee on the Status of Endangered Wildlife in Canada (COSEWIC) lists are frequently revised.
(1) SARA Schedule 1 ranks species at risk as Extirpated, Endangered, Threatened Species and Special Concern. Prohibitions of the Act do not apply to species of Special Concern.
(2) The provincial Endangered Species Act (2007) came into effect on June 30, 2008 and it applies to species once they appear on the official list.
(3) The COSEWIC status of the Least Bittern, Eastern Whip-poor-will, Barn swallow, and Bobolink were assessed as Special Concern.
(4) The COSEWIC status of the Peregrine Falcon was assessed as Not at Risk.
Sources: (Beacon, 2017a, 2017b, 2018, 2022, 2023a, 2023b; OPG, 2016).

4.6 Radiation and Radioactivity

During normal operations, the PN site releases radiation fields into the surrounding environment. It is also a source of radionuclide emissions to air and water, as discussed in **Section 4.1.1.1** and **Section 4.2.2.1.3**, respectively. Radiation doses arising from these sources are discussed in the following sections.

4.6.1 Human Dose

In 2013, the annual Radiological Environmental Monitoring Program report was changed to the annual EMP report entitled "Results of Environmental Monitoring Programs". During this time, the EMP was redesigned to meet the requirements of CSA N288.4-10 (CSA, 2010) and expanded to include conventional contaminants, physical stressors and non-human biota, in addition to the radiological contaminants and human receptors. More recently, the EMP is now compliant with CSA N288.4-19 (CSA, 2019).

For the radiological exposure assessment, exposure point concentrations are either based on measured data from the annual EMP or modelled from emissions data, as described in the EMP report (OPG, 2024d). Additionally, when measurement averages or other calculations are performed, they are calculated using all results obtained, including detection limit values if the results are below the critical level for detection (OPG, 2024d).

Table 4-18 below presents a summary of the annual doses reported for the potential critical groups from 2021 to 2023. Although the current PN EMP design currently focuses on the Urban Resident, Dairy Farm, Sport Fisher, and Industrial Worker, the dose for receptors at the correctional institution is also reported to show variation in dose. **Table 4-19** presents a summary of the maximum dose to each limiting critical group from 2021 to 2023. The annual dose during the three-year period of interest (2021 to 2023) ranged from 1.5 to 2.0 µSv. The limiting critical group for all years was the Urban Resident (adult). The dominant pathways and radionuclides that contribute significantly to the total dose are inhalation of tritium and external exposure to noble gases. Overall, the reported annual doses between 2021 and 2023 are comparable with those presented in the recent 2022 PN ERA, which assessed annual doses from 2016 to 2020.

Table 4-18: Summary of Dose to Potential Critical Groups from 2021-2023

Year	Age Class	Radiological Dose (µSv/a)				
		Dairy Farm	Urban Resident	Sport Fisher	Correctional Institution	Industrial Worker
2021	Adult	0.30	1.99	0.38	1.00	1.56
	Child	0.35	1.74	0.43	1.03	--

Year	Age Class	Radiological Dose (µSv/a)				
		Dairy Farm	Urban Resident	Sport Fisher	Correctional Institution	Industrial Worker
	Infant	0.43	1.97	0.38	--	--
2022	Adult	0.35	1.94	0.17	0.98	1.45
	Child	0.40	1.76	0.19	1.04	--
	Infant	0.50	1.90	0.15	--	--
2023	Adult	0.38	1.54	0.19	0.94	1.42
	Child	0.47	1.31	0.20	0.98	--
	Infant	0.63	1.44	0.17	--	--

Source: (OPG, 2023b, 2023a, 2024d)

Table 4-19: Summary of Dose to Limiting Critical Group from 2021 to 2023

Year	Limiting Receptor Group	Effective Dose (µSv)	Percentage of Regulatory Limit (%)	Percentage of Dose from Canadian Background Radiation (%)
2021	Urban Resident (Adult)	1.99	0.20%	0.14%
2022	Urban Resident (Adult)	1.94	0.19%	0.14%
2023	Urban Resident (Adult)	1.54	0.15%	0.11%

Source: (OPG, 2023b, 2023a, 2024d)

4.6.1.1 Radiological Dose from the NSS-PWMF

Radiation fields outside the NSS-PWMF are due primarily to contributions from direct gamma radiation and secondarily from gamma skyshine. Given that radiation intensity decreases as distance from the source increases, the Sport Fisher is the only critical group for which gamma radiation would likely be measurable due to its relatively close proximity to the PN site compared to the other critical groups. Based on a study from 2017 (OPG, 2024d), at a distance

of 400 m from the NSS-PWMF, the measured air kerma rate was below the detection limit of 0.33 nGy/h. At a distance of 1 km from the NSS-PWMF, the air kerma rate was estimated to be negligible.

When the NSS-PWMF Dry Storage Container (DSC) Buildings #1 to #4 are filled to capacity, the calculated dose rate at the eastern lakeside exclusion zone boundary is $1.41x10^{-3}$ µSv/hr, or 1.41 µSv per year based on 1,000 hours occupancy (OPG, 2023i). This is conservative for the Sport Fisher who is assumed to have 1% occupancy at the outfall, or 87.6 hours per year. By adjusting the occupancy to 1%, the predicted total annual dose to the Sport Fisher from the NSS-PWMF when DSC Buildings #1 to #4 are at capacity is 0.124 µSv (**Table 4-20**).

Table 4-20: Dose Rate at the NSS-PWMF Exclusion Zone Boundary

Occupancy	Dose Rate – Full Capacity (µSv/h)	Annual Dose – Full Capacity (µSv)
1,000 hrs/yr (11%)	$1.41x10^{-3}$	1.41
87.6 hrs/yr (1%)	$1.41x10^{-3}$	0.124

Source: (OPG, 2023i)

4.6.2 Ecological Dose

Ecological receptors are exposed to radiation fields and radionuclides released by the PN site during normal operations.

In the 2022 PN ERA, radiation dose benchmarks of 400 µGy/h (9.6 mGy/d) and 100 µGy/h (2.4 mGy/d) (UNSCEAR, 2008) were selected for the assessment of radiological effects on aquatic biota and terrestrial biota, respectively, as recommended in the CSA N288.6 standard. This is a total dose benchmark, therefore the dose to biota due to each radionuclide of concern is summed to compare against this benchmark. Further information as to the selection of these benchmarks is provided in Section 4.3.2 of the 2022 PN ERA (Ecometrix, 2023a).

A summary of estimated radiological doses for ecological receptors from the 2022 PN ERA is provided in **Table 4-21** below.

No exceedances of the selected radiation dose benchmarks were reported for any terrestrial and aquatic receptors assessed in the 2022 PN ERA, a conclusion shared with the prior 2017 PN ERA report. The most recent maximum terrestrial dose was estimated to be $2.79x10^{-2}$ mGy/d for the Ring-billed Gull assessed at the Outfall. This dose represents 1.2% of the radiological dose benchmark of 100 µGy/h (2.4 mGy/d) for terrestrial ecological receptors. The maximum aquatic dose was estimated to be $3.82x10^{-2}$ mGy/d for benthic invertebrates in the Outfall. This dose represents 0.4% of the radiological dose benchmark of 400 µGy/h (9.6 mGy/d) for aquatic ecological receptors.

The above results represent an improvement in the existing radiological conditions at the PN site from the earlier 2014 PN ERA, where it was estimated that the terrestrial radiological dose benchmark of 100 µGy/h (2.4 mGy/d) was exceeded for the Earthworm and Red-winged Blackbird receptors at the PN Site. It was noted at the time that the areas of high radiological exposure are highly localized near the reactor buildings and do not present a risk to populations of earthworms and other soil-dwelling organisms across the overall PN site. The exceedance of the terrestrial benchmark for the Red-winged Blackbird was determined to be driven by the assumed ingestion of maximally exposed earthworms; however, since the blackbird is a mobile receptor and is unlikely to be ingesting maximally exposed earthworms at all times, the calculated mean dose was considered a more representative dose for the blackbird, which did not exceed the dose benchmark.

Overall, ecological receptors are not expected to be at risk of radiological effects from current environmental conditions at the PN site.

4.6.2.1 Radiological Dose from the NSS-PWMF

The dose rate for ecological receptors within the immediate vicinity of the NSS-PWMF could be up to 0.5 µGy/h (0.012 mGy/d), assuming full capacity of the NSS-PWMF (OPG, 2023i). The dose rate to any ecological receptors at the closest PN property boundary would be lower than 0.5 µGy/h (0.012 mGy/d). As noted in the 2022 PN ERA (Ecometrix, 2023a), the above assumption is conservative as it assumes the receptor is always located at the NSS-PWMF and does not incorporate an occupancy factor based on the fraction of time a receptor is likely to be in close proximity to the NSS-PWMF.

As noted above, the maximum dose rate to any ecological receptor residing in close proximity to the NSS-PWMF could be up to 0.012 mGy/d, which is lower than the 2.4 mGy/d radiation benchmark for terrestrial biota. When considering the maximum dose from the NSS-PWMF (1.20×10^{-2} mGy/d) together with the maximum dose to any ecological receptor (2.79×10^{-2} mGy/d for the Ring-Billed Gull) from being exposed to radionuclides through other existing PN operations (see **Table 4-21**), the total combined dose of 3.99×10^{-2} mGy/d remains below the 2.4 mGy/d radiation benchmark for terrestrial biota.

Table 4-21: Summary of Radiation Dose Estimates for Biota at the Pickering Site

Location	Receptor	Units	C-14		Cs-134		Cs-137		Co-60		Tritium (HTO+OBT)		I-131		Ar-41		Total Dose	
			Max	UCLM	Max	UCLM	Max	UCLM	Max	UCLM	Max	UCLM	Max	UCLM	Max	UCLM	Max	UCLM
Outfall	Benthic Fish	mGy/d	3.96E-05	2.18E-05	2.37E-02	1.47E-03	1.28E-06	6.78E-07	7.75E-07	5.58E-07	2.74E-05	2.43E-06	-	-	-	-	2.38E-02	1.49E-03
	Pelagic Fish	mGy/d	1.43E-05	3.11E-06	1.56E-02	9.61E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-05	1.17E-05	-	-	-	-	1.56E-02	9.76E-04
	Benthic Invertebrate	mGy/d	1.40E-05	3.04E-06	3.82E-02	2.36E-03	0.00E+00	0.00E+00	3.36E-06	2.42E-06	2.58E-05	1.17E-05	-	-	-	-	3.82E-02	2.38E-03
	Ring-Billed Gull	mGy/d	4.43E-03	2.03E-03	2.29E-02	1.44E-03	2.37E-05	2.37E-05	3.97E-05	3.93E-05	5.17E-04	2.16E-04	1.01E-11	1.76E-12	7.05E-05	9.82E-06	2.79E-02	3.76E-03
PN Site	Earthworm	mGy/d	1.81E-04	3.63E-05	2.00E-05	2.00E-05	7.35E-06	7.35E-06	3.14E-05	3.10E-05	5.96E-04	2.47E-04	1.06E-08	1.84E-09	7.05E-05	9.82E-06	9.07E-04	3.52E-04
	Grass/Shrub	mGy/d	2.16E-04	4.33E-05	7.54E-05	7.54E-05	2.86E-05	2.86E-05	1.16E-04	1.12E-04	5.74E-04	2.38E-04	1.02E-07	1.77E-08	7.05E-05	9.82E-06	1.08E-03	5.07E-04
	Pine	mGy/d	2.16E-04	4.33E-05	2.25E-05	2.25E-05	8.14E-06	8.14E-06	3.54E-05	3.40E-05	5.74E-04	2.38E-04	5.77E-09	1.00E-09	7.05E-05	9.82E-06	9.26E-04	3.55E-04
	Red-winged Blackbird	mGy/d	3.68E-04	7.39E-05	3.30E-05	3.16E-05	1.14E-05	1.14E-05	4.78E-05	4.69E-05	3.25E-04	1.35E-04	8.19E-11	1.42E-11	7.05E-05	9.82E-06	8.56E-04	3.08E-04
	Red-tailed Hawk	mGy/d	4.84E-04	9.70E-05	3.34E-05	3.15E-05	1.13E-05	1.13E-05	4.69E-05	4.68E-05	1.85E-04	7.69E-05	2.84E-11	4.92E-12	7.05E-05	9.82E-06	8.30E-04	2.73E-04
	Red Fox	mGy/d	2.95E-03	1.33E-03	3.54E-05	3.41E-05	2.85E-05	2.83E-05	4.54E-05	4.54E-05	3.27E-04	1.36E-04	2.35E-09	4.07E-10	7.05E-05	9.82E-06	3.46E-03	1.58E-03
	Meadow Vole	mGy/d	4.34E-04	8.69E-05	3.18E-05	3.13E-05	1.17E-05	1.17E-05	4.95E-05	4.94E-05	2.51E-04	1.05E-04	1.27E-08	2.20E-09	7.05E-05	9.82E-06	8.48E-04	2.94E-04
	White-tailed Deer	mGy/d	4.34E-04	8.69E-05	2.30E-05	1.66E-05	5.87E-06	5.87E-06	2.63E-05	2.52E-05	2.83E-04	1.18E-04	8.22E-08	1.42E-08	7.05E-05	9.82E-06	8.42E-04	2.62E-04
Frenchman's Bay	White Sucker	mGy/d	1.74E-03	9.15E-04	1.72E-03	1.72E-03	1.55E-03	1.54E-03	3.92E-05	3.23E-05	6.16E-06	4.10E-06	-	-	-	-	5.05E-03	4.21E-03
	Lake Trout	mGy/d	1.74E-03	9.15E-04	1.72E-03	1.72E-03	1.54E-03	1.54E-03	3.06E-05	3.06E-05	6.16E-06	4.10E-06	-	-	-	-	5.03E-03	4.21E-03
	Frog	mGy/d	1.74E-03	9.15E-04	8.10E-04	8.10E-04	1.13E-03	1.12E-03	2.09E-05	1.33E-05	6.16E-06	4.10E-06	-	-	-	-	3.70E-03	2.87E-03
	Aquatic Plant	mGy/d	1.80E-03	9.47E-04	6.44E-05	6.43E-05	8.19E-05	7.59E-05	1.79E-04	1.71E-04	5.95E-06	3.96E-06	-	-	-	-	2.13E-03	1.26E-03
	Benthic Invertebrate	mGy/d	1.70E-03	8.93E-04	3.17E-05	3.10E-05	6.24E-05	3.56E-05	5.40E-05	2.42E-05	6.18E-06	4.11E-06	-	-	-	-	1.85E-03	9.88E-04
	Bufflehead	mGy/d	7.28E-03	3.83E-03	8.87E-05	8.85E-05	8.45E-05	7.55E-05	6.34E-05	5.50E-05	1.11E-05	6.50E-06	1.28E-14	2.23E-15	9.84E-06	3.71E-06	7.54E-03	4.06E-03
	Common Tern	mGy/d	3.51E-03	1.85E-03	2.17E-03	2.17E-03	1.85E-03	1.85E-03	2.68E-05	1.87E-05	7.94E-06	4.41E-06	1.21E-14	2.10E-15	9.84E-06	3.71E-06	7.58E-03	5.90E-03
	Trumpeter Swan	mGy/d	3.51E-03	1.85E-03	1.26E-04	1.26E-04	1.14E-04	1.06E-04	1.80E-04	1.71E-04	7.78E-06	4.30E-06	1.37E-14	2.37E-15	9.84E-06	3.71E-06	3.94E-03	2.26E-03
	Ring-Billed Gull	mGy/d	1.05E-02	5.55E-03	1.34E-03	1.34E-03	1.15E-03	1.14E-03	5.90E-05	5.10E-05	1.55E-05	9.06E-06	1.33E-14	2.31E-15	9.84E-06	3.71E-06	1.31E-02	8.09E-03
	Muskrat	mGy/d	2.89E-03	1.52E-03	7.94E-05	7.92E-05	8.59E-05	7.87E-05	1.66E-05	8.12E-06	7.33E-06	4.19E-06	8.86E-13	1.53E-13	9.84E-06	3.71E-06	3.09E-03	1.70E-03

Source: (Ecometrix, 2023a)

Notes:

Dashed line indicates radionuclide not assessed for the specified receptor.

Bold and shaded values exceed the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d.

Max and mean dose for Cobalt-60, Cesium-134, and Cesium-137 are generally equivalent for most receptors since their concentrations in surface water, sediment, and soil were generally measured below the detection limit. Iodine-131 and Argon-41 are only applicable to terrestrial and riparian biota.

HTO – tritiated water; OBT – organically bound tritium

4.7 Uncertainty in the Existing Conditions

Considering the effort spent in 2024 and 2025 to collect additional data on existing conditions at the PN site, including supplementary studies for air quality data, noise levels, surface water and sediment quality, soil quality, fish tissue, and aquatic habitat characterization; along with OPG's routine annual environmental and groundwater monitoring programs, the PN Site is well-characterized.

For this PERA, less than 2 months (beginning of January 2025 to middle of February 2025) of air monitoring data were available, which are used to represent existing air quality conditions in **Section 4.1.1**. The air monitoring study for existing conditions will continue so that 6 months of data will be collected. The additional air quality result will be incorporated into the next revision of the PERA.

Aquatic monitoring studies were completed based on project planning for the DWI at the time when the studies were designed. Further data collection is planned for 2025 for the aquatic environment to accommodate the changes to DWI planning since the studies were initiated. The additional aquatic environment results will also be incorporated in the next revision of the PERA.

No other residual uncertainties in the existing environment site characterization have been identified.

5.0 Tier 1 Qualitative Assessment

This section presents the qualitative Tier 1 assessment to identify Project interactions that are not bounded by existing conditions or previous assessments. The qualitative assessment utilizes the description of activities identified in **Section 3.0** that are planned to occur during PNGS Units 1-4 decommissioning and PNGS Units 5-8 refurbishment and continued operations, and the understanding of existing conditions identified in **Section 4.0** to identify potentially increasing interactions with environmental components during the Project phases.

Where Project-environment interactions are bounded by previous operational conditions as assessed in the 2022 PN ERA for 6 operating units (Ecometrix, 2023a), or other assessments such as the 2017 Safe Storage PEA and 2022 PEA Addendum, they are considered to be adequately assessed and are not considered further in this PERA. The existing operating licence for PNGS allows for OPG to operate PNGS Units 1 and 4 until the end of 2024, operate PNGS Units 5-8 until the end of 2026, and perform Stabilization and SWS activities.

As shown in the conceptual timeline for the Project in **Figure 1-2**, there will be activities occurring in one phase that occur at the same time as another phase. For example, while PNGS Units 1 and 4 are in the Stabilization Phase, and PNGS Units 2 and 3 are in SWS phase, risk reduction and removal activities will also occur, along with PNGS Units 5-8 refurbishment activities, and construction of the DWI. The assessment by environmental component considers activities that are occurring at the same time, where relevant.

Those Project-environment interactions not readily bounded by previous operational conditions in the 2022 PN ERA (for 6 operating units), or by previous assessment in the 2017 Safe Storage PEA and 2022 PEA Addendum, are considered in this PERA to identify whether predicted effects could exceed accepted screening values for the protection of human health and the environment. If screening values are predicted to be exceeded, the interactions are evaluated further in the Tier 2 quantitative assessment (**Section 6.0**).

The results of the qualitative assessment of Project-environment interactions are shown in **Table 5-1** and described in the subsections below by environmental component: atmospheric environment (air, noise), surface water environment (surface water flow, surface water and sediment quality), geological and hydrogeological environment (soil, groundwater), radiation and radioactivity, aquatic environment (fish and fish habitat, benthic invertebrates), and terrestrial environment (vegetation, wildlife).

Table 5-1: Identification of Project-Environment Interactions

Project Activities	Atmospheric Environment (Air/Noise)	Surface Water Environment - Flow	Surface Water Environment - Quality	Hydrogeological and Geological Environment – Groundwater Flow	Hydrogeological and Geological Environment – Groundwater Quality	Hydrogeological and Geological Environment - Soils	Radiation and Radioactivity (Gamma Radiation Field)	Terrestrial Environment	Aquatic Environment
PNGS Units 1-4 Decommissioning									
PNGS Units 1 and 4 Stabilization	✓	✓	✓	✓	✓	✓	✓	✓	✓
PNGS Units 1-4 Storage with Surveillance	✓	✓	✓	✓	✓	✓	✓	✓	✓
Risk Reduction and Removal Activities	✓	-	-	✓	✓	✓	-	✓	-
Dismantle/Demolish	✓	-	-	✓	✓	✓	✓	✓	-
PNGS Units 5-8 Refurbishment									
Preparation for Refurbishment									
• Procurement and Mobilization of Equipment and Components	✓	-	-	-	-	-	-	✓	✓
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	✓	-	-	✓	-	✓	-	✓	-
• Construction of PCSS and SB #5	✓	-	-	✓	-	✓	-	✓	-
• Defuel and Dewater	✓	✓	✓	-	-	-	-	-	-
• Islanding the Unit	-	-	-	-	-	-	-	-	-
• Management of Heavy Water	✓	-	-	-	-	-	-	-	-
• Construction of DWI	✓	✓	✓	-	-	-	-	✓	✓
Refurbishment									
• Replacement of Reactor Components	✓	-	-	-	-	-	-	-	-
• Removal and Replacement of Steam Generators	✓	-	-	-	-	-	-	-	-
• Operation of DWI	-	✓	✓	-	-	-	-	-	✓
• Refurbishment of Other Plant Systems	✓	-	-	✓	-	-	-	-	-
• Waste Management and Transportation	✓	-	-	-	-	-	✓	✓	-
• Refuelling and Restarting	✓	✓	✓	-	-	-	-	-	-

Project Activities	Atmospheric Environment (Air/Noise)	Surface Water Environment - Flow	Surface Water Environment - Quality	Hydrogeological and Geological Environment – Groundwater Flow	Hydrogeological and Geological Environment – Groundwater Quality	Hydrogeological and Geological Environment - Soils	Radiation and Radioactivity (Gamma Radiation Field)	Terrestrial Environment	Aquatic Environment
Continued Operations									
• Operation and Maintenance of PNGS Units 5-8	✓	✓	✓	✓	✓	✓	✓	✓	✓
• Waste Management and Transportation	✓	-	-	-	-	-	✓	✓	-

Notes:

✓: Indicates an interaction between the Project activity and the environmental component. The Tier 1 assessment determines if this interaction is negligible and/or bounded by another previous assessment (2017 Safe Storage PEA and 2022 PEA Addendum, the PCSS PERA, or 2022 PN ERA), or if further quantitative evaluation in the Tier 2 assessment is warranted.

- : Indicates no interaction between the Project activity and the environmental component.

5.1 Atmospheric Environment

5.1.1 Air Quality

5.1.1.1 PNGS Units 1-4 Decommissioning

5.1.1.1.1 Stabilization and Storage with Surveillance

Non-Radiological Emissions

As stated in the 2017 Safe Storage PEA and updated in the 2022 PEA Addendum, non-radiological emissions will gradually decrease during the Stabilization Phase compared to previous operations (6 operating units). Steam generating boilers for electricity production are the only emission sources with the potential to change emissions notably. Starting in 2026, emissions will be reduced, 4 electrode boilers will be used to provide steam for building heating. The Auxiliary Boiler will be standby and only used if required to meet peak load. No other substantial changes to non-radiological atmospheric emission sources are anticipated. These findings from the 2017 Safe Storage PEA and updated in the 2022 PEA Addendum continue to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

Radiological Emissions

As indicated in the 2017 Safe Storage PEA and 2022 PEA Addendum, tritium is released to the environment during reactor dewatering and draining during the Stabilization Phase. It was concluded that previous operational conditions (for 6 operating units) are bounding of tritium emissions to air during the Stabilization Phase. Additionally, tritium and C-14 emissions during SWS will be even lower and remain below existing emissions assessed in the 2022 PN ERA (for 6 operating units). Even though tritium and C-14 emissions are expected to be lower than existing emissions (for 6 operating units), the 2017 Safe Storage PEA evaluated the resulting radiation dose to human receptors in the vicinity of PN and it was determined to be a small fraction of the public dose limit. These findings from the 2017 Safe Storage PEA and updated in the 2022 PEA Addendum continue to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

While no specific radiological COPCs were identified for the atmospheric environment during Stabilization and SWS, general feedback from the WTFNs during engagement on other PERAs has indicated that it would be beneficial to include a Harvester receptor, to account for Indigenous people who may live and work near the facility and consume traditional foods harvested near the facility. As such, assessment of a Harvester for atmospheric radiological emissions is considered in the Tier 2 quantitative assessment.

The 2022 PEA Addendum identified that approximately 1,500 Mg of heavy water (D_2O) will be transported to the Darlington Nuclear (DN) site for storage towards the end of the Stabilization Phase at the DN Heavy Water Management Building – West Annex. The movement of heavy water to the DN site may result in some additional releases of tritium to air during the

Stabilization Phase due to venting. However, PN currently transports heavy water to Darlington on a routine basis to modulate tritium concentration in the heavy water inventory. OPG will continue to use existing processes and practices of transporting heavy water and the frequency for transporting heavy water will be bounded by previous operational conditions (for 6 operating units). Additionally, OPG will manage heavy water in accordance with the D_2O Management Plan for Pickering Safe Storage. These findings from the 2022 PEA Addendum continue to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

One activity not assessed in the 2017 Safe Storage PEA and 2022 PEA Addendum is removal of modules and baskets from the AIFB and IFB-A. As fuel is removed, empty baskets and associated frames will be removed from the AIFB and IFB-A and disposed of using existing waste routes (see **Section 3.3.3.1**). The modules and baskets will have some radiological contamination. All waste being transported will be radiologically surveyed before transportation and disposal, as part of best practices and in accordance with procedures for waste removal. If waste is identified that does not meet clearance criteria, OPG has procedures in place to appropriately handle radioactive waste before and during transportation.

5.1.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities. As identified in **Section 3.3.4**, during the 2025 to 2033 timeframe OPG plans to initiate risk reduction and removal activities, which will include dismantling of non-nuclear systems and outbuildings. More specifically, PE-A (Groups A-1 and A-2) includes dismantling and removal of end-stated and abandoned/retired structures within the PNGS Units 1-4 protected area, excluding the main powerhouse structure; and PE-B (Groups B-1 and B-2) includes the dismantling and removal of SSCs considered to be non-nuclear that are located within the TH and TAB.

From 2034 to 2037, OPG plans to execute PE-A (Group A-3) which includes complete removal of non-nuclear outbuildings, as identified in **Figure 3-7**.

Non-Radiological Emissions

During dismantling of non-nuclear systems and outbuildings, air emissions may result from general activities such as clearing of the work area and accessing the structure, which involve vehicle movement, and lifting and removing structures. Dismantling and/or segmenting larger tanks and water lines may emit particles or fumes from the grinding work. It is expected that all grinding and segmentation work would be carried out indoors in a ventilated environment. Work related to CCW lines may include hazards from asbestos in gaskets, tiles and insulation. These hazards will be mitigated by complying with OPG's Asbestos management procedures. OPG will follow typical construction best practices including implementation of an Environmental Management Plan. The decommissioning phase work plan will include protocols for dust suppression to reduce the release of particulates and dust into the atmosphere. Vehicle

traffic associated with transporting dismantled material off-site will be similar to or slightly higher than the traffic associated with current PN operations; thus, the slight increase of traffic volumes would overall be considered negligible. OPG's implementation of the Environmental Management Plan is sufficient to mitigate the expected negligible impacts.

Radiological Emissions

No radiological atmospheric emissions to the environment are expected during the dismantling and demolition activities. Other than removal of frames and baskets from IFB-A and AIFB, none of the dismantled equipment are from radiological systems or systems that are likely to be radiologically contaminated. All waste being transported will be radiologically surveyed before transportation and disposal, as part of best practices and in accordance with existing procedures of waste removal.

Execution of PE-A-3 (dismantle/demolish activities from 2034 to 2037) involves complete removal of non-nuclear outbuildings shown in **Figure 3-7**. Complete removal for these specific non-nuclear outbuildings may have residual radiological contamination. The specific plans for environmental risk mitigation and strategy to execute any radiological work safely will be determined via the completion of a Decommissioning Safety Assessment, which is planned for the next DDP update. All SSCs will be characterized prior to dismantling and demolishing in accordance with OPG's Characterization Implementation Strategy which follows industry best practices (OPG, 2024j).

Overall, air emissions during risk reduction and dismantle/demolish activities during this licensing period will be similar to that assessed in the 2022 PN ERA with 6 operating units; therefore, no further assessment is warranted in the PERA.

5.1.1.2 PNGS Units 5-8 Refurbishment

Non-Radiological Emissions

During routine operations at the PN site, there are emissions to air from boiler chemicals, ventilation and chemical use, combustion equipment, and vehicular movement. During preparation for refurbishment, releases to the atmospheric environment are expected from construction activities as well as activities during refurbishment such as replacement of reactor components, removal and replacement of steam generators, waste management, and refuelling and restarting. Similar to SWS, during Refurbishment, in 2026 the heating source will transition to electric boilers and the Auxiliary Boiler will be available on standby.

To support this PERA, a maximum bounding emission scenario was developed to assess the effects of refurbishment and decommissioning activities. The bounding scenario considered was the combined emissions from activities that will occur on the PN site in 2027 for both PNGS Units 5-8 refurbishment as well as PNGS Units 1-4 decommissioning activities. A screening activity was performed to identify all activities that will occur during all Project phases, and the

year 2027 was identified as the bounding case where maximum emissions from equipment and vehicular traffic are expected.

Potential effects associated with site and facility preparation for refurbishment, management of heavy water, transfer of low and intermediate level refurbishment waste, transportation of low and intermediate level refurbishment waste, and the management of non-nuclear waste were not considered for the bounding scenario as they are only a small fraction of the potential effects from the bounding emission scenario.

Construction equipment, such as cranes, forklifts, excavators and loaders, will be used during the site preparation earthworks and the removal and replacement of steam generators, and will result in the release of constituents such as particulate matter, carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), PAHs, and VOCs.

During preparation for refurbishment, the PCSS, RFRISA, and other buildings needed to support refurbishment will be constructed. Activities associated with the construction of the PCSS for the storage of low and intermediate-level refurbishment waste were assessed as part of the PCSS PERA (Ecometrix, 2024). The activities associated with construction of the RFRISA are expected to be similar to the PCSS. While construction of these buildings is not explicitly included in the updated air model for this PERA, the results of the air model are considered bounding of building construction.

Additionally, construction is planned for SB #5 in the PWMF Phase II Site for future storage of used fuel, with an in-service date of Q3 2027. Assessment of the construction of SB #5 was completed as part of the approved Pickering B Refurbishment EA.

During refurbishment, the steam generators (also known as boilers) will be physically removed and replaced. A temporary construction opening will be created in the roof of the reactor buildings to allow for extraction of the large steam generators. It is assumed that any concrete cutting will be done with wet methods (i.e., hydrojet cutting) and will have spray drift covers, thus ensuring that dust emissions are minimal.

Refurbishment activities will also involve metal cutting and welding within the reactor buildings to remove and replace reactor components. The reactor buildings will generally remain sealed; therefore, emissions from this activity would be contained within the building. Given that these activities would still occur within the building and would likely be minimized during these complicated lift operations, emissions released from the building are considered to be insignificant and are not considered further.

The maximum bounding emission scenario also considered on-site vehicular traffic (approximately 2,200 vehicles per day), specifically haul trucks for movement of material associated with refurbishment activities (i.e., hauling of excavated materials, concrete trucks supporting construction), as well as employee and delivery traffic from previous conditions (with 6 operating units) and additional refurbishment contract employee and delivery traffic.

Sources of emissions considered in the model included combustion emissions from construction equipment, activity in the harbour (tugboats), tailpipe emissions and re-suspended road dust generated by vehicle movements, wind-blown dust from construction sites, and dust generated from material handling (e.g., fugitive dust from transferring excavated materials to trucks). With regard to combustion emissions, it was assumed that diesel fuel would be used to run construction equipment. With regard to fugitive dust emissions (i.e., from road dust, wind erosion and material handling), it was assumed that watering methods would be utilized as a dust control measure, and this was accounted for in the modelling. The constituents that were modelled included: nitrogen dioxide, sulphur dioxide, carbon monoxide, total suspended particulates, $PM_{2.5}$, PM_{10}, benzo(a)pyrene (surrogate for total PAHs), and acrolein (representative of VOCs).

5.1.1.2.1 Screening of Atmospheric Non-Radiological Constituents of Potential Concern

The modelled concentrations of non-radiological COPCs in air were compared against provincial and federal ambient air quality standards, including the MECP Ambient Air Quality Criteria (AAQCs) (MECP, 2023) and Canadian Ambient Air Quality Standards (CAAQS) from the Canadian Council of Ministers of the Environment (CCME) (CCME, 2019) to determine whether modelled concentrations of atmospheric COPCs could pose a risk to human and ecological receptors. Modelled concentrations were directly compared to guidelines with the same averaging periods. The air quality criteria with averaging times of 24 hours or longer are considered protective of chronic health effects, while air quality criteria with averaging times of 1-hr and 8-hr are considered protective of short-term health effects. The air quality guidelines used as part of this risk assessment are shown in **Table 5-2**. The human and ecological receptor locations retained for the air quality modelling assessment are shown in **Figure 5-1** and **Figure 5-2**, respectively.

The human receptor locations are generally consistent with existing receptor locations considered in OPG's existing annual EMP (OPG, 2024d) and the 2022 PN ERA (Ecometrix, 2023a), except for the new Harvester and three Local Harvesting Area locations. The Harvester is assumed to live close to the PN site (at the Urban Resident) and also hunts and gathers traditional foods at Hydro Marsh (R1-R3, three local harvesting areas). The ecological receptor locations were chosen from a larger list of locations used in the air quality and noise modelling for the PERA. Some locations overlap with those in the 2022 PN ERA, and an additional location (R3) was included to represent ecological receptors in Hydro Marsh.

A summary of the predicted exceedances of applicable ambient air quality criteria are shown in **Table 5-3**. Detailed results of the air modelling and comparison with applicable ambient air quality criteria are presented from **Table 5-4** to **Table 5-11**. Further discussion of ambient air quality criteria exceedances, and a summary of the non-radiological emission screening, are provided in **Section 5.1.1.2.2.1** and **Section 5.1.1.2.2.2** for human and ecological receptors, respectively.

Table 5-2: Ambient Air Quality Screening Criteria

Constituent	Units	Averaging Period	Value	Basis	Reference	Notes
Total suspended particulates (TSP)	µg/m^3	24-hr	120	Visibility	(MECP, 2023)	--
	µg/m^3	Annual	60	Visibility	(MECP, 2023)	--
Particulate matter <10 µm (PM_{10})	µg/m^3	24-hr	50	Health	(MECP, 2023)	--
Particulate matter <2.5 µm ($PM_{2.5}$)	µg/m^3	24-hr	27	Health / Environment	(CCME, 2019; MECP, 2023)	--
	µg/m^3	Annual	8.8	Health / Environment	(CCME, 2019; MECP, 2023)	--
Sulphur dioxide (SO_2)	µg/m^3	1-hr	170	Health / Environment	(CCME, 2019)	Converted from 65 ppb, where 1 ppb of SO_2 is equal to 2.62 µg/m^3 at 20°C and 1 atm.
	µg/m^3	1-hr	105	Health	(MECP, 2023)	Converted from 40 ppb, where 1 ppb of SO_2 is equal to 2.62 µg/m^3 at 20°C and 1 atm.
	µg/m^3	Annual	11	Vegetation	(CCME, 2019; MECP, 2023)	Converted from 4 ppb, where 1 ppb of SO_2 is equal to 2.62 µg/m^3 at 20°C and 1 atm.
Nitrogen dioxides (as NO_2)	µg/m^3	1-hr	79	Health / Environment	(CCME, 2019)	Converted from 42 ppb, where 1 ppb of NO_2 is equal to 1.88 µg/m^3 at 20°C and 1 atm.
	µg/m^3	1-hr	400	Health	(MECP, 2023)	--
	µg/m^3	24-hr	200	Health	(MECP, 2023)	--

Constituent	Units	Averaging Period	Value	Basis	Reference	Notes
	µg/m^3	Annual	23	Health / Environment	(CCME, 2019)	Converted from 12 ppb, where 1 ppb of NO_2 is equal to 1.88 µg/m^3 at 20°C and 1 atm.
Carbon monoxide (CO)	µg/m^3	1-hr	36,200	Health	(MECP, 2023)	--
	µg/m^3	8-hr	15,700	Health	(MECP, 2023)	--
Acrolein	µg/m^3	1-hr	4.5	Health	(MECP, 2023)	Surrogate for Volatile Organic Compounds (VOCs) without separate AAQC.
	µg/m^3	24-hr	0.4	Health	(MECP, 2023)	
Benzo(a)pyrene (BaP)	µg/m^3	24-hr	0.00005	Health	(MECP, 2023)	Surrogate for total Polycyclic Aromatic Hydrocarbons (PAHs) without separate AAQC
	µg/m^3	Annual	0.00001	Health	(MECP, 2023)	

Notes:
µg/m^3 – micrograms per cubic meter
ppb – parts per billion
atm – standard atmosphere of pressure
MECP, 2023 – Ontario's Ambient Air Quality Criteria (AAQC)
CCME, 2019 – CCME's Canadian Ambient Air Quality Standards (CAAQS)

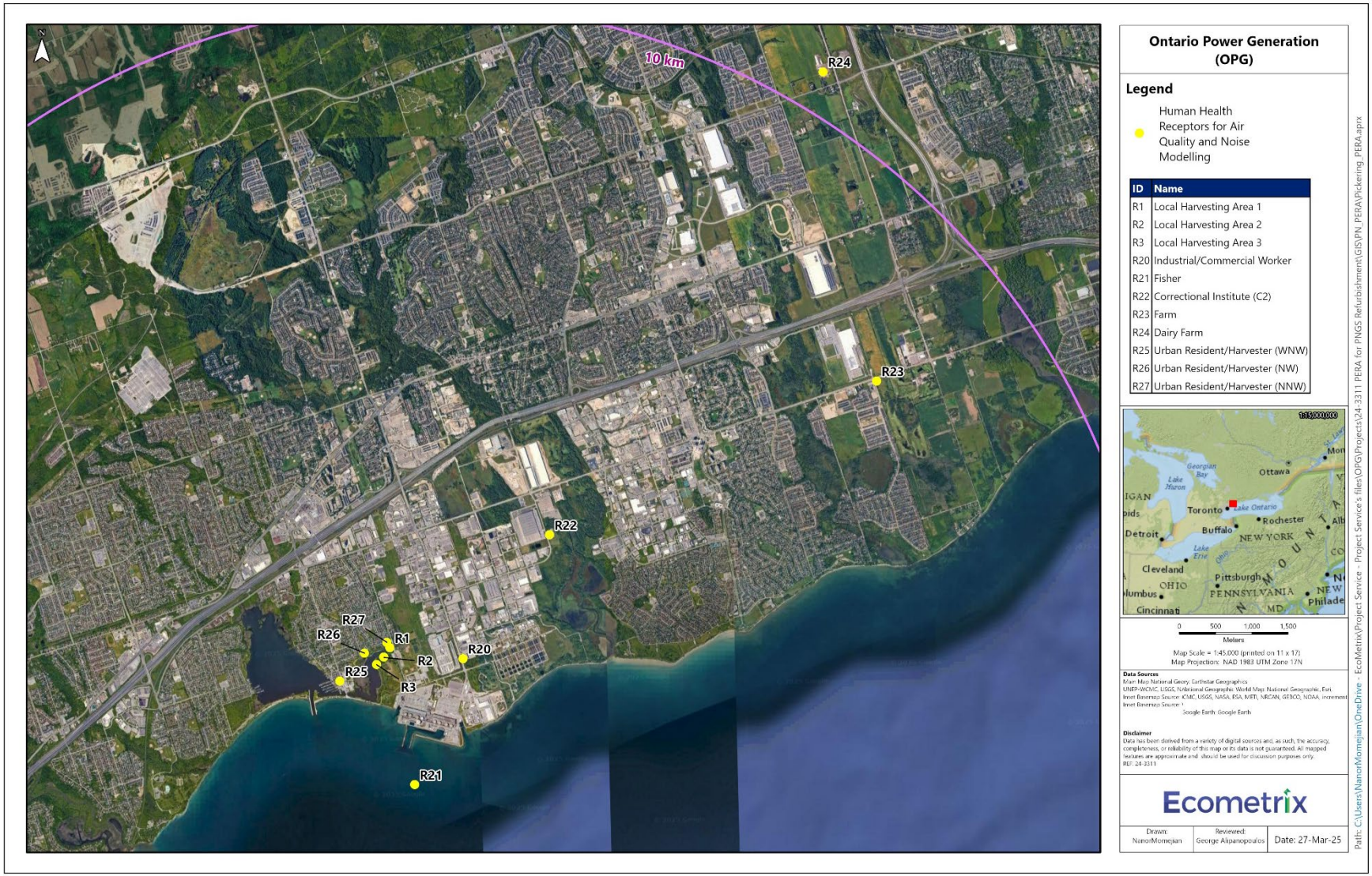


Figure 5-1: Human Health Receptors for Air Quality and Noise Modelling

Figure 5-2: Ecological Receptor Locations for the Air Quality and Noise Modelling

Table 5-3: Summary of Exceedances of Ambient Air Quality Guidelines during PNGS Units 5-8 Refurbishment

Constituent	Averaging Period	Existing Conditions	Refurbishment
Total suspended particulates (TSP)	24-hr	-	✓
	Annual	-	-
Particulate matter <10 µm (PM_{10})	24-hr	-	✓
Particulate matter <2.5 µm ($PM_{2.5}$)	24-hr	-	✓
	Annual	-	-
Sulphur dioxide (SO_2)	1-hr (CCME)	-	-
	1-hr (AAQC)	-	-
	Annual	-	-
Nitrogen dioxides (as NO_2)	1-hr (CAAQS)	-	✓
	1-hr (AAQC)	-	✓ (on-site)
	24-hr	-	-
	Annual	-	✓ (on-site)
Carbon monoxide (CO)	1-hr	-	-
	8-hr	-	-
Acrolein	1-hr	-	-
	24-hr	-	-
Benzo(a)pyrene (BaP)	24-hr	✓	✓
	Annual	✓	✓

Notes:
✓ = exceedance of ambient air quality criteria at both human and ecological receptor locations.
✓ (on-site) = exceedance of ambient air quality criteria at on-site ecological receptor locations only.
- = no exceedance of ambient air quality criteria.

5.1.1.2.2 Discussion of Air Quality Modelling Results

5.1.1.2.2.1 Human Health

Ambient air concentrations at the human receptor locations shown in **Figure 5-1** were predicted for different averaging periods for TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, acrolein, and BaP. It is acknowledged that there are exceedances of the selected air quality criteria for some constituents at a number of the human receptor locations. The specific predicted exceedances are discussed below:

- TSP (**Table 5-4**): There are no exceedances of the annual TSP criterion of 60 µg/m^3 at any of the human receptor locations. There are predicted exceedances of the 24-hr TSP criterion of 120 µg/m^3 at a number of receptor locations, including the three local harvesting areas, the industrial/commercial worker, the correctional institute (C2), and the three urban resident/harvester locations. Except for the industrial/commercial worker, exceedances of the 24-hr criterion for TSP at the other receptor locations tend to be relatively infrequent (<45 days per year, representing approximately 12% of the year).

- PM_{10} (**Table 5-5**): There are predicted exceedances of the 24-hr PM_{10} criterion of 50 µg/m^3 at a number of receptor locations, including the three local harvesting areas, the industrial/commercial worker, and the three urban resident/harvester locations. Except for the industrial/commercial worker, exceedances of the 24-hr criterion for PM_{10} at the other receptor locations tend to be relatively infrequent (<8 days per year, representing approximately 2% of the year).

- $PM_{2.5}$ (**Table 5-6**): There are no exceedances of the annual $PM_{2.5}$ criterion of 8.8 µg/m^3 at any of the human receptor locations. There are predicted exceedances of the 24-hr $PM_{2.5}$ criterion of 27 µg/m^3 at one receptor location, specifically the industrial/commercial worker. Exceedances at the industrial/commercial worker are predicted to occur 249 days of the year.

- NO_2 (**Table 5-7**): There are no predicted exceedances of both the maximum 1-hr (400 µg/m^3), 24-hr (200 µg/m^3) and annual (23 µg/m^3) air quality criteria for NO_2 at any of the human receptor locations. The 1-hr 98th percentile criterion of 79 µg/m^3 is only predicted to be exceeded at the sport fisher receptor location.

- SO_2 and CO (**Table 5-8** and **Table 5-9**): Predicted air concentrations for all averaging periods for SO_2 and CO are predicted to remain below air quality criteria at all human receptor locations.

- BaP (**Table 5-10**): Predicted BaP concentrations exceed both the 24-hr criterion of 5.00E-05 µg/m^3 and the annual criterion of 1.00E-05 µg/m^3 at all human receptor locations; however, it should be noted that the existing 24-hr and annual concentrations of BaP are already above their respective criteria without the addition of BaP from PN site activities. The maximum predicted 24-hr and annual incremental increases in BaP concentrations

resulting from planned Project activities respectively represent 8.22×10^{-10} % and 2.36×10^{-11} % changes from existing 24-hr and annual conditions.

- Acrolein (**Table 5-11**): 24-hr and annual acrolein concentrations are predicted to be below their respective air quality criteria at all human receptor locations.

Total suspended particulates (TSP) and inhalable/respirable particulates (PM_{10}/$PM_{2.5}$)

The 24-hr TSP criterion of 120 µg/m^3 is from the Ontario MECP, which identifies visibility as the sensitive endpoint for the TSP criterion rather than human or ecological health. Elevated TSP concentrations are generally not considered to pose significant health risks because these particles are too large (50 – 100 µm) to be inhaled deep into the lungs ; therefore, TSP is not considered for further assessment for human receptors in this PERA.

Occasional exceedances of the 24-hr PM_{10} criterion are predicted at various human receptor locations. Exposures to elevated concentrations of PM_{10} are associated with various adverse respiratory and cardiovascular effects in humans. When inhaled, PM_{10} can deposit onto surfaces of the upper region of the lungs. However, finer particles that can be inhaled deeply into the lungs (i.e., $PM_{2.5}$) are associated with greater risk because they are more chemically active, and have more complex characteristics than larger particles (HC, 2016a). If individuals are present during short periods of elevated PM_{10} they may experience short-term respiratory symptoms such as coughing, difficulty breathing, asthma symptoms and/or chronic bronchitis; however, effects should be reversible and subside after exposure. Excluding the industrial/commercial worker, exceedances of the 24-hr criterion for PM_{10} at the receptor locations further away from the PN site tend to be relatively infrequent (<8 days per year), suggesting that any short-term effects would be temporary and expected to subside after the exposure ends. Considering $PM_{2.5}$, and again excluding the industrial/commercial worker, no exceedances of the 24-hr criterion for $PM_{2.5}$ are predicted to occur at any of the other human receptor locations.

Considering the industrial/commercial worker, there are numerous predicted exceedances of both 24-hr criteria for PM_{10} and $PM_{2.5}$. The annual $PM_{2.5}$ criterion is not predicted to be exceeded at any human receptor locations, which is an indication that long-term, chronic health effects associated with $PM_{2.5}$ exposure are not expected to occur. However, daily exceedances of the 24-hr criteria can result in temporary respiratory symptoms. It is expected that OPG will develop and implement a dust management plan and utilize construction best practices to mitigate dust and particulate generation during planned Project activities. Potential mitigation options to manage dust generation include the application of dust suppressants, stabilization of completed soil surfaces, and the suspension of dust-generating activities during periods of inclement weather. It is expected that dust mitigation measures would also reduce concentrations of smaller particulates (PM_{10} and $PM_{2.5}$), further limiting exposures to nearby human receptors. It should also be noted that the air quality modelling conducted for the PERA is extremely conservative in its assumptions, and is intended to represent a worst-case scenario for potential air quality impacts. The predicted concentrations were calculated assuming maximum equipment use, fuel consumption, and emission factors, without accounting for any significant

variability in operational practices. As such, real-world emissions during the Units 5-8 refurbishment and Units 1-4 decommissioning activities are expected to be lower than those estimated in the modelled scenario. As project details continue to develop over time, the air quality modelling is expected to be revisited to provide results more representative of the planned Project activities.

Considering the conservative assumptions used in the modelling and the expected implementation of a dust management plan, ambient concentrations of PM_{10} and $PM_{2.5}$ are not expected to result in risks to any human receptors. As such, further assessment of PM_{10} and $PM_{2.5}$ is not included in this PERA. As noted above, the air quality modelling is likely to be updated in a future iteration of the PERA as details of the planned Project activities become better refined over time. At that point, the updated predicted concentrations of the relevant air quality parameters will be re-evaluated for their potential to result in health risks to local human receptors.

Nitrogen oxides (NO_X)

There are no predicted exceedances of both the 24-hr and annual screening criteria at any of the human receptor locations; therefore, no long-term effects are expected.

There is one predicted exceedance of the short-term 1-hr screening criterion provided by the CCME for the sport fisher receptor. Potential adverse health effects that are attributed to short-term exposures to ambient NO_2 include asthma exacerbations and possibly increased risk of cardiopulmonary effects, and to a lesser extent cardiovascular and respiratory mortality (HC, 2016b). Individuals with certain pre-existing diseases such as asthma appear to be sensitive to exposure to ambient NO_2. Although it has been suggested that there may not be a threshold for the health effects of NO_2, even considering short-term (1-hour) exposures (CCME, 2020), at least some reviews (Hesterberg et al., 2009) do not support this assertion and rather support a 1-hour threshold. Hesterberg et al. (2009) completed a critical review of over 50 human clinical studies in which human volunteers (including sensitive sub-populations: the elderly, children, and asthmatics) were exposed to NO_2 at concentrations ranging from 0.1 to 3.5 ppm (equivalent to 188 to 6,580 µg/m^3 [1 ppm = 1,880 µg/m^3) for periods of 30 minutes to 6 hours, often combined with exercise and co-pollutants. Their findings indicated that there is evidence of no-effect at low concentrations, and that a threshold of approximately 0.2 ppm (or 376 µg/m^3) is supported. Additionally, as reported in Health Canada (2016b), both the WHO and US EPA concluded that healthy individuals do not experience any adverse effects at concentrations up to 1 ppm (or 1,880 µg/m^3).

The highest 98th percentile 1-hr NO_2 concentration, which represents a more realistic real-world exposure concentration than the 1-hr maximum concentration, was predicted to be 115.1 µg/m^3 at the sport fisher receptor location. This concentrations represents 6% of the concentration protective for short-term exposures in asthmatics per Hesterberg et al. (2009).

Considering the above discussion, NO_X (as NO_2) is not considered for further assessment for any human receptors in the PERA.

Benzo(a)pyrene (BaP)

The 24-hr and annual BaP air quality criteria are predicted to be exceeded at all human receptor locations. However, exceedances are exclusively associated with elevated existing concentrations of BaP in air at the PN site. The contribution of BaP from the PN site to the atmospheric environment (represented as the "increment" values in **Table 5-10**) is noted to be many orders of magnitude less than both the 24-hr and annual BaP air quality criteria. Thus, BaP is not assessed further in this PERA.

5.1.1.2.2.2 Ecological Health

Similar to the assessment of human health receptors, ambient air concentrations at the ecological receptor locations shown in **Figure 5-2** were predicted for different averaging periods for TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, acrolein, and BaP. It is acknowledged that there are exceedances of the selected air quality criteria for some constituents at a number of the ecological receptor locations. The specific predicted exceedances are discussed below:

- TSP (**Table 5-4**): There are no exceedances of the annual TSP criterion of 60 µg/m^3 at any of the ecological receptor locations. There are predicted exceedances of the 24-hr TSP criterion of 120 µg/m^3 at all receptor locations. At the receptor locations representative of Frenchman's Bay and the nearby Hydro Marsh, exceedances of the 24-hr criterion for TSP tend to be less frequent (<49 days per year, representing approximately 13% of the year) compared with receptor locations representing the PN site and nearshore area of Lake Ontario at the PN southern property boundary (predicted exceedances range from 115 to 364 days per year).

- PM_{10} (**Table 5-5**): There are predicted exceedances of the 24-hr PM_{10} criterion of 50 µg/m^3 at a number of ecological receptor locations, excluding the three furthest receptor locations within Frenchman's Bay (R15, R16 and P8). Predicted exceedances of the 24-hr criterion for PM_{10} at the other receptor locations representative of Frenchman's Bay and the Hydro Marsh tend to be relatively infrequent (<9 days per year, representing approximately 2.5% of the year). Predicted PM_{10} concentrations at receptors within the PN site and nearshore Lake Ontario area are modelled to exceed the 24-hr criterion between 56 and 353 days per year.

- $PM_{2.5}$ (**Table 5-6**): There are no exceedances of the annual $PM_{2.5}$ criterion of 8.8 µg/m^3 at any of the ecological receptor locations. There are predicted exceedances of the 24-hr $PM_{2.5}$ criterion of 27 µg/m^3 at all ecological receptor locations within the PN site and nearshore Lake Ontario area. The noted exceedances are predicted to occur between 4 and 296 days per year. There are no exceedances of the 24-hr $PM_{2.5}$ criterion for any of the receptor locations representing Frenchman's Bay and the Hydro Marsh.

- NO_2 (**Table 5-7**): There are no predicted exceedances of the maximum 24-hr (200 µg/m^3) air quality criterion for NO_2 at any of the ecological receptor locations. The annual NO_2 air quality criterion (23 µg/m^3) is predicted to be exceeded at two receptor locations, R10 within the PN site and along the southern property boundary in the nearshore Lake Ontario area. The 1-hr maximum criterion of 400 µg/m^3 is modelled to be exceeded at two receptor locations within the PN site (R11 and R28) and again along the southern property boundary representative of the nearshore Lake Ontario area. The 1-hr 98th percentile criterion of 79 µg/m^3 is predicted to be exceeded at every ecological receptor location within the PN site (with the exception of location R13) and again along the southern property boundary in the nearshore Lake Ontario area.

- SO_2 and CO (**Table 5-8** and **Table 5-9**): Predicted air concentrations for all averaging periods for SO_2 and CO are predicted to remain below air quality criteria at all ecological receptor locations.

- BaP (**Table 5-10**): Predicted BaP concentrations exceed both the 24-hr criterion of 5.00E-05 µg/m^3 and the annual criterion of 1.00E-05 µg/m^3 at all ecological receptor locations; however, it should be noted that the existing 24-hr and annual concentrations of BaP are already above their respective criteria without the addition of BaP from PN site activities. The maximum predicted 24-hr and annual incremental increases in BaP concentrations resulting from planned Project activities represent 8.22x10^{-10} % and 2.36x10^{-11} % changes from existing 24-hr and annual conditions, respectively.

- Acrolein (**Table 5-11**): 24-hr and annual acrolein concentrations are predicted to be below their respective air quality criteria at all ecological receptor locations.

Total suspended particulates (TSP) and inhalable/respirable particulates (PM_{10}/$PM_{2.5}$)

Dust (TSP), including particulates (PM_{10}, $PM_{2.5}$), could be generated from Project activities including mobilization, clearing, grubbing, on-land earthmoving, grading, and excavation. Dust deposition onto vegetation could impact growth and function. It should be noted that the air quality modelling assumptions are considered conservative and represent a "worst-case" scenario that is unlikely to occur. Furthermore, a dust management plan will be implemented that could involve mitigative measures such as the application of dust suppressants, stabilization of completed soil surfaces, and suspension of dust-generating activities during periods of inclement weather. It is expected that dust mitigation measures would also reduce concentrations of smaller particulates (PM_{10} and $PM_{2.5}$). As such, no adverse effects to vegetation and terrestrial/riparian habitat associated with vegetation are expected.

Mammals and birds are mobile receptors; thus, it is unlikely that these receptors would be continuously exposed to maximum concentrations of TSP, PM_{10} or $PM_{2.5}$. These receptors are presumed to be able to limit their exposure to TSP, PM_{10} and $PM_{2.5}$ by moving away from areas of elevated dust and particulate deposition and returning once the dust-generating activities have concluded. Mammals and birds are also expected to be protected through the

implementation and adherence with a dust management plan. Additionally, it should be noted again that the 24-hr TSP criterion of 120 µg/m^3 is derived with visibility as the sensitive endpoint rather than ecological (or human) health. Thus, exceedance of this criterion does not necessarily indicate a potential for ecological health risks. Exceedances of the 24-hr $PM_{2.5}$ criterion of 27 µg/m^3 are localized to the PN site, with no exceedances predicted at nearby Frenchman's Bay. While exceedances of the 24-hr PM_{10} criterion of 50 µg/m^3 are predicted to occur at receptor locations in Frenchman's Bay, the exceedances are modelled to occur, at most, for 9 days out of the year, representing approximately 2.5% of a calendar year. For this reason, exceedances of the 24-hr PM_{10} criterion at Frenchman's Bay are considered largely negligible, and the area is expected to remain an important habitat for local terrestrial and riparian receptors.

Considering the above, elevated TSP, PM_{10} and $PM_{2.5}$ concentrations are generally not considered to pose significant ecological health risks and are expected to be sufficiently mitigated through the implementation of a dust management plan. Thus, TSP, PM_{10} and $PM_{2.5}$ are not assessed further for any ecological receptors in this PERA.

Benzo(a)pyrene (BaP)

The 24-hr and annual BaP air quality criteria are predicted to be exceeded at all ecological receptor locations. However, exceedances are exclusively associated with elevated existing concentrations of BaP in air at the PN site. As noted in the bulleted list earlier in this section, the contribution of BaP from the PN site to the atmospheric environment (represented as the "increment" values in **Table 5-10**) is noted to be many orders of magnitude less than both the 24-hr and annual BaP air quality criteria. Thus, BaP is not assessed further in this PERA.

Nitrogen oxides (NO_X), sulphur dioxide (SO_2), carbon monoxide (CO), and acrolein

Substances that do not partition to soil include gases such as NO_X, SO_2, CO, and acrolein. No exceedances of any air quality criteria were identified for predicted concentrations of SO_2, CO, and acrolein at all ecological receptor locations; thus, these air quality parameters are not assessed further for any ecological receptors in the PERA.

As previously noted, modelled concentrations of NO_2 are predicted to exceed the 1-hr criteria from both CCME (79 µg/m^3, based on 98th percentile concentrations) and MECP (400 µg/m^3, based on maximum concentrations), in addition to the CCME annual criterion of 23 µg/m^3. There is no annual MECP AAQC and the CCME CAAQS are not appropriate for ecological receptors, thus, exceedance of the annual criterion does not suggest any potential risk to ecological receptors. Adverse effect levels for NO_X under short-term exposure are not expected below 5 ppm (9,000 µg/m^3) for dogs (Kleinman and Mautz, 1991), and below 3.5 ppm (6,300 µg/m^3) for plants (Heck, 1964). Predicted NO_2 concentrations are well below these adverse effect levels and are not considered to pose any potential short-term risk to ecological receptors. For these reasons, NO_X (as NO_2) is not assessed further for any ecological receptors in the PERA.

Table 5-4: Total Suspended Particulate Matter (TSP) Air Modelling Results

Receptor ID	Receptor Name	24-hr Maximum					Annual Maximum			
		24-hr 90th TSP (Existing Conditions)	Max 24-hr TSP (Increment)	Max 24-hr TSP (Total)	% of Criteria	# of Exceedances	Average Annual TSP (Existing Conditions)	Annual TSP (Increment)	Annual TSP (Total)	% of Criteria
		(µg/m³)	(µg/m³)	(µg/m³)	(%)	DAYS/YR	(µg/m³)	(µg/m³)	(µg/m³)	(%)
Criteria (µg/m³)		**120**					**60**			
Human Receptors										
R1	Local Harvesting Area 1 [a]	44.2	266.1	310.3	258.5%	30	25.5	1.1	26.6	44.4%
R2	Local Harvesting Area 2 [a]	44.2	247.2	291.4	242.9%	42	25.5	1.3	26.8	44.7%
R3	Local Harvesting Area 3 [a]	44.2	255.8	300.0	250.0%	44	25.5	1.3	26.8	44.7%
R20	Industrial/Commercial Worker	44.2	1605.8	1650.0	1375.0%	361	25.5	20.5	46.0	76.6%
R21	Sport Fisher	44.2	57.5	101.7	84.7%	0	25.5	0.7	26.2	43.6%
R22	Correctional Institute (C2)	44.2	80.6	124.8	104.0%	1	25.5	0.3	25.8	43.0%
R23	Farm	44.2	38.0	82.2	68.5%	0	25.5	0.1	25.6	42.6%
R24	Dairy Farm	44.2	15.7	59.9	49.9%	0	25.5	0.0	25.5	42.6%
R25	Urban Resident/Harvester [b] (WNW)	44.2	201.2	245.4	204.5%	38	25.5	1.2	26.7	44.4%
R26	Urban Resident/Harvester [b] (NW)	44.2	214.6	258.8	215.7%	22	25.5	1.0	26.5	44.1%
R27	Urban Resident/Harvester [b] (NNW)	44.2	250.1	294.3	245.2%	22	25.5	1.0	26.5	44.1%
Ecological Receptors										
R3	Hydro Marsh	44.2	255.8	300.0	250.0%	44	25.5	1.3	26.8	44.7%
R6	Frenchman's Bay	44.2	193.5	237.7	198.0%	36	25.5	1.1	26.6	44.4%
R8	Frenchman's Bay	44.2	213.7	257.9	214.9%	29	25.5	1.1	26.6	44.3%
R15	Frenchman's Bay	44.2	140.0	184.2	153.5%	5	25.5	0.6	26.1	43.5%
R16	Frenchman's Bay	44.2	134.6	178.8	149.0%	13	25.5	0.7	26.2	43.7%
R19	Frenchman's Bay	44.2	249.4	293.6	244.6%	48	25.5	1.4	26.9	44.8%
R25	Frenchman's Bay	44.2	201.2	245.4	204.5%	38	25.5	1.2	26.7	44.4%
P8	Frenchman's Bay	44.2	135.1	179.3	149.4%	20	25.5	0.9	26.4	44.0%
R9	PN Site	44.2	1131.6	1175.8	979.8%	282	25.5	11.6	37.1	61.8%
R10	PN Site	44.2	967.6	1011.8	843.2%	245	25.5	8.8	34.3	57.2%
R11	PN Site	44.2	488.4	532.6	443.8%	182	25.5	4.6	30.1	50.2%
R13	PN Site	44.2	1739.8	1784.0	1486.7%	364	25.5	24.6	50.1	83.5%
R14	PN Site	44.2	496.7	540.9	450.8%	115	25.5	2.7	28.2	47.0%
R28	PN Site	44.2	579.6	623.8	519.9%	214	25.5	5.1	30.6	51.0%
FL_WEN_1-394	PN Site [c]	44.2	2144.1	2188.3	1823.6%	348	25.5	30.8	56.3	93.8%
FL_S_1-144	Nearshore Lake Ontario [d]	44.2	1184.7	1228.9	1024.1%	326	25.5	19.3	44.8	74.7%

Notes:
µg/m³ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-5: Inhalable Particulates (PM_{10}) Air Modelling Results

Receptor ID	Receptor Name	24-hr Maximum				
		90th PM_{10} (Existing Conditions)	Max 24-hr PM_{10} (Increment)	Max 24-hr PM_{10} (Total)	% of Criteria	# of Exceedances
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	DAYS/YR
Criteria ($\mu g/m^3$)		**50**				
Human Receptors						
R1	Local Harvesting Area 1 [a]	22.1	51.4	73.5	146.9%	6
R2	Local Harvesting Area 2 [a]	22.1	48.0	70.1	140.1%	5
R3	Local Harvesting Area 3 [a]	22.1	49.7	71.8	143.6%	7
R20	Industrial/Commercial Worker	22.1	309.3	331.4	662.9%	346
R21	Sport Fisher	22.1	11.5	33.6	67.1%	0
R22	Correctional Institute (C2)	22.1	15.6	37.7	75.5%	0
R23	Farm	22.1	7.4	29.5	59.1%	0
R24	Dairy Farm	22.1	3.1	25.2	50.4%	0
R25	Urban Resident/Harvester [b] (WNW)	22.1	39.4	61.5	123.0%	4
R26	Urban Resident/Harvester [b] (NW)	22.1	41.6	63.7	127.5%	2
R27	Urban Resident/Harvester [b] (NNW)	22.1	48.2	70.3	140.7%	5
Ecological Receptors						
R3	Hydro Marsh	22.1	49.7	71.8	143.6%	7
R6	Frenchman's Bay	22.1	38.2	60.3	120.5%	5
R8	Frenchman's Bay	22.1	42.2	64.3	128.6%	3
R15	Frenchman's Bay	22.1	27.6	49.7	99.5%	0
R16	Frenchman's Bay	22.1	26.2	48.3	96.5%	0
R19	Frenchman's Bay	22.1	48.9	71.0	142.0%	9
R25	Frenchman's Bay	22.1	39.4	61.5	123.0%	4
P8	Frenchman's Bay	22.1	26.7	48.8	97.6%	0
R9	PN Site	22.1	219.9	242.0	484.0%	226
R10	PN Site	22.1	190.6	212.7	425.5%	155
R11	PN Site	22.1	95.9	118.0	236.0%	101
R13	PN Site	22.1	335.0	357.1	714.2%	353
R14	PN Site	22.1	98.4	120.5	241.1%	56
R28	PN Site	22.1	113.3	135.4	270.8%	130
FL_WEN_1-394	PN Site [c]	22.1	413.0	435.1	870.1%	316
FL_S_1-144	Nearshore Lake Ontario [d]	22.1	231.0	253.1	506.2%	297

Notes:
$\mu g/m^3$ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-6: Respirable Particulates ($PM_{2.5}$) Air Modelling Results

Receptor ID	Receptor Name	24-hr Maximum					Annual Maximum			
		90th 24-hr $PM_{2.5}$ (Existing Conditions)	Max 24-hr $PM_{2.5}$ (Increment)	Max 24-hr $PM_{2.5}$ (Total)	% of Criteria	Exceedance	Mean Annual $PM_{2.5}$ (Existing Conditions)	Annual $PM_{2.5}$ (Increment)	Annual $PM_{2.5}$ (Total)	% of Criteria
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	DAYS/YR	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)
Criteria ($\mu g/m^3$)		**27**					**8.8**			
Human Receptors										
R1	Local Harvesting Area 1 [a]	11.1	12.6	23.7	87.7%	0	6.70	0.08	6.78	77.0%
R2	Local Harvesting Area 2 [a]	11.1	11.8	22.9	84.7%	0	6.70	0.09	6.79	77.1%
R3	Local Harvesting Area 3 [a]	11.1	12.3	23.4	86.6%	0	6.70	0.09	6.79	77.2%
R20	Industrial/Commercial Worker	11.1	75.8	86.9	322.0%	249	6.70	0.99	7.69	87.4%
R21	Sport Fisher	11.1	2.9	14.0	51.9%	0	6.70	0.10	6.80	77.3%
R22	Correctional Institute (C2)	11.1	3.8	14.9	55.3%	0	6.70	0.02	6.72	76.4%
R23	Farm	11.1	1.9	13.0	48.1%	0	6.70	0.01	6.71	76.2%
R24	Dairy Farm	11.1	0.8	11.9	43.9%	0	6.70	0.00	6.70	76.2%
R25	Urban Resident/Harvester [b] (WNW)	11.1	9.8	20.9	77.5%	0	6.70	0.09	6.79	77.2%
R26	Urban Resident/Harvester [b] (NW)	11.1	10.3	21.4	79.1%	0	6.70	0.07	6.77	76.9%
R27	Urban Resident/Harvester [b] (NNW)	11.1	11.8	22.9	84.9%	0	6.70	0.07	6.77	76.9%
Ecological Receptors										
R3	Hydro Marsh	11.1	12.3	23.4	86.6%	0	6.70	0.09	6.79	77.2%
R6	Frenchman's Bay	11.1	9.7	20.8	77.1%	0	6.70	0.09	6.79	77.1%
R8	Frenchman's Bay	11.1	10.7	21.8	80.9%	0	6.70	0.09	6.79	77.1%
R15	Frenchman's Bay	11.1	7.0	18.1	67.2%	0	6.70	0.05	6.75	76.7%
R16	Frenchman's Bay	11.1	6.5	17.6	65.4%	0	6.70	0.07	6.77	76.9%
R19	Frenchman's Bay	11.1	12.4	23.5	87.0%	0	6.70	0.12	6.82	77.5%
R25	Frenchman's Bay	11.1	9.8	20.9	77.5%	0	6.70	0.09	6.79	77.2%
P8	Frenchman's Bay	11.1	6.9	18.0	66.5%	0	6.70	0.08	6.78	77.0%
R9	PN Site	11.1	54.1	65.2	241.6%	87	6.70	0.66	7.36	83.6%
R10	PN Site	11.1	48.1	59.2	219.3%	48	6.70	1.05	7.75	88.0%
R11	PN Site	11.1	24.1	35.2	130.2%	16	6.70	0.42	7.12	80.9%
R13	PN Site	11.1	82.0	93.1	344.8%	296	6.70	1.19	7.89	89.7%
R14	PN Site	11.1	25.0	36.1	133.7%	4	6.70	0.27	6.97	79.2%
R28	PN Site	11.1	27.8	38.9	144.2%	23	6.70	0.40	7.10	80.7%
FL_WEN_1-394	PN Site [c]	11.1	100.9	112.0	414.9%	222	6.70	1.48	8.18	92.9%
FL_S_1-144	Nearshore Lake Ontario [d]	11.1	57.0	68.1	252.2%	180	6.70	1.30	8.00	90.9%

Notes:
$\mu g/m^3$ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-7: Nitrogen Oxides (as NO_2) Air Modelling Results

Receptor ID	Receptor Name	1-hr 98th Percentile				1-hr Maximum					24-hr Maximum					Annual Maximum			
		98th 1-hr NO_2 (Existing Conditions)	98th 1-hr NO_2 (Increment)	98th 1-hr NO_2 (Total)	% of Criteria	90th 1-hr NO_2 (Existing Conditions)	Max 1-hr NO_2 (Increment)	Max 1-hr NO_2 (Total)	% of Criteria	# of Exceedances	90th 24-hr NO_2 (Existing Conditions)	24-hr NO_2 (Increment)	Max 24-hr NO_2 (Total)	% of Criteria	# of Exceedances	Mean Annual NO_2 (Existing Conditions)	Annual NO_2 (Increment)	Annual NO_2 (Total)	% of Criteria
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	HRS/YR	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	DAYS/YR	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)
Criteria ($\mu g/m^3$)		**79**				**400**					**200**					**23**			
Human Receptors																			
R1	Local Harvesting Area 1 [a]	25.6	19.5	45.1	57.1%	14.5	259.9	274.4	68.6%	0	12.6	37.2	49.8	24.9%	0	6.7	1.5	8.2	35.5%
R2	Local Harvesting Area 2 [a]	25.6	21.9	47.5	60.1%	14.5	267.0	281.5	70.4%	0	12.6	37.7	50.3	25.2%	0	6.7	1.6	8.3	36.1%
R3	Local Harvesting Area 3 [a]	25.6	22.9	48.5	61.3%	14.5	235.1	249.6	62.4%	0	12.6	37.4	50.0	25.0%	0	6.7	1.7	8.4	36.3%
R20	Industrial/Commercial Worker	25.6	43.9	69.5	88.0%	14.5	251.3	265.8	66.4%	0	12.6	47.1	59.7	29.9%	0	6.7	1.6	8.3	36.0%
R21	Sport Fisher	25.6	89.5	115.1	145.8%	14.5	142.9	157.4	39.3%	0	12.6	58.5	71.1	35.6%	0	6.7	3.9	10.6	46.0%
R22	Correctional Institute (C2)	25.6	4.3	29.9	37.8%	14.5	141.4	155.9	39.0%	0	12.6	11.4	24.0	12.0%	0	6.7	0.4	7.1	30.7%
R23	Farm	25.6	1.3	26.9	34.1%	14.5	60.5	75.0	18.7%	0	12.6	5.6	18.2	9.1%	0	6.7	0.2	6.9	29.8%
R24	Dairy Farm	25.6	0.3	25.9	32.8%	14.5	62.3	76.8	19.2%	0	12.6	2.6	15.2	7.6%	0	6.7	0.1	6.8	29.5%
R25	Urban Resident/Harvester [b] (WNW)	25.6	24.3	49.9	63.1%	14.5	199.2	213.7	53.4%	0	12.6	45.0	57.6	28.8%	0	6.7	1.8	8.5	36.8%
R26	Urban Resident/Harvester [b] (NW)	25.6	17.5	43.1	54.5%	14.5	207.7	222.2	55.5%	0	12.6	29.2	41.8	20.9%	0	6.7	1.3	8.0	34.7%
R27	Urban Resident/Harvester [b] (NNW)	25.6	18.4	44.0	55.7%	14.5	252.7	267.2	66.8%	0	12.6	35.2	47.8	23.9%	0	6.7	1.3	8.0	35.0%
Ecological Receptors																			
R3	Hydro Marsh	25.6	22.9	48.5	61.3%	14.5	235.1	249.6	62.4%	0	12.6	37.4	50.0	25.0%	0	6.7	1.7	8.4	36.3%
R6	Frenchman's Bay	25.6	22.9	48.5	61.4%	14.5	197.2	211.7	52.9%	0	12.6	44.3	56.9	28.5%	N/A	6.7	1.7	8.4	36.3%
R8	Frenchman's Bay	25.6	28.8	54.4	68.9%	14.5	184.3	198.8	49.7%	0	12.6	41.7	54.3	27.1%	N/A	6.7	1.9	8.6	37.5%
R15	Frenchman's Bay	25.6	18.7	44.3	56.0%	14.5	145.3	159.8	40.0%	0	12.6	26.4	39.0	19.5%	N/A	6.7	1.2	7.9	34.3%
R16	Frenchman's Bay	25.6	36.8	62.4	79.0%	14.5	125.9	140.4	35.1%	0	12.6	31.5	44.1	22.1%	N/A	6.7	1.7	8.4	36.6%
R19	Frenchman's Bay	25.6	47.8	73.4	92.9%	14.5	172.0	186.5	46.6%	0	12.6	47.8	60.4	30.2%	N/A	6.7	2.7	9.4	41.1%
R25	Frenchman's Bay	25.6	24.3	49.9	63.1%	14.5	199.2	213.7	53.4%	0	12.6	45.0	57.6	28.8%	N/A	6.7	1.8	8.5	36.8%
P8	Frenchman's Bay	25.6	35.0	60.6	76.7%	14.5	142.0	156.5	39.1%	0	12.6	33.5	46.1	23.0%	N/A	6.7	1.8	8.5	36.9%
R9	PN Site	25.6	70.5	96.1	121.7%	14.5	297.3	311.8	78.0%	0	12.6	76.0	88.6	44.3%	N/A	6.7	5.5	12.2	53.0%
R10	PN Site	25.6	206.4	232.0	293.7%	14.5	350.8	365.3	91.3%	0	12.6	115.3	127.9	64.0%	N/A	6.7	31.8	38.5	167.4%
R11	PN Site	25.6	107.4	133.0	168.3%	14.5	516.8	531.3	132.8%	15	12.6	94.4	107.0	53.5%	N/A	6.7	10.0	16.7	72.4%
R13	PN Site	25.6	52.3	77.9	98.7%	14.5	293.8	308.3	77.1%	0	12.6	48.7	61.3	30.6%	N/A	6.7	1.9	8.6	37.3%
R14	PN Site	25.6	94.6	120.2	152.2%	14.5	343.0	357.5	89.4%	0	12.6	89.9	102.5	51.3%	N/A	6.7	7.0	13.7	59.5%
R28	PN Site	25.6	91.3	116.9	148.0%	14.5	417.2	431.7	107.9%	2	12.6	78.2	90.8	45.4%	N/A	6.7	7.8	14.5	62.9%
FL_WEN_1-394	PN Site [c]	25.6	80.4	106.0	134.1%	14.5	334.2	348.7	87.2%	0	12.6	80.0	92.6	46.3%	N/A	6.7	6.2	12.9	56.0%
FL_S_1-144	Nearshore Lake Ontario [d]	25.6	235.5	261.1	330.6%	14.5	402.4	416.9	104.2%	4	12.6	128.6	141.2	70.6%	N/A	6.7	20.3	27.0	117.6%

Notes:
$\mu g/m^3$ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-8: Sulphur Dioxide (SO_2) Air Modelling Results

Receptor ID	Receptor Name	1-hr 99th Percentile				1-hr Maximum					Annual Maximum			
		99th 1-hr SO_2 (Existing Conditions)	99th 1-hr SO_2 (Increment)	99th 1-hr SO_2 (Total)	% of Criteria	90th 1-hr SO_2 (Existing Conditions)	Max 1-hr SO_2 (Increment)	Max 1-hr SO_2 (Total)	% of Criteria	# of Exceedances	Annual SO_2 (Existing Conditions)	Annual SO_2 (Increment)	Annual SO_2 (Total)	% of Criteria
		($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)	DAYS/YR	($\mu g/m^3$)	($\mu g/m^3$)	($\mu g/m^3$)	(%)
Criteria ($\mu g/m^3$)		**170**				**105**					**11**			
Human Receptors														
R1	Local Harvesting Area 1 [a]	51.45	0.04	51.49	30.3%	3.60	0.36	3.96	3.8%	0	4.20	0.0006	4.20	38.2%
R2	Local Harvesting Area 2 [a]	51.45	0.04	51.49	30.3%	3.60	0.35	3.95	3.8%	0	4.20	0.0007	4.20	38.2%
R3	Local Harvesting Area 3 [a]	51.45	0.03	51.49	30.3%	3.60	0.29	3.89	3.7%	0	4.20	0.0007	4.20	38.2%
R20	Industrial/Commercial Worker	51.45	0.12	51.57	30.3%	3.60	0.42	4.02	3.8%	0	4.20	0.0014	4.20	38.2%
R21	Sport Fisher	51.45	0.10	51.55	30.3%	3.60	0.17	3.77	3.6%	0	4.20	0.0020	4.20	38.2%
R22	Correctional Institute (C2)	51.45	0.01	51.46	30.3%	3.60	0.17	3.77	3.6%	0	4.20	0.0002	4.20	38.2%
R23	Farm	51.45	0.004	51.46	30.3%	3.60	0.05	3.65	3.5%	0	4.20	0.0001	4.20	38.2%
R24	Dairy Farm	51.45	0.002	51.45	30.3%	3.60	0.05	3.65	3.5%	0	4.20	0.0001	4.20	38.2%
R25	Urban Resident/Harvester [b] (WNW)	51.45	0.03	51.49	30.3%	3.60	0.20	3.80	3.6%	0	4.20	0.0007	4.20	38.2%
R26	Urban Resident/Harvester [b] (NW)	51.45	0.03	51.48	30.3%	3.60	0.26	3.86	3.7%	0	4.20	0.0006	4.20	38.2%
R27	Urban Resident/Harvester [b] (NNW)	51.45	0.04	51.49	30.3%	3.60	0.35	3.95	3.8%	0	4.20	0.0006	4.20	38.2%
Ecological Receptors														
R3	Hydro Marsh	51.45	0.03	51.49	30.3%	3.60	0.29	3.89	3.7%	0	4.20	0.0007	4.20	38.2%
R6	Frenchman's Bay	51.45	0.03	51.49	30.3%	3.60	0.22	3.82	3.6%	0	4.20	0.001	4.20	38.2%
R8	Frenchman's Bay	51.45	0.04	51.49	30.3%	3.60	0.19	3.79	3.6%	0	4.20	0.001	4.20	38.2%
R15	Frenchman's Bay	51.45	0.03	51.48	30.3%	3.60	0.16	3.76	3.6%	0	4.20	0.001	4.20	38.2%
R16	Frenchman's Bay	51.45	0.05	51.51	30.3%	3.60	0.13	3.73	3.6%	0	4.20	0.001	4.20	38.2%
R19	Frenchman's Bay	51.45	0.07	51.53	30.3%	3.60	0.19	3.79	3.6%	0	4.20	0.001	4.20	38.2%
R25	Frenchman's Bay	51.45	0.03	51.49	30.3%	3.60	0.20	3.80	3.6%	0	4.20	0.001	4.20	38.2%
P8	Frenchman's Bay	51.45	0.05	51.50	30.3%	3.60	0.14	3.74	3.6%	0	4.20	0.001	4.20	38.2%
R9	PN Site	51.45	0.13	51.58	30.3%	3.60	0.48	4.08	3.9%	0	4.20	0.002	4.20	38.2%
R10	PN Site	51.45	0.12	51.58	30.3%	3.60	0.42	4.02	3.8%	0	4.20	0.005	4.21	38.2%
R11	PN Site	51.45	0.12	51.57	30.3%	3.60	0.83	4.43	4.2%	0	4.20	0.002	4.20	38.2%
R13	PN Site	51.45	0.14	51.59	30.3%	3.60	0.48	4.08	3.9%	0	4.20	0.002	4.20	38.2%
R14	PN Site	51.45	0.09	51.55	30.3%	3.60	0.38	3.98	3.8%	0	4.20	0.002	4.20	38.2%
R28	PN Site	51.45	0.10	51.55	30.3%	3.60	0.70	4.30	4.1%	0	4.20	0.002	4.20	38.2%
FL_WEN_1-394	PN Site [c]	51.45	0.16	51.62	30.4%	3.60	0.55	4.15	4.0%	0	4.20	0.002	4.20	38.2%
FL_S_1-144	Nearshore Lake Ontario [d]	51.45	0.38	51.83	30.5%	3.60	0.54	4.14	3.9%	0	4.20	0.007	4.21	38.2%

Notes:
$\mu g/m^3$ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-9: Carbon Monoxide (CO) Air Modelling Results

Receptor ID	Receptor Name	1-hr Maximum				8-hr Maximum			
		90th 1-hr CO (Existing Conditions)	Max 1-hr CO (Increment)	Max 1-hr CO (Total)	% of Criteria	90th 8-hr CO (Existing Conditions)	Max 8-hr CO (Increment)	Max 8-hr CO (Total)	% of Criteria
		(µg/m³)	(µg/m³)	(µg/m³)	(%)	(µg/m³)	(µg/m³)	(µg/m³)	(%)
Criteria (µg/m³)		**36,200**				**15,700**			
Human Receptors									
R1	Local Harvesting Area 1 [a]	753	1,476	2,229	6.2%	738	713	1,451	9.2%
R2	Local Harvesting Area 2 [a]	753	1,573	2,326	6.4%	738	616	1,354	8.6%
R3	Local Harvesting Area 3 [a]	753	1,445	2,199	6.1%	738	673	1,411	9.0%
R20	Industrial/Commercial Worker	753	11,381	12,134	33.5%	738	3,766	4,504	28.7%
R21	Sport Fisher	753	397	1,150	3.2%	738	111	849	5.4%
R22	Correctional Institute (C2)	753	1,643	2,396	6.6%	738	223	961	6.1%
R23	Farm	753	588	1,342	3.7%	738	131	869	5.5%
R24	Dairy Farm	753	394	1,148	3.2%	738	50	788	5.0%
R25	Urban Resident/Harvester [b] (WNW)	753	1,420	2,173	6.0%	738	533	1,271	8.1%
R26	Urban Resident/Harvester [b] (NW)	753	1,191	1,944	5.4%	738	546	1,284	8.2%
R27	Urban Resident/Harvester [b] (NNW)	753	1,422	2,176	6.0%	738	646	1,384	8.8%
Ecological Receptors									
R3	Hydro Marsh	753	1,445	2,199	6.1%	738	673	1,411	9.0%
R6	Frenchman's Bay	753	1,342	2,096	5.8%	738	499	1,237	7.9%
R8	Frenchman's Bay	753	1,322	2,075	5.7%	738	581	1,319	8.4%
R15	Frenchman's Bay	753	961	1,715	4.7%	738	359	1,097	7.0%
R16	Frenchman's Bay	753	699	1,453	4.0%	738	313	1,051	6.7%
R19	Frenchman's Bay	753	1,223	1,976	5.5%	738	698	1,436	9.1%
R25	Frenchman's Bay	753	1,420	2,173	6.0%	738	533	1,271	8.1%
P8	Frenchman's Bay	753	883	1,636	4.5%	738	396	1,134	7.2%
R9	PN Site	753	6,708	7,461	20.6%	738	2,366	3,104	19.8%
R10	PN Site	753	6,342	7,095	19.6%	738	2,739	3,477	22.1%
R11	PN Site	753	3,022	3,776	10.4%	738	1,434	2,172	13.8%
R13	PN Site	753	5,066	5,819	16.1%	738	3,215	3,953	25.2%
R14	PN Site	753	2,935	3,688	10.2%	738	1,321	2,059	13.1%
R28	PN Site	753	2,820	3,574	9.9%	738	1,606	2,344	14.9%
FL_WEN_1-394	PN Site [c]	753	15,410	16,163	44.7%	738	5,019	5,757	36.7%
FL_S_1-144	Nearshore Lake Ontario [d]	753	4,537	5,290	14.6%	738	2,448	3,186	20.3%

Notes:
µg/m³ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-10: Benzo(a)pyrene (BaP) Air Modelling Results

Receptor ID	Receptor Name	24-hr Maximum				Annual Maximum			
		24-hr Avg BaP (Existing Conditions)	Max 24-hr BaP (Increment)	Max 24-hr BaP (Total)	% of Criteria	Annual Average BaP (Existing Conditions)	Annual BaP (Increment)	Annual BaP (Total)	% of Criteria
		(µg/m³)	(µg/m³)	(µg/m³)	(%)	(µg/m³)	(µg/m³)	(µg/m³)	(%)
Criteria (µg/m³)		**5.00E-05**				**1.00E-05**			
Human Receptors									
R1	Local Harvesting Area 1 [a]	6.85E-05	7.05E-17	6.85E-05	137%	3.58E-05	3.17E-19	3.58E-05	358%
R2	Local Harvesting Area 2 [a]	6.85E-05	6.71E-17	6.85E-05	137%	3.58E-05	3.58E-19	3.58E-05	358%
R3	Local Harvesting Area 3 [a]	6.85E-05	7.23E-17	6.85E-05	137%	3.58E-05	3.74E-19	3.58E-05	358%
R20	Industrial/Commercial Worker	6.85E-05	4.53E-16	6.85E-05	137%	3.58E-05	5.61E-18	3.58E-05	358%
R21	Sport Fisher	6.85E-05	1.52E-17	6.85E-05	137%	3.58E-05	2.84E-19	3.58E-05	358%
R22	Correctional Institute (C2)	6.85E-05	1.86E-17	6.85E-05	137%	3.58E-05	8.13E-20	3.58E-05	358%
R23	Farm	6.85E-05	1.09E-17	6.85E-05	137%	3.58E-05	1.99E-20	3.58E-05	358%
R24	Dairy Farm	6.85E-05	4.05E-18	6.85E-05	137%	3.58E-05	9.88E-21	3.58E-05	358%
R25	Urban Resident/Harvester [b] (WNW)	6.85E-05	5.82E-17	6.85E-05	137%	3.58E-05	3.29E-19	3.58E-05	358%
R26	Urban Resident/Harvester [b] (NW)	6.85E-05	5.96E-17	6.85E-05	137%	3.58E-05	2.70E-19	3.58E-05	358%
R27	Urban Resident/Harvester [b] (NNW)	6.85E-05	6.58E-17	6.85E-05	137%	3.58E-05	2.76E-19	3.58E-05	358%
Ecological Receptors									
R3	Hydro Marsh	6.85E-05	7.23E-17	6.85E-05	137%	3.58E-05	3.74E-19	3.58E-05	358%
R6	Frenchman's Bay	6.85E-05	5.68E-17	6.85E-05	137%	3.58E-05	3.22E-19	3.58E-05	358%
R8	Frenchman's Bay	6.85E-05	6.33E-17	6.85E-05	137%	3.58E-05	3.16E-19	3.58E-05	358%
R15	Frenchman's Bay	6.85E-05	4.16E-17	6.85E-05	137%	3.58E-05	1.90E-19	3.58E-05	358%
R16	Frenchman's Bay	6.85E-05	3.73E-17	6.85E-05	137%	3.58E-05	2.42E-19	3.58E-05	358%
R19	Frenchman's Bay	6.85E-05	7.14E-17	6.85E-05	137%	3.58E-05	4.28E-19	3.58E-05	358%
R25	Frenchman's Bay	6.85E-05	5.82E-17	6.85E-05	137%	3.58E-05	3.29E-19	3.58E-05	358%
P8	Frenchman's Bay	6.85E-05	4.03E-17	6.85E-05	137%	3.58E-05	2.76E-19	3.58E-05	358%
R9	PN Site	6.85E-05	2.85E-16	6.85E-05	137%	3.58E-05	3.10E-18	3.58E-05	358%
R10	PN Site	6.85E-05	3.22E-16	6.85E-05	137%	3.58E-05	2.68E-18	3.58E-05	358%
R11	PN Site	6.85E-05	1.52E-16	6.85E-05	137%	3.58E-05	1.33E-18	3.58E-05	358%
R13	PN Site	6.85E-05	4.63E-16	6.85E-05	137%	3.58E-05	6.85E-18	3.58E-05	358%
R14	PN Site	6.85E-05	1.40E-16	6.85E-05	137%	3.58E-05	8.09E-19	3.58E-05	358%
R28	PN Site	6.85E-05	1.78E-16	6.85E-05	137%	3.58E-05	1.48E-18	3.58E-05	358%
FL_WEN_1-394	PN Site [c]	6.85E-05	5.63E-16	6.85E-05	137%	3.58E-05	8.45E-18	3.58E-05	358%
FL_S_1-144	Nearshore Lake Ontario [d]	6.85E-05	3.17E-16	6.85E-05	137%	3.58E-05	5.26E-18	3.58E-05	358%

Notes:
µg/m³ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.

Table 5-11: Acrolein Air Modelling Results

Receptor ID	Receptor Name	1-hr Maximum				24-hr Maximum			
		90th 1-hr Acrolein (Existing Conditions)	Max 1-hr Acrolein (Increment)	Max 1-hr Acrolein (Total)	% of Criteria	90th 24-hr Acrolein (Existing Conditions)	Max 24-hr Acrolein (Increment)	Max 24-hr Acrolein (Total)	% of Criteria
		(µg/m³)	(µg/m³)	(µg/m³)	(%)	(µg/m³)	(µg/m³)	(µg/m³)	(%)
Criteria (µg/m³)		**4.50E+00**				**4.00E-01**			
Human Receptors									
R1	Local Harvesting Area 1 [a]	NA [e]	6.12E-14	6.12E-14	<0.01%	NA [e]	1.04E-14	1.04E-14	<0.01%
R2	Local Harvesting Area 2 [a]	NA [e]	6.38E-14	6.38E-14	<0.01%	NA [e]	1.02E-14	1.02E-14	<0.01%
R3	Local Harvesting Area 3 [a]	NA [e]	6.10E-14	6.10E-14	<0.01%	NA [e]	1.11E-14	1.11E-14	<0.01%
R20	Industrial/Commercial Worker	NA [e]	3.97E-13	3.97E-13	<0.01%	NA [e]	6.55E-14	6.55E-14	<0.01%
R21	Sport Fisher	NA [e]	1.69E-14	1.69E-14	<0.01%	NA [e]	2.85E-15	2.85E-15	<0.01%
R22	Correctional Institute (C2)	NA [e]	6.03E-14	6.03E-14	<0.01%	NA [e]	2.90E-15	2.90E-15	<0.01%
R23	Farm	NA [e]	2.25E-14	2.25E-14	<0.01%	NA [e]	1.78E-15	1.78E-15	<0.01%
R24	Dairy Farm	NA [e]	1.52E-14	1.52E-14	<0.01%	NA [e]	6.53E-16	6.53E-16	<0.01%
R25	Urban Resident/Harvester [b] (WNW)	NA [e]	6.77E-14	6.77E-14	<0.01%	NA [e]	1.01E-14	1.01E-14	<0.01%
R26	Urban Resident/Harvester [b] (NW)	NA [e]	5.07E-14	5.07E-14	<0.01%	NA [e]	8.97E-15	8.97E-15	<0.01%
R27	Urban Resident/Harvester [b] (NNW)	NA [e]	5.59E-14	5.59E-14	<0.01%	NA [e]	9.61E-15	9.61E-15	<0.01%
Ecological Receptors									
R3	Hydro Marsh	NA [e]	6.10E-14	6.10E-14	<0.01%	NA [e]	1.11E-14	1.11E-14	<0.01%
R6	Frenchman's Bay	NA [e]	6.50E-14	6.50E-14	<0.01%	NA [e]	1.04E-14	1.04E-14	<0.01%
R8	Frenchman's Bay	NA [e]	6.18E-14	6.18E-14	<0.01%	NA [e]	1.15E-14	1.15E-14	<0.01%
R15	Frenchman's Bay	NA [e]	4.42E-14	4.42E-14	<0.01%	NA [e]	7.29E-15	7.29E-15	<0.01%
R16	Frenchman's Bay	NA [e]	2.98E-14	2.98E-14	<0.01%	NA [e]	5.95E-15	5.95E-15	<0.01%
R19	Frenchman's Bay	NA [e]	5.69E-14	5.69E-14	<0.01%	NA [e]	1.16E-14	1.16E-14	<0.01%
R25	Frenchman's Bay	NA [e]	6.77E-14	6.77E-14	<0.01%	NA [e]	1.01E-14	1.01E-14	<0.01%
P8	Frenchman's Bay	NA [e]	4.06E-14	4.06E-14	<0.01%	NA [e]	6.92E-15	6.92E-15	<0.01%
R9	PN Site	NA [e]	2.49E-13	2.49E-13	<0.01%	NA [e]	4.43E-14	4.43E-14	<0.01%
R10	PN Site	NA [e]	2.62E-13	2.62E-13	<0.01%	NA [e]	6.01E-14	6.01E-14	<0.01%
R11	PN Site	NA [e]	1.70E-13	1.70E-13	<0.01%	NA [e]	2.67E-14	2.67E-14	<0.01%
R13	PN Site	NA [e]	1.74E-13	1.74E-13	<0.01%	NA [e]	6.69E-14	6.69E-14	<0.01%
R14	PN Site	NA [e]	1.50E-13	1.50E-13	<0.01%	NA [e]	2.92E-14	2.92E-14	<0.01%
R28	PN Site	NA [e]	1.52E-13	1.52E-13	<0.01%	NA [e]	2.91E-14	2.91E-14	<0.01%
FL_WEN_1-394	PN Site [c]	NA [e]	5.32E-13	5.32E-13	<0.01%	NA [e]	8.14E-14	8.14E-14	<0.01%
FL_S_1-144	Nearshore Lake Ontario [d]	NA [e]	1.83E-13	1.83E-13	<0.01%	NA [e]	5.36E-14	5.36E-14	<0.01%

Notes:
µg/m³ – micrograms per cubic meter.
Highlighted cell indicates an exceedance of the applicable ambient air quality criteria.
[a] Represents a location where the Harvester is assumed to engage in traditional harvesting activities.
[b] Represents modelled concentrations experienced by the Urban Resident/Harvester assuming the specified predominant wind direction.
[c] Represents the maximum concentration modelled along the western, eastern and northern fenceline property boundaries of the PN site.
[d] Represents the maximum concentration modelled along the southern fenceline property boundary of the PN site.
[e] No reliable concentration of acrolein is available for characterizing existing conditions.

Radiological Emissions

As described in **Section 3.1.1**, during preparation for refurbishment, the reactor will be defueled and dewatered. During reactor dewatering there may be emissions of radionuclides; however, emissions are expected to remain below previous operational conditions assessed in the 2022 PN ERA for 6 operating units. This reduction in emissions is shown in the 2017 Safe Storage PEA, which presented airborne tritium emissions data collected from PNGS Unit 2 and Unit 3 during draining, flushing, and drying, that were several times less than operational conditions. Draining, flushing, and drying activities are the first step for both the Stabilization Phase and the Refurbishment Phase.

Since the data demonstrates that tritium emissions from PNGS Unit2 and Unit 3 during dewatering and drying activities were substantially lower compared to operational units, a similar decrease in other radionuclides such as noble gases, particulates, radioiodines, and carbon-14 is expected. During refurbishment, OPG will use lessons learned from the PNGS Unit 1 and Unit 4 Stabilization Phase, as well as the Darlington refurbishment, to ensure emissions are minimized and maintained As Low as Reasonably Achievable (ALARA).

During the times when there will be openings in containment (i.e., specially prepared and approved openings in the reactor building dome for steam generator removal and replacement, and/or open airlocks), procedures will be in place to control radioactive releases to the environment and keep within previous levels (as evaluated in the 2022 PN ERA for 6 operating units). Prior to creating an opening in the dome, the unit will be isolated from the other operating units. Additionally, the heat transport and moderator system components will be dried to reduce potential for tritium emissions to the atmosphere through the opening. The specific control measures will be determined through an assessment of work that will be in progress and system/equipment availability (e.g. status of vapour barriers between boiler room and reactor vaults, status of reactor building ventilation and filter systems, status of monitoring systems). The controls will take into account allowed parallel work activities, directing air flow towards the inside of the reactor buildings, maintaining negative pressure in the reactor buildings, radioactivity monitoring, decontamination, and contingency actions should an abnormal event or condition occur.

Overall, radiological emissions to the atmospheric environment are expected to be similar to that evaluated in the 2017 Safe Storage PEA and overall bounded by that evaluated in the 2022 PN ERA for 6 operating units. As such, no further assessment is conducted in this PERA of radiological emissions to air during refurbishment.

5.1.1.3 PNGS Units 5-8 Continued Operations

Following refurbishment, PNGS Units 5-8 will operate in the same manner as current PNGS Units 5-8 operations; therefore, assessment of the potential effects from the Continued Operation Phase on the environment is similar to the assessment of effects under the 2022 PN ERA with 6

operating units; therefore, no further assessment is warranted in the PERA for continued operations.

During Continued Operations of PNGS Units 5-8, activities associated with PNGS Units 1-4 SWS and dismantle/demolish will be occurring, which could result in increased air emissions. It is expected that air predictions would be within the bounding air quality assessment presented in **Section 5.1.1.2**.

5.1.2 Noise

5.1.2.1 PNGS Units 1-4 Decommissioning

5.1.2.1.1 Stabilization and Storage with Surveillance

As stated in the 2017 Safe Storage PEA and the 2022 PEA Addendum, noise levels will be reduced during Stabilization and SWS as reactor units (including Units 1 and 4) are shutdown and facilities are transitioned to a SWS state. These findings from the 2017 Safe Storage PEA and updated in the 2022 PEA Addendum continue to remain valid for Units 1 and 4; therefore, no further assessment is conducted in this PERA.

5.1.2.1.2 Risk Reduction/Removal activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities, which will include dismantling and demolishing of buildings and structures. Dismantling activities (either under risk reduction and removal activities in 2025-2033 or dismantle/demolish activities in 2034-2037) will require equipment that may generate noise. These noise emissions would be coming from various sources such as road traffic and hauling machineries. Some SSCs require segmentation of the unit, which will generate additional noise as part of the process, which is temporary until the completion of the segmentation. Additional temporary noise would also be emitted from lifting the material on carts/buggies to transport to off-site waste disposal. Generally, it is anticipated that noise emitting activities will be associated with clearing work, segmentation/dismantling activities, hoisting and transporting the equipment.

OPG will implement a Noise Management Plan to mitigate noise generation at the site, maintain equipment in proper mechanical condition, and comply with applicable noise standards and regulations.

Overall, noise levels during risk reduction and removal activities and dismantle/demolish activities during this licensing period will be similar to noise levels assessed in the 2022 PN ERA with 6 operating units; therefore, no further assessment is warranted in the PERA.

5.1.2.2 PNGS Units 5-8 Refurbishment

During ongoing operations at the PN site, on-site continuous noise sources are primarily from building ventilation systems. Intermittent noise sources are primarily from the standby turbine

generator set, steam relief valves, switchyard, emergency power supply generator, auxiliary steam boiler, and the auxiliary power supply.

During refurbishment additional noise will be emitted from operation of all construction-related equipment, operating outside of the building envelope, including additional on-site vehicle movements (e.g., haul trucks, additional workforce traffic).

To support this PERA, a maximum bounding scenario was developed to evaluate the effects of refurbishment and decommissioning on noise levels. The noise assessment focused on noise from construction equipment such as diesel generators, cranes, excavators, loaders, drilling, tugboats for DWI construction, and use of a multi-wheeled ground transporter for moving construction equipment. The maximum bounding emission scenario also considered on-site vehicular traffic (approximately 2,200 vehicles per day), specifically haul trucks for movement of material associated with refurbishment activities (i.e., hauling of excavated materials, concrete trucks supporting construction), as well as employee and delivery traffic from existing conditions and additional refurbishment contract employee and delivery traffic.

Noise levels were previously evaluated as part of the Pickering B Refurbishment EA; however, an updated noise model was developed in 2025 which took into account current Project planning as well as activities not considered in the Pickering B Refurbishment EA, including construction of the DWI.

5.1.2.2.1 Noise Screening Guidelines

Human Health

The measurement used to assess sound levels is the day-night sound level (Ldn). This value represents a 24-hour energy equivalent sound level that includes a 10 dB penalty for sounds that occur during night-time hours (22:00-07:00). The intention is to account for the heightened sensitivity to noise during night-time hours and capture a higher potential for annoyance during common sleeping hours. To assess the impact of noise on human receptors, noise guidelines were retained from Health Canada's *Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise* (HC, 2017). This document provides a novel method for estimating the percentage of people that would be "highly annoyed" (%HA) by exposure to different noise levels and types. A dose-response curve is used to identify the %HA by sounds at the calculated levels. Health Canada suggests that a noise impact requiring further evaluation and noise control measures occurs when an activity causes a change in %HA of +6.5%.

In addition to the %HA guidance, Health Canada considers Project-associated noise levels greater than 75 dBA to potentially result in adverse effects such as sleep impairment and disturbance to vulnerable populations. Additional noise control measures are required when Project-associated Ldn values exceed 75 dBA (HC, 2017).

Ecological Health

There are minimal regulatory noise limits for the protection of ecological receptors. N288.6:22 (CSA, 2022a) points to Environment and Climate Change Canada's (ECCC) guidelines established to avoid causing harm to migratory birds and their nests (ECCC, 2023b). According to ECCC (2023b), birds can be potentially impacted by noise when:

- noise levels exceed 10 decibels (dB) above ambient noise levels in the natural environment (i.e., existing conditions pre-project); and,
- noises greater than about 50 dB are produced.

While ECCC caveats these guidelines as advice rather than regulatory limits, the ECCC values have been retained as the screening guidelines for assessing potential noise impacts to ecological receptors for the PERA.

5.1.2.2.2 Noise Modelling Results and Discussion

The human and ecological receptor locations retained for the noise modelling assessment are shown in **Figure 5-1** and **Figure 5-2**, respectively. Results of the noise modelling and comparisons with human health and ecological noise guidelines are presented in **Table 5-12** below.

Human Health

Predicted noise levels at the industrial/commercial worker receptor location are predicted to exceed the 75 dBA guideline provided by Health Canada. Modelled noise levels at these same receptor locations, in addition to the sport fisher, are predicted to exceed the +6.5 %HA guideline from Health Canada.

Despite some noted exceedances of the Health Canada noise guidelines, human receptors are not expected to be impacted by Project-associated noise levels. The industrial/commercial worker represents an off-site worker that be acclimated to elevated noise levels through exposure to other industrial activities. Noise impacts tend to be more disruptive during nighttime hours when sounds can be perceived as being louder than during the daytime and sleep can potentially be interrupted. Sleep disturbance is not considered a relevant health endpoint for this receptor location. Additionally, noise impacts tend to be more disruptive for certain sensitive receptors, such as residential areas, schools and daycares, hospitals, and places of worship. The industrial/commercial worker location is representative of a mix of various industrial and commercial operations and businesses and do not represent an area with receptors sensitive to noise impacts.

The sport fisher receptor represents a location where humans may be temporarily exposed to elevated noise levels resulting from Project activities. As described in **Section 6.1.1.2**, the sport fisher receptor is assumed to spend 1% of their time at the outfall location where atmospheric

exposure occurs. This equates to approximately 87.6 hours in a full calendar year. Similar to the industrial/commercial worker, the sport fisher receptor does not represent a location where sleep disturbance is a relevant health endpoint, nor is it representative of an area with elevated sensitivity to noise impacts.

Considering the above, noise impacts are not assessed further for human receptors in this PERA.

Ecological Health

When considering existing conditions characterized by the recent noise monitoring program conducted at the PN site in October 2024, no background noise levels exceeded the ECCC's 50 dB guideline. When considering Project-related sound sources only, predicted noise levels exceeded the 50 dB guideline for all ecological receptor locations excluding the two locations farthest away within Frenchman's Bay (R15 and R16). When the influence of Project-related activities are considered together with existing noise levels, the 50 dB guideline was exceeded at all ecological receptor locations. Predicted sound levels at all ecological receptor locations within the PN site (including the Bank Swallow Habitat) and along the southern fenceline (representative of the nearshore Lake Ontario area) exceeded current noise levels by more than 10 dB, with the exclusion of receptor location R9, which met the ECCC guideline by demonstrating a predicted 9.7 dB increase from current noise conditions.

Although the ECCC noise guidelines are predicted to be exceeded at many of the ecological receptor locations assessed, these guidelines are interpreted to be provided by ECCC as recommended reference values and are not representative of strict regulatory limits. Nonetheless, mitigation measures are expected to be implemented to minimize Project-related noise disturbances to local terrestrial and riparian biota. As much as its feasible to do so, work should be planned to occur during daytime hours when background sound levels are higher than nighttime hours to minimize disruption of nocturnal wildlife. The development and implementation of a Noise Management Plan will outline best construction practices and available mitigation measures for controlling noise generation. Noise levels at the PN site are characteristic of a typical urban and semi-urban environment; thus it is likely that many on-site ecological receptors are accustomed to living near human developments and are well adjusted to sound levels consistent with local human activities.

Predicted noise levels at the receptor locations representative of Frenchman's Bay (an important local habitat for terrestrial and riparian biota) are considerably lower than the predicted noise levels within the PN site and, in many cases, only slightly exceed the ECCC's 50 dB guideline. It is thus anticipated that noise impacts to Frenchman's Bay will be less severe relative to the PN site, allowing the area to continue to provide important refuge to local wildlife. This notion is further supported by the fact that predicted noise levels at the ecological receptor locations for Frenchman's Bay meet the ECCC recommendation that Project noise levels do not exceed background (i.e., pre-project) noise levels by more that 10 dB.

Predicted noise levels at the Bank Swallow Habitat location (receptor BSH) exceeded both noise guidelines provided by ECCC. This location corresponds to the site of the Fixed Face Earthen Embankment (FFEE), a pilot artificial nesting test structure designed for Bank Swallow, a Species at Risk (SAR). It should be noted that, without the pilot FFEE structure, the PN site does not provide suitable breeding habitat for the Bank Swallow. In addition to monitoring of the FFEE currently undertaken as part of the SHA, OPG maintains an annual biodiversity monitoring program that documents and monitors wildlife populations at the PN site, including for breeding birds.

Mitigation measures should be explored to reduce noise levels to species at risk during the breeding season including Bank Swallow. However. it should be noted that the noise modelling conducted for this PERA was developed with highly conservative assumptions relating to the planned Project activities, including maximum equipment use, without accounting for any significant variability in operational practices. The results represent a “worst-case” bounding scenario for potential noise impacts. It is expected that under real-world conditions, noise impacts to ecological receptors would be less severe than the predicted modelling values.

Considering the above discussion, noise impacts are not assessed further for any ecological receptors for this PERA; however, recommendations are provided for noise levels associated with species at risk such as the Bank Swallow.

Table 5-12: Human Health and Ecological Noise Modelling Results

Receptor ID	Receptor Name	Existing Conditions					PNGS Sources Only			Existing Conditions + PNGS Sources								
										Day		Night		24-hr		%HA Analysis		
		Day	Night	24-hr	Ldn	%HA	Day	Night	24-hr	Total	Increment	Total	Increment	Total	Increment	Total Ldn	Total %HA	Δ%HA
Noise Guidelines - Human Health (HC, 2017)																**75**		**+6.5**
Human Receptors																		
R1	Local Harvesting Area 1 [a]	48.4	46.9	48.0	53.6	3.5	49.0	49.0	49.0	51.7	3.3	51.1	4.2	51.6	3.5	57.6	5.8	2.3
R2	Local Harvesting Area 2 [a]	48.4	46.9	48.0	53.6	3.5	49.4	49.4	49.4	51.9	3.5	51.4	4.4	51.8	3.7	57.9	5.9	2.5
R3	Local Harvesting Area 3 [a]	48.4	46.9	48.0	53.6	3.5	49.1	49.1	49.1	51.8	3.4	51.2	4.2	51.6	3.6	57.7	5.8	2.3
R20	Industrial/Commercial Worker	47.7	46.9	47.5	53.4	3.4	70.3	70.3	70.3	70.3	22.7	70.3	23.4	70.3	22.9	76.7	43.3	39.9
R21	Sport Fisher	47.3	50.0	48.4	56.2	4.8	63.0	63.0	63.0	63.1	15.8	63.2	13.2	63.1	14.8	69.6	22.9	18.1
R22	Correctional Institute (C2)	47.7	46.9	47.5	53.4	3.4	42.5	42.5	42.5	48.8	1.2	48.2	1.3	48.7	1.2	54.7	4.0	0.6
R23	Farm	48.7	49.5	49.0	55.8	4.6	28.8	28.8	28.8	48.8	0.0	49.6	0.0	49.0	0.0	55.9	4.6	0.0
R24	Dairy Farm	48.7	49.5	49.0	55.8	4.6	16.9	16.9	16.9	48.7	0.0	49.5	0.0	49.0	0.0	55.8	4.6	0.0
R25	Urban Resident/Harvester [b] (WNW)	47.3	50.0	48.4	56.2	4.8	52.5	52.5	52.5	53.7	6.3	54.5	4.4	53.9	5.6	60.8	8.5	3.7
R26	Urban Resident/Harvester [b] (NW)	47.3	50.0	48.4	56.2	4.8	46.9	46.9	46.9	50.1	2.8	51.8	1.7	50.7	2.3	58.0	6.0	1.2
R27	Urban Resident/Harvester [b] (NNW)	48.4	46.9	48.0	53.6	3.5	48.3	48.3	48.3	51.4	2.9	50.7	3.7	51.2	3.1	57.2	5.5	2.0
Noise Guidelines - Ecological (ECCC, 2023)				**50**					**50**					**50**	**+10**			
Ecological Receptors																		
R3	Hydro Marsh	48.4	46.9	48.0	53.6	3.5	49.1	49.1	49.1	51.8	3.4	51.2	4.2	51.6	3.6	57.7	5.8	2.3
R6	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	52.0	52.0	52.0	53.3	5.9	54.1	4.1	53.6	5.2	60.4	8.2	3.3
R8	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	51.3	51.3	51.3	52.8	5.4	53.7	3.7	53.1	4.7	60.0	7.7	2.9
R15	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	47.7	47.7	47.7	50.5	3.2	52.0	2.0	51.1	2.7	58.3	6.2	1.4
R16	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	48.1	48.1	48.1	50.7	3.4	52.2	2.1	51.2	2.9	58.4	6.4	1.6
R19	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	53.5	53.5	53.5	54.4	7.1	55.1	5.1	54.7	6.3	61.4	9.2	4.4
R25	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	52.5	52.5	52.5	53.7	6.3	54.5	4.4	53.9	5.6	60.8	8.5	3.7
P8	Frenchman's Bay	47.3	50.0	48.4	56.2	4.8	50.5	50.5	50.5	52.2	4.9	53.3	3.2	52.6	4.2	59.6	7.3	2.5
R9	PN Site	48.7	49.5	49.0	55.8	4.6	58.2	58.2	58.2	58.7	9.9	58.8	9.2	58.7	9.7	65.1	14.2	9.6
R10	PN Site	48.4	46.9	48.0	53.6	3.5	73.5	73.5	73.5	73.5	25.1	73.5	26.6	73.5	25.5	79.9	53.7	50.3
R11	PN Site	48.4	46.9	48.0	53.6	3.5	70.0	70.0	70.0	70.0	21.6	70.0	23.1	70.0	22.0	76.4	42.3	38.8
R13	PN Site	47.7	46.9	47.5	53.4	3.4	65.0	65.0	65.0	65.1	17.4	65.1	18.2	65.1	17.6	71.5	27.6	24.2
R14	PN Site	48.4	46.9	48.0	53.6	3.5	58.8	58.8	58.8	59.2	10.8	59.1	12.1	59.2	11.1	65.5	14.8	11.3
R28	PN Site	47.7	46.9	47.5	53.4	3.4	70.3	70.3	70.3	70.3	22.7	70.3	23.4	70.3	22.9	76.7	43.3	39.9
BSH	Bank Swallow Habitat	48.7	49.5	49.0	55.8	4.6	63.2	63.2	63.2	63.4	14.6	63.4	13.9	63.4	14.4	69.8	23.4	18.8

Notes:
Shaded cells indicate exceedance of the specified noise guideline.
Background noise levels are L90 measurements presented in dBA.
"PNGS Sources Only" and "Existing Conditions + PNGS Sources" presented as Leq values in dBA, unless otherwise specified.

"Existing Conditions": Background (i.e., pre-Project) noise levels characterized during the recent PN noise monitoring study conducted in October 2024.
"PNGS Sources Only": Modelled noise levels associated with the planned Refurbishment and Decommissioning activities.
"Existing Conditions + PNGS Sources": Predicted noise levels calculated by considering the influence of the modelled PNGS Refurbishment and Decommissioning activities together with existing noise levels. "Total" values represent sound levels considering both existing conditions and PNGS activities; "Increment" values represent the contribution to total noise values from PNGS activities only.

5.1.2.3 PNGS Units 5-8 Continued Operations

Following refurbishment, PNGS Units 5-8 will operate in the same manner as current PNGS Units 5-8 operations; therefore, assessment of the potential effects from the Continued Operation Phase on the environment is similar to the assessment in the 2022 PN ERA with 6 operating units; therefore, no further assessment is warranted in the PERA for continued operations.

During Continued Operations of PNGS Units 5-8, activities associated with PNGS Units 1-4 SWS and dismantle/demolish will be occurring, which could result in increased noise levels. It is expected that noise predictions would be within the bounding noise assessment presented in **Section 5.1.2.2**.

5.1.3 Summary of Tier 1 Assessment

The initial screening of potential effects of Project activities on the atmospheric environment included consideration of both air quality and noise levels. The predicted interactions between the atmospheric environment and Project activities are summarized in **Table 5-13**.

Table 5-13: Summary of Interactions between Project Activities and Atmospheric Environment

Project Activities	Air	Noise
PNGS Units 1-4 Decommissioning		
PNGS Units 1 and 4 Stabilization	2017 Safe Storage PEA and 2022 PEA Addendum is bounding	2017 Safe Storage PEA and 2022 PEA Addendum is bounding
PNGS Units 1-4 Storage with Surveillance	2017 Safe Storage PEA and 2022 PEA Addendum is bounding • Activities associated with removal of modules and baskets from IFB-A and AIFB not previously assessed. Included in air model completed to support this PERA. • Radiological emissions consistent with previous assessments. • Harvester receptor not previously considered. Harvester receptor exposed to radiological COPCs in atmospheric environment considered further in Tier 2 assessment.	2017 Safe Storage PEA and 2022 PEA Addendum is bounding • Activities associated with removal of modules and baskets from IFB-A and AIFB not previously assessed. Included in noise model completed to support this PERA.
Risk Reduction and Removal Activities (2025-2033) Dismantle/Demolish (2034-2037)	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum • Non-Radiological Emissions – negligible and mitigated by Environmental Management Plan	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum. Noise levels would be mitigated by Noise Management Plan.

Project Activities	Air	Noise
	• Radiological Emissions – All SSCs will be characterized prior to dismantle/demolish. Decommissioning Safety Assessment will be completed	Noise levels would be similar to or bounded by the 2022 PN ERA for 6 operating units.
PNGS Units 5-8 Refurbishment		
Preparation for Refurbishment		
• Procurement and Mobilization of Equipment and Components	This activity is bounded by the activities assessed in the air model completed to support this PERA. Not a significant air source.	The activity is bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source.
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	This activity is bounded by the activities assessed in the air model completed to support this PERA. Not a significant air source.	The activity is bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source.
• Construction of PCSS and SB #5	This activity is bounded by the activities assessed in the air model completed to support this PERA. Not a significant air source.	The activity is bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source.
• Defuel and Dewater	• This activity is bounded by the activities assessed in the air model completed to support this PERA. Not a significant air source. • Radiological emissions bounded by existing conditions assessed in the 2022 PN ERA for 6 operating units.	The activity is bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source.
• Islanding the Unit	No interaction	No interaction
• Management of Heavy Water	This activity is bounded by activities assessed in the air model completed to support this PERA. Not a significant air source	The activity is bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source.
• Construction of DWI	Included in air model completed to support this PERA. Emissions associated with DWI construction such as launch shaft and tunnel construction, infill, construction equipment, etc. considered, as well as DSM moves.	Included in noise model completed to support this PERA. Noise associated with DWI construction such as launch shaft and tunnel construction, infill, construction equipment, etc. considered, as well as DSM moves.
Refurbishment		
• Replacement of Reactor Components	Equipment used to perform activity included in air model completed to support this PERA.	Equipment used to perform activity included in noise model completed to support this PERA.

Project Activities	Air	Noise
• Removal and Replacement of Steam Generators	Equipment used to perform activity included in air model completed to support this PERA.	Equipment used to perform activity included in noise model completed to support this PERA.
• Operation of DWI	No interaction	No interaction
• Refurbishment of Other Plant Systems	Included in air model completed to support this PERA.	Included in noise model completed to support this PERA.
• Waste Management and Transportation	On-site transportation included in air model completed to support this PERA.	On-site transportation included in noise model completed to support this PERA.
• Refuelling and Restarting	Equipment used to perform activity included in air model completed to support this PERA.	Equipment used to perform activity included in noise model completed to support this PERA.
Continued Operations		
• Operation and Maintenance of PNGS Units 5-8	2022 PN ERA is bounding	2022 PN ERA is bounding
• Waste Management and Transportation	2022 PN ERA is bounding	2022 PN ERA is bounding

5.2 Surface Water Environment

5.2.1 Surface Water Flow

5.2.1.1 PNGS Units 1-4 Decommissioning

5.2.1.1.1 Stabilization and Storage with Surveillance

The 2017 Safe Storage PEA and 2022 PEA Addendum assumed that the PN water balance will change in a stepwise manner during the Stabilization Phase, from its previous operational configuration (6 operating units) to its configuration during the SWS Phase (PNGS Units 1 and 4, and PNGS Units 5-8 shut down). PNGS Units 1 and 4 were shut down in Q4 2024, and based on current Project planning, PNGS Units 5-8 will continue to operate until the end of 2026 after which they will enter refurbishment (see **Section 5.2.1.2**). During Units 1 and 4 Stabilization and Units 1-4 SWS, the most significant change from previous operational conditions (for 6 operating units) results from the gradual shutting down of the CCW pumps throughout Stabilization and SWS.

During Stabilization a minimum of 2 CCW pumps (approximately 2,050,000 m^3/day) will continue to operate to support Stabilization activities.

Based on current Project planning, during Unit 1 and 4 Stabilization, some or all of PNGS Units 5 to 8 will be shutdown for refurbishment. As shown in the water balance in **Figure 5-3** for Stabilization, when all units at PNGS Units 5-8 are shutdown, the RLWMS flow will discharge through the PNGS Units 1-4 CCW discharge channel – no RLWMS effluent will be discharged from the PNGS Units 5-8 CCW discharge channel. Reactor building service water (RBSW) will be released through the PNGS Units 5-8 outfall. Consistent with the 2022 PEA Addendum, inactive

drainage will be discharged to the respective PNGS Units 1-4 or PNGS Units 5-8 CCW intake duct.

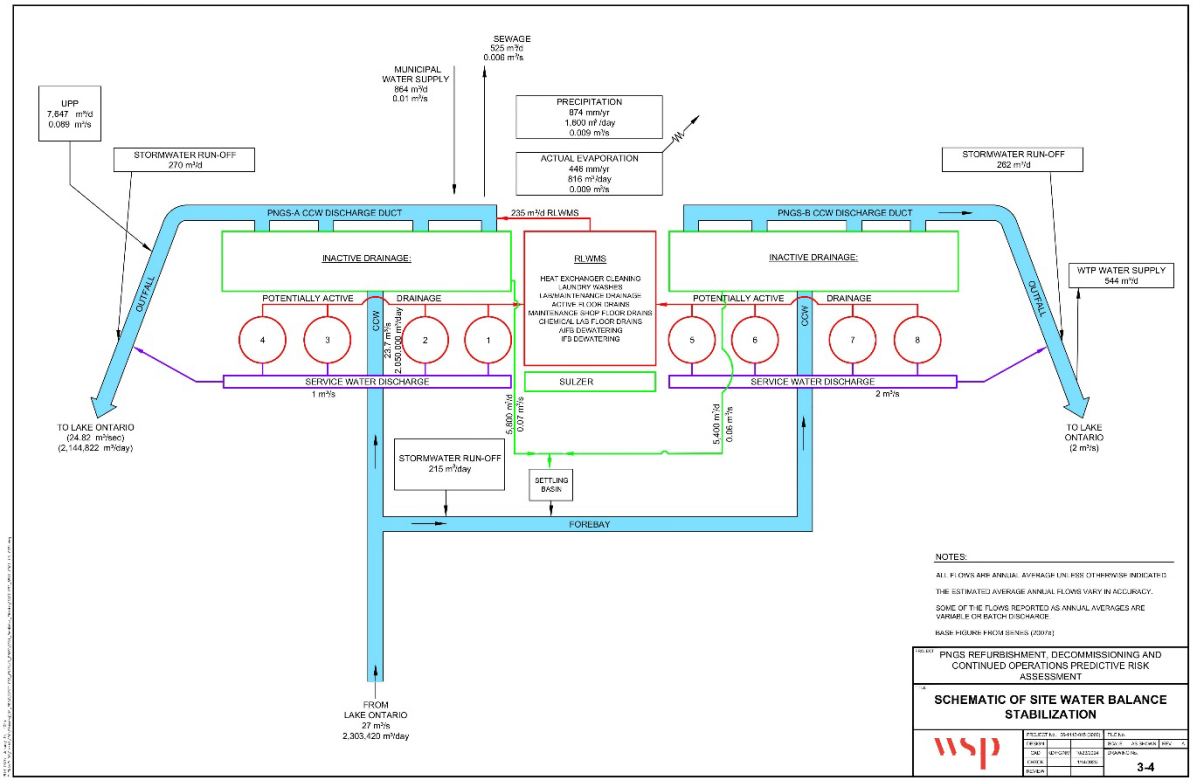
The 2022 PEA Addendum assumed that during SWS, the expected CCW intake flow will be 250,500 m^3/day (2,899 L/s).

A hydrodynamic surface water model (RMA10) was initially developed for the 2017 Safe Storage PEA and re-assessed in the 2022 PEA Addendum, to evaluate the changes to the nearshore hydraulic environment resulting from the reduced flow conditions during SWS (SWS in the 2017 Safe Storage PEA and 2022 PEA Addendum was for both PNGS Units 1-4 and Units 5-8). The model was employed to predict changes in lake currents during SWS. The model assumed a much lower flow of 50,000 m^3/day (from RBSW only), compared to current Project planning. The 2022 PEA Addendum concluded that the model used in 2017 provides a reasonable representation of existing lake water physical conditions (water level, water temperature, current speed) and that the concentration factors provided in the 2017 Safe Storage PEA continue to remain valid for PNGS Units 1-4 SWS. Furthermore, no changes in the amount of stormwater runoff were anticipated during the Stabilization and SWS activities. Overall, the findings from the 2017 Safe Storage PEA and updated in the 2022 PEA Addendum are bounding for PNGS Units 1 and 4 Stabilization and PNGS Units 1-4 SWS; therefore, no further assessment is conducted in this PERA.

A summary of assumptions made for surface water quantity from previous assessments and current Project planning is provided in **Table 5-14**.

Table 5-14: Summary of Surface Water Assumptions during the Project

Project Phase	2017 Safe Storage PEA	2022 PEA Addendum	Current Project Planning (this PERA)
PNGS Units 1 and 4 Stabilization	CCW pumps will be taken out of service as reactor units are shut down.	CCW pumps will be taken out of service as reactor units are shut down.	2 CCW pumps running (2,050,000 m^3/day), RLWMS released to PNGS Units 1-4 discharge channel PNGS Units 5-8 shutdown in 2026 for initiation of refurbishment (no CCW pumps running) – see Figure 5-3
PNGS Units 1 to 4 SWS	50,000 m^3/day cooling water from RBSW only. No CCW pumps operating. Assessed in RMA10 model.	Increased flow of 250,500 m^3/day compared to 2017 Safe Storage PEA	Same as Stabilization row
PNGS Units 5-8 Refurbishment	Not assessed; however, considered shutdown of PNGS Units 5-8 which is the first step of refurbishment	Not assessed; however, considered shutdown of PNGS Units 5-8 which is the first step of refurbishment	Bounding condition evaluated in additional RMA10 model scenario (Figure 5-4) - 1 unit has completed refurbishment and is operational, water drawn in from DWI (approximately 2,050,000 m^3/day) to PNGS Units 5-8, no flow to PNGS Units 1-4.



Note: Figure reflects PNGS Units 1 and 4 in Stabilization and PNGS Units 5-8 shutdown for initiation of Refurbishment.

Figure 5-3: Site Water Balance During PNGS Unit 1 and Unit 4 Stabilization

5.2.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities that will occur during the 2025 to 2033 timeframe, nor the additional dismantle/demolish activities that will occur from 2034 to 2037.

As outlined in **Section 3.3.4**, OPG intends to dismantle certain non-nuclear systems and outbuildings associated with PNGS Units 1-4. However, these specific SSCs do not interact with the drainage system, forebay, intake channel, and intake and discharge ducts.

Considering risk reduction and removal activities and dismantling/demolition activities of non-nuclear outbuildings, from 2025 to 2037, will have no impact on surface water quantity, no further assessment is warranted.

5.2.1.2 PNGS Units 5-8 Refurbishment

PNGS Units 5-8 will undergo refurbishment and return to operations in a staged manner. While PNGS Units 5-8 are shut down for refurbishment, water will be discharged via PNGS Units 1-4. Once PNGS Units 5-8 return to service, the discharge will be via PNGS Units 5-8 CCW discharge channel. The bounding water balance for the Refurbishment phase is shown in **Figure 5-4**.

Other refurbishment activities associated with the replacement of reactor components, replacement of steam generators, waste management, and refuelling and restarting are not anticipated to result in any major changes to the volume of effluent discharged or to Lake Ontario's hydrology.

Construction activities during the Refurbishment phase may disturb existing surfaces and reduce pervious cover, potentially altering stormwater volumes and flow rates, with an increase in sediment from disturbed areas and storm events. However, all activities during this phase will be conducted in accordance with an Erosion and Sediment Control Plan to ensure there are no measurable effects on stormwater runoff. Additionally, a Stormwater Management Plan will be developed. The assessment of potential modifications to existing stormwater infrastructure (e.g., the development of a new stormwater outfall, or the installation of new drainage ditches and storm sewers) needed to support the Project will be completed by a civil engineer. It is assumed that any modifications or expansions to the stormwater management system will meet water quality protection criteria as per MECP requirements. Additionally, any shoreline work for potential stormwater outfalls, if needed, would be done as per Toronto and Region Conservation Authority approvals. The stormwater management system itself will not represent an adverse effect to surface water quantity

As discussed in **Section 3.1.1.7**, the construction and operation of a DWI is proposed. The DWI is proposed to be located approximately 1.5 km offshore from the east end of the existing forebay and will replace the current shoreline surface water intake. Its construction will comprise shoreline modifications, including the potential addition of a dock structure will also involve shoreline modifications including a potential dock and possible West Infill, shoreline erosion mitigation area east of the PNGS Unit 5-8 outfall, and disposal of construction and dredged material.

The hydrodynamic surface water model (RMA10) developed for the 2017 Safe Storage PEA and re-assessed in the 2022 PEA Addendum did not consider the DWI. As such the RMA10 model was updated by WSP to change the intake location to the proposed location for the DWI and assess changes to lake circulation patterns. This was used to determine if previously used concentration factors at various receptor locations would change based on the new configuration. A bounding condition was evaluated where only 1 unit from PNGS Units 5-8 has completed refurbishment (and the remaining 3 units are not operating); therefore, the flow through the DWI is approximately 23.7 m^3/s. At that time all CCW pumps are shutdown on the PNGS Units 1-4 side. The water balance for the bounding condition during refurbishment is shown in **Figure 5-4**.

The RMA10 simulation periods included two modelling periods (September 4, 2011 to December 24, 2011, and March 29, 2012 to July 10. 2012), as used in the 2017 Safe Storage PEA. The 2022 PEA Addendum checked if the model predictions were still accurate using updated lake water data and future climate trends up to 2039. It concluded that the RMA10 model accurately represents current and future conditions. Based on that conclusion, the modelling periods continue to remain valid as simulation periods for the updated model.

The following assumptions in the RMA10 model were made to align with current Project planning:

- The future plant configuration includes a submerged DWI located approximately 1,500 m from the plant. The model was modified to draw intake water from a model element that was centered on the location of the new intake. The existing intake channel was removed from the model.
- The intake flow and CCW flow from PNGS Units 5-8 was assumed to be 23.7 m^3/s based on the latest flow diagram (**Figure 5-4**) for the bounding condition.
- The flow from the PNGS Units 1-4 discharge channel was assumed to be limited to the average stormwater runoff rate of 270 m^3/d (0.0031 m^3/s).
- The RLWMS discharge is to the PNGS Units 5-8 discharge channel and not PNGS Units 1-4 based on current Project planning.
- The intake temperature was assumed to be equal to the measured lake water temperature at temperature loggers near PNGS, consistent with the 2017 Safe Storage PEA.

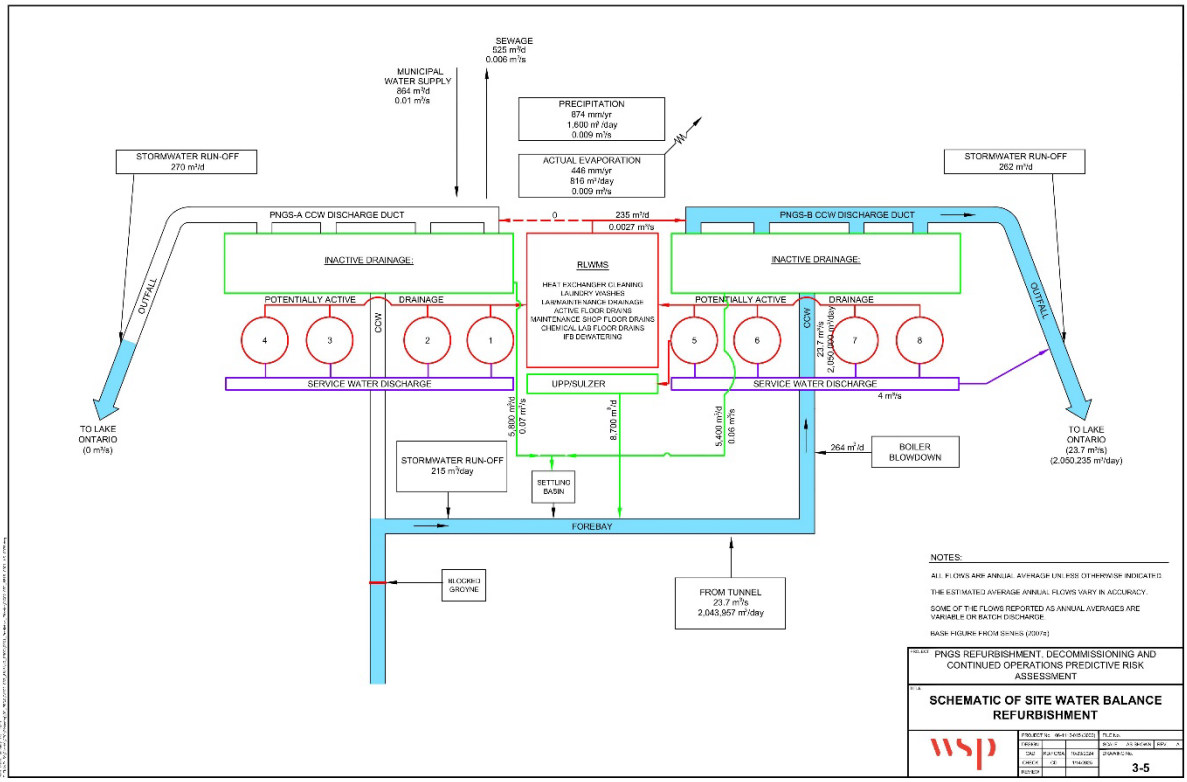
The RMA10 model was used to predict the transport and dispersion of a conservative tracer for the future conditions. Concentration factors were developed for each receptor location based on a constant discharge concentration of 1 g/m^3 (1 mg/L), and are shown on **Table 5-15**. The concentration factors represent the inverse of dilution factors. The concentration factor can be multiplied by a contaminant's outfall concentration to estimate its concentration at different lake locations. The conservative tracer is not intended to represent any specific contaminant, but is intended to provide a consistent method to determine concentrations at various receptors consistent with the 2017 Safe Storage PEA.

For the discussion on surface water quantity, the main differences in the assumptions behind the concentration factors for the 2025 modelling update and those from the 2017 Safe Storage PEA are that the 2025 modelling assumes 2,050,000 m^3/day of cooling water from CCW pumps, released to the PNGS Units 5-8 CCW discharge duct, whereas the 2017 Safe Storage PEA assumed 50,000 m^3/day of cooling water from the RBSW only. As well, addition of the DWI changes the circulation patterns. The concentration factors used in the 2017 Safe Storage PEA, along with those for existing condition (for 6 operating units) and the 2025 bounding condition are shown in **Table 5-15**. The main difference between the concentration factors is that in the 2017 Safe Storage PEA water was planned to be released to the PNGS Units 5-8 outfall from the RBSW only; however, in 2025 water is planned to be released via the PNGS Units 5-8 discharge duct with a greater flowrate. Interpretation of the concentration factors in terms of predicted concentrations of radionuclides and non-radionuclides is presented in **Section 5.2.2.2**.

Table 5-15: Summary of Predicted Surface Water Concentration Factors for PNGS Units 5-8 Outfall

Location of Interest	Distance from PNGS Units 5-8 Outfall (m)	2017 Safe Storage PEA RBSW Discharge to PNGS Units 5-8[1]	Existing Conditions[2] Discharge to PNGS Units 1-4	Existing Conditions[2] Discharge to PNGS Units 5-8	2025 Modelling Update Discharge to PNGS Units 5-8, during Refurbishment [3]
PNGS Units 1-4 Discharge Channel	939	3.56E-04	9.44E-01	3.84E-03	9.88E-03
PNGS Units 5-8 Discharge Channel	212	6.80E-02	1.05E-04	9.97E-01	8.97E-01
Off PNGS / Sport Fisher	515	1.25E-03	5.72E-02	1.81E-01	5.58E-02
Squires Beach	2,100	7.48E-04	1.26E-02	1.06E-01	2.93E-02
Liverpool Beach	1,485	3.62E-04	1.68E-01	4.54E-02	1.67E-02
Frenchman's Bay Inlet	1,970	3.16E-04	9.67E-02	4.28E-02	1.44E-02
Ajax Intake	5,061	1.01E-04	5.50E-03	1.86E-02	3.08E-03

Notes: Estimated average concentration factors based on constant discharge concentration of 1 g/m^3 (1 mg/L)
(1) Concentration factor applies to RBSW end of pipe concentration where flow is 50,000 m^3/day
(2) Existing conditions represents PNGS Units 1 and 4 operating and Units 5-8 operating.
(3) Concentration factor applies to PNGS Units 5-8 CCW discharge duct end of pipe where flow is 2,050,00 m^3/day. A bounding condition was evaluated where only 1 unit from PNGS Units 5-8 has completed refurbishment (and the remaining 3 units are not operating), and all of PNGS U1-4 are shut down.



Note: Figure reflects a bounding condition where 1 unit is operating for PNGS Units 5-8, DWI tunnel is operating, and PNGS Units 1-4 has no intake or discharge flow.

Figure 5-4: Water Balance for Bounding Condition during Refurbishment

5.2.1.3 PNGS Units 5-8 Continued Operations

As outlined in the previous section, the construction of the proposed DWI and associated activities will modify surface water flow and hydrology compared to previous conditions (with 6 operating units as assessed in the 2022 PN ERA).

During Continued Operations, the intake flow will come from the DWI, and will be lower than previous operational conditions (with 6 operating units) since there will be no flow to PNGS Units 1-4. The intake flow from the DWI will range from approximately 141 to 172 m^3/s (average of 156.5 m^3/s) with a similar discharge through the PNGS Units 5-8 discharge channel (see **Figure 5-5**). Since there will be no flow out the PNGS Units 1-4 discharge channel, the Continued Operations scenario will be similar to or lower than previous operational conditions (with PNGS Units 1 and 4 operating); therefore, no further assessment is warranted in the PERA for continued operations.

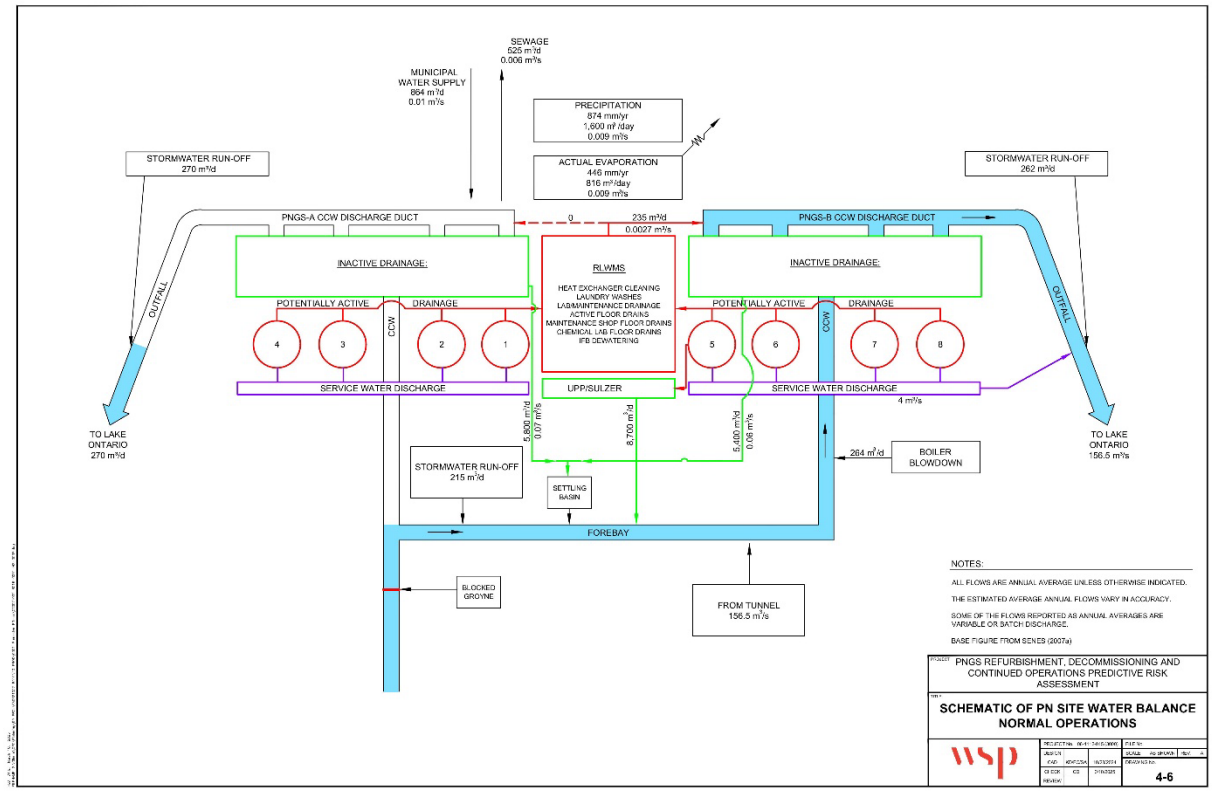


Figure 5-5: Water Balance for PNGS Units 5-8 Continued Operations

5.2.2 Surface Water Quality

5.2.2.1 PNGS Units 1-4 Decommissioning

5.2.2.1.1 Stabilization and Storage with Surveillance

5.2.2.1.1.1 Forebay

Non-Radiological and Radiological Emissions

In the 2017 Safe Storage PEA and 2022 PEA Addendum, the forebay was assessed as a potential aquatic habitat during the SWS Phase following reduced flows and removal of the FDS. In the 2022 PEA Addendum an updated mass balance box model was developed to predict surface water concentrations in the forebay during the SWS Phase based on groundwater contributions from the turbine auxiliary bay (TAB) inactive drainage (IAD) sumps and the vacuum building ramp sump (VBRS), as well as stormwater to the forebay. As shown in the 2022 PEA Addendum, predicted concentrations of non-radionuclides in the forebay were below screening criteria. For radionuclides, total doses to ecological receptors in the forebay were calculated using measured concentrations of tritium, C-14, Co-60, Cs-134 and Cs-137. Based on the modelling results, there were no potential adverse effects identified. All doses to the receptors assessed were predicted to be below the aquatic benchmark of 9.6 mGy/d, or the terrestrial benchmark of 2.4 mGy/d, as applicable to each receptor.

Based on current Project planning, a DWI will be used to draw water into the forebay and then into the PNGS Units 5-8 intake duct. The DWI will be used starting in 2030, and the FDS will remain operational as necessary. A cut-off wall will be installed at the entrance to the intake channel and water flowing through the cut-off wall into the forebay may serve as an emergency service water supply to the station. While some small fish may be able to enter the forebay through small holes in the cut-off wall, the forebay would not be considered fish habitat according to the DFO definition as "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration area." The cut-off wall will include fish mitigation measures to minimize the risk of fish entry, including species at risk such as American Eel. Since the assessment conducted in the 2022 PEA Addendum assumed that during SWS the forebay would become a potential aquatic habitat and assessed effects of radionuclides and non-radionuclides on ecological receptors, the 2022 PEA Addendum is considered bounding; therefore, no further assessment of water quality in the forebay is conducted in this PERA.

5.2.2.1.1.2 Stormwater

Non-Radiological and Radiological Emissions

Consistent with the 2017 Safe Storage PEA and 2022 PEA Addendum, there are no changes to the stormwater runoff anticipated as a result of the Stabilization and SWS activities. Stormwater is discharged through stormwater runoff outfalls at the shore of Lake Ontario, into the forebay and into the PNGS Units 1-4 and PNGS Units 5-8 discharge channels. Stormwater runoff catchments to Lake Ontario have been assessed in the 2022 PN ERA and that assessment is considered bounding for Stabilization and SWS. The stormwater runoff that drains into the discharge channels is assumed to be 270 m^3/day and 262 m^3/day for PNGS Units 1-4 and PNGS Units 5-8, respectively, based on annual precipitation of 872 mm (see **Figure 5-3**). The 2017 Safe Storage PEA assessed stormwater runoff mixed with cooling water (50,000 m^3/day) in the discharge channel. Using the maximum stormwater quality from the 2015/2016 sampling program, mixed with cooling water, all concentrations were below screening criteria. Based on current Project planning, with 2 CCW pumps running, additional cooling water will be available for dilution instead of 50,000 m^3/day (cooling water needs from RBSW assumed in 2017 Safe Storage PEA); therefore, concentrations in the PNGS Units 1-4 discharge channel are expected to be lower and will be bounded by the 2017 Safe Storage PEA and 2022 PEA Addendum. Additionally, during the end of Stabilization, all PNGS Units 5-8 units will be shutdown for refurbishment, so there will be a period of time where only RBSW and stormwater are discharged to the PNGS Units 5-8 discharge channel (no CCW pumps will be running) PNGS Units 5-8. Since additional dilution will be available from operation of the CCW pumps, the scenario for PNGS Units 1 and 4 Stabilization and Units 5-8 refurbishment is bounded by the stormwater concentrations predicted in the discharge channels for SWS in the 2017 Safe Storage PEA (Golder and Ecometrix, 2017). Overall, these findings for stormwater quality from the 2017 Safe Storage PEA are bounding for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

5.2.2.1.1.3 Lake Water Quality

Non-Radiological and Radiological Emissions

As discussed in **Section 5.2.1.1.1**, during Stabilization and SWS, a minimum of 2 CCW pumps will continue to be available.

During the end of PNGS Units 1 and 4 Stabilization, all PNGS Units 5-8 will be shutdown for refurbishment, so there may be a period of no flow (no CCW pumps running for PNGS Units 5-8), where the RLWMS will discharge through the PNGS Units 1-4 CCW discharge channel and only RBSW (and stormwater) will be released through the PNGS Units 5-8 CCW outfall (see **Figure 5-3**). Consistent with the 2022 PEA Addendum, the inactive drainage will be discharged to the respective PNGS Units 1-4 or PNGS Units 5-8 CCW intake duct, and not diverted to the RLWMS or RBSW. In addition, the increase in expected minimum flow rate from 50,000 m^3/day (assumed in the 2017 Safe Storage PEA) to 250,500 m^3/day (assumed in the 2022 PEA Addendum) will improve the dilution of contaminants discharged at the outfall.

The 2017 Safe Storage PEA evaluated lake water quality during SWS based on expected liquid effluent quality for tritium, carbon-14, and gross beta/gamma from the RLWMS and groundwater inputs. In the 2017 Safe Storage PEA, the release from the RLWMS and groundwater was assumed to be mixed with 50,000 m^3/day of RBSW, released to the PNGS Units 5-8 discharge channel. The end of pipe RBSW concentrations were multiplied by the concentration factors from the RMA10 model to calculate concentrations at various receptor locations as reproduced from the 2017 Safe Storage PEA in **Table 5-16**. End of pipe RBSW concentrations for non-radionuclides were compared against screening values in the 2017 Safe Storage PEA and it was determined that further consideration in a Tier 2 assessment was not warranted.

Table 5-16: Predicted Lake Water Concentrations for Radionuclides during SWS

Receptor Locations	Tritium (Bq/L)	Carbon-14 (Bq/L)	Beta/Gamma (Bq/L)
RBSW Discharge	7.00E+03	3.00E-01	5.00E-01
PNGS Units 1-4 Discharge Channel	2.49E+00	1.07E-04	1.78E-04
PNGS Units 5-8 Discharge Channel	4.76E+02	2.04E-02	3.40E-02
Sport Fisher	8.78E+00	3.76E-04	6.27E-04
Squires Beach	5.24E+00	2.24E-04	3.74E-04
Liverpool Beach	2.53E+00	1.08E-04	1.81E-04
Frenchman's Bay Inlet	2.21E+00	9.47E-05	1.58E-04
Ajax Intake	7.08E-01	3.03E-05	5.06E-05

Overall, since based on current Project planning more cooling water flow will be available for dilution during Stabilization and SWS than previously assessed, the findings from the 2017 Safe Storage PEA and updated in the 2022 PEA Addendum are bounding for PNGS Unit 1 and 4

Stabilization and PNGS Units 1-4 SWS. Therefore, no further assessment of lake water quality is warranted in this PERA.

While no specific COPCs were identified for the surface water environment during Stabilization and SWS, general feedback from the WTFNs on other PERAs has indicated that it would be beneficial to include a Harvester receptor in the PERA. As such, assessment of a Harvester for surface water radiological emissions is considered in the Tier 2 quantitative assessment.

5.2.2.1.1.4 Irradiated Fuel Bays

During SWS, the IFB-A will be drained by 2034. OPG may flush the IFB-A water directly to the PNGS Units 1-4 outfall using U1 CCW pump for dilution. Water drained from IFB-A will be released to Lake Ontario in a controlled manner that keeps tritium concentrations at the Water Supply Plants within existing tritium levels and well below regulatory limits.

5.2.2.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities that will occur during the 2025 to 2033 timeframe, nor the additional dismantle/demolish activities that will occur from 2034 to 2037.

As outlined in **Section 3.3.4**, OPG plans to dismantle certain non-nuclear systems and outbuildings associated with PNGS Units 1-4. As part of the dismantling activities, any potential impacts to surface water quality will be minimized or eliminated by following construction best practices and OPG's spill management protocols, which include the highest precautions to control and contain any potential spill and prevent release to the environment. Considering minimal interaction between surface water quality and risk reduction and removal activities and dismantling/demolition activities of non-nuclear buildings, from 2025-2037, no effects on surface water quality are expected; therefore, no further assessment is warranted.

5.2.2.2 PNGS Units 5-8 Refurbishment

Construction equipment, such as cranes and forklifts, will be used during the site preparation and the removal and replacement of steam generators. Possible effects of increased traffic, clearing operations and sanding/salting of parking and lay-down areas will be mitigated by implementing the procedures outlined in the Erosion and Sediment Control Plan or Stormwater Management Plan. Therefore, measurable changes to stormwater runoff, and consequently, to surface water and sediment quality are unlikely.

Project activities associated with the removal and replacement of reactor components, refurbishment of other plant systems (e.g., reactor auxiliary systems, feedwater systems), general upgrades and maintenance, and refuelling and restarting are not expected to have an increased interaction with surface water and sediment quality from previous operations (with 6 operating units). Activities associated with the construction of the PCSS for the storage of low and intermediate-level refurbishment waste were assessed as part of the PCSS PERA and were determined to have negligible interactions with surface water (Ecometrix, 2024). Consistent with

the PCSS PERA, and applicable for all planned construction of buildings to support the Project, OPG will employ best practices for stormwater management that would meet Ontario MECP requirements and industrial sewage works rules.

The main interactions between Project activities and surface water are likely to occur during PNGS Units 5-8 shutdown, defueling and dewatering since there will be a reduction in cooling water flow which may lead to changes in the surface water quality. This is discussed further below.

Non-Radiological Emissions

The reduction in CCW flow is not expected to result in any measurable changes in the concentrations of non-radiological parameters of interest within the CCW discharge channel compared to previous operational conditions (for 6 operating units). When a unit is shutdown there may be some liquid effluent discharges associated with draining and decontamination of systems and equipment; however, after this initial work there will be a proportional decrease in both liquid effluent and CCW flow.

During reactor shut down for refurbishment, morpholine and hydrazine will continue to be used to protect equipment and piping from corrosion. Hydrazine, a corrosion inhibitor utilized in station water systems and known to produce ammonia as a by-product, will continue to be applied at current levels during refurbishment. Under existing conditions, hydrazine, morpholine, and ammonia concentrations have been maintained below the boiler blowdown ECA limits (OPG, 2018b, 2019d, 2020b, 2021g, 2023b, 2023a, 2024d), and are expected to remain well within acceptable thresholds during refurbishment. If necessary, CCW flows can be adjusted to ensure discharges are within ECA limits. As such the assessment of hydrazine and morpholine in the 2022 PN ERA is bounding (for 6 operating units); therefore, no further assessment is conducted in the PERA for lake water quality during refurbishment.

Overall, it is expected that the waterborne non-radiological emissions released through the PNGS Units 5-8 CCW discharge channel during this phase would reduce considerably. Based on historical water quality monitoring, this will likely result in either a minor measurable decrease or no change in concentrations in Lake Ontario compared to previous operational conditions (as assessed in the 2022 PN ERA for 6 operating units). Consistent with the Surface Water TSD in the 2008 Pickering B Refurbishment EA (updated in **Table 5-17**), mixing calculations of inputs to the CCW duct show concentrations below the PWQO during refurbishment, assuming a CCW flow of 76.5 m^3/s for 2 units operating and 23.7 m^3/s for 1 unit operating (Golder, 2007d).

Table 5-17: Summary of CCW Mixing Calculations for RLWMS and NWTP

Parameter	Units	Intake Concentration[1]	ECA Limit at Effluent Discharge	Maximum Predicted Concentration in CCW (2 Units Operating)	Maximum Predicted Concentration in CCW (1 Unit Operating)	PWQO
RLWMS						

Parameter	Units	Intake Concentration[1]	ECA Limit at Effluent Discharge	Maximum Predicted Concentration in CCW (2 Units Operating)	Maximum Predicted Concentration in CCW (1 Unit Operating)	PWQO
Phosphorus	mg/L	<0.01	1	<0.01	<0.01	0.02
Total suspended solids	mg/L	<2	73	<2	<2	N/A
Zinc	mg/L	0.01	1	0.010	0.011	0.03
Iron	mg/L	0.025	9	0.026	0.030	0.3
Oil and Grease	mg/L	<1	36	<1	<1	Narrative
NWTP						
Aluminum	mg/L	0.004	13	0.0064	0.0117	0.075
Total suspended solids	mg/L	<2	70	<2	<2	N/A
Iron	mg/L	0.0025	2.5	0.0255	0.0265	0.3

Note:

[1] (Golder, 2007d)

Radiological Emissions

During refurbishment heavy water systems will be drained, moderator system flushed, and all other liquids, wastes and potentially hazardous transient materials will be removed. Initial dewatering may result in some increase in radiological emissions from the RLWMS. However, this activity is bounded by the assumptions in the 2017 Safe Storage PEA and 2022 PEA Addendum.

During the removal and replacement of steam generators, light water will be drained from the steam generators and released to Lake Ontario. This water will be monitored for non-radionuclides to ensure it is within ECA limits before being discharged to the lake. Water will also be monitored for radionuclides. If contamination is detected during the monitoring, the water will be sent to the RLWMS for processing.

OPG is developing a tritium emissions plan for light water to ensure that tritium concentrations at the Ajax WSP remain within the range seen during previous operations (6 operating units), i.e. below roughly 10 Bq/L. Since OPG intends to manage tritium emissions during refurbishment in alignment with previous operations, the 2022 PN ERA (with 6 operating units) is considered bounding and no further assessment of tritium emissions to lake water during refurbishment is warranted.

5.2.2.2.1 Deep Water Intake

The construction and operation of the planned DWI, as well as associated activities including the potential addition of a dock, possible infill and shoreline erosion mitigation areas, and material disposal, have the potential to alter sediment and water quality. Specifically, this includes disturbance of the sediment during dredging and subsequent relocation of dredge spoils, and possible changes in local hydrology during operation with intake flow. It is likely that these activities will only cause a temporary impact, or little-to-no impact, on surface water and sediment in Lake Ontario and Frenchman's Bay. As discussed in **Section 5.2.1.2**, an updated hydrodynamic surface water model (RMA10) was used to determine changes to concentration factors at various receptor locations due to the change in configuration with a DWI. A bounding condition was evaluated where only 1 unit from PNGS Units 5-8 has completed refurbishment (and the remaining 3 units are not operating); therefore, the flow through the DWI is approximately 23.7 m^3/s, as per the water balance for the bounding condition shown in **Figure 5-4**.

The expected bounding concentrations in the RLWMS are consistent with the 2017 Safe Storage PEA based on average operational RLWMS emissions from 2011 to 2015 and include:

- Tritium: 1.2E+06 Bq/L;
- Carbon-14: 46 Bq/L; and
- Beta/Gamma: 91 Bq/L.

The flow rate from the RLWMS is approximately 235 m^3/day and approximately 2,050,000 m^3/day of cooling water is being released from the PNGS Units 5-8 discharge channel. Using the concentration factors from the 2025 RMA10 modelling for refurbishment, the predicted concentrations at various receptor locations are shown in **Table 5-18**.

Predicted concentrations of radionuclides in surface water under the refurbishment bounding scenario are expected to be lower than those assessed in the 2017 Safe Storage PEA; therefore, the assessment in the 2017 Safe Storage PEA is bounding and no further assessment of radionuclides in surface water is warranted in the PERA for the Refurbishment Phase. As mentioned in **Section 5.2.2.1.1.3**, while no specific COPCs were identified for the surface water environment, general feedback from the WTFNs on other PERAs has indicated that it would be beneficial to include a Harvester receptor in the PERA. As such, assessment of a Harvester for surface water radiological emissions is considered in the Tier 2 quantitative assessment.

Table 5-18: Predicted Surface Water Concentrations for Radionuclides Released to PNGS Units 5-8 Outfall During Refurbishment

Location of Interest	Distance from PNGS Units 5-8 Outfall (m)	2017 Safe Storage PEA Concentrations (50,000 m^3/day cooling water from RBSW)			Refurbishment Concentrations (2,050,000 m^3/day CCW cooling water)		
		Tritium (Bq/L)	Carbon-14 (Bq/L)	Beta/Gamma (Bq/L)	Tritium (Bq/L)	Carbon-14 (Bq/L)	Beta/Gamma (Bq/L)
PNGS Units 1-4 Discharge Channel	939	2.49E+00	1.07E-04	1.78E-04	1.36E+00	5.21E-05	1.03E-04
PNGS Units 5-8 Discharge Channel	212	4.76E+02	2.04E-02	3.40E-02	1.23E+02	4.73E-03	9.36E-03
Sport Fisher	515	8.78E+00	3.76E-04	6.27E-04	7.68E+00	2.94E-04	5.82E-04
Squires Beach	2,100	5.24E+00	2.24E-04	3.74E-04	4.03E+00	1.55E-04	3.06E-04
Liverpool Beach	1,485	2.53E+00	1.08E-04	1.81E-04	2.30E+00	8.81E-05	1.74E-04
Frenchman's Bay Inlet	1,970	2.21E+00	9.47E-05	1.58E-04	1.98E+00	7.59E-05	1.50E-04
Ajax Intake	5,061	7.08E-01	3.03E-05	5.06E-05	4.24E-01	1.62E-05	3.21E-05

5.2.2.3 PNGS Units 5-8 Continued Operations

The construction and operation of the proposed DWI and associated activities could modify lake circulation and associated dilution patterns and surface water quality compared to previous operational conditions (with 6 operating units as assessed in the 2022 PN ERA). As described in Section 5.2.1.3, during Continued Operations the intake flow will be provided by the DWI, and will be lower than previous operational conditions for 6 operating units, since there will be no flow to PNGS Units 1-4. Concentrations in effluent released from PNGS Units 5-8 should be similar to previous operational conditions (for 6 operating units); however, concentrations in the nearshore Lake Ontario may be different, as water released from the PNGS Unit 5-8 outfall will no longer be drawn into the forebay due to the cutoff wall (while there will be some flow through the cut-off wall, recirculation of water into the forebay will be reduced).

Surface water quality during Continued Operations will be similar to previous operational conditions (with 6 operating units); however, continued monitoring of lake water through the EMP will confirm this assumption over time. No further assessment is warranted in the PERA for continued operations.

Beyond this, no significant changes to surface water are anticipated during this phase as PNGS Units 5-8 is expected to continue operating consistent with current practices.

5.2.3 Summary of Tier 1 Assessment

The initial screening of potential effects of Project activities on the surface water environment included consideration of both surface water flow and quality. The predicted interactions between the surface water environment and Project activities are summarized in **Table 5-19**.

Table 5-19: Summary of Interactions between Project Activities and Surface Water Environment

Project Activities	Surface Water Flow	Surface Water Quality
PNGS Units 1-4 Decommissioning		
PNGS Units 1 and 4 Stabilization	2017 Safe Storage PEA and 2022 PEA Addendum is bounding • 2 CCW pumps at PNGS Units 1-4 will continue to operate • PNGS Units 5-8 will enter refurbishment during PNGS Units 1 and 4 Stabilization – bounding condition when all U5-8 is shutdown for refurbishment	2017 Safe Storage PEA and 2022 PEA Addendum is bounding • Forebay not considered aquatic habitat • Stormwater and Lake water quality predictions bounded by 2017 Safe Storage PEA and 2022 PEA Addendum
PNGS Units 1-4 Storage with Surveillance	2017 Safe Storage PEA and 2022 PEA Addendum is bounding • Low flow of 50,000 m^3/day assumed in 2017 Safe Storage	2017 Safe Storage PEA and 2022 PEA Addendum is bounding

Project Activities	Surface Water Flow	Surface Water Quality
	PEA is bounding since flow will be higher based on current Project planning (less change).	• Forebay not considered aquatic habitat due to cut-off wall. • Lake water quality assessed in 2017 Safe Storage PEA considered bounding; however, • Harvester receptor not previously considered. Harvester receptor exposed to radiological COPCs in surface water considered further in Tier 2 assessment.
Risk Reduction and Removal Activities (2025-2033) Dismantle/Demolish (2034-2037)	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum • No interaction with water quantity	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum • No interaction with water quality
PNGS Units 5-8 Refurbishment		
Preparation for Refurbishment		
• Procurement and Mobilization of Equipment and Components	No interaction	No interaction
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	No interaction	No interaction
• Construction of PCSS and SB #5	No interaction	No interaction
• Defuel and Dewater	• Reduction in cooling water flow during refurbishment • The impact of PNGS Units 5-8 on nearshore lake circulation will be reduced.	• Reduction in cooling water flow during refurbishment • Non-radiological emissions will remain below ECA limits and screening values. 2022 PN ERA is bounding • Radiological emissions from dewatering bounded by 2017 Safe Storage PEA and 2022 PEA Addendum • Tritium emissions will be managed to ensure tritium concentrations at Ajax WSP are within existing levels – 2022 PN ERA is bounding.
• Islanding the Unit	No interaction	No interaction
• Management of Heavy Water	No interaction	No interaction
• Construction of DWI	• Once construction complete, DWI will be used for water intake instead of the forebay • Updated hydrodynamic surface water model (RMA10) indicates flow pattern and velocity in the lake will be altered when DWI is operating,	• Bounding condition assessed with a CCW flow reduction to 23.7 m^3/s representing 1 unit operating on PNGS Units 5-8 side, no CCW flow through PNGS Units 1-4 side, and DWI operational (partial flow). • Updated concentration factors for the RMA10 model for the

Project Activities	Surface Water Flow	Surface Water Quality
	and velocities will be reduced during Refurbishment phase.	bounding condition show radiological concentrations in surface water from the 2017 Safe Storage PEA are bounding for the Refurbishment phase. • Harvester receptor not previously considered. Harvester receptor exposed to surface water considered further in Tier 2 assessment.
Refurbishment		
• Replacement of Reactor Components	No interaction	No interaction
• Removal and Replacement of Steam Generators	No interaction	No interaction
• Operation of DWI	• DWI will be used for water intake instead of the forebay • Updated hydrodynamic surface water model (RMA10) indicates flow pattern and velocity in the lake will be altered when DWI is operating and velocities will be reduced during Refurbishment phase.	• Bounding condition assessed with a CCW flow reduction to 23.7 m^3/s representing 1 unit operating on PNGS Units 5-8 side, no CCW flow through PNGS Units 1-4 side, and DWI operational (partial flow). • Updated concentration factors for the RMA10 model for the bounding condition show radiological concentrations in surface water from the 2017 Safe Storage PEA are bounding for the Refurbishment phase.
• Refurbishment of Other Plant Systems	No interaction	No interaction
• Waste Management and Transportation	No interaction	No interaction
• Refuelling and Restarting	• CCW pumps will return to full capacity for PNGS Units 5-8. • 2022 PN ERA is bounding.	• CCW pumps will return to full capacity for PNGS Units 5-8. • 2022 PN ERA is bounding.
Continued Operations		
• Operation and Maintenance of PNGS Units 5-8	2022 PN ERA is bounding	2022 PN ERA is bounding
• Waste Management and Transportation	No interaction	No interaction

5.3 Aquatic Environment

5.3.1 Fish and Fish Habitat

5.3.1.1.1 PNGS Units 1-4 Decommissioning

5.3.1.1.1.1 Stabilization and Storage with Surveillance

As discussed in **Section 5.2.2.1.1.3**, the 2017 Safe Storage PEA evaluated the effects of lake water quality during Stabilization and SWS activities.

Dose to ecological receptors at the outfall, Frenchman's Bay and forebay were calculated in the 2017 Safe Storage PEA and 2022 PEA Addendum – all doses to aquatic receptors including fish were below the aquatic dose benchmark of 9.6 mGy/d. No non-radiological constituents were identified that exceeded screening levels and required further quantitative assessment. The 2017 Safe Storage PEA and 2022 PEA Addendum remain bounding for Stabilization and SWS and no further assessment of effects on fish and fish habitat is required.

5.3.1.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities. As outlined in **Section 3.3.4**, OPG plans to initiate risk reduction and removal activities, which will include dismantling and demolishing of certain non-nuclear systems and outbuildings associated with PNGS Units 1-4.

The primary concern for aquatic habitats during dismantling activities is the potential release of contaminants into surface water. For example, residue from tanks could leak during the segmenting process. However, OPG's spill management protocols effectively mitigate this risk by ensuring all dismantling activities occur in controlled areas with proper containment systems and implementing practices to prevent any release of contaminants. By adhering to these precautions, OPG expects the impact on fish and their habitats from risk reduction and removal activities and dismantle/demolish activities during this licensing period to be negligible. As such, no further assessment is warranted in the PERA.

5.3.1.1.2 PNGS Units 5-8 Refurbishment

The construction of the intake structure as well as shoreline modifications including a potential dock, possible infill and erosion mitigation areas, and disposal of material during the Project are the main activities that will interact with the aquatic environment during refurbishment. Placement of the potential lake infill and dock structure will alter the conditions in the nearshore of Lake Ontario. Additionally, construction of the DWI will result in removal of lake bottom aquatic habitat within the construction footprint.

The modernized federal Fisheries Act provides two core prohibitions related to fish and fish habitat protection: a prohibition against persons carrying out works, undertakings, or activities that result in the death of fish by means other than fishing (subsection 34.4(1)), and a prohibition against persons carrying out works, undertakings, or activities that result in the

harmful alteration, disruption, or destruction (HADD) of fish habitat (subsection 35(1)) (Government of Canada, 2019). The modernized federal Fisheries Act includes a more comprehensive definition of fish habitat under subsection 2(1): "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes". The types of areas that can directly or indirectly support life processes include, but are not limited to, spawning grounds and nursery, rearing, food supply, and migration areas.

Given that the proposed DWI, west infill, and shoreline erosion mitigation areas provide potential fish habitat for certain species in Lake Ontario (refer to **Section 4.3.1** for details), project activities may result in HADD of aquatic habitat in these areas. Although designs are still being developed, preliminary estimates indicate that the DWI intake cap construction area may have a footprint of approximately 2.5Ha (2,500 m^2) and navigational channel and effect from the bridge may have a footprint of approximately 4.8 ha (48,000 m^2). Potential modifications to the west infill area, including cutoff wall, bridge structures, forebay channel dredging, permanent intake cap structure, lake infilling, dock construction, and supporting structures such as a seawall, are expected to cover roughly 13.5 ha (13,500 m^2). Similarly, the total area impacted by lake infilling in the east shoreline erosion mitigation area is estimated to be approximately 4 ha (40,000 m^2). These values have been conservatively derived based on the maximum potential extent of disruption, and final assessments may yield different estimates as designs are refined.

The modernized federal Fisheries Act also includes a prohibition against the deposit of deleterious substances of any type in water frequented by fish (subsection 36(3)) (Government of Canada 2019), which is administered by Environment and Climate Change Canada. In accordance with this regulation, OPG is currently evaluating various spoil management options to develop a comprehensive spoil management plan and minimize environmental impacts. Preliminary plans indicating that much of the rock will be disposed of in a lake infill, near-surface materials sent for inland disposal, and overburden materials disposed of in open aquatic areas. OPG is working with Indigenous Nations and communities to gather input and identify the best disposal options and mitigation measures.

To minimize the mobilization of suspended materials into the water, an Erosion and Sediment Control Plan will be developed, focusing on reducing sedimentation during all phases of the project. Measures include conducting in-water works in isolation of open or flowing water to reduce sediment introduction into the watercourse, regular inspection and maintenance of erosion controls, monitoring for signs of sedimentation, and ensuring the proper disposal of dredged materials. Similarly, a spill response plan will also be implemented to prevent spills of deleterious substances. This includes measures such as planning activities to ensure chemicals such as paints, solvents, and fuels do not enter the watercourse. Machinery used will be maintained in a clean condition to avoid fluid leaks, and an emergency spill kit will be on site during operations. Any spills will be contained, cleaned up, and disposed of properly to prevent further impact to the watercourse.

A Fisheries Act Authorization Application will be required for these works as they are affecting potential fish habitat. When death of fish or a HADD of fish habitat cannot be avoided or mitigated, an authorization under subsections 34.4(2) and 35(2), respectively, may be provided by the Minister of Fisheries and Oceans with the provision of appropriate offsetting of residual adverse effects.

Therefore, the habitat type lost, as well as the type of disturbance, and potential changes to habitat quality, resulting from the construction of the proposed DWI and associated structures such as the west infill area, shoreline erosion mitigation area, and dock are further evaluated in the Tier 2 Assessment.

5.3.1.1.3 PNGS Units 5-8 Continued Operation

Following refurbishment, continued operation of PNGS Units 5-8 is not expected to result in further loss of aquatic habitat. The DWI will be used to draw water into the station, and all other operations will be bounded by previous operational conditions (with 6 operating units). As such, no further assessment is warranted in the PERA for continued operations.

5.3.2 Impingement and Entrainment

5.3.2.1.1 PNGS Units 1-4 Decommissioning

5.3.2.1.1.1 Stabilization and Storage with Surveillance

The 2017 Safe Storage PEA and 2022 PEA Addendum assumed that the PN water balance will change in a stepwise manner during the Stabilization Phase, from its previous operational configuration (6 operating units) to its configuration during the SWS Phase (PNGS Units 1 and 4, and PNGS Units 5-8 shut down). Based on current Project planning, PNGS Units 1 and 4 were shut down in Q4 2024 and have entered stabilization, and PNGS Units 5-8 will continue to operate until the end of 2026 after which they will enter refurbishment (see **Section 5.2.1.2**). A minimum of 2 CCW pumps (see **Figure 5-3**) will be available to support PNGS Units 1 and 4 Stabilization activities. Given that this is considerably lower than the flow volumes under previous operational conditions (with 6 operating units) and is expected to result in a corresponding decrease in intake velocities, impingement and entrainment is also expected to be reduced accordingly in this phase. As the FDS is expected to remain in place during the Stabilization phase, the assumptions of the 2017 Safe Storage PEA and 2022 PEA Addendum remain bounding, and no further assessment is required. The 2022 PEA Addendum assumed a CCW intake flow rate of 250,500 m^3/day during the SWS Phase, an update from the 50,000 m^3/day estimate in the 2017 Safe Storage PEA. The velocity associated with the reduced flow relative to operational conditions was calculated in the forebay modelling update for the 2022 PEA Addendum to be a maximum of 11.5 mm/s. This maximum velocity is below the threshold established by the US EPA, which states that impingement is not considered an issue if intake water velocity is less than 0.5 fps (150 mm/s; US EPA, 2014). This value was derived from swim speed studies which demonstrated that an intake velocity of 0.5 fps or lower results in a 96% or greater reduction in impingement mortality for most species. Furthermore, the maximum velocity remains less than the mean swim speed of pertinent local fish species considered in the

2022 PN ERA, which range from 221 mm/s for Northern Pike to 3,612 mm/s for White Sucker. Therefore, impingement rates will decrease because of the significant reduction in flow volume into the station.

The proposed flow during the SWS Phase when cooling requirements are reduced will be 2.9 m^3/s, which is less than the flow of 5.5 m3/s identified as the volume of flow where entrainment may be of concern (US EPA, 2014). Therefore, entrainment will be negligible during SWS. There are a few deviations in assumptions between the 2022 PEA Addendum and current project planning. In the 2022 PEA Addendum, it was assumed the FDS would be removed during SWS. Based on current Project planning, the FDS will not be removed until the DWI is operational, and may remain in place even afterward as necessary. This would further reduce impingement and entrainment rates relative to the 2022 estimate. The 2022 PEA Addendum also assumed that PNGS Units 5-8 would be permanently shut down by 2026, while current project planning anticipates the refurbishment of these units beginning in 2026. As a result, there is expected to be some overlap of the SWS phase of PNGS Units 1-4 with the refurbishment/operations phase of PNGS Units 5-8. When PNGS Units 1-4 is in SWS and PNGS Units 5-8 is in the Refurbishment/Operations phase, the previous operational conditions (for 6 operating units) are assumed to be bounding (see **Section 5.3.2.1.2**). Therefore, no further assessment is conducted in this PERA.

5.3.2.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess the dismantling and demolishing of buildings and structures. As outlined in **Section 3.3.4**, OPG plans to dismantle certain non-nuclear systems and outbuildings associated with PNGS Units 1-4. The activities associated with dismantling and demolishing will not impact impingement and entrainment of fish; therefore, no further assessment is conducted in this PERA.

5.3.2.1.2 PNGS Units 5-8 Refurbishment

The main activity to interact with impingement and entrainment is the DWI. The DWI is planned to be operational by 2030. A preliminary evaluation of the change in impingement and entrainment levels resulting from the change in depth and design associated with the proposed DWI was conducted in 2024. The analysis compared impingement and entrainment levels at the existing shoreline intake at PNGS to those at the offshore intake at DNGS, as well as the estimated levels for the proposed DWI intake at PNGS. Initial estimates suggested that entrainment will be reduced by 60% following the change in intake location at PNGS. This value was derived from a similar assessment for the offshore intake at DNGS which estimated a baseline entrainment reduction of 60% relative to the onshore one because larval tow data from Lake Ontario indicated that larval abundance decreases with increasing depth (OPG, 2013b). Specifically, 44% of larvae captured in the area were located at approximately 5 m depth, with the majority being collected in waters less than 15 m in depth. Given that the DWI at PNGS is expected to be at a similar depth as the one at DNGS, a comparable reduction in entrainment is expected occur at PNGS. However, there is uncertainty in this estimate, and an entrainment monitoring program is planned for 2024-2025 to substantiate the value.

Similarly, the DWI is expected to result in an 89% reduction in impingement compared to levels prior to the implementation of any mitigation measures such as the FDS. This reduction is primarily due to two factors. First, deeper waters have lower fish productivity and are predominantly inhabited by larger-bodied fish, thereby reducing the number of fish susceptible to impingement. The second reason is due to the adoption of a porous veneer intake structure, flush with the lake bottom, similar to the intake structure at DNGS. A recent Best Available Techniques and Technology Economically Achievable (BATEA) assessment of different intake technologies and techniques showed that an enhanced porous veneer intake has the potential to significantly reduce I&E compared to other intake designs currently used in the Great Lakes watershed by preventing the entrapment of large fish schools.

Additional design modifications aimed at reducing impingement and entrainment, similar to those incorporated into the DNNP Intake Structure (OPG, 2013b) and the existing porous veneer intake at DNGS (Black & Veatch, 2024), are also being considered for the DWI at PNGS. These include modifications to optimize approach velocity and slot spacing to further reduce impingement (>89%) and entrainment (>60%). For example, a 15 cm/s approach velocity will not exclude larval fish based on operating experience (OPEX) and scientific literature, but will serve to reduce impingement. An approach velocity closer to 6-7 cm/s would minimize entrainment, while further reducing impingement. It should be noted that even an approach velocity as low as 6 cm/s would not effectively exclude entrained fish eggs or recently hatched yolk-sac larvae, the latter of which have limited swimming speed capabilities. However, several measures can be implemented to reduce these impacts. These include fine mesh screens (e.g., ≤2 mm) such as cylindrical wedge-wire screen structure, traveling screens, or specialized fish protection systems such as Geiger Multidisc or Hydrolox (Patrick et al., 2018). Narrow slot spacing of wedge-wire screens would result in reduced fish passage. Operational modifications, such as reducing intake flow during periods of peak entrainment, also serve as potential mitigation strategies. Furthermore, the proposed DWI is strategically located at a depth where the presence of eggs and early life stages of key species, such as Round Whitefish and Lake Trout, is unlikely, further minimizing entrainment risks. The specific approach velocity and screen size of the DWI structure, along with the methods to achieve them, are currently being determined.

While the DWI is under construction, PNGS Units 5-8 will be shut down in preparation for refurbishment. During this time, station requirements for cooling water will be substantially reduced relative to previous operational conditions (with 6 operating units), resulting in lower impingement and entrainment rates. The FDS will also continue to remain in place. As such, existing impingement and entrainment rates, as evaluated in the 2022 PN ERA, remain bounding. Once the DWI is in use a cut-off wall will be installed in the intake-forebay channel, as it will no longer be needed to supply water to the station; however, the cut-off wall will have small holes to allow for minimal exchange flow through the wall into the forebay. Current estimates suggest that the maximum flow into the forebay will be 5,395 L/s, with the potential to

be reduced to 600 L/s, both of which are considerably lower than the current flow rate (192,000-217,000 L/s).

The reduction in intake flow during Refurbishment, as well as a corresponding decrease in intake velocity, is expected to result in a proportional reduction in impingement and entrainment during this phase. Given that the flow is over the wide forebay, the velocity of the water may allow fish to escape the water flow, further reducing impingement counts. Additionally, the cut-off wall estimated flow rates into the forebay are below 5.5 m^3/s (5500 L/s), which is identified as the volume of flow where entrainment may be of concern (US EPA, 2014). However, the flow volumes still exceed 125 L/s, the threshold beyond which facilities require impingement and entrainment monitoring unless mitigation measures consistent with the DFO Freshwater Intake End-of-Pipe Fish Screen Guideline (CSA, 2018) are implemented. As such, the FDS will remain operational as necessary. Since the water flowing through the cut-off wall into the forebay may serve as an emergency service water supply to the station, an application for a FAA may be required for its operation following the expiry of the current FAA in 2028 as the flow volumes exceed 125 L/s. OPG may seek approval from the DFO to discontinue the use of the FDS in the future, provided such a decision is deemed feasible and adequately justified.

The intake flow rate through the DWI during the Refurbishment phase (see **Figure 5-4**), is estimated to be approximately 23.7 m^3/s (23,700 L/s). Consequently, the reduction in flow rate and intake velocity due to decreased station requirements for cooling water during Refurbishment is expected to result in lower impingement and entrainment rates.

Overall, given the lower intake flow rate and velocity, optimized intake design features, and lower abundance of ichthyoplankton and fish at deeper depths, impingement and entrainment rates are expected to be substantially reduced following construction of the DWI. Accordingly, no further assessment is conducted in this PERA.

5.3.2.1.3 PNGS Units 5-8 Continued Operations

Following refurbishment, continued operation of PNGS Units 5-8 and the DWI is expected to result in reduced impingement and entrainment compared to previous operational conditions (for 6 operating units) as discussed in **Section 5.3.2.1.2**. The reduction of impingement and entrainment will be confirmed through ongoing monitoring programs. As such no further assessment is warranted in the PERA for continued operations.

5.3.3 Thermal Effects

5.3.3.1.1 PNGS Units 1-4 Decommissioning

5.3.3.1.1.1 Stabilization and Storage with Surveillance

Consistent with the 2017 Safe Storage PEA and 2022 PEA Addendum, during Stabilization and SWS, as CCW pumps are shut down in a step-wise manner, the temperature difference between the water intake temperature and the CCW discharge temperature will be reduced. Units 1 and 4 were permanently shut down in Q4 of 2024, with a three-month interval between them. This

phased shutdown strategy mitigated the risk of cold shock, which can result from a sudden and simultaneous reduction in discharge temperatures. In general, the lake near the PNGS Units 1-4 discharge will be returned to a thermal condition that is more normal for the nearshore zone of Lake Ontario. Whereas the warmed waters in the current operating condition have attracted certain fish species to the discharge (e.g., Smallmouth Bass), and have enhanced aquatic productivity near the discharge, the cooler waters after shutdown will offer thermal habitat more similar to the regional nearshore zone. The findings in the 2017 Safe Storage PEA and 2022 PEA Addendum continue to remain valid; therefore, no further assessment is conducted in this PERA.

5.3.3.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess the dismantling and demolishing of buildings and structures. As outlined in **Section 3.3.4**, OPG plans to dismantle certain non-nuclear systems and outbuildings associated with PNGS Units 1-4 during SWS phase. The activities associated with dismantling and demolishing will not impact the thermal regime in the nearshore of Lake Ontario; therefore, no further assessment is conducted in this PERA.

5.3.3.1.2 PNGS Units 5-8 Refurbishment

In preparation for Refurbishment, PNGS Units 5-8 will be shutdown in 2026.To minimize cold shock-induced stress in fish caused by a sudden drop in discharge temperatures, shutdown of the units is planned to be staggered to facilitate a gradual reduction in thermal discharge temperatures. Each unit requires 48 hours for a complete shutdown. Once PNGS Units 5-8 are shutdown, water temperatures in the lake near the discharge will more closely resemble natural conditions.

During refurbishment, the DWI will be constructed and become operational by 2030. Once the DWI is in use, a cut-off wall will be installed in the intake channel, as it will no longer be needed to supply water to the station. The existing PNGS Units 5-8 CCW discharge channel will still be used. The DWI will be situated approximately 1.5 km offshore at an approximate depth between 10.5-12 m. Thermal profiles generated from temperature data collected during the macrozooplankton and deepwater fish community studies indicate that the temperature at the depth proposed for the DWI (between 10.5 - 12 m) is 3-5°C lower than at the surface water. OPG monitors temperature daily at the intake and discharge. For the past 5 years of monitoring, intake temperatures ranged from approximately 5°C in winter to greater than 20°C in summer. Since intake temperatures through the DWI are expected to be up to 3-5°C colder (depending on the season) than through the existing intake channel, average water temperature in the discharge channel is expected to be the same or lower than that currently observed.

The potential changes to the thermal plume resulting from the relocation of the intake, and its impacts on indicator fish species, will be quantitatively evaluated in the Tier 2 assessment.

5.3.3.1.3 PNGS Units 5-8 Continued Operations

Following refurbishment, continued operation of PNGS Units 5-8 and the DWI is expected to result in thermal effects that are either comparable to or lower than those observed under previous operational conditions (with 6 operating units as assessed in the 2022 PN ERA) as discussed in **Section 5.3.3.1.2**. Future monitoring of intake and discharge temperatures will confirm any resulting changes in the thermal plume. However, to assess potential future impacts on the thermal plume from PNGS, particularly in the context of climate change, the potential effluent temperatures following DWI construction and implementation will be evaluated in the Tier 2 assessment.

5.3.4 Summary of Tier 1 Assessment

The initial screening of potential effects of Project activities on the aquatic environment included consideration of fish and fish habitat, impingement and entrainment, and thermal effects. The predicted interactions between the surface water environment and Project activities are summarized in **Table 5-20.**

Table 5-20: Summary of Interactions between Project Activities and Aquatic Environment

Project Activities	Fish and Fish Habitat	Impingement and Entrainment	Thermal Effects
PNGS Units 1-4 Decommissioning			
PNGS Units 1 and 4 Stabilization	2017 Safe Storage PEA and 2022 PEA Addendum is bounding	2017 Safe Storage PEA and 2022 PEA Addendum is bounding.	2017 Safe Storage PEA and 2022 PEA Addendum is bounding. • PNGS Units 1 and 4 were permanently shut down in Q4 2024, with a three-month interval between them to prevent cold shock.
PNGS Units 1-4 Storage with Surveillance	2017 Safe Storage PEA and 2022 PEA Addendum is bounding	2022 PEA Addendum is bounding. • The 2022 PEA Addendum assumed an intake flow rate of 250,000 m^3/day, an increase from the 2017 PEA. The updated flow rate and velocity result in negligible impingement and entrainment. • The 2022 PEA Addendum assumed that the FDS would be removed. The	2017 Safe Storage PEA and 2022 PEA Addendum is bounding.

Project Activities	Fish and Fish Habitat	Impingement and Entrainment	Thermal Effects
		continued use of the FDS will further reduce impingement and entrainment.	
Risk Reduction and Removal Activities (2025-2033) Dismantle/Demolish (2034-2037)	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum • No interaction.	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum • No interaction.	Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum • No interaction
PNGS Units 5-8 Refurbishment			
Preparation for Refurbishment			
• Procurement and Mobilization of Equipment and Components	No interaction	As PNGS Units 5-8 will be shutdown in 2026 in preparation for refurbishment, impingement and entrainment are expected to be lower than previous operational conditions. FDS will remain in place. 2022 PN ERA is bounding.	PNGS Units 5-8 will be shutdown in a staggered manner to gradually reduce the temperature differential between the effluent and ambient waters. This will reduce likelihood of cold shock and return the lake water temperatures to natural conditions.
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	No interaction	No interaction	No interaction
• Construction of PCSS and SB #5	No interaction	No interaction	No interaction
• Defuel and Dewater	No interaction	No interaction	No interaction
• Islanding the Unit	No interaction	No interaction	No interaction
• Management of Heavy Water	No interaction	No interaction	No interaction
• Construction of DWI	Construction of DWI and associated nearshore modifications (shoreline erosion mitigation area, west infill area, and dock) is expected to result in habitat loss and changes to habitat quality. Potential effects will be quantitatively evaluated in the Tier 2 assessment.	No interaction	No interaction
Refurbishment			
• Replacement of Reactor Components	No interaction	No interaction	No interaction
• Removal and Replacement of Steam Generators	No interaction	No interaction	No interaction
• Operation of DWI	Once construction is complete, DWI will be used for water intake. No further loss of habitat is expected.	Cut-off wall will be installed at the current nearshore intake. Flows and velocity through wall will be considerably	Once the DWI is operational, discharge temperatures are expected to be similar to or lower than existing discharge temperatures.

Project Activities	Fish and Fish Habitat	Impingement and Entrainment	Thermal Effects
	2022 PN ERA is bounding.	lower, resulting in reduced impingement and entrainment. FDS to remain in place as necessary. 2022 PN ERA is bounding. Impingement and entrainment rates are expected to be substantially reduced by the DWI due to lower intake flow rate and velocity, optimized intake design features, and lower abundance of ichthyoplankton and fish at deeper depths.	Potential thermal effects from this change will be quantitatively evaluated in the Tier 2 assessment.
• Refurbishment of Other Plant Systems	No interaction	No interaction	No interaction
• Waste Management and Transportation	No interaction	No interaction	No interaction
• Refuelling and Restarting	No interaction	No interaction	No interaction
Continued Operations			
• Operation and Maintenance of PNGS Units 5-8	The DWI will be used to draw water into the station, and all other operations will be bounded by previous operational conditions.	The continued operation of the DWI is expected to result in reduced impingement and entrainment compared to previous operational conditions (for 6 operating units).	The continued operation of the DWI is expected to result in thermal effects that are lower than or similar to previous operational conditions (for 6 operating units). However, potential impacts of climate change on the thermal plume during continued operations are evaluated in the Tier 2 assessment.
• Waste Management and Transportation	No interaction	No interaction	No interaction

5.4 Geological and Hydrogeological Environment

5.4.1 Soil

5.4.1.1 PNGS Units 1-4 Decommissioning

5.4.1.1.1 Stabilization and Storage with Surveillance

Non-Radiological Constituents

As outlined in the 2017 Safe Storage PEA and 2022 PEA Addendum, soil quality beyond the protected area is expected to remain consistent with previous operational conditions (for 6 operating units). This finding continues to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

Radiological Constituents

As indicated in the 2017 Safe Storage PEA and 2022 PEA Addendum and summarized in **Section 5.1.1.1.1**, tritium will be released to the atmospheric environment during reactor dewatering and draining during the Stabilization Phase. It was concluded that previous operational conditions (for 6 operating units) are bounding of atmospheric tritium emissions during the Stabilization Phase. Additionally, tritium emissions during SWS will be even lower. As atmospheric deposition is the primary transport mechanism by which radionuclides are deposited to soils within and surrounding the PN site, tritium concentrations in soil (pore water) are expected to decrease over time following the reduction of atmospheric emissions and as natural decay of tritium currently present in soil occurs. These findings continue to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

The 2022 PEA Addendum identified that approximately 1,500 Mg of heavy water will be transported to the DN site for storage near the end of the Stabilization Phase. The transfer of heavy water to the DN site may result in additional releases of tritium to air. However, PN currently transports heavy water to Darlington on a routine basis to modulate the concentration of tritium in the heavy water inventory. OPG will continue to use existing processes and practices of transporting heavy water, and the frequency for transporting heavy water will be bounded by previous operational conditions (for 6 operating units). The findings from the 2022 PEA Addendum continue to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA.

5.4.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities or the dismantling and demolishing of buildings and structures. As identified in **Section 3.3.4**, during the 2025 to 2033 timeframe OPG will initiate some risk reduction and removal activities, which will include dismantling of non-nuclear systems and outbuildings. More specifically PE-A (Groups A-1 and A-2) includes dismantling and removal of end-stated and abandoned/retired structures within the PNGS Units 1-4 protected area, excluding the main

powerhouse structure; and PE-B (Groups B-1 and B-2) includes the dismantling and removal of non-nuclear SSCs that are located within the TH and TAB.

From 2034 to 2037, OPG plans to execute PE-A (Group A-3) which includes complete removal of non-nuclear outbuildings, as identified in **Figure 3-7**.

Most of the waste generated from the dismantled/demolished buildings and structures will be conventional waste, disposed of at approved conventional disposal facilities. Interim storage of conventional waste is not planned; therefore, soil is unlikely to be impacted.

Non-Radiological Constituents

Clearing the work area and accessing the structures involve vehicle movement, lifting and removing structures, which may release non-radiological emissions that could deposit on local soil. Dismantling and/or segmenting larger tanks and water lines may emit particles or fumes from the grinding work, but this work would occur indoors with adequate ventilation.

Spills to soil could potentially occur from ineffective capping of existing pipework, especially the CCW lines, but this risk is expected to be mitigated by planning for containment pre-dismantling. OPG will use existing spill recovery equipment and spill management procedures during decommissioning activities, with appropriate precautions to reduce risk. Overall, the risk of spills is considered negligible due to the presence of paved areas and secondary containment structures that are designed to prevent releases to the environment.

OPG will follow best construction ractices and implement an Environmental Management Plan for dismantling and demolition activities. The Decommissioning Phase Work Plan will include protocols for dust suppression to mitigate the release of particulates and dust that could deposit onto nearby soil surfaces. Vehicle traffic for transporting dismantled material off-site is expected to be similar to or marginally higher than current traffic levels at the PN site; overall, any small increase in traffic volume is considered negligible.

Overall, OPG's Environmental Management Plan is considered sufficient to mitigate negligible impacts to soil quality, and no further quantitative assessment is warranted in this PERA.

Radiological Constituents

No radiological atmospheric emissions to the environment are expected during the dismantling and demolition activities. Other than the removal of frames and baskets from IFB-A and AIFB, none of the dismantled equipment will be from radiological systems or systems that are likely to be radiologically contaminated. All waste will be radiologically surveyed before transportation and disposal, utilizing current best practices and operating in accordance with OPG's existing procedures for waste removal. The risk to soil quality from radiological contamination during dismantling/demolition is considered adequately mitigated, and no further quantitative assessment is warranted in this PERA.

5.4.1.2 PNGS Units 5-8 Refurbishment

Refurbishment activities identified as having a potential interaction with soil quality are related to the preparation of the site and facilities for refurbishment.

Non-Radiological Constituents

During preparation for refurbishment there may be interactions with soil quality due to construction of parking and laydown areas, set up of temporary construction facilities, construction of buildings including waste storage buildings at the NSS-PWMF These buildings/areas are located in paved or gravel areas, and no change to soil quality is expected due to any site or refurbishment preparation activities. This is consistent with the conclusions of the Pickering B Refrubishment EA (SENES, 2007). Furthermore, the 2003 PWMF Phase II EA did not identify any soil issues that would require consideration for the redistribution of soil within the NSS-PWMF area (OPG, 2003).

Activities associated with the construction of the PCSS for the storage of low and intermediate-level refurbishment waste were assessed as part of the PCSS PERA (Ecometrix, 2024). The PCSS PERA did not identify any activities that would pose a risk to soil quality that are not sufficiently mitigated by construction best practices, the implementation of an Environmental Management Plan, and/or the adherence to existing OPG policies and procedures for environmental protection and management. The activities associated with construction of the RFRISA or other buildings that will be constructed to support the Project are expected to be similar to those assessed for construction of the PCSS, and soil quality impacts are similarly considered sufficiently mitigated.

Construction is planned for DSC Storage Building #5 in the NSS-PWMF Phase II Site for future storage of used fuel, with a planned in-service date of Q3 2027. Assessment of the construction of additional DSC storage buildings was completed as part of the Pickering B Refurbishment EA.

The Pickering B Refurbishment EA did not assess the construction of the proposed DWI and any associated shoreline modifications, including construction of a dock, infilling and disposal of generated waste materials. The 2009 DNNP EIS is used for comparison purposes since the construction of a deepwater intake and discharge structures was assessed as part of general excavation and grading activities for the DNNP (SENES & MMM, 2009). Overall, shoreline and marine works were found not to affect soil quality and were not assessed further (SENES & MMM, 2009). The construction of the DWI and associated works for PNGS Units 5-8 Refurbishment are expected to be similar to those assessed in the 2009 DNNP EIS, and are not expected to result in impacts to soil quality at the PN site.

Considering the above, the assessment of soil quality is considered sufficiently mitigated by current construction best practices and OPG's existing environmental protection procedures. Thus, no further quantitative assessment of non-radiological soil quality is required for this PERA.

Radiological Constituents

As described in **Section 3.1.1**, the reactors will be defueled and dewatered during preparation for refurbishment. During reactor dewatering there may be atmospheric emissions of radionuclides; however, emissions at this time are expected to be below those of previous operational conditions (for 6 operating units). This reduction in emissions is described in the 2017 Safe Storage PEA that demonstrates that tritium emissions from PNGS Unit 2 and Unit 3 during dewatering and drying activities were substantially lower compared to operational units. A similar decrease in other radionuclides such as noble gases, particulates, radioiodines, and carbon-14 is expected. The reduction in atmospheric radionuclide emissions is expected to result in a decrease in the deposition of radionuclides to soil. Additionally, soil quality is expected to gradually improve over time as natural decay of deposited radionuclides occurs. Thus, the radiological soil quality condition as assessed in the 2022 PN ERA and the more recent 2024 soil data (see **Section 4.4.1.1**) is considered bounding for PNGS Units 5-8 Refurbishment. Furthermore, during refurbishment, OPG will rely on lessons learned from the PNGS Units 1-4 Stabilization Phase, as well as the refurbishment of DN to ensure that radiological emissions (and their deposition to soil) are minimized and maintained As Low as Reasonably Achievable (ALARA).

During the times when there will be openings in containment (i.e., specially prepared and approved openings in the reactor building dome for steam generator removal and replacement, or open airlocks), procedures will be in place to control and minimize radioactive releases to the environment. It is assumed that any concrete cutting will be done with wet methods (i.e., hydrojet cutting) and will have spray drift covers, thus ensuring that dust emissions and deposition to soil are minimal.

No radiological materials are associated with construction of the proposed DWI, and thus no radiological impacts to soil quality are expected.

Overall, any risk to soil quality resulting from potential radiological contamination during PNGS Units 5-8 Refurbishment is bounded by the 2022 PN ERA, and is considered sufficiently mitigated by OPG's existing policies and procedures for environmental protection and management. No further quantitative analysis is warranted in this PERA.

5.4.1.3 PNGS Units 5-8 Continued Operations

Once PNGS Units 5-8 refurbishment activities are complete and the remaining reactors re-enter normal operations, chemical and radiological emissions from the PN site are expected to resume. Since the number of operating units will be reduced to 4, it is anticipated that chemical and radiological emissions post-refurbishment would be similar to or lower than previous operational conditions assessed in the 2022 PN ERA with 6 operating units. Thus, any human health and ecological impacts resulting from the release and deposition of chemical and radiological materials to soil post-refurbishment would be bounded by the results of the 2022 PN ERA and are not assessed further in this PERA.

During Continued Operations of PNGS Units 5-8, activities associated with PNGS Units 1-4 SWS and dismantle/demolish will be occurring. PNGS Units 1-4 SWS and dismantle/demolish have already been determined to have minimal interaction with soil quality (see **Section 5.4.1.1**), so no further discussion is warranted.

5.4.2 Groundwater

5.4.2.1 Groundwater Quantity and Flow

5.4.2.1.1 PNGS Units 1-4 Decommissioning

5.4.2.1.1.1 Stabilization and Storage with Surveillance

Groundwater flow at PNGS is significantly influenced by the inactive TAB foundation drainage system located beneath the deep building foundations. The drainage system has locally lowered groundwater levels below the level of Lake Ontario, creating a hydraulic sink that captures groundwater beneath and immediately adjacent to the PNGS reactor buildings. Groundwater from the TAB foundation drains and VBRS sumps flows, ultimately discharged to the forebay via pumping.

During Stabilization and SWS, the groundwater flow regime is not expected to change substantially as the existing drainage systems are expected to remain operational. The 2017 Safe Storage PEA assumed that discharges from the TAB foundation drains and the VBRS would be routed to the RLWMS. However, in the 2022 PEA Addendum, this assumption was updated to assess the continued discharge of groundwater from the TAB foundation drains and VBRS to the CCW intake ducts, eventually reaching the forebay. The assumption in the 2022 PEA Addendum is still valid.

The forebay was assessed as a habitat for aquatic and riparian ecological receptors during SWS, with loadings contributing to the forebay from stormwater and the additional tritium contribution from groundwater collected in the TAB foundation IAD sumps on the PNGS Units 1-4 side and the VBRS. Based on the modelling results in the 2022 PEA Addendum, there were no potential adverse effects identified. All doses to the receptors assessed were below the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d (Ecometrix, 2023b).

The 2022 PEA Addendum remains bounding of the planned Stabilization and SWS activities for PNGS Units 1-4, and no further assessment of these activities is warranted in this PERA.

5.4.2.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess the risk reduction and removal activities or the dismantling and demolishment of buildings and structures. However, it is not expected that risk reduction and removal activities and/or dismantling and demolition activities would disrupt the quantity and flow of groundwater at the PN site. All drainage systems, including stormwater runoff, sewer, and active and inactive drainage systems will remain operational to the extent necessary to meet operational and regulatory requirements. Some excavation of underground piping and utilities may be necessary; it is expected that all

excavation activities will follow construction best practices and will adhere to the Environmental Management Plan. Dewatering of groundwater is not expected during excavation activities. However, if dewatering is needed, it will only be done with necessary permissions, intended to be protective against the discharge or re-infiltration of collected groundwater.

In general, the risk of impacts to groundwater flow during the planned risk reduction and removal activities and dismantling and demolition activities is considered negligible, and no further quantitative assessment is warranted in this PERA.

5.4.2.1.2 PNGS Units 5-8 Refurbishment

As noted in **Table 5-1**, certain activities related to PNGS Units 5-8 refurbishment are expected to interact with the groundwater flow component of the PN site. These activities include the relocation, removal, and construction of buildings (i.e., RFRISA), structures, and equipment, in addition to the construction of the PCSS and SB #5.

As described in **Section 3.1.1.2**, some structures and equipment within the PNGS Protected Area will need to be temporarily relocated or removed to accommodate the large crane. Additional structures may need to be temporarily relocated or removed to allow for the movement of refurbishment equipment, system components and waste materials through the station. Most of this work is not expected to require excavation at depths that would intersect with the groundwater at the site. In cases where excavation and dewatering are required, it will only be done with necessary permissions, intended to be protective against the discharge or re-infiltration of collected groundwater.

It is likely that site preparation will include the hardening of surfaces by grading, paving and constructing buildings and laydown areas, potentially increasing runoff and reducing infiltration to the underlying Upper Till aquifer. However, paving a relatively small portion of the PN site for any proposed buildings or laydown areas will not measurably affect local shallow groundwater recharge enough to cause any significant change in local groundwater flow (SENES, 2007).

As part of preparation for refurbishment, a number of buildings will need to be constructed included the PCSS, SB #5, and the RFRISA, among others (see **Section 3.1.1.2** and **3.1.1.3)**.

The PCSS PERA (Ecometrix, 2024) concluded there would be no expected impacts to groundwater quantity and flow from construction and operation of the PCSS. Dewatering during excavation would be completed with the necessary permissions following MECP regulations intended to be protective against discharge or re-infiltration of collected groundwater. The activities associated with construction of the RFRISA or other planned buildings are expected to be similar to those assessed for construction of the PCSS, and groundwater flow impacts are similarly considered sufficiently mitigated. Similar to the PCSS, any dewatering required during construction of the RFRISA would be completed with the necessary permissions following applicable MECP regulations (i.e., water takings over 50,000 L/d require the project to register under the Environmental Activity and Sector Registry, intended to be protective against the discharge or re-infiltration of collected groundwater). A geotechnical investigation will be

completed to determine if dewatering is required for any buildings that will be constructed on the PN site. Overall, building construction is not expected to change the groundwater quantity and flow conditions during the Refurbishment Phase.

PNGS Units 5-8 TAB inactive building effluent sumps receive both groundwater and inactive water from the stations' inactive systems. Groundwater flows into the PNGS Units 5-8 TAB inactive building effluent sumps via the TAB foundation drains are relatively low, but these drains act as groundwater level controls to keep groundwater from entering the lower levels of the powerhouses (SENES, 2007). The 2022 PEA Addendum concluded that groundwater discharges from the TAB foundation drains would continue to be routed to CCW intake ducts, eventually reaching the forebay (Ecometrix, 2023b); this assumption continues to be applicable to reactor shutdown procedures for PNGS Units 5-8 Refurbishment. Overall, the 2022 PEA Addendum concluded there would be no significant changes to groundwater quantity and flow during PNGS Units 5-8 unit shutdowns, and this result remains valid for the planned PNGS Units 5-8 Refurbishment.

5.4.2.1.3 PNGS Units 5-8 Continued Operations

Following refurbishment, PNGS Units 5-8 will operate under conditions similar to previous operations (with 6 operating units). The Continued Operations Phase is not expected to influence groundwater quantity or flow in any way that differs from previous operations at the site. Thus, previous operations (with 6 operating units) remain bounding to PNGS Units 5-8 Continued Operations post-refurbishment and no further assessment of groundwater quantity or flow is required as part of this PERA.

During Continued Operations of PNGS Units 5-8, activities associated with PNGS Units 1-4 SWS and dismantle/demolish will be occurring. During PNGS Units 1-4 SWS and dismantle/demolish groundwater quantity and flow will remain similar to previous operations (with 6 operating units), as discussed in **Section 5.4.2.1**, so no further discussion is warranted.

5.4.2.2 Groundwater Quality

5.4.2.2.1 PNGS Units 1-4 Decommissioning

5.4.2.2.1.1 Stabilization and Storage with Surveillance

As identified in **Section 5.4.2.1.1.1**, during Stabilization and SWS, groundwater from the TAB foundation drains and VBRS sumps will continue to be discharged to the forebay. Assessment of surface water quality in the forebay due to inputs from PNGS including groundwater was assessed in the 2022 PEA Addendum and is also discussed in **Section 5.2.2.1.1.1**. Based on the modelling results in the forebay, there were no potential adverse effects identified for radionuclides and non-radionuclides. All doses to the receptors assessed were below the aquatic benchmark of 9.6 mGy/d or the terrestrial benchmark of 2.4 mGy/d (Ecometrix, 2023b).

The 2022 PEA Addendum remains valid for PNGS Unit 1 and 4 Stabilization and Units 1-4 SWS; thus, no further assessment of groundwater quality is required as part of this PERA.

5.4.2.2.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities or the dismantling and demolishing of buildings and structures. However, it is not expected that risk reduction and removal activities and dismantling and demolition activities would disrupt groundwater quality at the PN site. During system opening when the risk of spills is highest, precautions will be taken to prevent or minimize the potential for release to the environment. Furthermore, any risk during the planned risk reduction and removal activities and dismantling activities will be mitigated by planning for containment in the event of a spill.

Overall, with respect to radiological groundwater quality, risk reduction and removal activities and dismantling and demolition activities associated with PNGS Units 1-4 Decommissioning are not assessed further in this PERA.

5.4.2.2.2 PNGS Units 5-8 Refurbishment

No refurbishment activities were identified that would impact groundwater quality at the PN site (SENES, 2007). As noted previously, a large portion of the PN site consists of paved and hardened surfaces, limiting infiltration into the underlying groundwater. It is also expected that OPG and all sub-contractors will utilize construction best practices and follow the construction Environmental Management Plan to ensure that all equipment is well maintained and functioning correctly to limit fuel spills and environmental contamination. Spills of any hazardous materials will be sufficiently managed utilizing OPG's existing spill management protocols. Overall, the potential for impacts to groundwater quality resulting from the planned refurbishment activities is considered negligible and is not assessed further in this PERA.

5.4.2.2.3 PNGS Units 5-8 Continued Operations

Consistent with **Section 5.4.1.3**, chemical and radiological emissions from the PN site are expected to resume once PNGS Units 5-8 refurbishment activities are complete and the remaining reactors re-enter normal operations. Since the number of operating units will be reduced to 4, it is anticipated that chemical and radiological emissions post-refurbishment would be similar to or lower than previous operational conditions assessed in the 2022 PN ERA with 6 operating units. Thus, any human health and ecological impacts resulting from the release of chemical and radiological materials to groundwater (via atmospheric deposition) post-refurbishment would be bounded by the results of the 2022 PN ERA and are not assessed further in this PERA.

During Continued Operations of PNGS Units 5-8, activities associated with PNGS Units 1-4 SWS and dismantle/demolish will be occurring. PNGS Units 1-4 SWS and dismantle/demolish have already been determined to have minimal impact on groundwater quality (see **Section 5.4.2.2.1**), so no further discussion is warranted.

5.4.3 Summary of Tier 1 Assessment

The initial screening of potential effects of Project activities on the geological and hydrogeological environment included consideration of soil quality, groundwater flow, and groundwater quality. The predicted interactions between the geological and hydrogeological environment and Project activities are summarized in **Table 5-21**.

Table 5-21: Summary of Interactions between Project Activities and Geological and Hydrogeological Environment

Project Activities	Soil Quality	Groundwater Flow	Groundwater Quality
PNGS Units 1-4 Decommissioning			
PNGS Units 1 and 4 Stabilization	2017 Safe Storage PEA and 2022 PEA Addendum are bounding • Impacts further mitigated by OPG's existing radiological waste handling procedures	2022 PEA Addendum is bounding	2022 PEA Addendum is bounding
PNGS Units 1-4 Storage with Surveillance	2017 Safe Storage PEA and 2022 PEA Addendum are bounding • Impacts further mitigated by OPG's existing radiological waste handling procedures	2022 PEA Addendum is bounding	2022 PEA Addendum is bounding
Risk Reduction and Removal Activities (2025-2033) Dismantle/Demolish (2034-2037)	Negligible impacts; impacts sufficiently mitigated by OPG's spill management procedures, construction best practices, and implementation of an Environmental Management Plan	Negligible impacts; excavation and dewatering impacts mitigated by construction best practices and adherence to the Environmental Management Plan	Negligible impacts; groundwater quality impacts mitigated by spill prevention and sufficiently planned containment
PNGS Units 5-8 Refurbishment			
Preparation for Refurbishment			
• Procurement and Mobilization of Equipment and Components	No interaction	No interaction	No interaction
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	• Soil impacts limited by gravel and paved surfaces	2022 PEA Addendum is bounding • No significant changes to groundwater flow	No interaction

Project Activities	Soil Quality	Groundwater Flow	Groundwater Quality
	• Further mitigation through construction best practices and OPG's existing environmental protection procedures	during PNGS Units 5-8 shutdown and refurbishment	
• Construction of PCSS and SB #5	PCSS PERA is bounding	PCSS PERA is bounding	No interaction
• Defuel and Dewater	No interaction – indirect reduced interaction through reduction in atmospheric radionuclide emissions resulting in decrease in deposition to soil.	No interaction	No interaction
• Islanding the Unit	No interaction	No interaction	No interaction
• Management of Heavy Water	No interaction	No interaction	No interaction
• Construction of DWI	No interaction	No interaction	No interaction
Refurbishment			
• Replacement of Reactor Components	No interaction	No interaction	No interaction
• Removal and Replacement of Steam Generators	No interaction	No interaction	No interaction
• Operation of DWI	No interaction	No interaction	No interaction
• Refurbishment of Other Plant Systems	No interaction	2022 PEA Addendum is bounding • No significant changes to groundwater flow during PNGS Units 5-8 shutdown and refurbishment	No interaction
• Waste Management and Transportation	No interaction	No interaction	No interaction
• Refuelling and Restarting	No interaction	No interaction	No interaction
Continued Operations			
Operation and Maintenance of PNGS Units 5-8	2022 PN ERA is bounding	2022 PN ERA is bounding	2022 PN ERA is bounding
Waste Management and Transportation	No interaction	No interaction	No interaction

5.5 Terrestrial Environment

5.5.1 Vegetation and Wildlife

5.5.1.1 PNGS Units 1-4 Decommissioning

5.5.1.1.1 Stabilization and Storage with Surveillance

As outlined in previous sections, non-radiological airborne and waterborne emissions are expected to decrease gradually during the Stabilization and SWS phases relative to previous operational conditions (for 6 operating units). This reduction is anticipated to either lower or maintain current levels of contaminant loading to the soil, as assessed in the 2022 PN ERA. Consequently, exposures to non-radiological contaminants for terrestrial receptors on or near the PN site are expected to remain within the bounds of previous operational conditions (for 6 operating units) in the 2022 PN ERA. These findings continue to remain valid for Stabilization and SWS; therefore, no further assessment is conducted in this PERA related to impacts of airborne and waterborne emissions on vegetation and wildlife during Stabilization and SWS.

Levels of noise, traffic, and light associated with PNGS Units 1-4 will remain similar to or decrease relative to current conditions during the Stabilization and SWS phases as the units are shut down, further minimizing disturbances to birds and other wildlife relative to current conditions. Thus, the activities during SWS are not expected to significantly affect the terrestrial environment and are considered to be bounded by the 2022 PN ERA. Therefore, they are not assessed further in this PERA.

5.5.1.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The 2017 Safe Storage PEA and 2022 PEA Addendum did not assess risk reduction and removal activities or the dismantling and demolishing of buildings and structures. Activities such as site clearing, structure removal, excavation, and dismantling larger tanks and water lines are expected to have minimal impacts on air, surface water, stormwater, and soil quality due to adherence to best construction practices and OPG's Environmental Management Plan. Consequently, exposures of terrestrial biota to particulates, dust, and non-radiological contaminants from PNGS are expected to remain within the range of current conditions (with 6 operating units).

Construction activities such as dismantling and removal of structures, as well as land excavation, are expected to occur outdoors and can therefore interact with the terrestrial environment. However, these activities are not expected to result in a measurable change to vegetation communities and species as the type of habitat provided by the disturbed area is common and found in adjacent areas, or is of poor quality due to its fragmented, sparse and disturbed character. No effect on vegetation communities in nearby wetlands (e.g., Frenchman's Bay and Hydro Marsh), woodlands (e.g., Brock Woodlot and Alex Robertson Woodlot), shrubland, shoreline and open water, is likely to occur as a result of project activities. Notably, only one terrestrial plant species at risk is currently present within the PN Study Area: a single Butternut

tree located within the Alex Robertson Woodlot (Beacon, 2023a, 2023b). This tree is not anticipated to be impacted by these activities, as it lies outside the affected area.
Though excavation activities may cause localized impacts on soil organisms inhabiting the subsurface, the affected area represents only a small fraction of the site and does not represent unique habitat for these organisms. Consequently, the overall soil biota on the site is not expected to be significantly impacted.

Noise, odour, and light generated from clearing work, segmentation/dismantling activities, and the utilization and transportation of equipment during this phase can temporarily reduce the attractiveness of the PN site as habitat for wildlife. However, these impacts can be mitigated through application of various management plans and strategies. Activities are not expected to result in elevated vibration levels that would impact wildlife and are not considered. The impact of sound levels is expected to be mitigated through proper equipment maintenance and the implementation of a Noise Management Plan. Odour and emissions produced from diesel or gasoline powered equipment and vehicles will be kept to a minimum by reducing vehicle idling and making use of construction best practices. Additionally, since most wildlife in the area (onsite and offsite) are likely to be accustomed to noise and light levels associated with an urban environment, as PNGS has been fully operational for over three decades (Golder, 2007c), the increase in noise levels is expected to have a negligible effect. While some of the more noise or light sensitive species may display an escape response to the increased disturbance, they may be able to habituate and resume current behaviors over time, as they have done with existing levels of noise, light, and human presence on site (OPG, 2000). If habituation does not occur, species can relocate to adjacent habitats such as Frenchman's Bay, Hydro Marsh, Krosno Creek valley, and other areas on the PN site that are not predicted to be influenced by these activities and are close enough to not require substantial energy expenditures for relocation.

As detailed in **Section 4.5.2,** most terrestrial species at risk have been observed beyond the PN Site boundaries in adjacent woodlots, parks, and wetlands (Beacon, 2018, 2022, 2023a, 2023b; OPG, 2016). These areas are not predicted to be degraded by activities in this phase. Species at risk observed within the site have mostly been recorded occasionally while transiting between nearby areas. Two species at risk have been confirmed to breed within the PN site boundaries. These are the Peregrine Falcon and Barn Swallow. Pairs of these species have been observed nesting at the PN site. OPG will comply with the species and habitat protection provisions of the Endangered Species Act, Species at Risk Act, and Migratory Birds Convention Act during all project activities. Additionally, to mitigate potential disturbances from project activities, various measures are currently being evaluated.

Mitigation measures under consideration include undertaking project activities outside of the sensitive bird nesting period (approximately April 1st to August 31st; after confirming that no nesting is taking place in the areas to be disturbed; or by avoiding nesting areas during project activities. Additionally, other mitigation measures should be explored to reduce noise levels during the breeding season, which may include alternate truck routes.

It should be noted that the PN site does not provide unique breeding habitat for other species observed on-site (i.e., species that are not at risk, non-migratory birds and other birds not covered under the Migratory Birds Convention Act). Thus, individuals, have the potential to temporarily relocate to other nearby areas until construction activities are complete.

Vehicle traffic associated with transporting dismantled material off-site is expected to be similar to or slightly higher than the traffic levels associated with current PN operations. As a result, the slight increase in traffic volumes would likely have a negligible impact on wildlife road mortality. Safe driving best practices will also be implemented to minimize vehicle collisions with wildlife.

Environmental Management Plans will be developed for the construction activities, such that all project works are carried out in accordance with regulatory requirements to minimize impacts on the terrestrial environment and local wildlife. These plans will outline mitigation measures including best practices for air and water management, noise control, contaminated soil management, and wildlife management. As a result, no adverse impacts on terrestrial biota are anticipated during dismantling and demolition activities. Thus, the changes in this phase are considered bounded by previous operational conditions (with 6 operating units) and will not be assessed further in this PERA.

5.5.1.2 PNGS Units 5-8 Refurbishment

The effects of PNGS Units 5-8 refurbishment activities on terrestrial biota, with the exception of the construction of the DWI, have been evaluated in either the Pickering B Refurbishment EA or the PCSS PERA. In support of this PERA, predictive air quality and noise modelling associated with planned Project activities was completed and is described in further detail in **Section 5.1.1.2** (air quality) and **Section 5.1.2.2** (noise). Discussion of the modelling includes interpretation of predicted exceedances of applicable air quality and noise screening guidelines and a discussion of potential impacts and associated mitigation measures, as necessary.

As noted in **Table 5-1**, the procurement and mobilization of equipment, as well as relocation, removal, and construction of buildings and structures planned for this phase have the potential to interact with the terrestrial environment. These activities are not expected to affect terrestrial plant communities and species as vegetation on site is sparse and consistent with rugged vegetation typical of a highly-disrupted, developed environment (e.g., weeds, grasses, small shrubs). Vegetation communities in nearby wetlands, woodlands, shrubland, open grassland, parkland, and the built environment on the PN site are not expected to be affected as a result of these construction activities. Consequently, the overall effect on vegetation is expected to be negligible.

Disturbances associated with construction activities, including increased human presence, have the potential to startle wildlife in the affected areas through the increase of auditory, olfactory, visual, and mechanical stimuli. Noise levels during Refurbishment were previously estimated in Pickering B Refurbishment EA. However, an updated noise model was developed in 2025 which accounted for the change in vehicles and equipment associated with current Project planning as

well as activities not considered in the Pickering B Refurbishment EA, including construction of the DWI in 2025.

As described in **Section 5.1.2.2.2**, despite predicted exceedances of ecological noise guidelines, no adverse impacts are expected for local ecological receptors. Since most wildlife species in the affected area are likely acclimatized to urban noise and lighting conditions, the impact of activities in this phase on wildlife is expected to be minimal. Residual impacts from elevated levels of noise are expected to be mitigated through proper maintenance of machinery and vehicles, and the implementation of construction best practices, a Noise Management Plan, and various Environmental Management Plans.

Elevated noise levels on site during refurbishment may impact species at risk including Bank Swallow nesting at the FFEE, or Barn Swallow and Peregrine Falcon which have historically nested on the PN site. As discussed in **Sections 5.5.1.1.2** and **5.1.2.2.2**, mitigation measures to reduce noise impacts to species at risk should be implemented. Additionally, OPG will comply with the species and habitat protection provisions of the Endangered Species Act, Species at Risk Act, and Migratory Birds Convention Act during all project activities.

The maximum bounding emissions scenario used in the air/noise model considered on-site vehicular traffic (approximately 2,200 vehicles per day), which is inclusive of trucks to support DWI construction, employee and delivery traffic from previous conditions (with 6 operating units) as well as additional refurbishment contract employee and delivery traffic. A small increase in wildlife mortality may occur as a result of increased traffic associated with Refurbishment activities. However, this change is considered to be negligible, because the loss of a few individuals that may be struck by vehicles at the PN site will not affect populations of terrestrial animals. Additionally, past monitoring data (Golder, 2007c) indicates that no species at risk have been involved in vehicle collisions on or near the PN site. This trend is expected to continue due to the absence of significant changes in traffic patterns, habitat use, or species movement corridors in the area. Best safe driving practices will also be implemented to further minimize the likelihood of wildlife strikes.

Nearby wildlife habitats, such as Frenchman's Bay, are not expected to be impacted by Refurbishment activities and offer suitable alternate habitat for displaced mammals and birds if habituation to the elevated levels of noise and light is not possible. As detailed in **Section 4.5.2**, the only species at risk confirmed to breed within the site are Peregrine Falcon and Barn Swallow pairs, which have been observed nesting inside the Protected Area. However, the PN site does not provide unique breeding habitat for these species. Therefore, any disturbances during Refurbishment will likely have only a minor effect on wildlife communities and species.

Activities associated with the construction of the PCSS for the storage of low and intermediate-level refurbishment waste were assessed as part of the PCSS PERA (Ecometrix, 2024). The PCSS PERA did not identify any activities that would pose a risk to terrestrial biota that are not sufficiently mitigated by construction best practices, the implementation of an Environmental

Management Plan, and/or the adherence to existing OPG policies and procedures for environmental protection and management.

The Pickering B Refurbishment EA did not assess the construction of the proposed DWI and any associated shoreline modifications, including construction of a dock, infilling and disposal of generated waste materials. For comparison purposes, the 2009 DNNP EIS assessed the construction of a deepwater intake and discharge structure as part of general excavation and grading activities for the DNNP. The placement of excavated earth and/or rock as lakefill was similarly assessed as part of general marine and shoreline works (Beacon, 2009). Based on current terrestrial species accounts at the PN site from the ongoing biodiversity monitoring program (Beacon, 2017b, 2018, 2022, 2023b; OPG, 2016), the potential shoreline erosion mitigation and west infill areas are primarily inhabited by riparian birds which forage in the nearshore. Though construction activities in the excavation and grading phase could interfere with riparian birds use of the inshore lake area, these effects are predicted to be minimized through construction best practices. Marine and shoreline works were also expected to have the potential to affect waterfowl use of the waterfront, as well as shoreline vegetation communities and species. However, since most of the riparian birds that nest and forage along the shoreline can temporarily relocate to other suitable habitats nearby, and shoreline vegetation is sparse and hardy, wildlife and vegetation communities are not expected to be affected. Following lake infilling and the construction of the dock, it is possible that the new infrastructure could provide suitable habitat for riparian birds.

The Pickering B Refurbishment EA concluded that the effects of refurbishment on air quality, as well as surface water flow, temperature, and quality, were expected to be bounded by effects of operation under previous operational conditions (with 6 operating units). Considering the recent inclusion of DWI construction, updated modeling scenarios were developed to assess the potential influence of DWI construction activities on the aforementioned environmental parameters. As described in **Section 5.1.1.2.1**, despite predicted exceedances of the selected air quality criteria, no adverse impacts to ecological receptors are expected. Air quality impacts resulting from Project activities are expected to be negligible or sufficiently managed by construction best practices and dust reduction measures. For other air quality parameters, the inhalation exposure route is considered a minor pathway relative to food and water ingestion and is considered negligible. As surface water and soil conditions during refurbishment were considered to be bounded by previous operational conditions (with 6 operating units) as discussed in **Sections 5.2.2.2.1** and **5.4.1.2**, the impacts of the quality of these media on terrestrial biota will not be evaluated further.

5.5.1.3 PNGS Units 5-8 Continued Operation

Following refurbishment, PNGS Units 5-8 will operate in the same manner as previous operations. As such, the levels of noise, light, and traffic will return to previous conditions (with 6 operating units). No further changes to the physical habitat features or habitat quality are expected from operations. Therefore, assessment of the potential effects from the Continued

Operation Phase on the environment is bounded by the assessment of effects under the 2022 PN ERA with 6 operating units.

During Continued Operations of PNGS Units 5-8, activities associated with PNGS Units 1-4 SWS and dismantle/demolish will be occurring, which could result in increased airborne emissions and noise levels. It is expected that air and noise predictions would be within the bounding air and noise assessment presented in **Sections 5.1.1.2** and **5.1.2.2**, respectively.

5.5.2 Summary of Tier 1 Assessment

The initial screening of potential effects of Project activities on the terrestrial environment included consideration of vegetation and wildlife. The predicted interactions between the terrestrial environment and Project activities are summarized in **Table 5-22.**

Table 5-22: Summary of Interactions between Project Activities and Terrestrial Environment

Project Activities	Vegetation and Wildlife
PNGS Units 1-4 Decommissioning	
PNGS Units 1 and 4 Stabilization	2022 PN ERA is bounding. Assumptions in 2017 Safe Storage PEA and 2022 PEA Addendum are still valid.
PNGS Units 1-4 Storage with Surveillance	2022 PN ERA is bounding. • Exposures to non-radiological contaminants for terrestrial receptors are expected to remain within the bounds of previous operational conditions (with 6 operating units). Noise, light, and traffic levels are expected to be bounded by previous operational conditions (with 6 operating units).
Risk Reduction and Removal Activities (2025-2033) Dismantle/Demolish (2034-2037)	2022 PN ERA is bounding. Not assessed in 2017 Safe Storage PEA or 2022 PEA Addendum. • Exposures of terrestrial biota to particulates, dust, and non-radiological contaminants are expected to remain within the bounds of previous operational conditions (with 6 operating units). • No unique habitat will be affected. • No work is planned in nearby wetlands, woodlots, or parklands. • Residual impacts are expected to be mitigated through proper maintenance, construction best practices, a Noise Management Plan, and various Environmental Management Plans • Elevated noise levels for breeding species at risk should be mitigated • Though a slight increase in traffic is expected, population-level impacts to terrestrial biota from vehicle collisions are not expected. There are no significant changes in traffic patterns and routes in this project phase. Best safe driving practices will also be implemented to further minimize the likelihood of wildlife strikes.

Project Activities	Vegetation and Wildlife
PNGS Units 5-8 Refurbishment	
Preparation for Refurbishment	
• Procurement and Mobilization of Equipment and Components	This activity is bounded by results of air/noise modelling. • Exposures of terrestrial biota to particulates, dust, and non-radiological contaminants from PNGS are bounded by previous operational conditions (with 6 operating units). • No unique habitat will be affected. • No work is planned in nearby wetlands, woodlots, or parklands. • Noise levels are bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source. • Though a slight increase in traffic is expected, population-level impacts to terrestrial biota from vehicle collisions are not expected.
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	This activity is bounded by results of air/noise modelling. • Exposures of terrestrial biota to particulates, dust, and non-radiological contaminants from PNGS are bounded by previous operational conditions (with 6 operating units). • No unique habitat will be affected. • No work is planned in nearby wetlands, woodlots, or parklands. • Noise levels are bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source. • Though a slight increase in traffic is expected, population-level impacts to terrestrial biota from vehicle collisions are not expected.
• Construction of PCSS and SB #5	This activity is bounded by results of air/noise modelling. • Exposures of terrestrial biota to particulates, dust, and non-radiological contaminants from PNGS are bounded by previous operational conditions (with 6 operating units). • No unique habitat will be affected. • No work is planned in nearby wetlands, woodlots, or parklands. • Noise levels are bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source. • Though a slight increase in traffic is expected, population-level impacts to terrestrial biota from vehicle collisions are not expected.
• Defuel and Dewater	No interaction
• Islanding the Unit	No interaction
• Management of Heavy Water	No interaction
• Construction of DWI	This activity is bounded by results of water, air, and noise modelling. • Exposures of terrestrial biota to particulates, dust, and non-radiological contaminants from PNGS are bounded by previous operational conditions (with 6 operating units). • Some shoreline vegetation will be removed during nearshore modifications associated with DWI construction. This vegetation is sparse, hardy, and not unique.

Project Activities	Vegetation and Wildlife
	• No unique habitat will be affected. • No work is planned in nearby wetlands, woodlots, or parklands. • Noise levels are bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source. • Though a slight increase in traffic is expected, population-level impacts to terrestrial biota from vehicle collisions are not expected.
Refurbishment	
• Replacement of Reactor Components	No interaction
• Removal and Replacement of Steam Generators	No interaction
• Operation of DWI	No interaction
• Refurbishment of Other Plant Systems	No interaction
• Waste Management and Transportation	This activity is bounded by results of water, air, and noise modelling. • Exposures of terrestrial biota to particulates, dust, and non-radiological contaminants from PNGS are bounded by previous operational conditions (with 6 operating units). • Noise levels are bounded by the activities assessed in the noise model completed to support this PERA. Not a significant noise source. • Though a slight increase in traffic is expected, population-level impacts to terrestrial biota from vehicle collisions are not expected.
• Refuelling and Restarting	No interaction
Continued Operations	
• Operation and Maintenance of PNGS Units 5-8	2022 PN ERA is bounding.
• Waste Management and Transportation	2022 PN ERA is bounding.

5.6 Radiation and Radioactivity

This section focuses on gamma radiation fields from waste storage structures on the PN site. An assessment of radionuclide emissions to the atmospheric and surface water environments resulting from PNGS Units 1-4 Decommissioning and PNGS Units 5-8 Refurbishment is provided in **Section 5.1.1** and **Section 5.2.2**, respectively.

The NSS-PWMF (**Figure 3-2**) consists of the Phase I site which contains two used fuel dry storage buildings and a Retube Component Storage area, and the Phase II site which contains two used dry storage buildings (SB #3 and SB #4) with a third dry storage building (SB #5) planned for Q3 2027, located east of SB #3 and SB #4.

New to this PERA is the addition of the Harvester receptor. While not specifically assessed in the 2022 PN ERA, the Harvester is not expected to be affected by gamma radiation due to this

receptor's relatively far distance from the PN site. The dose received by the Sport Fisher, the closest human receptor to PN site, would be considered conservative for the Harvester for assessment of gamma radiation.

5.6.1 PNGS Units 1-4 Decommissioning

5.6.1.1 Stabilization and Storage with Surveillance

The 2017 Safe Storage PEA and 2022 PEA Addendum assessed a scenario in which 100 DSCs containing 6-year decayed used fuel in SB #3, and additional storage in the newly constructed SB #4, were considered following the shutdown and transition of all six operational PNGS reactors into Stabilization and SWS. The predicted annual dose at the PN east property boundary was found to be well below the public dose limit for radiation protection, and below the terrestrial and aquatic dose benchmarks for the protection of ecological receptors (Ecometrix, 2023b; Golder and Ecometrix, 2017). The Stabilization and SWS activities assessed as part of the 2017 Safe Storage PEA and 2022 PEA Addendum are generally the same as the planned activities for PNGS Units 1-4 Decommissioning. However, refurbishment is now planned for PNGS Units 5-8 instead of shutdown. Additionally, a change in assumptions since the 2017 Safe Storage PEA and 2022 PEA Addendum would see OPG initiate some dismantling activities in the AIFB and IFB-A, specifically the removal of modules and baskets to aid in the removal of used fuel from the AIFB and IFB-A, an activity not previously assessed as part of Stabilization and SWS.

The planned dismantling activities in the IFBs are described in **Section 3.3.3.1**. To summarize, used fuel stored in the AIFB and IFB-A will continue to be loaded into DSCs and transported to the NSS-PWMF using the existing programs and procedures for the management of used fuel. As fuel is removed, empty baskets and associated frames will be removed from the AIFB and IFB-A and disposed of using existing waste routes. The removal of used fuel from the AIFB and IFB-A and the subsequent transfer of used fuel to the NSS-PWMF is part of OPG's current licensing and was most recently assessed in the 2022 PEA Addendum (Ecometrix, 2023b).

As the transfer of DSCs to the NSS-PWMF falls under current licensing activities for the PN site, the removal of used fuel from the AIFB and IFB-A during Stabilization and SWS is considered bounded by the 2017 Safe Storage PEA and 2022 PEA Addendum. The removal of empty modules and baskets will adhere to OPG's existing waste handling procedures and their disposal will utilize existing waste routes. Overall, the findings of the 2017 Safe Storage PEA and 2022 PEA Addendum remain valid and bounding of the planned Stabilization and SWS. The dismantling activities planned for the AIFB and IFB-A are bounded by current licensed activities and operational conditions. For this reason, no further assessment of Stabilization and SWS for PNGS Units 1-4 is warranted for this PERA.

5.6.1.2 Risk Reduction/Removal Activities and Dismantle/Demolish

The structures selected for dismantlement as part of risk reduction and removal activities would include non-nuclear systems that are non-operational and are not expected to contain

radioactivity above procedural or regulatory limits. Despite the dismantling activities occurring in parallel to the stabilization activities, OPG will ensure that no interaction between non-nuclear and nuclear components occurs. Furthermore, equipment will be surveyed before dismantling (to confirm no radiological hazards are present before beginning work), after decontamination (if required), and prior to off-site transportation to prevent any radiation risk. Thus, no radiological effects are anticipated resulting from risk reduction and removal activities, and these activities (with respect to radiation hazards) are not assessed further in this PERA.

The SSCs in PE-A and PE-B (see **Section 3.3.4.1** and **3.3.4.2**, respectively) selected for dismantlement and demolition (beyond those dismantled during earlier risk reduction and removal activities) include non-operational, non-nuclear systems that are not anticipated to be radiologically contaminated above procedural or regulatory limits. Prior to dismantling, equipment and materials will be surveyed to confirm no radiological hazards are present, and if required, again after decontamination (in cases where radiological hazards are encountered). Any dismantled equipment or materials selected for off-site transportation will be surveyed for radiological contamination prior to removal from the PN site.

PE-A Group A-3 decommissioning activities focus on the removal of outbuildings after IFB-A and AIFB are emptied, drained, and dried. Wastes produced during the dismantlement of the Heavy Water Upgrading Plant and its associated structures are expected to contain some level of radiological contamination due to the historic presence of heavy water within these structures. Consistent with current OPG waste handling procedures, equipment and structures will be surveyed to determine the extent of any radiological hazards prior to dismantlement or demolition. All waste will be managed in accordance with accepted procedures and licence requirements.

Overall, no radiological effects are expected resulting from dismantling and demolition activities, and these activities (with respect to radiation hazards) are not assessed further in this PERA. All risk reduction and removal activities and dismantling/demolition activities will adhere to OPG's existing waste management procedures to mitigate any potential radiological effects to human and ecological receptors.

5.6.2 PNGS Units 5-8 Refurbishment

The refurbishment of PNGS Units 5-8 is expected to involve the handling, repair or replacement of radiologically contaminated SSCs. Further details regarding the planned refurbishment activities are provided in **Section 3.1.2**.

5.6.2.1 Gamma Radiation Fields

During Refurbishment, project works and activities have the potential to interact with the human receptors and the terrestrial environment through gamma radiation fields. External gamma radiation fields are associated with the replacement of reactor components, removal of steam generators, and the management and transfer of radiological waste.

The storage of L&ILW waste is expected to adhere to OPG's existing waste management procedures and is part of current licensing activities for the PN site. Wastes from refurbishment activities will be sent for storage within the planned PCSS; gamma radiation resulting from operation of the PCSS is discussed in **Section 5.6.2.1.2** below.

5.6.2.1.1 Radiological Dose from DSC Storage Buildings Within the NSS-PWMF

Gamma radiation associated with the DSC storage buildings within the NSS-PWMF is bounded by the 2022 PEA Addendum, which assessed dose rates assuming the storage of 6-year aged fuel (i.e., higher activity than 10-year aged fuel) within the NSS-PWMF. Used fuel is typically stored within the IFBs for 10 years; however, OPG is authorized to process and store up to 100 DSCs with used fuel that has been stored in the IFBs for 6 years to free up space for additional fuel in the IFB.

In the 2022 PEA Addendum (Ecometrix, 2023b), up to 100 DSCs containing 6-year-cooled fuel were assumed to compose 20% of SB #3's storage capacity, while SB #4 was assumed to contain 10-year-cooled fuel at 40% capacity. The highest predicted annual dose of 3.56 µSv/a was modelled to occur at the PNGS eastern boundary fence and is considered to be representative of industrial/commercial workers and members of the public walking by the PN perimeter fenceline. This dose rate is below both the radiation safety requirement for the NSS-PWMF (10 µSv/a) and the public dose limit (1,000 µSv/a) when considering dose from the NSS-PWMF alone and together with the dose from the PNGS during SWS (cumulative dose of 5.56 µSv/a). The highest predicted annual dose at the shoreline is 0.14 µSv/a and is representative of the dose to a future Sport Fisher. Once again, this dose rate is below both the radiation safety requirement for the NSS-PWMF (10 µSv/a) and the public dose limit (1,000 µSv/a) when considering dose from the NSS-PWMF alone and together with the dose from the PNGS during SWS (cumulative dose of 0.35 µSv/a). As noted earlier in this chapter, the Sport Fisher result is considered conservatively protective of a Harvester receptor.

With respect to ecological receptors, the dose rates at the NSS-PWMF Phase II fence were considered. As indicated in the 2022 PEA Addendum, the tissue absorbed dose for ecological receptors in close proximity to SB #3 (assuming storage of up to 100 DSCs containing 6-year aged fuel) and SB #4 would be no more than 0.85 µGy/h at the west fence line. This is well below the terrestrial dose benchmark of 100 µGy/h for terrestrial and riparian receptors (Ecometrix, 2023b).

Construction is planned for SB #5 in the PWMF Phase II Site for future storage of used fuel, with an in-service date of Q3 2027. The assessment of the construction of additional DSC storage buildings was completed as part of the Pickering B Refurbishment EA. The design and construction of SB #5 to ensure the regulatory dose limits and OPG's dose targets for the public and workers at the facility fence and beyond are met.

Considering the storage of used fuel at the NSS-PWMF falls within OPG's current licensing activities for the PN site, and dose rates from the NSS-PWMF are well below the public dose

limit, no further assessment of gamma radiation fields from DSCs stored within the NSS-PWMF is warranted in this PERA. A safety assessment will be completed by the end of 2025 for SB #5 prior to construction to confirm dose limits and targets will be achieved.

5.6.2.1.2 Construction and Operation of the PCSS

Construction of the PCSS is planned to support refurbishment activities and will be used for the storage of L&ILW from decommissioning and refurbishment, including components such as steam generators, pressure and calandria tubes, calandria tube inserts, and end fittings, and concrete LLW. An evaluation of the environmental effects of the PCSS was part of a separate PERA (Ecometrix, 2024). The PCSS will be incorporated into the existing NSS-PWMF operating policies and procedures.

The PCSS PERA determined that there are no expected radiological risks to human and ecological receptors resulting from the operation of the PCSS (Ecometrix, 2024). The human health risk assessment evaluated the impact on human health of gamma radiation from the PCSS. The estimated dose for the Sport Fisher was 4.89×10^{-3} µSv/a (which includes contributions from PCSS, SB #3, #4, and #5); considering the other existing facilities on the PN site, the cumulative dose to the Sport Fisher could be up to 0.57 µSv/a. This estimate represents less than 1% of the regulatory public dose limit of 1,000 µSv/a. Overall, since the dose estimates were found to be a small fraction of the public dose limit and natural background exposure, no human health effects are anticipated due to exposure to gamma radiation from the PCSS (Ecometrix, 2024).

Similarly, the ecological risk assessment evaluated the impact on ecological health due to gamma radiation from the PCSS. For exposure of ecological terrestrial receptors to gamma radiation from the PCSS, the maximum dose rate to any ecological receptors residing in close proximity to the PCSS could be up to 0.057 mGy/d, and lower than 0.057 mGy/d for off-site ecological receptors residing at the PN fenceline. All predicted doses were found to be lower than the 2.4 mGy/d radiation benchmark for terrestrial biota. It was concluded that there are likely no radiological effects to ecological receptors, including in the scenario when the maximum dose from the PCSS is combined with the dose from exposure to radionuclides through other existing PN operations (Ecometrix, 2024).

Overall, the results of the PCSS PERA remain valid for the operation of the PCSS as part of PNGS Units 5-8 Refurbishment, and no further assessment is warranted for this PERA.

5.6.2.1.3 Dry Storage Module Transfer

Currently, the Retube Component Storage Facility (RCSF) sits within the NSS-PWMF I licensed site and is the location of a series of 36 DSMs used to contain ILW. Of these, 34 are loaded and two are empty. OPG has proposed the relocation of these DSMs by Q3 2025 to the NSS-PWMF II licensed site to accommodate the spatial requirements related to construction of the DWI (e.g., operation of the tunnel boring machine) and other shoreline works. Additionally, OPG has proposed the temporary relocation of the Protected Area fenceline in this area. OPG assessed

that the relocation of the DSMs falls within the bounds of permitted activities under existing NSS-PWMF licensing and has notified the CNSC of the intended relocation (OPG, 2024b).

Radiological impacts associated with the relocation of DSMs from the NSS-PWMF I site to the NSS-PWMF II site were assessed in December 2024 (OPG, 2024b). The assessment assumed that the DSMs would be transferred utilizing the same transfer route that existing DSCs use when being transferred to used fuel dry storage buildings within the NSS-PWMF II site.

Dose measurements from the existing NSS-PWMF Phase I DSM storage area (referred to as the RCS area) range from 0.067 µSv/h (south fence) to 1.24 µSv/h (north fence). Dose rates on the north fence have contributions from used fuel dry storage buildings and represent conservative estimates of DSM dose rates. The assessment concluded that the dose rate acceptance criteria ($5.00x10^{-2}$ µSv/h, equivalent to 10% of the limit for a member of the public when scaled with an occupancy of 2,000 hours per year) is unlikely to be exceeded in the planned DSM storage location within the NSS-PWMF II area, even with the contributions from the existing SB #3 and SB #4 structures (OPG, 2024b).

The nearest site boundary on land is noted to be approximately 200 m from the proposed DSM storage location. The worst-case dose rate calculated at the site boundary was found to be $1.75x10^{-2}$ µSv/h, which includes dose contributions from SB #3, SB #4, SB #5 and the PCSS. The dose rate is below the acceptance criterion of $5.00x10^{-2}$ µSv/h (OPG, 2024b).

Assuming a single DSM results in a maximum dose rate of 1.24 µSv/h at a distance of 8 m (conservatively estimated from the existing highest measurement on the north RCS fence, which again includes contributions from multiple DSMs and existing Dry Storage Containers), the attenuation at 200 m (NSS-PWMF II to site boundary) was estimated to be a factor of 10,000. Conservatively assuming the 36 relocated DSMs have the same dose rate, the dose rate at the site boundary is $4.50x10^{-3}$ µSv/h. This result assumes a straight line-of-sight to the site boundary and no shielding provided by other DSMs and other structures (e.g., SB #3 and SB #4), which is considered conservative. Thus, the assessment concluded there is sufficient margin to the dose rate target to accommodate the relocated DSMs on the NSS-PWMF II licensed site (OPG, 2024b). As the findings and assumptions used in this recently completed assessment remain valid, no further assessment is required for this PERA.

The assessment of radiological impacts associated with the relocation of the DSMs did not specifically address potential impacts to ecological receptors. Mobile ecological receptors (e.g., birds and mammals) can access the NSS-PWMF Phase II site and could be near the relocated DSMs. At present, ecological receptors can access the NSS-PWMF I licensed site and could also be near the DSMs in their current location; thus, current conditions at the NSS-PWMF Phase I site are considered representative of the future conditions at the NSS-PWMF Phase II site after DSM transfer. Off-site ecological receptors may exist closer than the 200 m assumed for the nearest fenceline. The maximum dose rate of 1.24 µSv/h (measured at 8 mfrom the DSM, the existing highest measurement on the north RCS fence) can conservatively be assumed as the dose rate at the fenceline for the NSS-PWMF II site. Considering this, the estimated fenceline

dose rate would be $2.98x10^{-2}$ mGy/d, which represents approximately 1.2% of the terrestrial radiation dose benchmark. Though ecological receptors may periodically exist closer than 8 m to the DSMs, the maximum dose rate of 1.24 µSv/h includes contributions from multiple DSMs and existing DSCs, making it a conservative estimate of dose from any one DSM. It is also unlikely that ecological receptors would remain in long-term close contact with the DSMs as the areas around the DSMs are paved and devoid of vegetation, and generally do not present suitable foraging or nesting habitat for birds and mammals. Thus, ecological receptors are not considered at risk from the relocation of the DSMs to the NSS-PWMF Phase II licensed site. Current conditions within the NSS-PWMF Phase I site are considered representative and no further assessment is warranted for this PERA.

While this PERA has included an assessment of modelled NSS-PWMF dose rates following the transfer of DSMs to the NSS-PWMF Phase II area, the next iteration of the PN ERA will consider the new NSS-PWMF layout and use updated measured dose rates to evaluate revised doses to human and ecological receptors and ensure that OPG's operational and regulatory limits continue to be met. Following transfer to the NSS-PWMF Phase II area, a series of thermoluminescent dosimeters (TLDs) will be installed to monitor gamma radiation fields surrounding the DSMs. At the current DSM storage location, quarterly catch basin stormwater samples are collected for the analysis of gross beta/gamma; this monitoring is expected to continue at the new DSM storage location within the NSS-PWMF Phase II site.

5.6.3 PNGS Units 5-8 Continued Operations

During normal operations, the PN site emits gamma radiation fields into the surrounding environment, primarily due to the storage of radiological waste within the NSS-PWMF. It is anticipated that gamma radiation fields post-refurbishment would be similar to those assessed in the PCSS PERA since those estimates include contributions from other facilities on the NSS-PWMF Phase II site including SB #3, #4, #5 (Ecometrix, 2024)

While the reactors themselves contribute minimally to gamma radiation due to extensive shielding from the reactor buildings, their contribution to gamma fields will be lower than previous operations (with 6 operating units) as the number of operational reactors will have been reduced to four.

In general, the Continued Operations Phase of the PNGS Units 5-8 Refurbishment Project is similar to the PCSS PERA; however, future TLD monitoring at the NSS-PWMF Phase II site will confirm gamma radiation fields.

5.6.4 Summary of Tier 1 Assessment

The initial screening of potential effects of Project activities on the radiation and radioactivity included consideration of gamma radiation. The predicted interactions between radiation and radioactivity and Project activities are summarized in **Table 5-23**.

Table 5-23: Summary of Interactions between Project Activities and Gamma Radiation

Project Activities	Gamma Radiation
PNGS Units 1-4 Decommissioning	
PNGS Units 1 and 4 Stabilization	Bounded by 2017 PEA and 2022 PEA Addendum
PNGS Units 1-4 Storage with Surveillance	Bounded by 2017 PEA and 2022 PEA Addendum • Removal of modules and baskets from AIFB and IFB-A bounded by current licensing activities and mitigated by existing waste management procedures
Risk Reduction and Removal Activities (2025-2033) Dismantle/Demolish (2034-2037)	Radiological effects sufficiently mitigated by adherence to OPG waste management procedures and licence requirements
PNGS Units 5-8 Refurbishment	
Preparation for Refurbishment	
• Procurement and Mobilization of Equipment and Components	No interaction
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	No interaction
• Construction of PCSS and SB #5	No interaction
• Defuel and Dewater	No interaction
• Islanding the Unit	No interaction
• Management of Heavy Water	No interaction
• Construction of DWI	No interaction
Refurbishment	
• Replacement of Reactor Components	No interaction
• Removal and Replacement of Steam Generators	No interaction
• Operation of DWI	No interaction
• Refurbishment of Other Plant Systems	No interaction
• Waste Management and Transportation	• PCSS PERA is valid • Safety assessment will be completed for SB #5 by the end of 2025, prior to construction to confirm dose limits and targets will be achieved • TLDs will be installed to monitor gamma radiation fields around the DSMs transferred to NSS-PWMF Phase II site
• Refuelling and Restarting	No interaction
Continued Operations	
• Operation and Maintenance of PNGS Units 5-8	Bounded by 2022 PN ERA and 2022 PEA Addendum
• Waste Management and Transportation	PCSS PERA is valid

5.7 Climate Change Considerations

OPG acquired local climate change projections and indicators for PNGS in 2023 (AECOM, 2023) which focused on the identification of climate change hazards and their bounding values. OPG

will be obtaining CMIP6 (Climate Model Intercomparison Project) climate projections for analysis and will include the updated projections during the next PERA update.

The bounding analysis considered gradual climate change and extreme weather events under two scenarios: Representative Concentration Pathway (RCP) 4.5, which accounts for intermediate Greenhouse Gas (GHG) emissions; and RCP 8.5, with accounts for high emissions. The future projections were analyzed for two time periods – 2021-2050 (which covers the licensing period of this PERA) and 2051-2080. The impacts of climate change on Project activities, and potential GHG emissions from these activities, during different phases are summarized below.

5.7.1 PNGS Units 1-4 Decommissioning

5.7.1.1 Stabilization and Storage with Surveillance

The potential influence of climate change on activities during the Stabilization and SWS phase was evaluated in the 2022 PEA Addendum. Regional Climate Models (RCMs) for RCP 4.5 and 8.5 scenarios indicated show slightly increasing water levels in Lake Ontario and greater variability, particularly as temperatures increase by 2050. The hydrodynamic surface water model developed for the 2017 Safe Storage PEA and the 2022 PEA Addendum utilized elevated water temperatures and levels, as well as early spring warming conditions, making it representative of future climate change scenarios. Additionally, as the discharges from PNGS Units 1-4 during the SWS Phase are non-thermal and small in volume, the thermal plume is expected to be reduced considerably from previous operational conditions (with 6 operating units). Furthermore, the predicted increase in the frequency and occurrence of extreme weather events (intense precipitation and drought) may increase exchange rates between the forebay and the lake, thus reducing concentrations of any contaminants in the forebay.

The results of the bounding analysis are consistent with the climate projections from the RCP models developed for the 2022 PEA Update. Additional climate hazards not considered in the PEA, such as increased annual ambient air temperatures, higher occurrences of biofouling and algal blooms, and a greater likelihood of heatwaves and storm events, are not expected to impact activities during this phase, as these changes primarily affect operations, which have ceased for PNGS Units 1-4. Consequently, the impacts of climate change on project activities during this phase are considered negligible.

5.7.1.2 Dismantle/Demolish Activities

The impact of climate change on dismantling activities for PNGS Units 1-4 was not evaluated in the 2022 PEA Addendum. As per the results of the bounding analysis, Lake Ontario's annual mean water temperature is projected to increase by 1.7 °C by mid-century under the RCP 8.5 scenario, which aligns with the activities during this phase. This gradual increase in average water temperatures will be minor relative to changes to the receiving environment as a result of reduction of the thermal plume due to minimal releases via the PNGS Units 1-4 discharge channel. Additionally, while increased ambient air temperatures due to climate change could

elevate fire risks for certain structures and equipment, the dismantling and removal of non-nuclear SSCs during this phase reduces this risk greatly.

The predicted increase in the frequency and intensity of extreme precipitation events and storms may result in higher runoff. However, existing drainage and stormwater systems will remain operational and are expected to accommodate these changes, with potential adjustments and modifications made to confer additional capacity as needed through adaptive management strategies. In the unlikely event of rainfall exceeding design capacity, localized erosion of ditches or soil cover may occur, but the integrity of site structures and equipment is anticipated to remain unaffected, minimizing risks to the public and environment. This is based on engineering best practices and safety margins at the time they were developed. OPG is currently evaluating the design to determine if it addresses future climatic conditions.

Finally, the utilization of vehicles and equipment for dismantling activities are expected to emit a small amount of greenhouse gases. However, vehicular traffic is not expected to increase significantly compared to previous operational conditions (with 6 operating units), and equipment will be operated intermittently and as efficiently as possible to limit emissions. Therefore, considering the relatively short time frame of project activities, limited project-environmental interactions, and robust mitigation measures (e.g., Emergency Management Program, climate considerations in infrastructure design at the time they were developed), the impacts of climate change on project activities during the Dismantle and Demolish phase are likely negligible.

5.7.2 PNGS Units 5-8 Refurbishment

An evaluation of the effects of climate change on activities during Refurbishment, except the construction and operation of the proposed DWI, was conducted as a part of the Pickering B Refurbishment EA (SENES, 2007). The conclusions of this evaluation are summarized in this section, integrating the predictions of climate parameters derived from the 2023 bounding analysis and recent climate change literature.

As suggested by the thermal stratification patterns in Lake Ontario (see **Section 4.3.1.3.5**), the water drawn through the proposed offshore DWI is expected to be 3–5°C cooler than that drawn through the existing nearshore intake channel at the surface, supporting improved thermal management in the future. Compared to surface water, deeper layers in lakes are expected to warm at a slower rate with climate change due to weaker coupling with air temperature (Anderson et al., 2021; Butcher et al., 2015; Pilla et al., 2020). The interactions that result in increasing water temperatures in Lake Ontario are complex and still the subject of ongoing studies. Additionally, preliminary estimates of the discharge temperature following intake relocation account for these climate change-induced increases and indicate that the discharge temperature will remain the same or lower than current conditions. As such, the thermal plume for previous operations (with 6 operating units) remains applicable under climate change conditions.

As water temperatures, particularly maximum temperatures, are expected to rise in the coming decades, an increased frequency and duration of biofouling events and algal blooms during the summer is anticipated. Lake buoyancy, surface winds, and lake currents can concentrate cyanobacteria near the surface. This suggests the projected increase in algal growth is expected to be less pronounced near the DWI. Additionally, increased turbidity in the epilimnion of stratified lakes due to algal blooms is expected to maintain or lower water temperatures in deeper layers. This is because higher turbidity leads to greater light absorption at the surface, limiting heat transfer to subsurface layers (Richardson et al., 2017; Rose et al., 2016). Consequently, this effect would buffer against increased algal growth in deeper layers. Despite this, potential impacts on operations from increased algal growth at depths between 10.5 - 12 m (within which the DWI will be sited), including blocking and restrictions of the intake, remain possible. To minimize these risks, OPG will deploy protective screens, prepare systems, and implement design modifications as necessary. OPG will also continue utilizing the Advanced Algae Warning System (AAWS), a predictive tool developed in 2019 (OPG, 2020c), to forecast and monitor algae events, and adjust operations accordingly to mitigate the effects.

The predicted increase in annual precipitation as well as the frequency and intensity of extreme weather events such as storms. This is expected to result in higher lake water levels in the coming years. Specifically, the bounding analysis projects that annual lake levels could rise to 76.3 m by the end of 2080 under the RCP 8.5 scenario, a 1 m increase from historical levels. However, as the projected annual level remains below the PN shoreline protection level of 78.6 m, the shoreline is expected to remain adequately protected even in the context of climate-induced changes. Conversely, the findings of the bounding analysis indicate that, despite predicted increases in drought events, a significant decline in annual lake levels is not expected under the RCP 8.5 scenario. Importantly, the International Joint Commission regulates lake levels through controlled outflows and is expected to continue doing so in the future. Thus, given the minor fluctuations in lake levels under climate change, along with the active regulation by the International Joint Commission, lake levels are anticipated to remain relatively stable and below the PNGS shoreline protection level.

OPG's severe weather emergency preparedness procedure (OPG, 2023j) has been effective in managing severe weather events, ensuring that the station operates without risk to the public or the environment. As climate change is expected to increase the frequency and intensity of extreme weather events, this procedure will continue to play a critical role in responding to these challenges and maintaining safe operations. Finally, all project-related structures, i.e., the DWI, shoreline erosion mitigation area, west infill area, and dock, will be designed using engineering best practices to withstand extreme weather conditions such as storms, droughts, floods, and blizzards.

The increased occurrence of extreme weather events such as storms and floods expected to occur with climate change, could result in increased shore erosion due to greater wave intensity, potentially impacting the stability of the nearshore study areas. Erosion is currently an ongoing process along the PN shoreline, and no adverse impacts on nearshore aquatic biota have been

observed as a result. However, the implementation of armoring measures is anticipated to effectively mitigate these effects. As the name suggests, the shoreline erosion mitigation area is specifically designed to support shoreline restoration in the nearshore area east of the PNGS Unit 5-8 outfall. Lake acidification due to climate change will also be considered in the design of the DWI intake and associated nearshore modifications.

Activities related to the relocation and removal of buildings, structures, and equipment, and the construction of buildings such as the PCSS and RFRISA, are anticipated to last for a short duration, and are expected to encounter a minimal impact from climate change. As detailed in the PCSS PERA (Ecometrix, 2024), though extreme precipitation events are predicted to increase in the coming decades, the water management infrastructure of the site would be designed to include additional capacity to accommodate this increase as applicable. Additionally, these buildings will be designed according to the National Building Code of Canada and will be constructed using engineering best practices to account for any impacts of extreme weather events. OPG's existing Emergency Management Program and severe weather emergency preparedness procedure are dynamic, and address actions to be taken to respond to emergencies including extreme weather events. Additionally, greenhouse gas emissions associated with the construction activities will be minimized by reducing vehicle idling and using energy-efficient systems and equipment.

5.7.3 Continued Operations

Following refurbishment, continued operation of PNGS Units 5-8 with the DWI is expected to result in the discharge temperature remaining the same or lower than current conditions. Therefore, climate change impacts on the thermal plume are not considered to be significantly different from current conditions based on these preliminary predictions. This will be confirmed through future monitoring of intake and discharge temperatures. As a subsequent step, the Tier 2 assessment evaluates thermal effects further.

Climate change is expected to lead to an increase in ambient air temperatures, with the average annual ambient air temperature in 2080 under the RCP 8.5 scenario projected to reach 16.5°C, increasing 4.3°C from historical observations. Ambient air temperatures are used as one of the inputs to the atmospheric dispersion model used in the 2022 PN ERA. As ambient air temperature increases, there is less difference between the ambient air temperature and the air emissions gas temperature from the PNGS stack. A lower difference between the gas and ambient air temperature results in less buoyancy of the plume and lower atmospheric dispersion. This would likely result in exposure to higher air concentrations for receptors proximal to the site, and lower concentrations for receptors farther from the PN site. The atmospheric dispersion of emissions is also expected to be influenced by higher wind speeds associated with tropical storms in the coming decades. In a 2°C warmer world, wind speeds during storms are projected to increase by 1-10%, with tropical cyclone wind speeds increasing by 0.5 to 5.2 km/h and extra-tropical cyclones increasing by 0.6 to 6.6 km/h compared to historical observations. These stronger winds would result in broader dispersion of emissions, further supporting the conservative nature of this assessment.

Finally, the refurbishment of PNGS Units 5-8 will allow the operational lifespan of the station to increase by 30 years. Given the role of greenhouse gas emissions in exacerbating climate change, the continued generation of electricity with minimal carbon emissions will contribute to Canada's efforts to reduce its overall greenhouse gas emissions, aligning with broader climate mitigation objectives.

5.8 Uncertainty in the Tier 1 Assessment

The Tier 1 assessment presented a qualitative assessment to identify Project interactions that are not bounded by previous operational conditions (with 6 operating units) or previous assessments. The qualitative assessment utilizes the description of Project activities that are planned to occur during PNGS Units 1-4 decommissioning, and during PNGS Units 5-8 refurbishment until the end of 2037 followed by continued operations. The Tier 1 assessment is based on understanding of Project activities as the Project is defined for the purposes of the PERA. The Project activities may evolve over time as the Project moves forward. As such, where there is uncertainty in the approach for executing activities, conservative or bounding assumptions have been made to capture the range of potential future effects, to ensure that effects are not underestimated.

5.9 Summary of Tier 1 Assessment

PNGS Units 1-4 Decommissioning and PNGS Units 5-8 Refurbishment activities were evaluated for interactions with environmental pathways and receptors in the Tier 1 assessment. **Table 5-24** provides a summary of the interactions and the findings (i.e., screening) from this assessment to determine which interactions require further quantitative assessment in the Tier 2 assessment. In general, interactions associated with project activities during the Stabilization and SWS phases of PNGS Units 1-4 are considered sufficiently bounded by the findings of the 2017 Safe Storage PEA and the 2022 PEA Addendum, or the 2022 PN ERA, and do not warrant further evaluation. Although PNGS Units 1-4 risk reduction and removal activities and dismantling and demolition activities were not evaluated in previous assessments, these activities are not anticipated to result in significant environmental effects as construction best practices and applicable mitigation plans will be implemented to minimize impacts. Environmental effects of future dismantle and demolish activities planned to start in 2050 will be detailed in subsequent DDP updates and PERA updates when more detailed work packages are defined.

Refurbishment activities for PNGS Units 5-8 including islanding the unit, refurbishment of reactor auxiliary systems, and other upgrades were determined in the Tier 1 assessment to have negligible interaction with the environment. Some activities, such as the construction of the PCSS, are evaluated as part of a separate PERA. Other activities, such and defueling and dewatering the units, are bounded by the 2017 Safe Storage PEA and the 2022 PEA Addendum, while still others, such as management of tritium emissions, are bounded by the 2022 PN ERA. These activities bounded by other assessments do not warrant further evaluation in the Tier 2 assessment.

The construction and operation of the DWI, along with associated activities such as the potential addition of a dock, potential infill, and material disposal, are major activities that were not part of the project scope at the time of earlier assessments. The Tier 1 screening identified that the impacts resulting from these activities—particularly in relation to the atmospheric environment, and aquatic ecosystems—are not bounded by earlier assessments or previous conditions (with 6 operating units). Specifically, aquatic habitat impacts from the DWI construction and thermal effects, especially as they relate to climate change, require further assessment. As such, these project-environment interactions will be comprehensively evaluated in the Tier 2 quantitative assessment to characterize the potential for adverse impacts.

While no specific COPCs were identified for the atmospheric or surface water environment, general feedback from the WTFNs on other PERAs has indicated that it would be beneficial to include a Harvester receptor in the PERA. As such, assessment of a Harvester is considered in the Tier 2 quantitative assessment.

Following refurbishment, PNGS Units 5-8 will operate in a manner consistent with previous operations (6 operating units). Consequently, the potential effects of the Continued Operation Phase on most environmental components are similar to those previously assessed in the 2022 PN ERA for 6 operating units and comparable to current conditions with 4 units (PNGS Units 5-8) operating.

As shown in the conceptual timeline for the Project in **Figure 1-2**, there will be activities occurring in one phase that occur at the same time as another phase. For example, while PNGS Units 1 and 4 are in the Stabilization Phase and PNGS Units 2 and are in SWS phase, risk reduction and removal activities will also occur, along with PNGS Units 5-8 refurbishment activities, and construction of the DWI. The air and noise modelling, and surface water quality modelling considered a bounding condition when activities are occurring at the same time, where relevant to the assessment.

In summary, the following potential effects are evaluated in the Tier 2 assessment:

- Inclusion of a Harvester in the Predictive Human Health Risk Assessment (HHRA) to assess radiation dose from exposure to releases of tritium, carbon-14, and beta/gamma to the atmospheric and surface water environment.
- Evaluation of aquatic habitat loss and potential changes to habitat quality in the Predictive Ecological Risk Assessment (EcoRA) from construction of the proposed DWI and associated nearshore modifications.
- Evaluation of changes to thermal effects on indicator fish species in the Predictive EcoRA due to operation of the DWI, with consideration of long-term climate change.

Table 5-24: Project-Environment Interactions Carried Forward into the Tier 2 Assessment

Project Activities	Atmospheric Environment (Air/Noise)	Surface Water Environment - Flow	Surface Water Environment - Quality	Hydrogeological and Geological Environment – Groundwater Flow	Hydrogeological and Geological Environment – Groundwater Quality	Hydrogeological and Geological Environment - Soils	Radiation and Radioactivity (Gamma Radiation Field)	Terrestrial Environment	Aquatic Environment
PNGS Units 1-4 Decommissioning									
PNGS Units 1 and 4 Stabilization	-	-	-	-	-	-	-	-	-
PNGS Units 1- 4 Storage with Surveillance	✓*	-	✓*	-	-	-	-	-	-
Risk Reduction and Removal Activities	-	-	-	-	-	-	-	-	-
Dismantle/Demolish	-	-	-	-	-	-	-	-	-
PNGS Units 5-8 Refurbishment									
Preparation for Refurbishment									
• Procurement and Mobilization of Equipment and Components	-	-	-	-	-	-	-	-	-
• Relocation/Removal/Construction of Buildings, Structures, and Equipment	-	-	-	-	-	-	-	-	-
• Construction of PCSS and SB #5	-	-	-	-	-	-	-	-	-
• Defuel and Dewater	-	-	-	-	-	-	-	-	-
• Islanding the Unit	-	-	-	-	-	-	-	-	-
• Management of Heavy Water	-	-	-	-	-	-	-	-	-
• Construction of DWI	-	-	-	-	-	-	-	-	✓*
Refurbishment									
• Replacement of Reactor Components	-	-	-	-	-	-	-	-	-
• Removal and Replacement of Steam Generators	-	-	-	-	-	-	-	-	-
• Operation of DWI	-	-	-	-	-	-	-	-	✓*
• Refurbishment of Other Plant Systems	-	-	-	-	-	-	-	-	-
• Waste Management and Transportation	-	-	-	-	-	-	-	-	-
• Refuelling and Restarting	-	-	-	-	-	-	-	-	-

Project Activities	Atmospheric Environment (Air/Noise)	Surface Water Environment - Flow	Surface Water Environment - Quality	Hydrogeological and Geological Environment – Groundwater Flow	Hydrogeological and Geological Environment – Groundwater Quality	Hydrogeological and Geological Environment - Soils	Radiation and Radioactivity (Gamma Radiation Field)	Terrestrial Environment	Aquatic Environment
Continued Operations									
• Operation of PNGS Units 5-8	-	-	-	-	-	-	-	-	✓*
• Waste Management and Transportation	-	-	-	-	-	-	-	-	-

Notes:

"✓*" Indicates an interaction between the Project activity and the environmental component that is not bounded by previous operational conditions (with 6 operating units) or previous assessments as determined by the Tier 1 assessment. These interactions will be evaluated quantitatively in the Tier 2 assessment.

"-" Indicates conclusions of the Tier 1 assessment show that no Tier 2 assessment is needed.

6.0 Tier 2 Quantitative Assessment

6.1 Predictive Human Health Risk Assessment (HHRA)

The conclusion from the Tier 1 assessment identified that the Harvester receptor should be evaluated in the Tier 2 assessment and that the radiological emissions to air and water assessed in the 2017 Safe Storage PEA continue to remain a conservative estimate of radiological emissions based on current Project planning for PNGS Units 1-4 Stabilization and SWS, as well as for PNGS Units 5-8 Refurbishment.

This predictive HHRA provides the conservative radiation dose for the Harvester, and also an updated dose prediction for the other human receptors evaluated in the 2017 Safe Storage PEA based on more recent meteorological data from PN (2017 to 2021).

6.1.1 Problem Formulation

The problem formulation provides the objectives, goals, framework and methodology for the PERA and consists of identifying the relevant components for the predictive human health risk assessment (HHRA). These components include the identification of human receptors that may be potentially present in or around the PN Site, the COPCs that may occur in or around the PN Site; and the exposure pathways by which receptors could be exposed to contaminants in the environment. A conceptual site model illustrates all of these relationships, based on the results of the problem formulation.

6.1.1.1 Health and Safety of On-site Workers

On-site workers, contractors, and visitors are potentially exposed to environmental contaminants, both chemical and radiological, but these exposures are considered and controlled through OPG's Health and Safety Management System and the Radiation Protection Program, and are not considered in this HHRA, as discussed below.

OPG's Health and Safety Management System Program is designed to ensure the protection of employees, contractors and visiting members of the public. The program outlines a systems approach used to manage risks associated with activities, products and services of OPG Nuclear operations. Contractors are required to maintain a level of safety equivalent to OPG staff while working at an OPG workplace. Work at OPG is subject to safe work planning requirements where safety hazards are identified and mitigating measures are communicated through Pre-Job Briefings. Routine or planned work is governed by approved procedures and operating instructions.

During PNGS Units 1-4 Decommissioning, PNGS Units 5-8 Refurbishment and Continued Operations, OPG's Radiation Protection Program will be applied. The Radiation Protection Program is designed to ensure that doses for employees, contractors and visiting members of the public are below regulatory limits, and As Low As Reasonably Achievable (ALARA), social and economic factors being taken into account. Employee radiation doses are monitored to ensure

they do not exceed exposure control levels that are below regulatory limits. Doses to visitors and contractors are also monitored. Only workers classified as Nuclear Energy Workers (NEWs) may perform radioactive work. Visitors are limited to non-radioactive work and escorted by a qualified NEW. Personal information is collected for the purposes of dose reporting.

As human exposures on the site are kept within safe levels through the Health and Safety Management System Program and Radiation Protection Program, on-site receptors are not addressed further in the predictive HHRA. The focus of the HHRA is on off-site members of the public.

6.1.1.2 Receptor Selection and Characterization

The focus of the HHRA is on potential risk to off-site members of the public. Off-site members of the public are potentially exposed to low levels of airborne or waterborne contaminants. The most-affected off-site members of the public are defined as potential "critical groups" or "representative persons". Potential critical groups are defined through site specific surveys and their doses are calculated in the OPG EMP Reports.

As a result of engagement activities to support the DNNP PERA, representatives from the WTFNs expressed interest in including a new human receptor in the DNNP PERA that aims to better represent the lifestyle characteristics of an Indigenous person who may work and/or live near the DN site and may also harvest traditional foods (animals and plants that are fished, hunted, or gathered from the land and consumed as food (HC, 2018) in the local area. This receptor is assumed to hunt, fish and consume traditional foods in a greater proportion compared to the lifestyles represented by the list of receptors currently characterized in OPG's existing EMPs and ERAs. The new receptor was identified in the DNNP PERA as a "Harvester". The Harvester was developed using publicly available information to form the basis of the diet and exposure characteristics; it is expected that this receptor will be further refined over time through the site-specific survey as well as ongoing engagement activities with Indigenous Nations and communities. The same diet and exposure characteristics from the DNNP PERA have been implemented in this PERA. The development of the Harvester receptor's diet is described in more detail in **Section 6.1.2.4.1**.

The potential critical group receptors used for the predictive HHRA (shown in **Figure 1-3**) are consistent with OPG's annual PN EMP reports and the 2022 PN ERA (Ecometrix, 2023a), with the addition of the Harvester receptor included as part of this PERA. The seven potential critical groups are:

- The **C2** potential critical group consists of inhabitants at a correctional institute located approximately 3 km NNE of the PN Site. The C2 group obtains drinking water from the Ajax Water Supply Plant (WSP) and does not consume locally grown fruits or vegetables. The C2 resident is conservatively assumed to be at this location 100 percent of the time over the full year.

- The **Industrial/Commercial** potential critical group consists of adult workers whose work location is close to the nuclear site. Members of this group are typically at this location about 23% of the time. They consume water from the Ajax WSP. The closest location for this group is about 1 km NNE of the site.

- The **Urban Residents** potential critical group consists of Pickering and Ajax area residents which surround the PN Site (e.g., Fairport, Fairport Beach, Rosebank, Liverpool, Pickering Village, etc.). The members of this group mostly consume water from the Ajax WSP and also consume a diet composed in part of locally grown produce and some locally caught fish. Members of this potential critical group are also externally exposed to beach sand at local beaches (Beachpoint Promenade, Beachfront Park, or Squires Beach). Surveys indicate that 16% of urban residents work within 5 km of the PN site.

- The **Farm** potential critical group consists of residents of agricultural farms (but not dairy farms) within a 10 km radius of the PN Site. Members of this group obtain most of their water supply from wells but also a portion from the Ajax WSP. Members of this potential critical group consume locally grown produce and animal products, as well as locally caught fish. They are also externally exposed to beach sand at local beaches (Beachpoint Promenade, Beachfront Park, or Squires Beach).

- The **Dairy Farm** potential critical group consists of residents of dairy farms within a 20 km radius of the PN Site. This group obtains most of their water supply from local wells. They also consume locally grown fruit and vegetables and locally produced animal products, including fresh cow's milk. Members of this potential critical group are also externally exposed to beach sand at local beaches (Beachpoint Promenade, Beachfront Park, or Squires Beach).

- The **Sport Fisher** potential critical group is comprised of non-commercial individuals fishing near the PN site outfalls, 0.5 km south of the PN site. Members of this group were conservatively assumed to obtain their entire amount of fish for consumption from the vicinity of the PN site and spend 1% of their time at the outfall location where atmospheric exposure occurs.

- The **Harvester** potential critical group represents local residents in the vicinity of PN site who hunt, fish and regularly consume traditional foods harvested from the areas around the PN site. The Harvester is meant to represent Indigenous local residents, some of whom may also work near the PN site. It is conservatively assumed that 16% of the adult Harvesters work within 5 km of the PN site (consistent with the assumption from the EMP for the urban resident). Doses to this portion of adults are adjusted using the Industrial/Commercial worker dose to account for the increased exposure while at work due to proximity of this worker location to the station. The Harvester potential critical group has been conservatively placed in the WNW wind sector, approximately 1 km from the PN site, consistent with the urban resident location.

The predictive HHRA and receptor selection does not directly address sensitive or vulnerable populations; however, demonstration that the receptors evaluated are well below the public dose limit would indicate that sensitive or vulnerable human health groups are considered protected as well. The public dose limit of 1 mSv/a is protective of all ages and populations.

6.1.1.3 Selection of Chemical, Radiological, and Other Stressors

The only COPCs that were identified for further assessment were radionuclides including tritium and C-14 in air, and tritium, C-14, and beta/gamma in water. Airborne particulates, noble gases and radioiodine emissions were not assessed as their sources terms are either minor or will be eliminated as described in 2017 Safe Storage PEA (Golder and Ecometrix, 2017).

Non-radionuclide COPCs or physical stressors were not identified for the Tier 2 assessment.

6.1.1.4 Selection of Exposure Pathways

For exposure of human receptors to radiological COPCs, the relevant exposure pathways include:

- Air inhalation and external exposure to air;
- Ingestion of water (WSP, wells) and external exposure to water (lakes, WSPs, wells)
- Incidental ingestion of soil and beach sand;
- External exposure to soil and beach sand; and,
- Ingestion of food (homegrown and traditional foods).

The complete exposure pathways, as defined in OPG's EMP, for exposure of relevant receptors to radiological COPCs are summarized in **Table 6-1**, with the addition of the Harvester receptor.

Table 6-1: Complete Exposure Pathways for Receptors for Exposure to Radiological COPCs

Receptor	Exposure Pathway	Environmental Media
Sport Fisher	Inhalation	Air
	Ingestion	Aquatic animals (fish)
	External	Air
Industrial/Commercial Worker[(1)]	Inhalation	Air
	Ingestion	Water (Ajax WSP) Soil (incidental) Sediment (incidental) Aquatic animals (fish) Terrestrial plants (local produce) Terrestrial animals (local produce)
	External	Air Water

Receptor	Exposure Pathway	Environmental Media
		Soil Sediment
Urban Resident	Inhalation	Air
	Ingestion	Water (Ajax WSP) Soil (incidental) Sediment (incidental) Aquatic animals (fish) Terrestrial plants (local produce) Terrestrial animals (local produce)
	External	Air Water Soil Sediment
Correctional Institution	Inhalation	Air
	Ingestion	Water (Ajax WSP) Soil (incidental)
	External	Air Water Soil
Farm	Inhalation	Air
	Ingestion	Water (Wells/Ajax WSP) Soil (incidental) Sediment (incidental) Terrestrial plants (locally grown) Terrestrial animals (locally grown)
	External	Air Water Soil Sediment
Dairy Farm	Inhalation	Air
	Ingestion	Water (Wells) Soil (incidental) Sediment (incidental) Terrestrial plants (locally grown) Terrestrial animals (locally grown)
	External	Air Water Soil Sediment
Harvester	Inhalation	Air
	Ingestion	Water (Ajax WSP) Soil (incidental) Sediment (incidental)

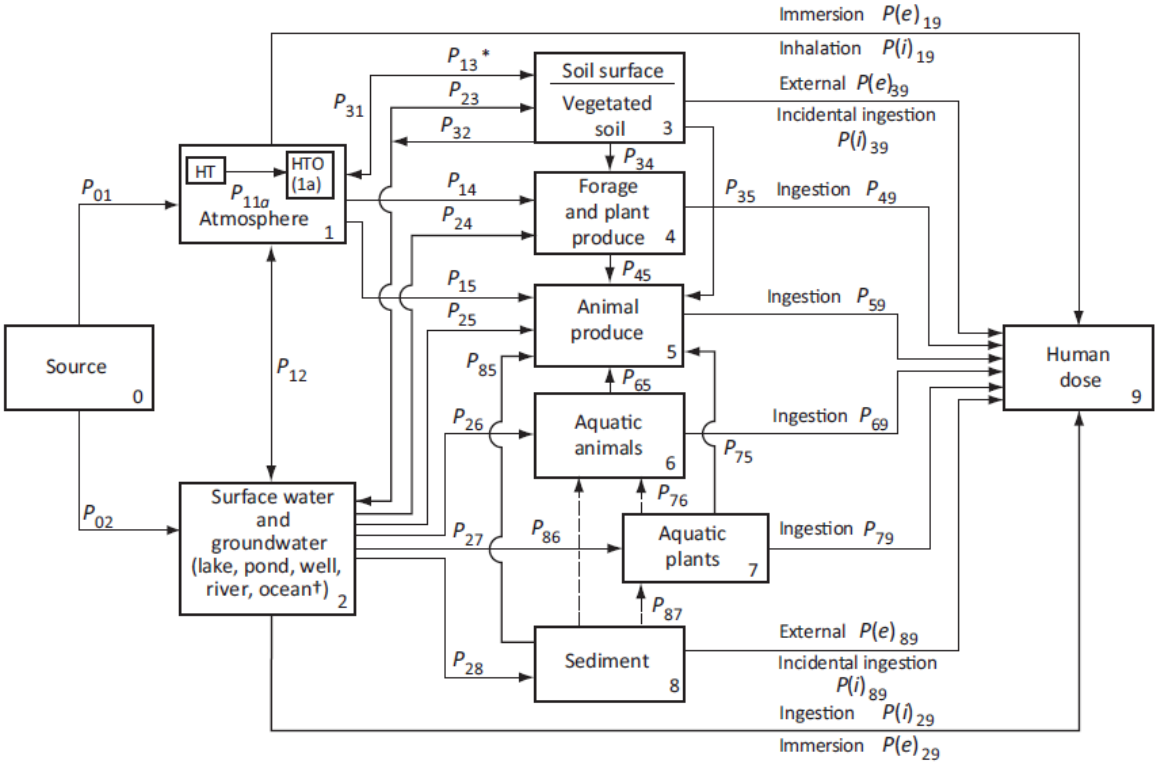
Receptor	Exposure Pathway	Environmental Media
		Aquatic animals (fish) Terrestrial plants (traditional foods) Terrestrial animals (traditional foods)
	External	Air Water Soil Sediment

Note:
(1) A small fraction of Industrial/Commercial workers are also Urban Residents; therefore, the ingestion pathway is included to account for when the worker is at home.

6.1.1.5 Human Health Conceptual Site Model

The human health conceptual site model (CSM) illustrates how human receptors are exposed to COPCs. It represents the relationship between the source and receptors by identifying the source of contaminants, receptor locations and the exposure pathways to be considered in the assessment for each receptor. Exposure pathways represent the various routes by which radionuclides and/or chemicals may enter the body of the receptor, or (for radionuclides) how they may exert effects from outside the body.

A generic CSM, taken from CSA N288.1:20 (CSA, 2020) is shown in **Figure 6-1**, and is applied to human receptors around the PN Site. This represents the exposure pathways from source to receptor. It is appropriate for radiological and non-radiological COPCs, except that, for non-radionuclides, external and immersion pathways are represented by dermal exposure. No non-radiological COPCs were identified for the predictive HHRA.



*Includes transfer factors P_{13area}, P_{13mass}, and P_{13spw}.
†For ocean water, pathways P_{23}, P_{24}, P_{25}, and $P(i)_{29}$ are not used.
Notes:
(1) *The broken lines represent pathways that are not explicitly considered in the model or are considered only in special circumstances.*
(2) *Factors include multiple transfers where appropriate.*

Figure 6-1: Conceptual Model for Human Receptors (CSA, 2020)

6.1.1.6 Uncertainties in the Problem Formulation

The data used in the predictive HHRA problem formulation were concluded to be of adequate quality and quantity to support the objectives of the PERA.

The development of the Harvester receptor relied on generic, non-site-specific information relating to Indigenous diet composition and traditional food consumption rates from the Ontario First Nations Food, Nutrition and Environment Study (FNFNES) published by Chan et al. (2014). The data used were for the ecozone that includes the PN site, but were not specific to the PN local area. Though the data used are considered adequate for modelling exposures to local Indigenous receptors via the traditional food consumption pathway, the inclusion of site-specific consumption information would reduce uncertainties in future risk assessments relating to the Harvester receptor's exposure to COPCs in local traditional foods.

6.1.2 Exposure Assessment

The exposure assessment includes identification of exposure locations and exposure factors for each receptor, explanation of dispersion models, and presentation of modelled exposure concentrations and doses. Uncertainties are also discussed. This section presents the information used in the IMPACT model, and the model results.

6.1.2.1 Exposure Locations

An exposure location is the place where the receptor comes into contact with a COPC. The relevant human receptors are the potential critical groups defined in OPG's annual PN EMP reports and the 2022 PN ERA (Ecometrix, 2023a), with the addition of the Harvester receptor included as part of this PERA. The exposure locations of the human receptors have been conservatively located at the nearest/most exposed location for each potential critical group. **Figure 1-3** presents the locations of these receptors which are generally consistent with the 2022 PN ERA (Ecometrix, 2023a), with the exception of the new Harvester receptor conservatively located at the same location as the urban resident location, which consistently receives the highest radionuclide concentrations in air due to the predominant wind direction to the west-north-west (WNW) basing on the annual average meteorology data from 2017 to 2021.

6.1.2.2 Exposure Duration and Frequency

Consistent with the 2017 Safe Storage PEA and the 2022 PN ERA, full-time residency was assumed for the correctional institute resident, Urban Resident, Farm resident, and Dairy Farm resident. For the Industrial/Commercial worker and the Sport Fisher a residency of 23% and 1% was assumed, respectively. A small fraction (16%) of urban residents living near the PN Site also work within 5 km of the PN Generating Station; therefore, they receive a portion of their dose while at home and a portion of their dose while at work. The same fraction (16%) as the urban resident was assumed for the harvester. A small fraction (8%) of workers in the Industrial/Commercial critical group also live near the PN Site; therefore, they receive a portion of their dose while at work and a portion of their dose while at home. The dose received by these critical groups has been adjusted to account for these lifestyles, consistent with the annual EMP reports.

6.1.2.3 Exposure and Dose Calculations

Radiological dose calculations follow the equations presented in CSA N288.1:20 (CSA, 2020) which are not reproduced in this report. IMPACT 5.5.2 is used for the dose calculations and is consistent with the method of dose calculation described in CSA N288.1:20 (CSA, 2020).

As no non-radiological contaminants of potential concern were carried forward from the Tier 1 screening assessment, non-radiological exposure and dose calculations were not required.

6.1.2.4 Exposure Factors

For the radiological dose calculations, the exposure factors (e.g., intake rates, occupancy and shielding factors, etc.) are generally those in CSA N288.1:20 (CSA, 2020). The intake rates for

ingestion and inhalation are the central or mean intake rates provided in CSA N288.1:20 (CSA, 2020), with the exception of the drinking water intake rate for a 1-year old infant. The drinking water intake rate for the 1-year old infant was adjusted from the default value in CSA N288.1 based on guidance in Clause 6.15.3.2, since the PN infant is assumed to drink only cow's milk (and not water and infant formula) (OPG, 2024e). **Table 6-2** summarizes the exposure factors used in the radiological dose calculations that were used for the 2023 EMP report (OPG, 2024g).

Table 6-2: Human Exposure Factors for Radiological Dose Calculations

Exposure Factor	Units[4]	Infant 1 year	Child 10 year	Adult
Inhalation rate	m^3/a	1830	5660	5950
Inhalation occupancy factor	unitless	1.0	1.0	1.0
Incidental soil ingestion rates	g dw/d	0.061	0.055	0.004
Incidental ingestion of sediment	g dw/d	0.061	0.055	0.004
Drinking water intake rate[1] Aquatic animal intake rate[2] Terrestrial animal intake rates Terrestrial plant intake rates	L/a kg/a kg/a kg/a	0 1.68 262.3 144.5	151.1 4.82 286.3 331.1	379.6 6.86 255.5 440
Outdoor occupancy factor	unitless	0.2	0.2	0.2
Indoor plume shielding factor (skin dose and pure beta emitters)	unitless	1.0	1.0	1.0
Indoor groundshine shielding factor (gamma emitters)[3]	unitless	0.5	0.5	0.5
Groundshine shielding factor (uneven surface shielding)	unitless	0.2	0.2	0.2
Beach swim occupancy factor	unitless	0	0.014	0.014
Bathing occupancy factor	unitless	0.014	0.014	0.014
Pool swim occupancy factor (WSP fill)	unitless	0	0.028	0.028
Pool swim occupancy factor (Well water fill)	unitless	0	0.014	0.014
Skin area	m^2	0.72	1.46	2.19
Dilution factor (DF) for shoreline sediments	unitless	1.0	1.0	1.0
Shore Width factor (lake)	unitless	0.3	0.3	0.3
Shoreline occupancy factor	unitless	0.02	0.02	0.02
No. days/a soil ingested	d/a	135	135	135
No. days/a sediment ingested	d/a	45	45	45

Notes:
(1) The infant is conservatively assessed as consuming only cow's milk which is included in the terrestrial animal intake rate.
(2) Excludes shellfish due to fresh water environment at PN. Shellfish are a marine environment food product.
(3) For effective and skin dose. For essentially pure beta emitters, this shielding factor is zero.
(4) dw used in specification of units indicates dry weight.
Sources: (COG, 2013; CSA, 2020)

6.1.2.4.1 Harvester Diet

Neither a site-specific traditional foods diet study nor a WTFNs Indigenous Knowledge study is available currently as inputs to this PERA; therefore, publicly available information is used to form the initial basis of the diet for the Harvester. The assumptions for the Harvester diet identified below are consistent with those assumed in the DNNP PERA prepared in 2024.

The diet for the Harvester is composed of traditional foods as well as store-bought foods. Traditional foods are animals and plants that are fished, hunted, or gathered from the land and consumed as food (HC, 2018). The discussion below is focused on the traditional foods component of the diet. The main source of information for ingestion rates and food components of traditional foods is the First Nations Food, Nutrition and Environment Study (FNFNES) for Ontario (Chan et al., 2014). Part of the FNFNES included household interviews to collect information on foods consumed. The FNFNES is the most recent publicly available study from Ontario on traditional food consumption rates. The FNFNES is split up by the three ecozones in Ontario: Boreal Shield, Hudson Plains, and Mixedwood Plains.

The Harvester receptor utilizes, as an initial set of characteristics, available information from the FNFNES for the Mixedwood Plains (Chan et al., 2014). The PN site is located in the Mixedwood Plains ecozone which consists of gentle rolling hills and lowlands, bounded by the Great Lakes. Data were collected from 18 First Nations communities in Ontario, with 4 located in the Mixedwood Plains. Based on the data review, the following key assumptions and methodologies for traditional foods consumption were applied:

- The consumption rates for the average consumer were assumed to be representative of the Harvester receptor. Harvesting of traditional food was conservatively assumed to occur near the PN site.
- The consumption rates were assumed to be the average of those reported for male and female, for each traditional food category (fish, game meat, game organs, birds, and plants). The consumption rate for fish, game meat and organs is higher for males, and the consumption rate for birds and plants is higher for females; therefore, the gender-averaged consumption rates were considered appropriate.
- The traditional food categories are broken down into more detailed categories which include: fish, large mammal, small mammal, mammal organs, riparian bird, terrestrial bird, and plants.
- Based on knowledge of ecological receptors that exist near the PN site, a representative traditional food was then selected to represent the traditional foods identified in each traditional food category (**Table 6-4**).
    - Walleye was selected as the representative fish since it was more commonly observed in Lake Ontario near the PN site than yellow perch or smallmouth bass.

- Deer was selected as the representative large mammal. While deer are uncommon at the PN site, deer potentially breed near the PN site and are present year-round. The closest Wildlife Management Unit in Ontario that allows sustainable harvest of moose is approximately 100 km away. While members of Indigenous peoples may harvest moose, deer is more common near the PN site.

- Canada goose was selected as the representative terrestrial bird. While both Canada goose and wild turkey have been observed on the PN site, Canada goose was selected since it was identified as a species that has been injured/killed through vehicle collisions; indicating it is likely more common than wild turkeys near the PN site.

The consumption rates used for each food category for the Harvester receptor are shown in **Table 6-3** in the column "proportioned consumption rate". The specific food items that are modelled to represent each food category are shown in **Table 6-4** in the column "representative traditional food for modelling". It is understood that this is the starting point to represent the Harvester diet for assessment purposes and these characteristics will be refined over time and updated in future ERAs.

Table 6-3: Proportioned Consumption Rates for Harvester Modelling

Traditional Food Category	Table 10a FNFNES (g/d)[(b)]	Table 10e FNFNES (g/d) [(b)]	% of Traditional Food Category	Traditional Food Category (Detailed)	% of Traditional Food Category (Detailed)	Proportioned Consumption Rate (g/d)	% of Traditional Food Diet
Total Traditional Food[(a)]	**41.81**	**-**	**-**	**-**	**-**	**41.81**	**100%**
Fish	**10.35**	**-**	**100%**	**-**	**-**	**-**	**-**
Walleye/pickerel	-	4.92	34%	Fish	100%	10.35	25%
Yellow perch	-	6.69	46%				
Smallmouth bass	-	2.99	20%				
Game meat	**8.21**	**-**	**100%**	**-**	**-**	**-**	**-**
Deer	-	6.71	55%	Large mammal	83%	6.85	16%
Moose	-	3.51	29%				
Rabbit	-	2.03	17%	Small mammal	17%	1.36	3%
Game organs	**4.88**	**-**	**100%**	**-**	**-**	**-**	**-**
Moose liver	-	3.69	56%	Mammal organs	100%	4.88	12%
Deer liver	-	2.9	44%				
Birds	**2.28**	**-**	**100%**	**-**	**-**	**-**	**-**
Wild turkey	-	0.97	30%	Terrestrial bird	69%	1.58	4%
Canada Goose	-	1.27	39%				
Ducks	-	1.00	31%	Riparian bird	31%	0.7	2%
Plants	**16.09**	**-**	**100%**	**-**	**-**	**-**	**-**
Corn	-	3.79	37%	Terrestrial Plants	100%	16.09	38%
Squash	-	2.30	22%				
Beans	-	4.28	41%				

Notes:

[(a)] The sum of the consumption rates for the Traditional Food Categories is used rather than the total reported in Table 10e in the FNFNES (Chan et al., 2014). This is considered conservative.

[(b)] Represents an average consumer, average of men and women surveyed in the FNFNES (Chan et al., 2014).

Table 6-4: Traditional Foods Selected for Harvester Modelling

Traditional Food Category	Traditional Food Category (Detailed)	Traditional Foods Most Consumed (from FNFNES)	Representative Traditional Food for Modelling
Fish	Fish	Walleye/pickerel	Walleye
		Yellow perch	
		Smallmouth bass	
Game	Large mammal	Deer	Deer
		Moose	
	Small mammal	Rabbit	Rabbit
Game Organs	Mammal organs	Deer organs	Deer organs
		Moose organs	
Birds	Riparian bird	Duck	Mallard
	Terrestrial bird	Canada goose	Canada goose
		Wild turkey	
Plants	Plants	Corn	Vegetables
		Squash	
		Beans	

The adult, child, and infant age groups were assessed for the Harvester in this PERA. The Harvester was conservatively assumed to be located at the same location as the Urban Resident potential critical group characterized in OPG's existing EMP and ERAs, since the Urban Resident location consistently has the highest radionuclide concentrations in air due to the predominant wind direction to the west-north-west (WNW), based on the annual average meteorology data from 2017 to 2021. The Harvester was conservatively assumed to reside at the most exposed residential location 100% of the time, except for those who may work near the PN site.

The Harvester is assumed to obtain the majority of drinking water from the Ajax WSP, which is the same as the Urban Resident. Other water for drinking, bathing, and gardening is obtained from both shallow and deep wells. Consistent with existing EMP assumptions, a small fraction of adult residents living near PN also work within 5 km of the PN site. Therefore, it is assumed that 16% of the Harvester residents are also Industrial/Commercial workers, spending 23% of their time at work and 77% of the time at home.

The traditional food items consumed by the Harvester adult were conservatively assumed to be taken from locations close to the residence, and fish were obtained from the outfall location at PN, which is representative of fish in Lake Ontario in the initial mixing zone.

The local food intake fractions implemented in the IMPACT model for the Harvester receptor are shown in **Table 6-5**. The local food intake fraction was calculated as follows:

Local Intake Fraction (%) = (Annual Intake of a Traditional Food Type / Total Annual Food Intake in the Corresponding Food Category) * Local Harvest Fraction * 100%

where,

Annual Intake of a Traditional Food Type = annual ingestion rate of a traditional food type consumed within each relevant food category (kg/yr).

Total Annual Food Intake in the Corresponding Food Category = annual ingestion rate for traditional + store bought food in the food category (kg/yr).

Local Harvest Fraction = the fraction of the traditional food type that is harvested locally (unitless). For this assessment a local harvest fraction of 1 has been conservatively assumed for all food types.

As discussed above, the annual traditional food intake of the Harvester adult was developed utilizing the available information from the FNFNES for the Mixedwood Plains ecozone, while the total annual food intake of a Harvester adult is taken from Table G.9b in CSA N288.1:20 (CSA, 2020), split up by food categories. The data in CSA N288.1:20 (CSA, 2020) are based on a survey conducted jointly by Health Canada and Statistics Canada in 2004 (Statistics Canada, 2004). They represent the average dietary intakes for the different age groups of the general population, with diets adjusted to reference energy intakes. The FNFNES report only provides traditional food intake rates for adults. The traditional food intake rates for the Harvester 10y-child and Harvester 1y-infant were determined based on the ratio of the consumption rates by food item for the 10y-child/adult and 1y-infant/adult, as provided in CSA N288.1:20; Table G.9b (CSA, 2020).

Table 6-5: Local Food Intake Fractions for Harvester for IMPACT Model – Adult, Child, and Infant

Food Category in IMPACT Model	Traditional Food Type (Detailed)	Representative Traditional Food for Modelling	Adult			Child-10y			Infant-1y		
			Total Diet by Food Category (kg fw/a) [a]	Proportioned Traditional Foods Consumption Rate (kg fw/a) [b]	Local Intake Fraction [c]	Total Diet by Food Category (kg fw/a) [a]	Proportioned Traditional Foods Consumption Rate (kg fw/a) [d]	Local Intake Fraction [c]	Total Diet by Food Category (kg fw/a) [a]	Proportioned Traditional Foods Consumption Rate (kg fw/a) [d]	Local Intake Fraction [c]
Aquatic Animals	Fish	Walleye	6.86	3.78	55.07%	4.82	2.65	55.03%	1.68	0.92	55.02%
Terrestrial Animals	Large mammal	Deer	253.9	2.50	0.98%	286.25	0.70	0.24%	262.28	0.20	0.08%
	Small mammal	Rabbit		0.50	0.20%		0.14	0.05%		0.05	0.02%
	Mammal organs	Deer organs		1.78	0.70%		1.24	0.43%		0.45	0.17%
	Riparian bird	Mallard		0.26	0.10%		0.14	0.05%		0.05	0.02%
	Terrestrial bird	Canada goose		0.58	0.23%		0.32	0.11%		0.12	0.05%
Terrestrial Plants	Plants	Vegetables	441.7	5.87	1.33%	331.09	3.19	0.96%	144.54	0.12	0.08%

Notes:

[a] Total diet by food category is from CSA N288.1:20; Table G.9b.

[b] Proportioned consumption rate in Table 6-3 with unit conversion from g/d to kg/a.

[c] Local Intake Fraction represents the percentage of food in the food category that is obtained from traditional foods near the PN site. The remaining portion of the diet is obtained from store bought foods which are not impacted by releases from the PN site. Local Intake Fraction = (annual food Intake of a traditional food type / total annual food intake in the corresponding food category) * local harvest fraction * 100%. Note, local harvest fraction is conservatively assumed to be 1 indicating that all traditional food to be consumed is obtained locally.

[d] Consumption rates for 10y-child and 1y-infant were proportioned from adult based on the consumption rate ratio of 10y-child/adult and 1y-infant/adult by food item as provided in CSA N288.1:20; Table G.9b.

6.1.2.5 Dispersion Models

An environmental transport and pathways model, IMPACT Version 5.5.2, is used to evaluate the transport and effects of contaminants on the local environment including human and ecological receptors. IMPACT is a modelling tool, created, maintained and supported by Ecometrix Incorporated (Ecometrix). The IMPACT model is a customizable tool that allows the user to assess the transport and fate of COPCs through a user-specified environment. The model is used to estimate concentrations of COPCs in a range of media.

IMPACT Version 5.5.2 is consistent with the equations outlined in CSA N288.1:20 (CSA, 2020) for pathways analysis and for calculation of radiological dose to humans. IMPACT uses specific activity models for tritium and C-14 as per CSA N288.1:20 (CSA, 2020) and as recommended by CSA N288.6:22 (CSA, 2022a). The formation of organically bound tritium (OBT) in plants and animals from HT (elemental tritium) and HTO (tritium oxide) is accounted for in the specific activity model for tritium and the dose from OBT is included in the dose results in IMPACT.

The model was originally developed in 1993 as part of research projects funded by the Atomic Energy Control Board (now the CNSC). Since the initial development, the IMPACT software package has been continuously revised to improve the interface, and the integration with various operating systems, and most importantly to embody an up-to-date understanding of the fate, transport and dose impacts of radionuclides released to the environment. There are several built in libraries for parameters relevant to atmospheric dispersion, groundwater transport, soil processes, and water-sediment interaction. IMPACT can be used in various applications such as: human and ecological risk assessment; environmental impact assessments; pathways analysis; food-chain modeling; cumulative impacts; and derived release limits. IMPACT is able to model doses from emissions that can otherwise not be calculated from environmental measurements, including doses for future timeframes.

IMPACT was verified and validated in accordance with CSA N286.7-99. It has also been audited against CSA N286.7-16 and meets these requirements. The IMPACT code is verified in the IMPACT 5.5.2 – Tool Qualification Report (Ecometrix, 2023e).

IMPACT is designed to model routine, continuous and low-level emissions, and models transport of radionuclides through equilibrium partitioning. Time-dependent equations are used to model the soil compartment. Initial concentrations in environmental media (background concentrations) are not accounted for in the analysis. Thus, doses calculated from facility emissions are incremental doses.

The IMPACT code models radionuclides cycling through the biosphere from both airborne and waterborne effluent releases.

A hydrodynamic surface water model (RMA10) was used in the 2017 Safe Storage PEA to predict changes to lake currents, sediment transport and water temperature in Lake Ontario during the previous operational conditions (for 6 operating units) and SWS. The surface water model provides plume concentration factors at selected receptor locations that were used to predict

concentration of COPCs at these locations. The concentrations of COPCs were used as inputs (dictator sources) to the IMPACT model to calculate radiological doses to human receptors identified in **Section 6.1.1.2**.

6.1.2.6 Exposure Point Concentrations and Doses

Exposure point concentrations are based on the predicted airborne and waterborne emissions from the PN Generating Station for the conservative estimate of emissions (during the SWS Phase).

Concentration factors (**Table 5-15**) from the surface water model for a number of receptor locations were applied to the predicted waterborne emissions. Assumption in 2017 Safe Storage PEA is that 50,000 m^3/day of cooling water from the RBSW is released with the RLWMS stream via the PNGS Units 5-8 outfall during the SWS Phase. Since based on current Project planning, additional dilution will be available from CCW pumps, the concentration factors from the 2017 Safe Storage PEA are a conservative representation of conditions during PNGS Units1-4 decommissioning and PNGS Units 5-8 refurbishment, see **Table 5-14**, to determine the exposure point concentrations for tritium, carbon-14, and gross beta/gamma. Cs-134 is considered appropriate to represent gross beta/gamma in water based on the most recent derived release limit calculations (OPG, 2024e).

The exposure point concentrations for waterborne radionuclides used as input (dictator sources) to the IMPACT model for dose calculations are presented in **Table 6-6**. For receptors exposed to the beach (e.g., urban resident), the average of the water concentrations from Squires Beach, Liverpool Beach, and Frenchman's Bay Inlet were used.

Table 6-6: Exposure Point Concentrations for Water Contaminants of Potential Concern Used in Dose Calculations

Receptor Locations	Unit	Tritium	Carbon-14	Beta/Gamma
RBSW Discharge	Bq/L	7.00E+03	3.00E-01	5.00E-01
Sport Fisher	Bq/L	8.78E+00	3.76E-04	6.27E-04
Squires Beach	Bq/L	5.24E+00	2.24E-04	3.74E-04
Liverpool Beach	Bq/L	2.53E+00	1.08E-04	1.81E-04
Frenchman's Bay Inlet	Bq/L	2.21E+00	9.47E-05	1.58E-04
Average Beach	Bq/L	3.33E+00	1.43E-04	2.38E-04
Ajax Intake	Bq/L	7.08E-01	3.03E-05	5.06E-05

Notes:
(a) Gross beta / gamma is represented in IMPACT by cesium-134 (In the 2017 Safe Storage PEA Cs-137 was used based on the 2016 PN DRLs).
(b) "Average Beach" is the average of Squires Beach, Liverpool Beach, and Frenchman's Bay (inlet)
(c) This table is reproduced from Table 6-3 in the 2017 Safe Storage PEA

For airborne emissions, predicted releases of tritium and carbon-14 were presented in **Table 4-2** in the 2017 Safe Storage PEA and reconfirmed in the 2022 PEA Addendum (Table 5.1). Airborne

particulates, noble gases and radioiodine emissions were not assessed as their sources terms are either minor or will be eliminated as described in 2017 Safe Storage PEA (Golder and Ecometrix, 2017).

The Gaussian plume model described in CSA N288.1:20 (CSA, 2020) and implemented in IMPACT was used to estimate COPC concentrations in air at receptor locations. The PN Generating Station has multiple sources of airborne releases; however, two virtual sources were modelled, one in the midpoint of PNGS Units 1-4 and one in the midpoint of PNGS Units 5-8, consistent with the 2017 Safe Storage PEA. This simplification has been shown to have little effect on modelled concentrations at receptor locations 1 km or more off-site (COG, 2019). The air concentrations at human receptor locations including the Harvester are shown in **Table 6-7**.

Meteorological data used in the atmospheric dispersion model were average triple joint frequencies of wind direction, speed and stability class compiled from hourly data collected over the 5-year period 2017 to 2021 from the on-site Pickering meteorological tower at the 10 m elevation.

Table 6-7: Air Concentrations at Human Receptor Locations

Receptor Locations	Unit	Carbon-14	Tritium
Farm	Bq/m^3	6.96E-05	4.14E-01
Dairy Farm	Bq/m^3	2.96E-05	1.77E-01
Sport Fisher	Bq/m^3	6.24E-03	3.78E+01
Urban Resident WNW	Bq/m^3	7.62E-04	4.47E+00
Harvester	Bq/m^3	8.80E-04	5.16E+00
Industrial/Commercial	Bq/m^3	1.25E-03	7.39E+00
C2	Bq/m^3	2.22E-04	1.33E+00

The resulting dose to the harvester as well as the other human receptors based on the exposure point concentrations for air and water presented above are summarized in **Table 6-8**. The dose breakdown by pathway is presented for each potential critical group in **Appendix C**.

Table 6-8: Total Dose to Human Receptors for Conservative Estimate

Receptors	Adult Total Dose (µSv/a)	Child 10 yr old Total Dose (µSv/a)	Infant 1 yr old Total Dose (µSv/a)
Farm	1.95E-01	1.79E-01	1.35E-01
Dairy Farm	8.63E-02	9.11E-02	9.54E-02
Sport Fisher	3.51E-01	2.32E-01	1.19E-01
Urban Resident+	8.75E-01	9.99E-01	6.99E-01
Harvester+	1.17E+00	**1.24E+00**	8.26E-01
Industrial Commercial+	3.58E-01	N/A	N/A
C2	2.42E-01	2.84E-01	N/A

Note:
"+" indicates that a portion of the adults work near PN site and for modelling purposes are attributed the Industrial Commercial receptor dose while at work.
Bold indicates the receptor with the highest dose.

6.1.2.7 Uncertainties in the Exposure Assessment

The IMPACT model was used to predict dose to identified human receptors from the Project. This model is a steady state model; however, it includes time dependent equations to account for buildup in soil from deposition, for all radionuclides released.

It includes progeny buildup through use of progeny inclusive dose coefficients. Forty years of ingrowth was used to develop the progeny inclusive external dose coefficients for sediment and soil for each radionuclide, which is the timeframe used in CSA N288.1:20 for development of progeny-inclusive dose coefficients for sediment and soil exposure (CSA, 2020). This is a reasonable assumption considering the timeline for the Project. Exposure factors were based on best-available information from literature with preference for exposure factors identified in CSA N288.1:20 (CSA, 2020).

Uncertainties in predictions of media concentrations arise from inherent uncertainty in the air model in IMPACT. The model reports an annual average concentration, and typically over-predicts this concentration by a factor of 1.5. Uncertainty in the air predictions arises from the following assumptions made in the model:

- The activity in the plume has a normal distribution in the vertical plane.
- The effects of building-induced turbulence on the effective release height and plume spread have been generalized, while data suggest that effects of building wakes vary substantially depending upon the geometry of the buildings and their orientation with respect to wind direction.
- A given set of meteorological and release conditions leads to a unique modelled air concentration, whereas in reality measured concentrations can vary by a factor of 2 under identical conditions.

The dispersion model is valid for distances up to approximately 20 km. CSA N288.1:20 indicates that at distances greater than 20 km the dispersion model should be used with caution because at distances greater than 20 km the assumption of steady state meteorological conditions implicit in the model becomes less valid (CSA, 2020).

The concentration factors developed through the hydrodynamic surface water model were used to predict water concentrations used in the dose calculations. The uncertainties associated with the hydrodynamic model were outlined in the 2017 Safe Storage PEA. The main uncertainties include:

- The data available for use in developing the model has limits, as is common for any field data, and the limits are discussed in Section A.2 of the 2017 Safe Storage PEA.

- The calibration of the model indicates acceptable results however, as with all surface water models there is not perfect reproducibility of actual conditions. A qualitative assessment of the model indicates that the model predicts alongshore current well, but is less accurate for offshore components of flow. Alongshore current is considered the primary factor affecting thermal and contaminant plumes and therefore this was not considered a significant limitation. A quantitative calibration and verification was conducted and indicates the model generally meets industry standard acceptance criteria with a higher degree of uncertainty for offshore flow (see Section A.3 of the 2017 Safe Storage PEA).

- The sensitivity of the model predictions with respect to the concentration factors is addressed by providing predictions for extended simulation periods. These simulation periods are expected to encompass all of the expected variations and combinations of current speed, current direction, duration of current event, and water temperature. Appendix A of the 2017 Safe Storage PEA provides the average, minimum, maximum, and standard deviation for concentration factors at each of the receptor locations. Use of the average concentration factor was considered suitable for long term predictions. However, it is expected that use of the maximum concentration factors would still result in acceptable dose calculations as the doses calculated are orders of magnitude below the acceptable limits.

The uncertainties from the exposure assessment also include uncertainty in the exposure factors selected. In general, exposure factors used to characterize human receptors were selected from published sources such as CSA N288.1:20 (CSA, 2020), or site-specific values were identified based on OPG's site-specific surveys.

For the Harvester, there is uncertainty related to the dietary assumptions. Publicly available information from FNFNES (Chan et al., 2014) was used; however, the intent is to refine the assumptions through site specific surveys, if possible. In lieu of site specific information for the Harvester, various conservative assumptions were made. The Harvester was conservatively assumed to live at the Urban Resident location that has the highest air concentrations for a residential location and harvest traditional foods nearby. The Harvester was also conservatively assumed to remain at this location 100% of their time, except for those who may work within 5 km of the PN site, which is also considered in the total dose.

Considering the conservatism described above in the air and surface water model, and in the exposure factors, it is reasonable to conclude that doses arising from Project activities have not been underestimated.

6.1.3 Toxicity Assessment

The public dose limit for radiation protection is 1 mSv/a, as described in the Radiation Protection Regulations under the Nuclear Safety and Control Act. This limit is defined as an incremental dose. It is set at a fraction of natural background exposure to radiation. Public doses

arising from licensed facilities are compared to the public dose limit. Doses above the public dose limit are considered unacceptable.

6.1.4 Risk Characterization

The total radiation doses to human receptors are compared to the regulatory public dose limit of 1 mSv/a. A summary of the total dose for each human receptor and age group and comparison against the dose limit is provided in **Table 6-9**.

The total dose to the Harvester is 1.24 µSv/a for the Harvester (child). The dose estimate for the Harvester is 0.12% of the regulatory public dose limit (1,000 µSv/a). The highest dose for other receptors is 0.999 µSv/a to an urban resident (child), which is 0.10% of the regulatory public dose limit. Demonstrating that these human receptor groups are protected implies that other receptor groups near the PN site with anticipated lower exposure are also protected.

Since the dose estimates are a small fraction of the incremental public dose limit of 1 mSv/a, and of the natural background dose of 1.4 mSv/a, no health effects are anticipated due to exposure of potential critical groups to radiological releases from the PN Site.

Table 6-9: Summary of Total Dose to Human Receptors and Comparison to Dose Limit

Human Receptor	Adult		Child-10y		Infant-1y	
	Total Dose (µSv/a)	% of Dose Limit	Total Dose (µSv/a)	% of Dose Limit	Total Dose (µSv/a)	% of Dose Limit
Farm	1.95E-01	0.02%	1.79E-01	0.02%	1.35E-01	0.01%
Dairy Farm	8.63E-02	0.01%	9.11E-02	0.01%	9.54E-02	0.01%
Sport Fisher	3.51E-01	0.04%	2.32E-01	0.02%	1.19E-01	0.01%
Urban Resident+	8.75E-01	0.09%	9.99E-01	0.10%	6.99E-01	0.07%
Harvester+	1.17E+00	0.12%	**1.24E+00**	0.12%	8.26E-01	0.08%
Industrial Commercial+	3.58E-01	0.04%	N/A	N/A	N/A	N/A
C2	2.42E-01	0.02%	2.84E-01	0.03%	N/A	N/A

Note:
"+" indicates that a portion of the adults work near PN site and for modelling purposes are attributed the Industrial Commercial receptor dose while at work.
The bold value indicates the highest total dose for human receptor due to radiological releases to air and water
NA: not applicable.
There are no exceedances of the public dose limit of 1,000 µSv/a.

6.1.4.1 Uncertainty in Risk Characterization

The uncertainties in the characterization of risk consist of those identified in the exposure assessment (**Section 6.1.2.7**) and toxicity assessment (**Section 6.1.3**), since these two assessments are the inputs to the risk characterization.

The uncertainties from the exposure assessment include model uncertainty and uncertainty in the exposure factors selected. There were no major uncertainties identified from the toxicity assessment. In general, in each step of the predictive HHRA, conservative assumptions were used to address uncertainties or realistic assumptions were made. The use of this approach is far more likely to overestimate potential risk than to underestimate it.

6.2 Predictive Ecological Risk Assessment (EcoRA)

6.2.1 Problem Formulation

The Tier 1 assessment concluded that further evaluations of aquatic habitat impacts and thermal effects should be conducted in the Tier 2 assessment. All other Project-related interactions with the environmental components examined in the Tier 1 assessment were deemed to pose negligible risks, or to be sufficiently mitigated, or they are bounded by previously completed risk assessments or current operating conditions.

The predictive EcoRA provides a detailed assessment of aquatic impacts and thermal effects with respect to aquatic receptors in Lake Ontario.

6.2.1.1 Receptor Selection and Characterization

In total, 30 fish species were considered for the Tier 2 assessment. Most species (26) were found during the 2024 Deepwater and/or Nearshore fish community studies. The remaining 4 fish species (Emerald Shiner, American Eel, Smallmouth Bass, and Northern Pike) were not found during either of the 2024 fish community studies but have been included in the assessment due to their known presence near PN and inclusion as ecological receptors in the 2022 PN ERA.

As of late February 2025, two fish species, Lake Sturgeon and American Eel are notably species at risk (SAR). Lake Sturgeon (Great Lakes – Upper St. Lawrence populations) are currently not on Schedule 1 of the *Species at Risk Act* (SARA) but are under consideration for addition. They are listed as "Threatened" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Provincially, Lake Sturgeon are listed as "Endangered" on the Species at Risk in Ontario (SARO) list (O. Reg. 230/08). Similarly, the American Eel is also currently not listed on Schedule 1 of the SARA but is under consideration for addition. They are classified as "Threatened" by COSEWIC. In Ontario, the provincial government has listed American Eel as "Endangered" on the SARO list.

6.2.1.2 Assessment and Measurement Endpoints

Assessment endpoints are explicit expressions of the environmental values that are to be protected. Assessment endpoints should include the ecological receptor and the attribute of the receptor that is to be protected (e.g., abundance or viability of populations) (FCSAP, 2012). Measurement endpoints are conceptually related to assessment endpoints and are defined as the tools that are used to measure exposure of or effects on each ecological receptor. Based on these measures, a potential for effect on the attribute of an assessment endpoint can be inferred. Measurement endpoints are the foundation for the lines of evidence (LOE) that are used to estimate risks to ecological receptors (FCSAP, 2012).

For most ecological receptors, the assessment endpoint is the viability of the population. This implies that very localized areas of effect on individuals may be tolerated, based on minimal expected effect at the population level. For SAR, the assessment endpoint is individual health, recognizing that each individual is important to the population.

The assessment and measurement endpoints considered for the predictive EcoRA are presented in **Table 6-10**.

Table 6-10: Assessment Endpoints, Measurement Endpoints, and Lines of Evidence

Organism Class	Level of Protection	Protection Goal	Assessment Endpoint	Lines of Evidence (LOE)	
				Line of Evidence	Use of Measurement Endpoints for Specific LOEs
Bottom Feeding Fish	Population or Individual for SAR (*i.e., Lake Sturgeon, American Eel*)	*Population:* Maintenance of bottom feeding fish populations in Lake Ontario as source of food for piscivorous fish and wildlife. *Species at Risk:* Survival of individual organisms.	Viability of bottom-feeding fish populations.	Habitat Loss	Evaluate the amount, quality and type of habitat lost in relation to the habitat needs of each species and life stage.
				Water Temperature	Comparison of water temperature metrics with thermal benchmarks for effect on each species and life stage. TRV
Pelagic Fish	Population	Maintenance of pelagic fish populations in Lake Ontario as source of food for piscivorous fish and wildlife.	Viability of pelagic fish populations.	Habitat Loss	Evaluate the amount, quality and type of habitat lost in relation to the habitat needs of each species and life stage.
				Water Temperature	Comparison of water temperature metrics with thermal benchmarks for effect on each species and life stage.

6.2.1.3 Selection of Chemical, Radiological and Other Stressors

Based on the results of the Tier 1 assessment, aquatic habitat loss and thermal effects are the only stressors retained for the Tier 2 ecological assessment. No chemical or radiological COPCs were identified based on the Tier 1 assessment.

6.2.1.4 Selection of Exposure Pathways

As no chemical or radiological COPCs were identified for the Tier 2 assessment, an assessment of selected exposure pathways is not warranted.

6.2.1.5 Ecological Health Conceptual Site Model

The ecological health conceptual site model (CSM) illustrates how receptors are exposed to the physical stressors retained for the Tier 2 EcoRA. It identifies the source of the stressors, main exposure effects and receptor responses to be considered in each assessment. The CSM for the predictive EcoRA is illustrated in **Figure 6-2**.

6.2.1.6 Uncertainties in the Problem Formulation

In general, the data used in the predictive EcoRA Problem Formulation were concluded to be of adequate quality and quantity to support the objectives of the PERA. The EcoRA Problem Formulation is based on the current understanding of the existing aquatic habitat and thermal conditions in Lake Ontario. Aquatic monitoring studies were completed based on project planning for the DWI at the time when the studies were designed. Further data collection is planned for 2025 for the aquatic environment to accommodate the changes to DWI planning since the studies were initiated (see **Section 4.3.1.4**). Additional aquatic environment studies will help to further reduce uncertainties associated with the proposed changes to the DWI and will further characterize the aquatic habitat for the predictive EcoRA. The results of these studies will be incorporated in the next revision of the PERA.

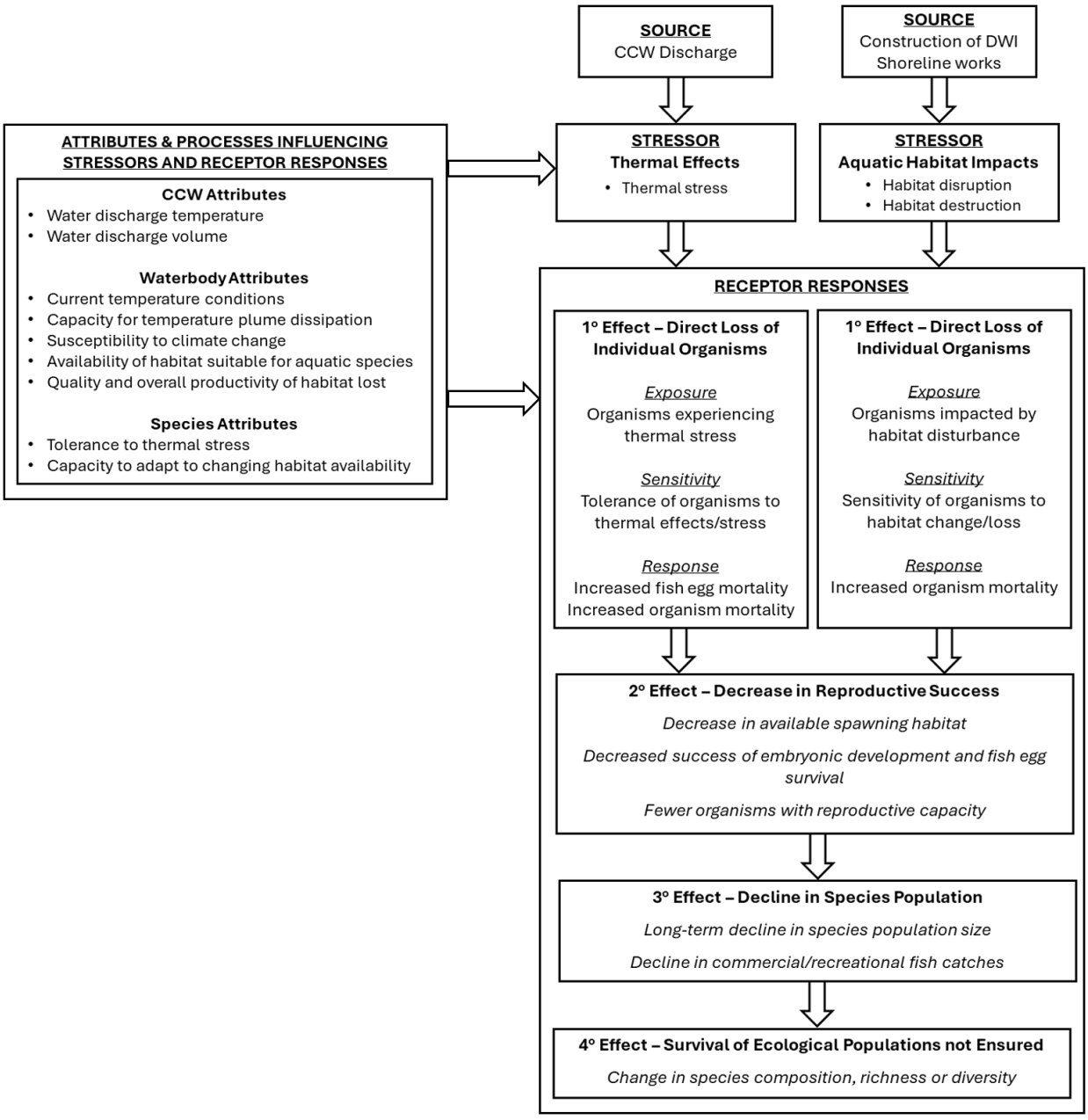


Figure 6-2: Ecological Health CSM for Physical Stressors in the Tier 2 Assessment

6.2.2 Aquatic Habitat Impacts

The aquatic environment around PNGS will primarily be impacted during PNGS Units 5-8 Refurbishment. Specifically, refurbishment activities expected to contribute to these impacts include the construction of a DWI intake cap, a bored tunnel running several metres below the lake bed from the intake cap to PNGS, and modifications to the shoreline. The proposed shoreline works include the potential installation of a dock, lake infilling and armoring, construction of a cut-off wall in the forebay and a bridge over the current CCW outfall for PNGS Units 5-8, and managed disposal of spoils including soil, sand, and rock. Currently, the intake cap is planned for 1.5 km offshore, south of the existing forebay. An alternate location, is under consideration for the intake cap, sited at 1.25 km offshore. The areal footprint of the construction activities associated with these modifications is depicted in **Figure 6-3.** This section integrates results of the 2024 environmental studies conducted within these areas to estimate the potential impacts of refurbishment activities on fish habitat.

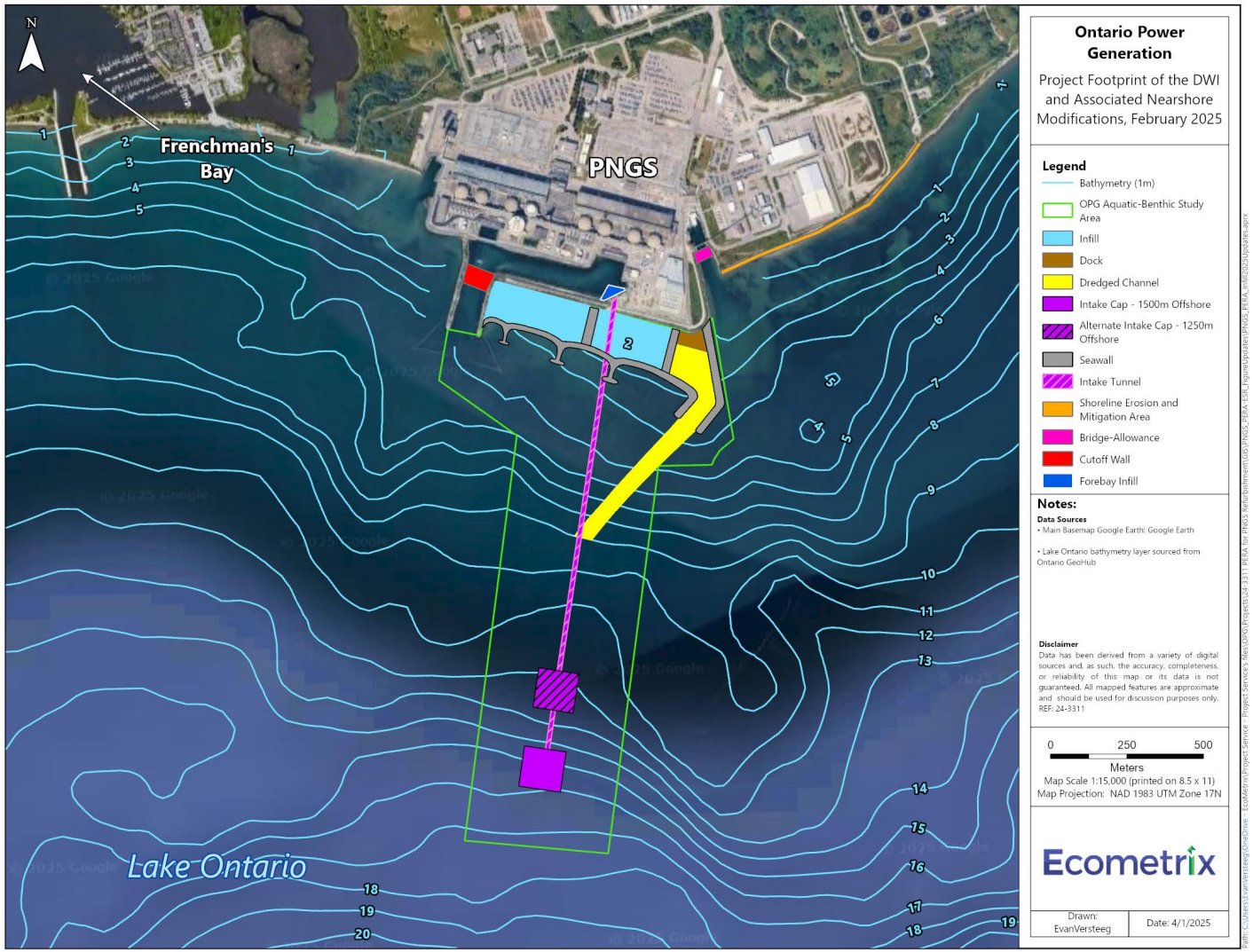


Figure 6-3: Project Footprint of Potential DWI and Nearshore Modifications Associated with the PNGS Refurbishment

6.2.2.1 Characterization of Habitat disturbance associated with Project activities

The proposed DWI and associated nearshore structures are located within Lake Ontario, which is home to a rich diversity of aquatic life, including over 90 fish species. As part of the 2024 environmental studies, the Deepwater Fish Community Study documented 13 fish species in the area proposed for the DWI intake cap, while the Nearshore Fish Community Study recorded 20 species across the shoreline erosion modification and west infill study areas. Thus, construction works associated with project activities could lead to direct fish mortality, which is prohibited under subsection 34.4(1) of the Fisheries Act. Additionally, harmful alteration, disruption or destruction of fish habitat (HADD) may result from physical changes or habitat loss due to infrastructure development. As such, a FAA application will be submitted to the DFO for the proposed activities.

In order to assess the potential impacts on aquatic habitat, the areal extent (in hectares) of the footprint associated with each project activity was estimated, along with the corresponding type of disturbance (i.e., alteration, disruption, or destruction, as defined in the Fisheries Act). These estimates are presented in **Table 6-11**. It is important to note that these numbers are preliminary estimates based on conceptual designs and are subject to change as the design progresses.

Table 6-11: Estimated Areal Footprint and Disturbance Type for Construction Activities in the DWI and Nearshore Study Areas

Component	Disturbance Type	Structure / Area	Approximate Aquatic Habitat Use	Estimated Area Disturbed (ha)
DWI	Destruction	DWI (1500m)[a]	Transient foraging and seasonal movement corridor	1.00
		Alternate DWI Location (1250m)[a]		1.0
	Disruption	Intake Cap	Transient foraging and seasonal movement - progressing to potential spawning and sheltering habitat with decreasing depth	2.5
Erosion Control	Destruction	Shoreline Erosion Mitigation Area	Foraging habitat and physical shelter for small fish species	4.00
Bridge allowance	Alteration	Bridge over outfall	Foraging habitat and physical shelter for small fish species	0.3
	Destruction	Bridge over outfall	Foraging habitat and physical shelter for small fish species	0.3
Forebay	Destruction	Cut-off wall	Transient foraging and sheltering habitat when FDS is not in place.	0.50
	Destruction	Forebay Infill	Transient foraging and sheltering habitat when FDS is not in place.	0.20
Dock	Alteration	Dredged Dock Channel	Transient foraging and seasonal movement – progressing to potential spawning and sheltering habitat with decreasing depth	4.5
	Destruction	Dock	Nearshore spawning habitat	0.47
Seawall	Destruction	Seawall	Nearshore spawning habitat. Presence of macrophytes may	3.92

Component	Disturbance Type	Structure / Area	Approximate Aquatic Habitat Use	Estimated Area Disturbed (ha)
			provide spawning options specifically for phytophiles.	
West Infill	Destruction	West Infill Area	Potential nearshore spawning habitat. Presence of macrophytes may provide spawning options specifically for phytophiles. Foraging habitat and physical shelter for small fish species	7.12

Notes: a – Based on 100x100m intake cap structure.

6.2.2.2 Habitat Suitability Assessment – Exposure Assessment

To assess the suitability of the DWI and nearshore study areas for fish captured during the 2024 Deepwater and Nearshore fish community studies, species-specific habitat preferences from the literature were compared against the existing habitat conditions identified through the 2024 aquatic habitat studies. Additionally, although Emerald Shiner, American Eel, Smallmouth Bass, and Northern Pike were not captured in the 2024 fish community studies, these species were included in this assessment due to their known presence in the area and status as ecological receptors in the 2022 PN ERA.

The habitat preferences for spawning and adult life stages were evaluated separately, as these can differ significantly. The habitat preferences for the adult stage of the species considered, including substrate type, water temperature, depth, and other relevant requirements, are presented in **Table 6-12**. Similarly, habitat preferences for spawning are listed in **Table 6-13**. The substrate types identified in the DWI and nearshore study areas, as well as their associated proportions, are presented in **Table 6-14**. Substrate was considered one of the most important physical habitat parameters because many species require specific substrates for spawning because eggs adhere to them. The depth ranges considered were 12-18 m for the DWI, as used in the Deepwater Fish Community Study, and 0-3 m for the nearshore study areas, as determined by the Nearshore Fish Community Study.

Table 6-12: Catch and/or Life History Information of Adult Fish Species Near PNGS

Catch Location[1,2]	Catch Season[3]	Species	Scientific Name	Thermal Regime[5]	Catch / Life History Information[1,4]			
					Trophic Class	Catch Depth(s) (m)	Temperature(s) (°C) at Catch Depth(s)	Substrate at Catch Location(s)
Nearshore	SP	Atlantic Salmon	*Salmo salar*	Cold	invertivore/carnivore	2.4	14.3	sand/cobble/boulder
Nearshore	SU,FA	Brown Bullhead	*Ameiurus nebulosus*	Warm	invertivore/herbivore/carnivore	1.9-3.4	20.3-22.9	sand/gravel/boulder
Nearshore	FA	Common Carp	*Cyprinus carpio*	Warm	invertivore/detritivore	3.4	21.2	sand/cobble/boulder
Nearshore	SP	Chinook Salmon	*Oncorhynchus tshawytscha*	Cold	invertivore/carnivore	1.6	15.0	sand/cobble/boulder
Nearshore	SU	Coho Salmon	*Oncorhynchus kisutch*	Cold	invertivore/carnivore	2	22.8	sand/gravel/boulder
Nearshore	FA	Largemouth Bass	*Micropterus nigricans*	Warm	invertivore/carnivore	4.9	21	sand/gravel/boulder
Nearshore	FA	Log Perch	*Percina caprodes*	Warm	invertivore	4.9	21	sand/gravel/boulder
Nearshore	FA	Longnose Sucker	*Catostomus catostomus*	Cold	invertivore	3.8-4.9	21-21.1	sand/gravel/boulder
Nearshore	FA	Pumpkinseed	*Lepomis gibbosus*	Warm	invertivore/carnivore	3.4	20.6	sand/cobble/boulder
Nearshore	SP	Rainbow Trout	*Oncorhynchus mykiss*	Cold	invertivore/carnivore	4.1	11.1	sand/gravel/cobble/boulder
Nearshore	FA	Sculpin	*Cottus bairdii*	Cold	invertivore	3.8	21	sand/gravel/boulder
Nearshore	SP	Threespine Stickleback	*Gasterosteus aculeatus*	Cold	invertivore	1.6	15	sand/cobble/boulder
Nearshore	FA	Yellow Perch	*Perca flavescens*	Cold	invertivore/carnivore	3.8	21	sand/gravel/boulder
Nearshore/Offshore	SP,SU,FA	Brown Trout	*Salmo trutta*	Cold	invertivore/carnivore	5.5 - 14	11.4-21.1	sand/gravel/cobble/boulder
Nearshore/Offshore	SP,SU	Alewife	*Alosa pseudoharengus*	Cold	planktivore	1.6 - 19.7	8.6-27	sand/gravel/cobble/boulder
Nearshore/Offshore	FA	Rainbow Smelt	*Osmerus mordax*	Cold	invertivore/carnivore	2.8 - 19.7	9.7-22.6	sand/gravel/cobble/boulder
Nearshore/Offshore	SU,FA	Rock Bass	*Ambloplites rupestris*	Cold	invertivore/carnivore	2.8 - 17	8.6-22.6	sand/gravel/cobble/boulder
Nearshore/Offshore	SP,SU,FA	Round Goby	*Neogobius melanostomus*	Cold	invertivore	1.6 - 17	10.4-27	sand/gravel/cobble/boulder
Nearshore/Offshore	FA	Walleye	*Sander vitreus*	Cold	invertivore/carnivore	5.5 - 17	9.9-21.1	sand/gravel/cobble/boulder
Nearshore/Offshore	SU,FA	White Sucker	*Catostomus commersonii*	Cold	invertivore/detritivore	3.4 - 15	9.9-21.2	gravel/cobble/boulder
Offshore	SU	Burbot	*Lota lota*	Cold	invertivore/carnivore	15	10.8	gravel/cobble/boulder
Offshore	FA	Lake Sturgeon	*Acipenser fulvescens*	Cool	invertivore/herbivore	19.5	10.7	gravel/cobble/boulder
Offshore	SP,SU,FA	Lake Trout	*Salvelinus namaycush*	Cold	invertivore/carnivore	11 - 21.1	8.6-10.6	sand/gravel/cobble/boulder
Offshore	FA	Lake Whitefish	*Coregonus clupeaformis*	Cold	invertivore/carnivore	11 - 21.1	8.6-10.7	sand/gravel/cobble/boulder
Offshore	SP,SU,FA	Round Whitefish	*Prosopium cylindraceum*	Cold	invertivore/carnivore	11 - 19.7	9.7-10	sand/gravel/cobble/boulder
Offshore	FA	Sea Lamprey	*Petromyzon marinus*	Cold	herbivore/detritivore (carnivore)	13.1	8.6	sand/gravel/cobble
NA[2]	-	American Eel	*Anguilla rostrata*	Cool	invertivore/carnivore	<15[3]	-	mud/sand/cobble/boulder[3]
NA[2]	-	Emerald Shiner	*Notropis atherinoides*	Cold	planktivore	Shallow[3]	-	sand/gravel[3]
NA[2]	-	Northern Pike	*Esox lucius*	Cold	carnivore	Shallow[3]	-	mud/sand/gravel - Weeds[3]
NA[2]	-	Smallmouth Bass	*Micropterus dolomieu*	Cold	invertivore/carnivore	5-7[3]	-	rocky and sandy areas[3]

1 - Catch information was collected during the 2024 field study at PNGS
2 - Fish species with "NA" catch location are included in this table despite not being caught in the 2024 field study. These were chosen due either to their ecological importance, SAR status, and/or due to their known prevalence in the area
3 - SP = Spring, SU = Summer, FA = Fall
4 - In the case of fish species that were not caught in 2024, known depth and substrate preferences were used in the place of catch information.
5 – Fish species are grouped into thermal guilds based on their thermal optimums. In general, cold-water species prefer waters <19°C in the summer, cool-water fish prefer between 19-25°C, and warm-water fish prefer waters >25°C (Coker et al., 2001; Magnuson et al., 1979).
Notes: Fish life history data was collected from Scott and Crossman (1973), and from the Ontario Fishes Life History database (Eakins, R.J. 2024, accessed February 2025).

Table 6-13: Habitat Preferences of Fish Species Based on Spawning Requirements

Catch Location[1,2]	Catch Season[3]	Species	Scientific Name	Thermal Regime	Adult Fish Spawning Preferences				
					Preferred Spawning Substrate	Spawning Guild	Preferred Spawning Temperature (°C)	Preferred Spawning Depth (m)	Preferred Spawning Season
Nearshore	SP	Atlantic Salmon	*Salmo salar*	Cold	NA (Riverine)	Lithophils	6-10	NA (Riverine)	Oct-Nov
Nearshore	SU,FA	Brown Bullhead	*Ameiurus nebulosus*	Warm	Cobble/Boulder	Speleophils	14-25	Shallow	May-June
Nearshore	FA	Common Carp	*Cyprinus carpio*	Warm	vegetation, logs, etc	Phyto-lithophils	17-26	Shallow	May-Aug
Nearshore	SP	Chinook Salmon	*Oncorhynchus tshawytscha*	Cold	NA (Riverine)	Lithophils	5.5-14.5	NA (Riverine)	Sept-Oct
Nearshore	SU	Coho Salmon	*Oncorhynchus kisutch*	Cold	NA (Riverine)	Lithophils	4-8	NA (Riverine)	Oct-Nov
Nearshore	FA	Largemouth Bass	*Micropterus nigricans*	Warm	Sand/Gravel	Polyphils	15-21	<6	May-June
Nearshore	FA	Log Perch	*Percina caprodes*	Warm	Sand/Gravel/Cobble	Lithophils	10-18	Shallow	May-June
Nearshore	FA	Longnose Sucker	*Catostomus catostomus*	Cold	Gravel/Cobble	Litho-pelagophils	5-15	<1-2	April-June
Nearshore	FA	Pumpkinseed	*Lepomis gibbosus*	Warm	Sand/Gravel	Polyphils	17-26	Shallow	May-Aug
Nearshore	SP	Rainbow Trout	*Oncorhynchus mykiss*	Cold	NA (Riverine)	Lithophils	4-10	NA (Riverine)	March-May
Nearshore	FA	Sculpin	*Cottus bairdii*	Cold	Cobble/Boulder	Speleophils	5-16	Shallow	April-May
Nearshore	SP	Threespine Stickleback	*Gasterosteus aculeatus*	Cold	vegetation	Ariadnophils	10-22	Shallow	May-July
Nearshore	FA	Yellow Perch	*Perca flavescens*	Cold	vegetation/logs, etc	Phyto-lithophils	6-12	Shallow	April-May
Nearshore/Offshore	SP,SU,FA	Brown Trout	*Salmo trutta*	Cold	NA (Riverine)	Lithophils	6-9	NA (Riverine)	Oct-Nov
Nearshore/Offshore	SP,SU	Alewife	*Alosa pseudoharengus*	Cold	vegetation/logs, etc	Phyto-lithophils	13-21	Shallow	June-Aug
Nearshore/Offshore	FA	Rainbow Smelt	*Osmerus mordax*	Cold	Sand/Gravel	Litho-pelagophils	4.5-11	Shallow	March-April
Nearshore/Offshore	SU,FA	Rock Bass	*Ambloplites rupestris*	Cold	Veg, Gravel/Cobble/Boulder	Polyphils	16-23	Shallow	May-June
Nearshore/Offshore	SP,SU,FA	Round Goby	*Neogobius melanostomus*	Cold	Sand/Gravel/Cobble	Lithophils	9-26	Shallow	May-July
Nearshore/Offshore	FA	Walleye	*Sander vitreus*	Cold	Gravel/Cobble/Boulder	Litho-pelagophils	4-11	Shallow	April-June
Nearshore/Offshore	SU,FA	White Sucker	*Catostomus commersonii*	Cold	Gravel/Cobble	Litho-pelagophils	10-20	Shallow	April-June
Offshore	SU	Burbot	*Lota lota*	Cold	Sand/Gravel	Litho-pelagophils	1-4	Shallow	Jan-March
Offshore	FA	Lake Sturgeon	*Acipenser fulvescens*	Cool	Gravel/Cobble/Boulder	Litho-pelagophils	11-18	1-8m	May-June
Offshore	SP,SU,FA	Lake Trout	*Salvelinus namaycush*	Cold	Gravel/Cobble/Boulder	Lithophils	9-14	Wide Range, prefer shoals	Sept-Nov
Offshore	FA	Lake Whitefish	*Coregonus clupeaformis*	Cold	Gravel/Cobble/Boulder	Litho-pelagophils		5-10	Oct-Dec
Offshore	SP,SU,FA	Round Whitefish	*Prosopium cylindraceum*	Cold	Sand/Gravel/Cobble	Lithophils	2-4.5	1-2m	Nov-Dec
Offshore	FA	Sea Lamprey	*Petromyzon marinus*	Cold	NA (Riverine)	Lithophils	11-24	NA (Riverine)	May-June
NA[2]	-	American Eel	*Anguilla rostrata*	Cool	NA (Marine)	Litho-pelagophils	17	NA (Marine)	Feb-March
NA[2]	-	Emerald Shiner	*Notropis atherinoides*	Cold	Sand/Gravel	Pelagophils	20-24	Shallow	June-Aug
NA[2]	-	Northern Pike	*Esox lucius*	Cold	vegetation	Phytophils	4-11	Shallow	March-May
NA[2]	-	Smallmouth Bass	*Micropterus dolomieu*	Cold	Sand/Gravel	Polyphils	13-20	Shallow	May-June

1 - Catch information was collected during the 2024 field study at PNGS

2 - Fish species with "NA" catch location are included in this table despite not being caught in the 2024 field study. These were chosen due either to their ecological importance, SAR status, and/or due to their known prevalence in the area

3 - SP = Spring, SU = Summer, FA = Fall

Notes: Fish life history data was collected from Scott and Crossman (1973), and from the Ontario Fishes Life History database (Eakins, R.J. 2024, accessed February 2025).

Table 6-14: Substrate Types and Proportions in the Footprint of the DWI and Nearshore modifications

Components	Disturbance Type	Structure / Area	Total Area (ha)	Type 2 Sediment		Type 3 Sediment		Type 4 Sediment		Type 5 Sediment		Type 6 Sediment	
				Fine sediments with distinct ridges		Sand/Gravel/Cobble		Gravel and Cobble in a base of sediment		Rocks ranging in size from gravel to boulders in a base of finer sediments		Densely packed cobble and boulder	
				Prop %	Area (ha)	Prop %	Area (ha)	Prop %	Area (ha)	Prop %	Area (ha)	Prop %	Area (ha)
DWI	Destruction	DWI Cap (1500 m)[a]	1.00	-	-	-	-	74.43%	0.74	25.57%	0.26	-	-
	Destruction	Alternate DWI Cap Location (1250 m)	1.00	-	-	72.93%	0.73	21.40%	0.21	-	-	-	-
	Disruption	DWI Cap	2.5	-	-	-	-	74.53%	1.86	25.57%	0.64	-	-
Erosion Control	Destruction	Shoreline Erosion Mitigation Area	4.00	20.00%	0.80	20.00%	0.80	20.00%	0.80	20.00%	0.80	20.00%	0.80
Bridge allowance	Alteration	Bridge over outfall	0.3	NA									
	Destruction	Bridge over outfall	0.3	NA									
Forebay	Destruction	Cut-off wall, Forebay Infill	0.7	NA									
West Infill, Dock, Seawall	Alteration	Dredged Dock Channel	4.5	NA									
	Destruction	Dock, West Infill, Seawall	11.5	25.00%	2.88	25.00%	2.88	35.00%	4.03	10.00%	1.15	5.00%	0.58

* For shoreline erosion mitigation area and west infill area, proportions were estimated and area then calculated. For DWI the area was calculated first, followed by proportions
NA = Not evaluated during the 2024 field study
a - Based on 100x100m intake cap.

6.2.2.2.1 DWI Area

The 2024 Deepwater Fish Community Study identified 13 fish species utilizing the offshore waters of the DWI area. Substrate types and depths consistent with the adult foraging habitat of all species could be found in the DWI area. Adult stages of most species captured in the study utilize substrate Types 4 (gravel and cobble in a base of sediment), 5 (gravel/boulders in a base of finer sediments), and 6 (densely packed cobble and boulder). While neither of the proposed intake cap locations contains substrate of Type 6, the first intake location (1.5 km offshore) is primarily composed of Type 4 substrate (74%), while the alternate intake location (1.25 km offshore) is dominated by Type 3 substrate (77%). Therefore, the first intake location resides in more suitable habitat for the adult stages of the species identified in the DWI area.

The species observed in this area in 2024 were Alewife, Brown Trout, Burbot, Lake Sturgeon, Lake Trout, Lake Whitefish, Rainbow Smelt, Rock Bass, Round Goby, Round Whitefish, Sea Lamprey, Walleye, and White Sucker. Alewife was the most frequently caught species in the spring and summer sampling events of the 2024 deepwater fish community study, while Lake Trout and Lake Whitefish dominated the fall catch. This seasonal shift in the dominant species captured is reflective of the migratory nature of Alewife, which make seasonal spawning migrations to the nearshore zone to spawn in the late spring. Other species captured likely also use the area for foraging. Salmonid species encountered at various times during the sampling program such as Brown Trout and Lake Trout are known to prey on smaller fish species such as Alewife, Rainbow Smelt, and Round Goby. Other species caught such as Walleye and White Sucker use the waters in Lake Ontario to move into, around, and between foraging habitats along the lake's shoreline and nearby waterbodies such as Frenchman's Bay, Rouge River, and Duffin's Creek. Most of the species identified in the DWI belonged to the invertivore/carnivore trophic class, reflecting the foraging opportunities available in the deepwater habitat (see **Section 4.3.3**).

Two invasive species, namely, Round Goby and Sea Lamprey, were caught in the DWI area. Round Goby have historically been a sub-dominant yet ubiquitous species in past OPG studies near PNGS and DNGS (Golder 2007a, Hatch, 2013, Ecometrix, 2021). Sea Lamprey are parasitic and prey on Lake Trout, Salmon, Whitefish, Cisco and Burbot in the Great Lakes.

A Lake Sturgeon was captured during the fall 2024 sampling event, which is a rare occurrence at that location and depth in the lake. Lake Sturgeon have been stocked by the New York state into the Lake Ontario-St. Lawrence River system intermittently since 1993, with the most recent program conducted from 2014 to 2019 (Great Lakes Fishery Commission, 2023; Stewart et al., 2012; Welsh et al., 2020). While Lake Sturgeon occasionally migrate long distances in search of food or suitable spawning habitat and to avoid unfavourable environmental conditions, they are rarely found outside their shallow riverine spawning areas (Auer, 1996; Bemis and Kynard, 1997; Peterson et al., 2007). Given that sturgeon prefer muddy, sandy or gravel substrates, rather than the cobble/boulder of the DWI area, it is possible that this individual was caught moving between foraging habitats. It should be noted that American Eel, a species at risk that has been consistently recorded in the annual impingement monitoring from 2016 to 2022, was not captured in the 2024 Deepwater Fish Community Study. Typically, the freshwater habitat in lakes

for American Eel spans from depths of 10 m to deeper waters (COSEWIC, 2012). Given their frequent detection in previous studies and consistent presence in impingement monitoring, it is likely that American Eel remain present in the area despite not being captured in this study.

Generally, it is unlikely that the species found in the DWI area will use the DWI area as spawning habitat. Although substrate suitable for spawning is available for species such as Burbot, Lake Trout, Alewife, Rainbow Smelt, Rock Bass, Round Goby, Walleye, and White Sucker, these fish typically utilize shallower nearshore waters with faster flow rates for spawning. Round Whitefish typically spawn over gravel or cobble substrates at depths of 5–10 m (Haymes and Kolenosky, 1984; Petrudev, 2022), though they have also been reported to spawn at depths greater than 10 m. Similarly, Lake Whitefish have been documented spawning in deeper lake waters (e.g., 18–45 m), with most spawning occurring at depths of less than 25 m (Schaefer et al., 2022). Therefore, it is possible that both Round Whitefish and Lake Whitefish spawn in the DWI areas, though this was not evaluated in the 2024 Deepwater Fish Community study.

Of the four species that were not caught in the 2024 fish community studies but were assessed as ecological receptors in the 2022 PN ERA (Ecometrix 2023), those being American Eel, Emerald Shiner, Northern Pike, and Smallmouth Bass, all four species may potentially utilize the DWI area for foraging as adults. None of the four fish species would utilize the substrates or depths of the DWI for spawning.

Overall, the primary use of the potential DWI areas by fish species caught in the 2024 sampling event appears to be for transient foraging and as a seasonal movement corridor. Although coregonine species such as Lake Whitefish and Round Whitefish may spawn in the DWI area, this was not confirmed, as spawning was not evaluated in the 2024 Deepwater Fish Community Study. Given that the approximate loss of 1.0 ha of bottom habitat for DWI construction represents a relatively small percentage of the total offshore foraging area available to these species, and that the available zooplankton and benthic species and habitat features in this region are ubiquitous, any long-term negative impact on foraging opportunities is unlikely. The approximate loss of 1.0 ha of bottom habitat for DWI construction is therefore unlikely to have any long-term negative impact on foraging opportunities for these species.

6.2.2.2.2 Nearshore Study Areas

The 2024 Nearshore Fish Community Study identified 20 fish species in the shoreline erosion mitigation and west infill study areas. Small-bodied forage fish such as Alewife and Round Goby dominated spring and summer communities, while fall communities were more varied, and were characterized by larger-bodied bottom feeders, salmonids, and predatory fish. As seen in the DWI area, the adult stages of most species captured in the nearshore study areas utilized substrate of Types 3, 4 and 5. The west infill area comprised substrates from Types 2 to 6, with Type 4 being the most dominant (35%), followed by Type 2 (25%) and Type 3 (25%). The shoreline erosion mitigation area had a more even spread, with Types 2 through 6 each comprising 20%. As such, both nearshore study areas provide diverse substrate opportunities, which can be utilized by the species identified based on their specific habitat preferences.

The nearshore study areas likely serve as adult foraging habitats for the species captured. As with the fish in the DWI area, most species captured belong to invertivore/carnivore trophic levels. Small-bodied fish species such as Alewife, Round Goby, and Rainbow Smelt present in these areas likely serve as prey for larger species observed in the area such as Walleye, Brown Trout, Rainbow Trout, Largemouth Bass, Atlantic Salmon, and Coho Salmon. The presence of aquatic vegetation in the nearshore study areas, specifically the west infill, likely enhances foraging opportunities and provides protective cover. Additionally, species such as Common Carp, Largemouth Bass, Yellow Perch, Threespine Stickleback, and Pumpkinseed are commonly found in areas with significant aquatic vegetation, and all but the bass use plant material for spawning.

Of the species that were not captured in the nearshore study areas but observed in the DWI areas, most are deepwater species that utilize offshore waters as adults. However, Round Whitefish may feed on benthic invertebrates associated with aquatic vegetation and diverse substrates found within the nearshore study areas, as they have previously been seen in nearshore environments. Additionally, although Emerald Shiner, American Eel, Northern Pike, and Smallmouth Bass were not captured in the 2024 fish community study, it is possible that these species use the nearshore study areas as foraging habitats. Emerald Shiner, a small planktivorous species, is typically found in the nearshore regions of Lake Ontario, including the shallows near breakwalls of the forebay. As highlighted in **Section 6.2.2.2.1**, although American eels were not captured in the Fish Community Study of the area, it is possible that the species traverses the nearshore study areas, as they have been impinged at PNGS.

Based only on substrate types available and depth of water, the nearshore areas may support spawning for 15 of the 20 species identified in the 2024 Nearshore Fish Community Study. Species like Round Whitefish and Lake Trout, known to spawn on shoals and rocky substrates in shallow nearshore study areas, may utilize these habitats. The vegetation in the nearshore study areas provides attachment sites for the embryos of species such as Common Carp, Threespine Stickleback, Alewife, Yellow Perch, and Rock Bass, and offers protective cover for early life stages. The west infill area, with its greater abundance of vegetation compared to the shoreline erosion mitigation area, is more suitable for species that require vegetative cover to reproduce. Notably, though, both nearshore study areas are subjected to high wave energy from the lake, making them sub-optimal for spawning for most species. The west infill area, with the protection offered by the intake channel's seawall, may provide some relief from the wave action, potentially enhancing its suitability for spawning of phytophiles. The nearshore waters may also serve as overwintering habitats for species such as Lake Trout and White Sucker, though these fish may prefer embayments to avoid the effects of wave action along the shoreline. Overall, the proposed shoreline erosion mitigation and west infill areas likely offer potential foraging, juvenile, and overwintering habitats for certain fish species in Lake Ontario, though they generally provide unsuitable spawning habitat.

6.2.2.3 Potential Impacts and Mitigation Strategies – Risk Characterization

Based on the habitat assessment results, the construction of the DWI cap will result in the destruction of approximately 1.0 ha of habitat utilized by species for foraging and migration.

The shoreline erosion mitigation area would result in the destruction of approximately 4 ha of potential foraging, juvenile, and overwintering habitat. Construction of the possible dock and seawall, as well as lake infilling in the West Infill area is expected to result in the destruction of approximately 11.5 ha of similar habitat.

Although the substrate and depth in both nearshore study areas meet the spawning requirements of some species, high wave energy along the shoreline makes them unsuitable for spawning. Furthermore, both the DWI and nearshore study areas lack unique habitat features, as they are typical of other areas found throughout Lake Ontario. Therefore, while construction activities will result in habitat loss, no rare or unique habitats will be lost.

To mitigate the impacts of habitat loss resulting from project activities, several strategies will be implemented during construction. These include measures to limit the spread of aquatic invasive species, such as cleaning, draining, and drying any equipment used in the water, and avoiding the transfer of organisms or water between bodies of water. Additionally, OPG will replace and restore disturbed habitat features, as well as remediate any impacted areas, in accordance with DFO authorization requirements, if applicable.

6.2.3 Thermal Effects

PNGS Units 1 and 4 were permanently shut down in Q4 of 2024 and are now in Stabilization phase. Units were shut down in two phases with a three-month interval between phases, reducing the risk of cold shock to aquatic life in the area. To facilitate PNGS Units 1 and 4 Stabilization activities, a minimum of one CCW pump from PNGS Units 1 and 4 will continue to run while PNGS Units 5-8 are still operating; therefore, water will continue to be released through the PNGS Units 1-4 discharge channel. Over time, as all PNGS Units 1-4 CCW are shut down, water temperatures around the PNGS Units 1-4 CCW discharge will return to temperatures typical of the regional Lake Ontario nearshore habitat. Fish species that were drawn to the warmer temperatures of the PNGS Units 1-4 discharge (e.g., Smallmouth Bass, Common Carp, and Emerald Shiner), will likely reduce in number in the immediate vicinity of the discharge channel over the coming seasons. Aquatic productivity in the area around the discharge is also expected to be reduced to levels more commonly associated with natural Lake Ontario nearshore habitat in the region. No long-term adverse thermal effect is anticipated from the shutdown of the PNGS Units 1-4 discharge.

During PNGS Units 5-8 refurbishment, the DWI will be constructed and become operational by 2030. Once the DWI is in use, a cut-off wall will be installed in the intake channel, with small holes to allow some water to pass through. The existing PNGS Units 5-8 CCW discharge channel will still be used. All CCW discharge from Units 5-8 will be paused starting in the fall of 2026 as Units 5-8 will be shut down for refurbishment (**Figure 5-3**). The shutdown will be done in stages to reduce potential cold shock to aquatic life and, likewise, re-start near the end of the refurbishment process will also occur in stages allowing time for aquatic life to thermally adjust.

During PNGS Units 5-8 continued operations, the DWI will operate at full capacity bringing water into PNGS Units 5-8 for use during operations. As such, the discussion around thermal effects below is focused on continued operations.

6.2.3.1 Anticipated Discharge Temperatures post DWI Implementation – Exposure Assessment

The PNGS DWI is currently planned to be constructed and become operational by 2030, at which point the plant will receive intake water at temperatures below what is currently being used from the surface intake since the water will be drawn in from the bottom of the lake, at a farther distance than the intake channel. Discharge temperatures are estimated to be similar to or slightly less than previous operational conditions (with 6 operating units). Thermal data from the existing PNGS intake channel and PNGS Units 5-8 CCW discharge channel were compared to similar data from DNGS to estimate potential effluent temperatures at PNGS post DWI construction and implementation.

DNGS currently utilizes a DWI roughly 800-1000 m offshore at a depth of about 10 m. Water is pulled in through the DWI for the four DNGS reactor units and then discharged to Lake Ontario via a diffuser system. The flow rate through the DNGS DWI as it is currently operated is 123.1 m^3/s (OPG, 2022f). The flow rate at PNGS once Units 5-8 are back online from refurbishment is expected to be slightly higher than at DNGS. The DWI setup and operational load (i.e., providing cooling for four reactor units) at DNGS is akin to what PNGS would experience post-refurbishment, with the exception of moderately lower flow rates at DNGS than what is projected for PNGS. This, along with the proximity of the stations (roughly 27 km apart) on the north shore of Lake Ontario, suggests that future PNGS discharge temperatures upon continued operation of PNGS Units 5-8 would be similar to or slightly lower than those at DNGS.

Figure 6-4 presents the surface intake and effluent temperatures at PNGS, and the DWI intake and calculated effluent temperatures at DNGS, from January 2021 to December 2023.

DNGS DWI intake temperatures were consistently 3-5 °C cooler than PNGS surface intake temperatures across the three years. This is expected given the colder temperatures at the depth in which the DWI operates, as opposed to the warmer surface water currently being used by PNGS at the intake. Notably however, DNGS calculated discharge temperatures were equivalent to current PNGS discharge temperatures. Therefore, while DNGS intake temperatures are lower than those at PNGS, DNGS experiences a larger ΔT, resulting in similar discharge temperatures between sites.

Though the DWI intake at PNGS will be installed at a depth ranging from 11-11.5m, roughly 1-1.5 m deeper than that at DNGS (10 m), thermal profiles taken offshore from PNGS in 2024 (**Figure 6-5**) indicate that the change in temperature from 10 m to 11.5 m depth is minimal (roughly 1°C) once the lake has turned over (Lake Ontario turnover occurred during late May and late October in 2024).

It is anticipated that the discharge temperatures at PNGS during continued operations could be similar to or slightly lower than current temperatures.

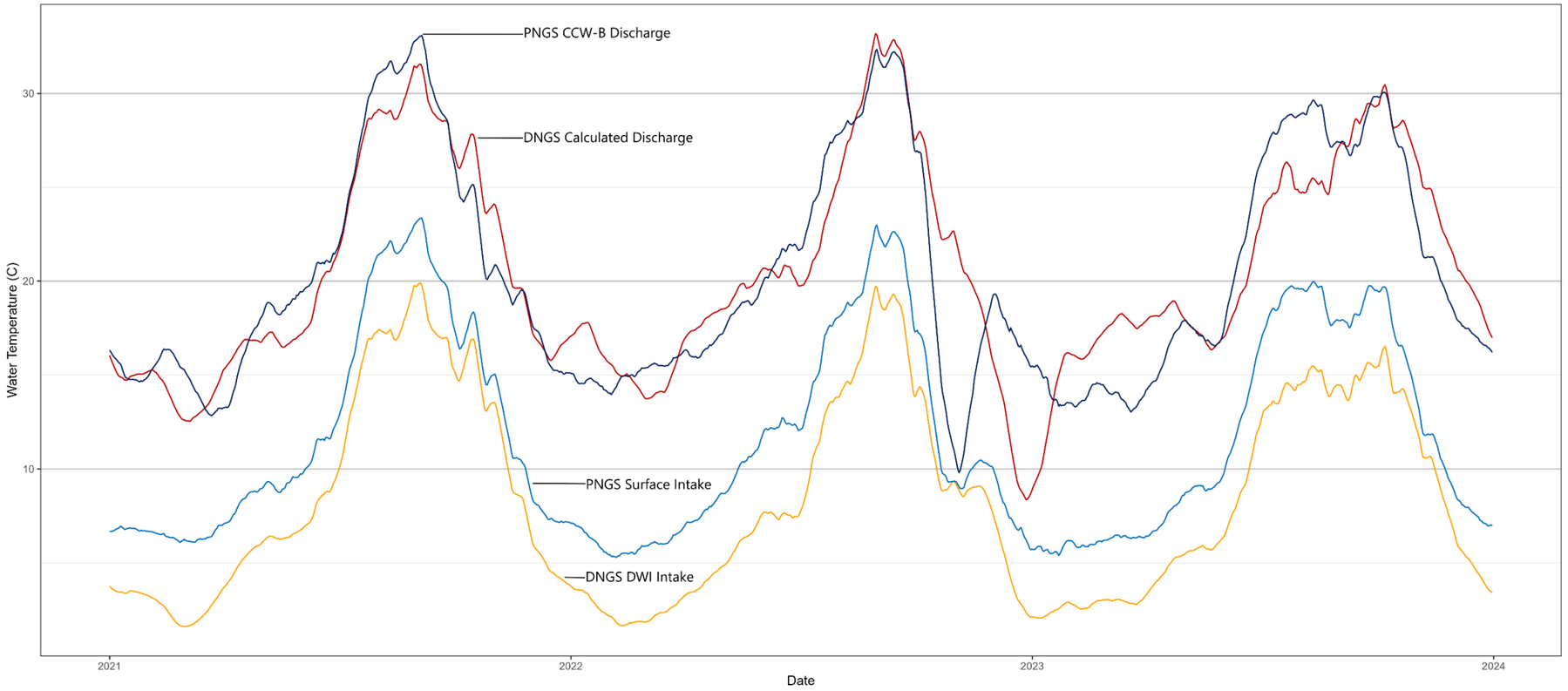


Figure 6-4: Intake and Discharge Temperatures (°C) at PNGS and DNGS from January 2021 to December 2023

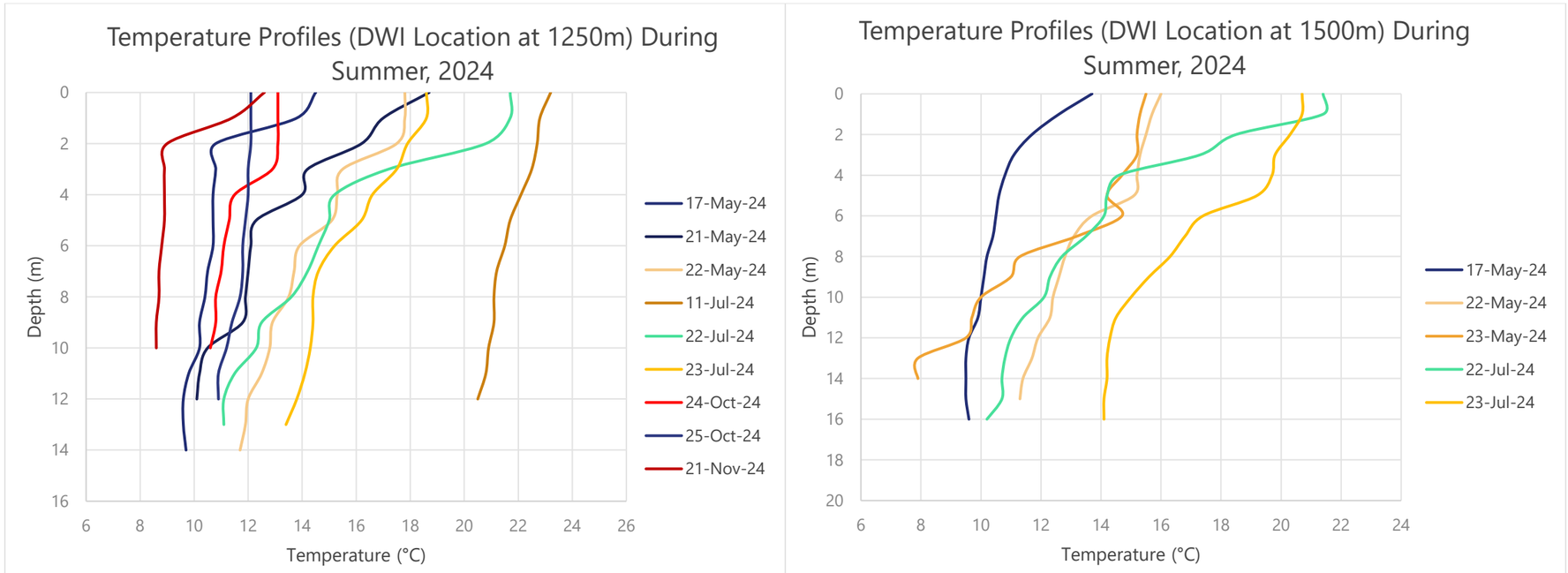


Figure 6-5: Thermal Profiles Taken Across Multiple Seasons in 2024 at Both Potential Locations for the PNGS DWI

6.2.3.2 Anticipated Thermal Effects on Fish Communities – Risk Characterization

The potential effects of the thermal plume on fish eggs and larvae were evaluated several times at PNGS (Cooper, 2013; Golder, 2007a; OPG, 2018d, 2021f). Golder (2007a) evaluated modeled Maximum Weekly Average Temperature (MWAT) against MWAT criteria provided by the ECCC for Smallmouth Bass (*Micropterus dolomieu*), Emerald Shiner (*Notropis atherinoides*), and Lake Trout (*Salvelinus namaycush*), and Round Whitefish (*Prosopium cylindraceum*). Water temperatures were monitored across all four seasons in the PNGS Intake channel, PNGS Units 5-8 CCW discharge channel, the nearshore study areas west and east of PNGS, and the nearshore area in front (south) of PNGS. They found no exceedances during the appropriate timeframes for these species. Cooper (2013) compared water temperatures around the PNGS Units 5-8 discharge to MWAT and Short Term Daily Maximum (STDM) criteria of 15 different fish species, nine of which are considered in the 2022 PN ERA. These fish were American Eel (*Anguilla rostrata*), Brown Bullhead (*Ameiurus nebulosus*), Round Whitefish (Prosopium cylindraceum), White Sucker (*Catostomus commersonii*), Emerald Shiner , Lake Trout (*Salvelinus namaycush*), Northern Pike (*Esox Lucius*), Smallmouth Bass and Walleye (*Sander vitreus*). Cooper found that five of the nine species had exceedences in their criteria when using temperatures from the PNGS Units 5-8 thermal plume. Four of these species however, had exceedances in the reference areas (Thickson Point and Bonnie Brae Point) as well. Only Walleye demonstrated a marginally high exceedance (5% above the thermal criteria) in the thermal plume. However, the temperatures in the reference area were only slightly below the Walleye thermal criteria (4%).

OPG evaluated the effects of the PNGS thermal plume on Round Whitefish embryo survival in 2009-2012 (OPG, 2018d) and 2019-2020 (OPG, 2021f). The plume was modelled using measured water temperature in the winter (December). In both studies, embryo losses generally fell well below the CNSC threshold of concern of 10% relative survival loss. Both studies found that there is no chronic adverse effect on round whitefish egg survival. Griffiths (1980) conducted a study on acute round whitefish egg mortality at varying water temperatures (2, 4, 7, and 10°C). After continuous exposure, only the eggs in 10°C water experienced acute mortality. OPG chose to use a conservative value of 7°C as the threshold at which there could be a possible indication of acute temperature effects on Round Whitefish embryonic development. Any exceedances in lake bottom temperatures greater than 7°C during the study were short term (max 26 hours), and are believed to have no adverse effects on the development of round whitefish embryos. More recently, in a Tri-party meeting (CNSC, ECCC, and OPG), it was agreed that 6°C would serve as the thermal threshold that triggers an adaptive management response for Round Whitefish embryos, particularly during Block 1 development .

Previous work at PNGS on the potential thermal effects from the PNGS Units 5-8 CCW discharge have found there to be minimal impact on the local fish communities (Specifically the species described above). Considering that PNGS Units 5-8 discharge temperatures during continued operations are estimated to be the same or slightly lower than current conditions (with 6 operating units), no change in direct thermal effects are expected after the refurbishment and continued operation of PNGS Units 5-8.

6.2.3.3 Climate Change Considerations for Thermal Effects

Thermal plume temperatures are not anticipated to increase from current conditions as a direct result of the PNGS Units 5-8 refurbishment and continued operations. However, indirect impacts to the lake thermal environment must be considered. Lake water temperatures are anticipated to increase as climate change progresses over the long-term. Generally, larger waterbodies like Lake Ontario are expected to see less severe climate related changes than small waterbodies (Woolway and Merchant, 2019). In a recent paper, (Ivanova et al., 2024) summarize the potential environmental changes in the Great Lakes. These could include shorter periods of ice cover, earlier spring and later fall overturn, which would in turn create a longer stratification period, and a smaller hypolimnion because of a deeper thermocline (Ivanova et al., 2024). Water column temperatures are anticipated to increase by 2°C by 2050-2100, with most of this temperature increase anticipated to occur in the epilimnion of stratified lakes (Logfren, 2014). It is still not fully understood how this may impact fish communities. Adult cold-water fish may be able to behaviorally thermoregulate by moving to deeper waters, but their spawning needs may not be as adaptable (i.e., requiring specific substrates, water temperatures, plant growth, etc.). Warmwater fish species might be most exposed to climate-related changes in lake water temperature, as they typically dwell in the epilimnion and near shore.

Future conditions resulting from climate change related warming in Lake Ontario is a large and fluctuating topic in the scientific literature. Several assumptions have to be made when considering the intersection of climate change and warm-water discharge from PNGS, and how these may impact the local aquatic environment. These assumptions are as follows:

1) Any discussion involving long term environmental impacts as a result of climate change are subject to change. Water temperature predictions are estimated via climate modelling, and may vary between sources, and fluctuate over time from the same source.

2) Recent literature indicates that deeper layers in lakes are expected to warm at a slower/more variable rate under climate change due to weaker coupling with air temperature (Anderson et al., 2021; Butcher et al., 2015; Pilla et al., 2020). For example, projections specific to Lake Ontario which account for this predicts that annual water temperature is predicted to increase by 1.3-1.6°C at the surface and by 0.4-1.0°C in the hypolimnion by 2070. These projections, originally developed by (Trumpickas et al., 2009) and later utilized in Ivanova et al., (2024) based on low and high CO_2 emission scenarios for the period 2011–2070 (IPCC, 2000) with earlier onset of spring and delay of fall. Therefore, for the purposes of the following evaluation, it was assumed that water temperature is expected to increase by 1.3-1.6°C at the surface and 0.4-1.0°C below the thermocline to address thermal effects from the PNGS Units 5-8 CCW discharge and climate change on the local fish communities.

3) It is assumed based on current modelling that, despite increases in water temp due to effects of climate change, the discharge temp following the shift will not increase relative

to current. OPG intends to confirm these predictions via further thermal monitoring once the DWI is operational.

6.2.3.3.1 Potential Effects to Round Whitefish

Past assessments by OPG on thermal effects of PNGS discharge on Round Whitefish have found there to be no chronic or acute adverse effects on embryo survival and development (OPG, 2018d, 2021f). The monitoring threshold of 6°C was exceeded several times within the thermal plume, but only for short periods of time and at specific locations. Given that Round Whitefish typically spawn over gravel and cobble substrates at preferred depths of 5–10 m, the warming experienced in these habitats is likely to align with hypolimnion conditions more, resulting in more gradual and less extreme increases in temperature. Under a lower warming rate scenario, with an annual increase of +0.4°C, minimal impacts on embryo survival are anticipated. However, under higher warming projections of +1.0°C, effects may be more pronounced. The climate-driven increases may lead to an increase in the frequency and duration of threshold exceedances, resulting in lower survival and recruitement. Moreover, under this climate change scenario, it is possible that water temperatures in Lake Ontario may not fall below 4°C, which is one degree warmer than the spawning MWAT criteria for round whitefish (ECCC, 2019; Logfren, 2014). Thus, it is possible that climate change may reduce the spawning success of Round Whitefish in general, as well as embryo survival within the thermal plume of PNGS Units 5-8 CCW discharge.

Importantly, discharge temperatures are expected to remain similar to or lower than current conditions following the construction and operation of the DWI, even under climate change. This suggests that there will be no additional thermal load from PNGS following Refurbishment, with the potential for improved conditions. Future monitoring of intake and discharge temperatures will validate any changes in the thermal plume, and potential impacts on Round Whitefish will be assessed in subsequent ERAs and additional studies as required.

6.2.3.3.2 Potential Effects to Other Fish Species

Cooper (2013) found that, while there were HQ exceedances of the thermal criteria of several fish species within the thermal plume of PNGS, similar exceedances (with the exception of Walleye) were seen in reference areas outside of the effect of the PNGS Units 5-8 CCW discharge. This suggests that exceedances of thermal criteria may be more tied to high ambient lake temperatures than to the Units 5-8 discharge. However, HQ are useful as a screening tool for assessing potentail impacts, and as such are more of a qualitative tool. Golder (2007) found that modeled temperatures (predicted for the timeline of the refurbishment) in the PNGS discharges, nearshore environment south of PNGS, and the nearshore environments east and west of PNGS, did not exceed the thermal criteria for Smallmouth Bass, Round Whitefish, Emerald Shiner, or Lake Trout in the months critical to spawning and development (Golder, 2007a). Apart from Smallmouth Bass, even an additional warming of 1.3-1.6°C at the surface would not exceed these fish's upper lethal temperatures. Smallmouth Bass were found to utilize the PNGS discharge channels for spawning and can be exposed to fairly high temperatures relative to natural Lake Ontario habitats.

The effects of lake warming are anticipated to impact all fish in varying degrees. In conjunction with warm water discharge from PNGS Units 5-8, this is likely to place more stress on the local fish communities by reducing the margin between water temperatures and fish thermal criteria. Walleye and Smallmouth Bass populations might experience the greatest shift in stress from the combined inputs of climate change and the PNGS discharge. It is likely these fish would have to shift to different habitats as climate change progresses to stay within a more optimal temperature range.

6.2.3.3.3 Future Investigations

Discharge temperatures from PNGS Units 5-8 during continued operations are anticipated to remain similar to or slightly lower than current temperatures. As thermal effects have already been examined for previous operational conditions (with 6 operating units), an additional thermal effects assessment of existing conditions is not considered necessary. However, as climate change progresses, future assessments may be required to verify how rising lake temperatures are impacting the nearshore environment down-current of the PNGS Units 5-8 discharge, and whether mitigation measures may have to be implemented to reduce thermal stress on fish communities.

7.0 Cumulative Effects Consideration

Cumulative effects are those that may result from the combined effects of one project with those of other existing, planned, and/or reasonably anticipated future projects. The focus of this discussion is on other OPG projects on the same site, or at nearby sites. Environmental monitoring data collected at PN would include the contribution, if any, from DNGS effluent and emissions as well as, in the future, DNNP effluent and emissions. However, considering the PN site is approximately 34 km west of the DN site, the influence from the DNGS and future DNNP at PN would be small.

As part of OPG's commitment under the Environmental Monitoring and Environmental Assessment Follow-up (EMEAF) Program for the DNNP, OPG has initiated a cumulative effects assessment for the aquatic environment. The thermal plume, habitat loss, impingement and entrainment, and climate change will be integrated to inform a cumulative effects assessment for the aquatic environment which considers PNGS, DNGS, and DNNP. The cumulative effects assessment for the aquatic environment is being performed as part of a separate assessment for the DNNP outside of this PERA.

This PERA encompasses all existing and known future activities on the PN site including evaluation of: previous PNGS operations (for 6 operating units), PNGS Units 1 and 4 Stabilization, PNGS Units 1-4 SWS and dismantle/demolish activities, PNGS Units 5-8 Refurbishment (including construction and operation of the DWI), PNGS Units 5-8 Continued Operations, the NSS-PWMF including construction of additional storage building (SB #5) and the PCSS, and construction of other planned buildings. As shown in **Figure 1-2**, based on the conceptual timeline, some Project activities will occur at the same time. For example, in 2027, PNGS Units 1 and 4 are still in the Stabilization Phase and PNGS Units 2 and 3 are in SWS phase, risk reduction and removal activities will also occur, along with early PNGS Units 5-8 refurbishment activities, and construction of the DWI. In the Tier 1 assessment, the air and noise model conservatively evaluated this bounding case where maximum emissions from equipment and vehicular traffic are expected to occur from Project activities occurring at the same timeframe. In the Tier 1 surface water assessment three configurations of water balance were evaluated: PNGS Units 1 and 4 in Stabilization with PNGS Units 5-8 in shutdown for Refurbishment (**Figure 5-3**), PNGS Units 1-4 in SWS and 1 unit from PNGS Units 5-8 returned to service (DWI is operational, **Figure 5-4**), and PNGS Units 5-8 in continued operations with PNGS Units 1-4 in SWS (**Figure 5-5**). As such, cumulative effects on the PN site haves been considered in this PERA.

8.0 Conclusions

8.1 Tier 1 Assessment Conclusions

The Tier 1 assessment evaluated PNGS Units 1-4 Decommissioning and PNGS Units 5-8 Refurbishment activities to determine potential Project interactions with various environmental components and receptors. **Table 5-24** summarizes these interactions and the findings from this assessment, identifying which interactions require further quantitative evaluation in the Tier 2 assessment. In general, Project activities during the Stabilization and SWS phases of PNGS Units 1-4 were found to be sufficiently bounded by the 2017 Safe Storage PEA, the 2022 PEA Addendum, or the 2022 PN ERA; thus no additional evaluation is needed. Although risk reduction and removal activities, and dismantling activities for PNGS Units 1-4 were not previously assessed, they are expected to have minimal environmental effects due to the implementation of construction best practices and mitigation plans. Future dismantling and demolition activities, starting in 2050, will be detailed in subsequent DDP updates and PERA updates when more precise work packages are defined.

Refurbishment activities for PNGS Units 5-8, including islanding the unit, refurbishment of reactor auxiliary systems, and other enhancements were determined to have negligible interaction with the environment in the Tier 1 assessment. Some activities, such as the construction of the PCSS, are evaluated as part of a separate PERA. Other activities, including defueling and dewatering the units, are bounded by the 2017 Safe Storage PEA and the 2022 PEA Addendum, while other activities, such as the management of tritium emissions, are bounded by the 2022 PN ERA. As these activities are bounded by previous assessments, no further evaluation was warranted in the Tier 2 assessment.

The construction and operation of the DWI, along with associated activities such as the potential addition of a dock, potential infill, and material disposal, are major activities that were not part of the project scope at the time of earlier assessments. The Tier 1 screening identified that the impacts resulting from these activities—particularly in relation to the atmospheric environment, and aquatic ecosystems—are not bounded by earlier assessments or previous operational conditions (with 6 operating units). Specifically, aquatic habitat impacts from DWI construction and thermal effects, particularly as they relate to climate change, required further assessment. These interactions were retained for further evaluation in the Tier 2 assessment to determine the potential for negative impacts.

To support this PERA, predictive air quality and noise modelling was completed to assess potential impacts to human and ecological receptors resulting from the planned PNGS Units 1-4 Decommissioning and PNGS Units 5-8 Refurbishment. The modelling was developed as a conservative "worst-case" bounding scenario for the planned Project activities.

No long-term human health effects are expected to occur as a result of the predicted ambient air quality or noise conditions for the bounding scenario. Exceedances of the selected ambient air quality criteria were predicted for TSP, $PM_{10,}$ $PM_{2.5}$), nitrogen dioxide (NO_2, representative of nitrogen oxides [NO_X]), and benzo(a)pyrene (BaP, representative of polycyclic aromatic

hydrocarbons [PAHs]) for at least one of the human receptor locations assessed. No health risks are anticipated for the bounding scenario since short-term air quality criteria exceedances are predicted to occur infrequently (i.e., only a few days up to a few weeks in the year), or at receptor locations where people stay for short periods of time (i.e., the Sport Fisher). For noise, predicted exceedances of human health noise guidelines are modelled to only occur at locations where people stay for short periods of time (i.e., the Sport Fisher, Industrial/Commercial Worker), limiting the overall exposure to elevated noise levels.

No long-term ecological health effects are expected to occur as a result of the predicted ambient air quality for the bounding scenario. Some exceedances of the selected ambient air quality criteria were predicted for TSP, PM_{10}, $PM_{2.5}$, NO_2, and BaP for at least one of the ecological receptor locations assessed. No effects are expected since exceedances are largely localized to the PN site where mitigation measures (e.g., dust suppression measures) will be utilized to further minimize dust and particulate emissions. Project-related exceedances of short-term 24-hr TSP and PM_{10} criteria off-site at Frenchman's Bay occur relatively infrequently (i.e., exceedances on a few days up to a few weeks in a year). It is expected that Frenchman's Bay will continue to provide suitable habitat for local terrestrial and riparian biota over the course of the Project.

No noise impacts to receptors at Hydro Marsh and Frenchman's Bay are expected since predicted noise levels are less than the 10 dB guideline for incremental change above existing conditions. Exceedances of noise guideline are localized to the PN site. It is presumed that wildlife currently inhabiting the PN site are well adjusted to noise levels characteristic of an urban/semi-urban environment and are relatively tolerant of human activity. Increased noise levels above the 10 dB guideline are predicted at the Bank Swallow FFEE. As such, mitigation measures should be considered to reduce noise levels during the breeding season (approximately April 1st to August 31st). Additionally, the assumptions in the noise model can be re-evaluated once Project planning is further underway to provide more realistic predictions.

While air quality and noise were not assessed further for any human or ecological receptors in the Tier 2 assessment, recommendations are included to protect breeding birds on-site including species at risk from elevated air concentrations and noise levels (see recommendations, **Section 8.3**). Barn swallow, bank swallow, and peregrine falcon are known to breed on the PN site.

No specific COPCs were identified for the atmospheric or surface water environment. However, feedback from WTFNs on other PERAs indicated the inclusion of a Harvester receptor would be beneficial for the PERA. Thus, an assessment of a Harvester was considered as part of the Tier 2 quantitative assessment.

Post-refurbishment, PNGS Units 5-8 will operate in a manner consistent with previous operations (with 6 operating units). Therefore, the potential effects of the Continued Operation Phase on most environmental components are similar to those previously assessed in the 2022 PN ERA for six operating units and comparable to existing conditions with four units (PNGS Units 5-8) operating.

As shown in the conceptual timeline for the Project in **Figure 1-2**, there will be activities occurring in one phase that occur at the same time as another phase. For example, while PNGS Units 1 and 4 are in the Stabilization Phase and PNGS Units 2 and 3 are in SWS phase, risk reduction and removal activities will also occur, along with PNGS Units 5-8 refurbishment activities, and construction of the DWI. The air quality and noise modelling and surface water quality modelling considered a bounding scenario when activities are occurring at the same time, where relevant to the assessment.

In summary, the following potential effects were evaluated in the Tier 2 assessment:

- Inclusion of a Harvester in the Predictive Human Health Risk Assessment (HHRA) to assess radiation dose from exposure to releases of tritium, carbon-14, and beta/gamma to the atmospheric and surface water environment.
- Evaluation of aquatic habitat loss and potential changes to habitat quality in the Predictive Ecological Risk Assessment (EcoRA) from construction of the proposed DWI and associated nearshore modifications.
- Evaluation of changes to thermal effects on indicator fish species in the Predictive EcoRA due to operation of the DWI.

8.2 Tier 2 Assessment Conclusions

8.2.1 Predictive Human Health Risk Assessment (HHRA)

A Harvester receptor was further evaluated in the Tier 2 assessment. The radiological emissions to air and water assessed in the 2017 Safe Storage PEA continue to remain a conservative estimate of radiological emissions based on current Project planning for PNGS Units 1-4 Stabilization and SWS, as well as for PNGS Units 5-8 Refurbishment.

The incremental radiation dose from the Project to all human receptors evaluated is predicted to be well below the regulatory public dose limit of 1 mSv/a. The total dose to the Harvester is 1.24 µSv/a for the Harvester (child), representing 0.12% of the regulatory public dose limit (1,000 µSv/a). The highest dose to other receptors is 0.99 µSv/a for an urban resident (child), which is 0.10% of the regulatory public dose limit. This PERA has demonstrated that receptor groups near the PN site with anticipated lower exposure are also protected.

Since the dose estimates are a small fraction of the incremental public dose limit of 1 mSv/a and of the natural background dose of 1.4 mSv/a, The Tier 2 predictive HHRA determined there are no health effects anticipated due to exposure of potential critical groups to radiological releases from the PN site.

Based on the results of this PERA, the planned safe storage of PNGS Units 1 and 4, decommissioning of PNGS Units 1-4 and refurbishment of PNGS Units 5-8 are not predicted to cause any adverse effects to the human receptors evaluated.

8.2.2 Predictive Ecological Risk Assessment (EcoRA)

Further evaluations of aquatic habitat impacts and thermal effects were conducted in the Tier 2 assessment. All other Project interactions with the environmental components examined in the Tier 1 assessment were deemed to either pose negligible risks, be sufficiently managed or mitigated, or are bounded by previously completed assessments or current operating conditions.

8.2.2.1 Aquatic Habitat Impacts

Based on the habitat assessment, the construction of the DWI and associated lake infill areas and dock could result in the destruction of approximately 17.5 ha of fish habitat utilized by species for potential spawning, foraging and migration, and 4.8 ha of habitat alteration from dredging and potential bridge over the PNGS Units 5-8 CCW outfall. Additionally, the construction of the intake channel (a bored tunnel running from the intake cap to PNGS) could result in temporary disruption of approximately 2.5 ha of fish habitat.

Although the substrate and depth in both nearshore study areas meet the spawning requirements of some species, high wave energy along the shoreline (0-1 m) makes them unsuitable for spawning. Furthermore, both the DWI and nearshore study areas lack unique habitat features, as they are typical of other areas found throughout Lake Ontario. Therefore, while construction activities will result in significant habitat loss, it was determined that no rare or unique habitats will be lost. A habitat suitability assessment using DFO's HEAT tool may be utilized to quantitatively assess this loss.

8.2.2.2 Thermal Effects

The thermal impact of the PNGS Units 5-8 discharge during operation of the DWI was evaluated. It is anticipated that once the DWI is in operation the discharge temperature will be the same or lower than the existing PNGS Units 5-8 discharge temperatures. Thus, the PNGS Refurbishment activities are not expected to add any additional thermal load to the aquatic environment, and may even result in an improvement relative to current thermal conditions.

In the future, lake water temperatures are anticipated to increase as climate change progresses over the long-term; however, it is generally understood that larger waterbodies like Lake Ontario are expected to see less severe climate related changes than smaller waterbodies. The effects of lake warming are anticipated to impact all fish in varying degrees. Some fish species may have to shift to different habitats to remain within their optimal temperature range or acclimate as climate change continues to progress.

During Continued Operation the thermal effects are expected to be similar or slightly less than previous conditions (i.e., with 6 operating units), in the future, unrelated to the thermal discharge from PNGS, climate change and rising lake temperatures may result in increased thermal stress to local fish communities.

Based on the results of the PERA, most activities associated with PNGS Units 1-4 Decommissioning, PNGS Units 5-8 Refurbishment, and Continued Operations are not predicted to result in adverse effects to human and/or ecological receptor groups evaluated. Some aquatic habitat will be disturbed or removed from DWI construction – OPG will meet all Fisheries and Oceans Canada (DFO) authorization requirements including implementation of fish habitat compensation measures to offset the loss of habitat and associated productivity, As such the effect of aquatic habitat loss should be minimal with implementation of mitigation measures. While some individual exceedances of air quality or noise guidelines were identified, monitoring and mitigation measures identified in **Section 8.3** will be implemented to confirm no adverse effects.

8.3 Recommendations for Monitoring and Mitigation

OPG has a robust environmental monitoring program where environmental media are sampled and analyzed at locations within and outside the PN site. This program will continue during PNGS Units 1-4 Decommissioning, PNGS Units 5-8 Refurbishment, and Continued Operations.

Through the normal course of implementation of the N288 standards, the changes in activities associated with the Project will be considered as part of the periodic review and update of the monitoring programs resulting in a continual assessment of effects on human and non-human biota.

Based on the results of this PERA, the following recommendations are made for monitoring and mitigation in **Table 8-1** below.

Table 8-1: Recommendations for Monitoring and Mitigation

Environmental Component	Recommendation for Monitoring and Mitigation
Atmospheric Environment	• Air Quality: Air monitoring of existing conditions should continue so that at least 6 months of air quality data are available to characterize the existing environment. The additional air monitoring data should be included in the next iteration of the PERA. • Air Quality: Implementation of a dust management plan that could involve mitigative measures such as the application of dust suppressants, stabilization of completed soil surfaces, and suspension of dust-generating activities during periods of inclement weather. This is expected to reduce dust and particulate emissions and deposition on to vegetation surfaces, limiting pollution of local wildlife habitat. • Noise: The development and implementation of a Noise Management Plan will outline best construction practices and available mitigation measures for controlling noise generation. • Noise: Mitigation measures should be explored to reduce noise levels to species at risk during the breeding season, including Bank Swallow, Barn Swallow, and Peregrine Falcon (known to nest on the PN site). Mitigation measures may include alternate truck routes, revisiting assumptions in noise model to reduce conservatism.
Surface Water Environment	• No additional recommendations beyond continuing to implement surface water quality monitoring through OPG's ongoing environmental monitoring program. • OPG will employ best practices for stormwater management that would meet Ontario Ministry of Environment, Conservation and Parks (MECP) requirements and industrial sewage works rules.
Aquatic Environment	• Aquatic monitoring studies were completed to support this PERA based on current Project planning for the DWI at the time of study design. As the design of the DWI evolves, it presents some uncertainty in the study area size and location. As such, further data (fish community, benthic macroinvertebrate community, microzooplankton community) should be collected for the aquatic environment to reflect changes to DWI planning since the Project was initiated. The additional aquatic environment data should be included in the next version of the PERA. • Aquatic Habitat: To mitigate impacts of habitat loss from DWI construction, measures should be taken to limit the spread of aquatic invasive species, such as cleaning, draining, and drying

Environmental Component	Recommendation for Monitoring and Mitigation
	any equipment used in the water, and avoiding the transfer of organisms or water between bodies of water. Additionally, OPG will replace and restore disturbed habitat features, as well as remediate any impacted areas, in accordance with DFO authorization requirements, if applicable. • Aquatic Habitat: An Erosion and Sediment Control Plan should be developed to minimize the mobilization of suspended materials into the water during DWI construction. Mitigation measures may include conducting in-water works in isolation of open or flowing water to reduce sediment introduction into the watercourse, regular inspection and maintenance of erosion controls, monitoring for signs of sedimentation, and ensuring the proper disposal of dredged materials. Similarly, a spill response plan should be implemented to prevent spills of deleterious substances. • Impingement and Entrainment: The reduction of impingement and entrainment once the DWI is operational should be confirmed through monitoring programs. • Thermal Effects: The assumption that PNGS Units 5-8 discharge temperatures post-DWI implementation will be the same or slightly lower than previous operational conditions (with 6 operating units) should be confirmed through evaluation of lake water temperatures in terms of hazard quotients to key indicator fish species, as well as evaluation of the influence of climate change over time. This evaluation should be included in routine PN ERA updates. Additionally, monitoring of lake bottom temperatures within the thermal plume, once the DWI is operational is recommended to improve the understanding of habitat conditions.
Geological and Hydrogeological Environment	• During construction of the PCSS, SB #5, and RFRISA, and other planned buildings any dewatering during excavation should be completed with the necessary permissions following MECP regulations intended to be protective against discharge or re-infiltration of collected groundwater. • A geotechnical investigation should be completed to determine if dewatering is required for the RFRISA or any other planned building. A geotechnical investigation has already been completed for the PCSS and is discussed in the PCSS PERA.
Terrestrial Environment	• See atmospheric environment row for recommendations on reducing noise levels for species at risk.

Environmental Component	Recommendation for Monitoring and Mitigation
	• As much as its possible to do so, construction activities should be adjusted as needed to minimize impacts, such as modifying work schedules or implementing noise and activity restrictions near nesting sites. To further reduce disturbance, heavy construction activity should be avoided during key breeding periods. Furthermore, work could be planned to occur during daytime hours to minimize disruption of nocturnal wildlife. • OPG will comply with the species and habitat protection provisions of the Endangered Species Act, Species at Risk Act, and Migratory Birds Convention Act during all project activities. • OPG will continue to monitor breeding birds and conduct broader biodiversity monitoring on an annual basis to support conservation efforts and regulatory compliance.
Radiation and Radioactivity (Gamma Radiation)	• Future iterations of the PN ERA (based on the time period they encompass) should consider the new NSS-PWMF layout with inclusion of the transferred DSMs from the Phase I to the Phase II NSS-PWMF site. Data from TLDs surrounding the DSMs as well as quarterly catch basin stormwater monitoring can be used to verify that the conclusion that doses remain acceptable.

9.0 References

AECOM, 2023. Technical Memorandum – Bounding Analysis for PNGS. Report No. NK30-CORR-07007–1235347. February.

Anderson, E.J., Stow, C.A., Gronewold, A.D., Mason, L.A., McCormick, M.J., Qian, S.S., Ruberg, S.A., Beadle, K., Constant, S.A., Hawley, N., 2021. Seasonal overturn and stratification changes drive deep-water warming in one of Earth's largest lakes. Nat Commun 12, 1688. March. https://doi.org/10.1038/s41467-021-21971-1

Auer, N.A., 1996. Importance of habitat and migration to sturgeons with emphasis on lake sturgeon. Can. J. Fish. Aquat. Sci. 53, 152–160. December. https://doi.org/10.1139/f95-276

Barbiero, R.P., Little, R.E., Tuchman, M.L., 2001. Results from the U.S. EPA's Biological Open Water Surveillance Program of the Laurentian Great Lakes: III. Crustacean Zooplankton. Journal of Great Lakes Research 27, 167–187.

Barbiero, R.P., Tuchman, M.L., 2001. Results from the U.S. EPA's Biological Open Water Surveillance Program of the Laurentian Great Lakes: I. Introduction and Phytoplankton Results. Journal of Great Lakes Research 27, 134–154.

Beacon, 2017a. Pickering Nuclear Site Biodiversity Monitoring Program Annual Report 2016. February.

Beacon, 2017b. Pickering Nuclear Site Biodiversity Monitoring Program Annual Report 2017. December.

Beacon, 2018. Pickering Nuclear Site Biodiversity Monitoring Program Annual Report 2018. December.

Beacon, 2020. Draft Pickering Nuclear Generating Station Study Area Species Lists.

Beacon, 2022. Pickering Nuclear Site Biodiversity Monitoring Program Three Year Report (2019 - 2021). January.

Beacon, 2023a. Pickering Nuclear Site Biodiversity Monitoring Program Annual Report 2022. February.

Beacon, 2023b. 2023 Pickering Nuclear Biodiversity Program Technical Memo. December.

Bemis, W.E., Kynard, B., 1997. Sturgeon rivers: an introduction to acipenseriform biogeography and life history. Environmental Biology of Fishes 48, 167–183. March. https://doi.org/10.1023/A:1007312524792

Black & Veatch, 2024. Methodology for Estimating Percent Reduction in Impingement & Entrainment. Darlington New Nuclear Project.

Butcher, J.B., Nover, D., Johnson, T.E., Clark, C.M., 2015. Sensitivity of lake thermal and mixing dynamics to climate change. Climatic Change 129, 295–305. March. https://doi.org/10.1007/s10584-015-1326-1

CCME (Canadian Council of Ministers of the Environment), 2000. Canadian Tissue Residues Guidelines for the Protection of Wildlife Consumers of Aquatic Biota – Methylmercury.

CCME (Canadian Council of Ministers of the Environment), 2010. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health – Polycyclic Aromatic Hydrocarbons.

CCME (Canadian Council of Ministers of the Environment), 2019. Guidance Document on Air Zone Management. URL https://ccme.ca/en/res/guidancedocumentonairzonemanagement_secured.pdf

CCME (Canadian Council of Ministers of the Environment), 2020. Guidance Document on Achievement Determination for Canadian Ambient Air Quality Standards for Nitrogen Dioxide. Report No. PN 1608.

CCME (Canadian Council of Ministers of the Environment), 2024. Canadian Environmental Quality Guidelines - Canadian Water Quality Guidelines for the Protection of Aquatic Life and Recreational Water Quality Guidelines and Aesthetics.

CH2M (CH2M Gore and Storrie), 2000. Tritium in Groundwater Study. Report No. NA44-REP-07010–10001. September.

Chan, L.A., Receveur, O., Batal, M., David, W., Schwartz, H., Ing, A., 2014. First Nations Food, Nutrition & Environment Study. Results from Ontario 2011/2012.

Choudhary, G., Hansen, H., 1998. Human health perspective on environmental exposure to hydrazines: A review. Chemosphere 37, 801–843.

CNSC (Canadian Nuclear Safety Commission), 2009. CNSC Letter, L. Levert to D.P. McNeil, OPG Record of Proceedings - Ontario Power Generation Inc. Report No. CD# NK30-CORR-00531-05083. January.

CNSC (Canadian Nuclear Safety Commission), 2018. REGDOC-3.2.1, Public Information and Disclosure. May.

CNSC (Canadian Nuclear Safety Commission), 2020. Environmental Protection. Environmental Principles, Assessments and Protection Measures. Report No. REGDOC-2.9.1 Version 1.2. September.

CNSC (Canadian Nuclear Safety Commission), 2021. REGDOC-2.11.2, Decommissioning.

CNSC (Canadian Nuclear Safety Commission), 2022. REGDOC-3.2.2, Indigenous Engagement, Version 1.2. February.

COG (CANDU Owners Group), 2013. Derived Release Limits Guidance. Report No. COG-06-3090-R3-I, 2013-12.

COG (CANDU Owners Group), 2019. Derived Release Limits Guidance. Report No. COG-06-3090-R4.

Coker, G.A., Portt, C.B., Minns, C.K., 2001. Morphological and Ecological Characteristics of Canadian Freshwater Fishes. January.

Cooper, F., 2013. Thermal effects Risk Assessment for the Darlington and Pickering Nuclear Generating Stations. Report No. COG-12-3053.

COSEWIC, 2012. COSEWIC assessment and status report on the American Eel Anguilla rostrata in Canada. Committee on the Status of Endangered Wildlife in Canada. May.

Coutant, C.C., 1977. Cold shock to aquatic organisms: guidance for power plant siting, design and operation. Nuclear Safety 329–342.

CSA (Canadian Standards Association), 2010. Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills. Report No. CSA N288.4-10 (Reaffirmed 2015). May.

CSA (Canadian Standards Association), 2012. Environmental risk assessments at Class I nuclear facilities and uranium mines and mills. Report No. CSA N288.6-12 (Reaffirmed 2017).

CSA (Canadian Standards Association), 2018. Guideline for design of fish impingement and entrainment programs at nuclear facilities. Report No. CSA N288.9-18.

CSA (Canadian Standards Association), 2019. Environmental monitoring programs at nuclear facilities and uranium mines and mills. Report No. CSA N288.4-19. September.

CSA (Canadian Standards Association), 2020. Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities. Report No. CSA N288.1:20. March.

CSA (Canadian Standards Association), 2022a. Environmental risk assessments at nuclear facilities and uranium mines and mills. Report No. CSA N288.6:22.

CSA (Canadian Standards Association), 2022b. N288.6:22. Environmental risk assessments for nuclear facilities and uranium mines and mills.

CSA (Canadian Standards Association), 2024. N288.9-24, Guideline for Design of Fish Impingement and Entrainment Programs at Nuclear Facilities. Draft in progress.

Durham Region (The Regional Municipality of Durham), 2022a. Oshawa Drinking Water System 2022 Annual Report.

Durham Region (The Regional Municipality of Durham), 2022b. Bowmanville Drinking Water System 2022 Annual Report.

EC (Environment Canada), 1998. Lakewide Management Plan for Lake Ontario. Environment Canada, USEPA, Ontario, NYDEC.

EC (Environment Canada), 2009a. Durham Regional Coastal Wetland Monitoring Project: 6-year Technical Report. Module 3 - Biological Condition.

EC (Environment Canada), 2009b. Durham Regional Coastal Wetland Monitoring Project: 6-year Technical Report. Module 1 - Introduction and Assessment Methods.

EC, HC (Environment Canada and Health Canada), 2011. Screening Assessment for the Challenge. Hydrazine. Report No. CAS Registry Number 302-01-2.

ECCC (Environment and Climate Change Canada), 2019. Guidance document: environmental effects assessment of freshwater thermal discharge. February. URL http://publications.gc.ca/site/eng/9.867894/publication.html

ECCC (Environment and Climate Change Canada), 2022. Canadian Environmental Protection Act, 1999. Federal Environmental Quality Guidelines Selenium.

ECCC (Environment and Climate Change Canada), 2023a. Canadian Ambient Air Quality Standards (CAAQS).

ECCC (Environment and Climate Change Canada), 2023b. Guidelines to avoid harm to migratory birds. July. URL https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/reduce-risk-migratory-birds.html

Ecometrix (Ecometrix Incorporated), 2012. Pickering Nuclear Generating Station Groundwater Monitoring Program Design. Report No. P-REP-10120-10037-R000. September.

Ecometrix (Ecometrix Incorporated), 2015. Pickering EMP Supplementary Study - Hydrazine in Lake Water - 2014. Report No. P-REP-03443-0538647. April.

Ecometrix (Ecometrix Incorporated), 2021. DNNP Aquatic Community Characterization for Siting of Intake and Diffuser – Final Report. Prepared for Ontario Power Generation. Report No. NK054-REP-07730–0731545. August.

Ecometrix (Ecometrix Incorporated), 2023a. Environmental Risk Assessment Report for Pickering Nuclear. Report No. P-REP-07701-00007-R001. March.

Ecometrix (Ecometrix Incorporated), 2023b. Pickering Safe Storage Project Predictive Effects Assessment - 2022 Addendum Update. Report No. P-REP-07701-00006 R001. March.

Ecometrix (Ecometrix Incorporated), 2023c. Conceptual Site Model – CSA N288.7 Implementation at Pickering Nuclear. Prepared for: OPG. Report No. P-REP-07294-00001. September.

Ecometrix (Ecometrix Incorporated), 2023d. Groundwater Protection and Monitoring Programs for Pickering Nuclear - CSA N288.7 Implementation. Report No. P-REP-07294-00002. September.

Ecometrix (Ecometrix Incorporated), 2023e. IMPACT-DRL v5.5.2 - Tool Qualification Report. December.

Ecometrix (Ecometrix Incorporated), 2024. Predictive Environmental Risk Assessment for Pickering Component Storage Structure. Report No. 92896-REP-07701–00019 R002 (LOF). November.

Ecometrix, Golder (Ecometrix Incorporated and Golder Associates Ltd), 2018. Environmental Risk Assessment Report for Pickering Nuclear. Report No. P-REP-07701-00001-R000. February.

Eme, J., Mueller, C.A., Manzon, R.G., Somers, C.M., Boreham, D.R., Wilson, J.Y., 2015. Critical windows in embryonic development: Shifting incubation temperatures alter heart rate and oxygen consumption of Lake Whitefish (Coregonus clupeaformis) embryos and hatchlings. Comp Biochem Physiol A Mol Integr Physiol 179, 71–80. January. https://doi.org/10.1016/j.cbpa.2014.09.005

EPRI (Electric Power Research Institute), 2014. Entrainment Abundance Monitoring Technical Support Document: updated for the New Clean Water Act 316(b) Rule. Technical Report. Palo Alto CA. September.

Favot, E.J., Holeton, C., DeSellas, A.M., Paterson, A.M., 2023. Cyanobacterial blooms in Ontario, Canada: continued increase in reports through the 21st century. Lake and Reservoir Management 39, 1–20. February. https://doi.org/10.1080/10402381.2022.2157781

FCSAP (Federal Contaminated Sites Action Plan), 2012. Federal Contaminated Sites Action Plan (FCSAP): Ecological Risk Assessment Guidance. March.

Golder, Ecometrix (Golder Associates Ltd. and Ecometrix Incorporated), 2017. Pickering Safe Storage Project Predictive Effects Assessment. Report No. P-REP-07701-00002-R000. April.

Golder (Golder Associates Ltd.), 2005. Elements 4.1, 4.3 and 4.4 – Aquatic Environment Post-Restart Follow-Up Monitoring Program 2004 Pickering A Return To Service. Report No. N44-REP-07701.1–00004. April.

Golder (Golder Associates Ltd.), 2007a. Aquatic Environment Technical Support Document Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30-REP-07701–00008. March.

Golder (Golder Associates Ltd.), 2007b. Geology, Hydrogeology and Seismicity Technical Support Document Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30-REP-07701–00006. March.

Golder (Golder Associates Ltd.), 2007c. Terrestrial Environment Technical Support Document Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30-REP-07701–00009. March.

Golder (Golder Associates Ltd.), 2007d. Surface Water Resources Technical Support Document Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30-REP-07701–00007. April.

Golder (Golder Associates Ltd.), 2015. Emission Summary and Dispersion Modelling Report. Report No. P-REP-00541-00014-R001. August.

Golder, SENES (Golder and SENES Consultants Limited), 2009. Aquatic Environment Existing Environmental Conditions Technical Support Document New Nuclear – Darlington Environmental Assessment. Prepared for Ontario Power Generation. Report No. NK054-REP-07730-00003-R000. September.

Government of Canada, 2018. Canada, Ontario and Williams Treaties First Nations reach negotiated settlement agreement for Alderville Litigation. Crown-Indigenous Relations and Northern Affairs Canada. September.

Government of Canada, 2019. Fisheries Act, R.S.C., 1985, c. F-14.

Great Lakes Fishery Commission, 2023. Great Lakes Fishery Commission - Fish Community Objective indicator [WWW Document]. December. URL https://www.glfc.org/indicator.php?indicator=54

Griffiths, J.S., 1980. Potential Effects of Unstable Thermal Discharges on Incubation of Round Whitefish Eggs. Ontario Hydro Research Division. Report No. 80-140-K.

Harrow-Lyle, T.J., Chomicki, K.M., Kirkwood, A.E., 2024. Coastal wetlands as sources of *Escherichia coli* to the nearshore of Lake Ontario. Journal of Great Lakes Research 50, 102292. April. https://doi.org/10.1016/j.jglr.2024.102292

Haymes, G.T., Kolenosky, Dianne P., 1984. Distribution and characteristics of spawning round whitefish in Lake Ontario, 1976-1981. Ontario Ministry of Natural Resources, Toronto.

HC (Health Canada), 2013. Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Ammonia. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

HC (Health Canada), 2016a. Human Health Risk Assessment for Coarse Particulate Matter.

HC (Health Canada), 2016b. Human Health Risk Assessment for Ambient Nitrogen Dioxide.

HC (Health Canada), 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. January.

HC (Health Canada), 2018. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Country Foods. May.

HC (Health Canada), 2024. Guidelines for Canadian Drinking Water Quality - Summary Tables. October. URL https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html

Heck, W., 1964. Plant injury induced by photochemical reaction products of propylene-nitrogen dioxide mixtures. J. Air Pollut. Control Assoc 14, 255–261.

Hesterberg, T.W., Bunn, W.B., McClellan, R.O., Hamade, A.K., Long, C.M., Valberg, P.A., 2009. Critical review of the human data on short-term nitrogen dioxide (NO2) exposures: evidence for NO2 no-effect levels. Critical Reviews in Toxicology 39, 743–81.

Holm, E., Mandrake, N.E., Burridge, M.E., 2021. A Field Guide to Freshwater Fishes of Ontario, Second Edition. Royal Ontario Museum.

IJC (International Joint Commission), 1977. New and Revised Great Lakes Water Quality Objectives, Volume II. October.

Ivanova, S.V., Fisk, A.T., Johnson, T.B., 2024. Predicted growth of lake trout and Chinook salmon in a warming lake. Journal of Great Lakes Research 50, 102310. April. https://doi.org/10.1016/j.jglr.2024.102310

Kleinman, M.T., Mautz, W.J., 1991. The Effects of Exercise on Dose and Dose Distribution of Inhaled Automotive Pollutants. Res Rep Health Eff Inst. 45, 1–40. October.

Lampman, G.G., Makarewicz, J.C., 1999. The Phytoplankton Zooplankton Link in the Lake Ontario Food Web. Journal of Great Lakes Research 25, 239–249. January. https://doi.org/10.1016/S0380-1330(99)70733-1

Logfren, B.M., 2014. Simulation of atmospheric and lake conditions in the Laurentian Great Lakes region using the Coupled Hydrosphere-Atmosphere Research Model (CHARM).

Magnuson, J.J., Crowder, L.B., Medvick, P.A., 1979. Temperature as an Ecological Resource. American Zoologist 19, 331–343. February. https://doi.org/10.1093/icb/19.1.331

MECP (Ministry of Environment, Conservation and Parks), 2008. Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario. May.

MECP (Ministry of the Environment, Conservation and Parks), 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario. Standards Development Branch. April.

MECP (Ministry of the Environment, Conservation and Parks), 2013. Environmental Noise Guideline - Stationary and Transportation Sources - Approval and Planning (NPC-300). August. URL https://www.ontario.ca/page/environmental-noise-guideline-stationary-and-transportation-sources-approval-and-planning

MECP (Ministry of the Environment, Conservation and Parks), 2023. Ontario's Ambient Air Quality Criteria. URL https://www.ontario.ca/page/ontarios-ambient-air-quality-criteria

MNRF (Ministry of Natural Resources and Forestry), 2018. Lake Ontario Fish Communities and Fisheries: 2017 Annual Report of the Lake Ontario Management Unit. Ontario Ministry of Natural Resources and Forestry, Picton, Ontario, Canada. Report No. ISSN 1201-8449.

MOE (Ontario Ministry of the Environment), 1978. Model Municipal Noise Control By-Law - Final Report. August.

MOEE (Ministry of Environment and Energy), 1994. Water management: policies, guidelines, provincial water quality objectives.

Morrison, B., 2019. Chronology of Lake Ontario ecosystem and fisheries. Aquat. Ecosyst. Health Manag. 22, 294–304.

OPG (Ontario Power Generation), 2000. Pickering A Return to Service Environmental Assessment Report Volume 1 Main Report. Report No. NA44-REP-07730–372537. April.

OPG (Ontario Power Generation), 2003. Pickering Waste Management Facility Phase II Project - Submission of Final Environmental Assessment Study Report. December.

OPG (Ontario Power Generation), 2007. OPG Letter, D.P. McNeil to T.E. Schaubel, CNSC, Pickering B Environmental Assessment (EA) for Proposed Refurbishment and Continued Operation - Submission of Final EA Study Report. Report No. Cd# NK30-CORR-00531-04644. December.

OPG (Ontario Power Generation), 2010. Impact of PNGS Thermal Discharge During the Winter of 2010 on Potential Round Whitefish Spawning. Report No. P-REP-07250-00001-R000. August.

OPG (Ontario Power Generation), 2011. Acoustic Assessment of Pickering Nuclear Generating Station, Supporting Document for a Renewal of a Basic Comprehensive Certificate of Approval (C of A) - Air & Noise). Report No. P-REP-00541-00015 R00. May.

OPG (Ontario Power Generation), 2012a. Pickering Nuclear Site Species List - 2011. Report No. P-LIST-07811-00001. July.

OPG (Ontario Power Generation), 2012b. PNGS Thermal Plume Monitoring During Winter of 2010-2011. Report No. P-REP-07250-00003. May.

OPG (Ontario Power Generation), 2012c. Pickering Nuclear Generating Station 2011 Impingement Monitoring Report. Report No. P-REP-07263-00003-R000. October.

OPG (Ontario Power Generation), 2012d. Mitigation of Fish Entrainment at PNGS. Report No. PREP-07262-00001-R000. April.

OPG (Ontario Power Generation), 2013a. PNGS Thermal Plume Monitoring During Winter of 2011-2012. Report No. P-REP-07250-00004. October.

OPG (Ontario Power Generation), 2013b. Condenser Cooling Water Option Assessment Report - OPG Darlington New Nuclear Project. Report No. NK054-REP-01210–00093 R002. January.

OPG (Ontario Power Generation), 2016. Pickering Nuclear Site Species List 2015. Report No. P-LIST-07811-00001-R005. April.

OPG (Ontario Power Generation), 2017a. Pickering Nuclear 2016 Impingement Monitoring Report. Report No. P-REP-07263-00010-R000. April.

OPG (Ontario Power Generation), 2017b. 2016 Results of Environmental Monitoring Programs. Report No. N-REP-03443-10016-R000. April.

OPG (Ontario Power Generation), 2017c. Memorandum: 2016 Pickering Nuclear Thermal Effluent Report. Report No. P-CORR-00541-00848. April.

OPG (Ontario Power Generation), 2018a. Pickering Nuclear 2017 Impingement Monitoring Report. Report No. P-REP-07263-00011-R000. April.

OPG (Ontario Power Generation), 2018b. 2017 Results of Environmental Monitoring Program. Report No. N-REP-03443-10017-R000. April.

OPG (Ontario Power Generation), 2018c. Memorandum: 2017 Pickering Nuclear Thermal Effluent Report. Report No. P-CORR-00541-00863. May.

OPG (Ontario Power Generation), 2018d. Potential Effect of the Thermal Plume from the Pickering Nuclear Generating Station on the Survival of Round Whitefish Embryos. Report No. P-REP-07250-00005-R001. February.

OPG (Ontario Power Generation), 2019a. Dosimetry and Radiological Environmental Quality Assurance Program Manual. Report No. N-MAN-03416.3-0020 R016. November.

OPG (Ontario Power Generation), 2019b. 2018 Acoustic Assessment Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10011-R002. April.

OPG (Ontario Power Generation), 2019c. Pickering Nuclear Generating Station 2018 Impingement Monitoring Report. Report No. P-REP-07263-00012-R000. October.

OPG (Ontario Power Generation), 2019d. 2018 Results of Environmental Monitoring Program. Report No. N-REP-03443-10019-R000. April.

OPG (Ontario Power Generation), 2019e. Memorandum: 2018 Pickering Nuclear Thermal Effluent Report. Report No. P-REP-00541-0766719. May.

OPG (Ontario Power Generation), 2020a. 2019 Acoustic Assessment Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10018-R000. June.

OPG (Ontario Power Generation), 2020b. 2019 Results of Environmental Monitoring Programs. Report No. N-REP-03443-10023-R000. March.

OPG (Ontario Power Generation), 2020c. Memorandum: 2019 Pickering Nuclear Thermal Emission Protection (TEEP) Effluent Report. Report No. P-REP-00541-10017. May.

OPG (Ontario Power Generation), 2021a. 2020 Acoustic Assessment Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10024-R000. June.

OPG (Ontario Power Generation), 2021b. Stormwater and Foundation Drainage Monitoring Assessment for the Darlington and Pickering Waste Management Facilities. Report No. W-CORR-00531-01762. September.

OPG (Ontario Power Generation), 2021c. Pickering Nuclear Generating Station 2020 Impingement Monitoring Report. Report No. P-REP-07263-00014-R000. April.

OPG (Ontario Power Generation), 2021d. Pickering Nuclear Generating Station 2019 Impingement Monitoring Report. Report No. P-REP-07263-00013-R000. January.

OPG (Ontario Power Generation), 2021e. Memorandum: 2020 Pickering Nuclear Thermal Emission Protection (TEEP) Effluent Report. Report No. P-REP-00541-10022. April.

OPG (Ontario Power Generation), 2021f. Potential Effects of the Pickering Nuclear Generating Station Thermal Plume on the Survival of Round Whitefish Embryos, 2018-2020. Report No. P-REP-07250-00007-R002. August.

OPG (Ontario Power Generation), 2021g. 2020 Pickering Nuclear Environmental Compliance Approval NO. 0590- BEDKHH-Annual Performance Report. Report No. P-REP-00541-10023-R000. May.

OPG (Ontario Power Generation), 2022a. 2021 Acoustic Assessment Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10029-R000. May.

OPG (Ontario Power Generation), 2022b. 2021 Pickering Nuclear Environmental Compliance Approval No. 0590- BEDKHH- Annual Performance Report. Report No. P-REP-00541-10028-R000. April.

OPG (Ontario Power Generation), 2022c. Pickering Nuclear Generating Stations 2021 Impingement Monitoring Report. Report No. P-REP-07263-00015. March.

OPG (Ontario Power Generation), 2022d. Memorandum: 2021 Pickering Nuclear Thermal Emission Environmental Protection (TEEP) Effluent Report. Report No. P-REP-00541-10027. April.

OPG (Ontario Power Generation), 2022e. 2021 Pickering Nuclear Groundwater Monitoring Program Results. Report No. P-REP-10120-10048. March.

OPG (Ontario Power Generation), 2022f. Derived Release Limits and Environmental Action Levels for Darlington Nuclear Generating Station. Report No. NK38-REP-03482-100001-R003. December.

OPG (Ontario Power Generation), 2023a. 2022 Results of Environmental Monitoring Programs for Darlington and Pickering Nuclear. Report No. N-REP-03443-10029, R000. April.

OPG (Ontario Power Generation), 2023b. 2021 Results of Environmental Monitoring Programs. Report No. N-REP-03443-10027-R001. July.

OPG (Ontario Power Generation), 2023c. 2022 Acoustic Assessment Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10034-R000. May.

OPG (Ontario Power Generation), 2023d. Pickering Nuclear Generating Stations 2022 Impingement Monitoring Report. Report No. P-REP-07263-00016-000. March.

OPG (Ontario Power Generation), 2023e. 2022 Pickering Nuclear Environmental Compliance Approval No. 1859- C5AKBZ- Annual Performance Report. Report No. P-REP-00541-10033-R000. May.

OPG (Ontario Power Generation), 2023f. Memorandum: 2022 Pickering Nuclear Thermal Emission Environmental Protection (TEEP) Effluent Report. Report No. P-REP-00541-10032. April.

OPG (Ontario Power Generation), 2023g. Groundwater Protection and Monitoring Programs for Pickering Nuclear - CSA N288.7 Implementation. Prepared by: Ecometrix Inc. Report No. P-REP-07294-00002. September.

OPG (Ontario Power Generation), 2023h. 2022 Pickering Nuclear Groundwater Monitoring Program Results. Report No. P-REP-10120-10050. November.

OPG (Ontario Power Generation), 2023i. Nuclear Sustainability Services - Pickering Waste Management Facility - Safety Report. Report No. 92896-SR-01320-10002-R007. October.

OPG (Ontario Power Generation), 2023j. Severe Weather Emergency preparedness. September.

OPG (Ontario Power Generation), 2024a. Pickering NGS Stabilization Activity Plan (SAP). Report No. P-PLAN-00990-00007 R005. November.

OPG (Ontario Power Generation), 2024b. OPG Letter, K. Aggarwal to N. Greencorn, Pickering Waste Management Facility – Notification of Relocation of the Dry Storage Modules from the Phase I Site to the Phase II Site. Report No. CD# 92896-CORR-00531-01600 P. December.

OPG (Ontario Power Generation), 2024c. PNGS-A Detailed Decommissioning Plan Volume 1 - Outbuildings Removal. Report No. NA44-PLAN-00960-00005–00. December.

OPG (Ontario Power Generation), 2024d. 2023 Results of Environmental Monitoring Programs for Darlington and Pickering Nuclear. Report No. N-REP-03443-10031 R000. April.

OPG (Ontario Power Generation), 2024e. Derived Release Limits and Environmental Action Levels for Pickering Nuclear. Report No. P-REP-03482-00006-R001. July.

OPG (Ontario Power Generation), 2024f. 2023 Acoustic Assessment Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10040-R000. June.

OPG (Ontario Power Generation), 2024g. 2023 Pickering Nuclear Environmental Compliance Approval No. 1859 - C5AKBZ Annual Performance Report. Report No. P-REP-00541-10038-R000. May.

OPG (Ontario Power Generation), 2024h. Memorandum: 2023 Pickering Nuclear Thermal Emission Environmental Protection (TEEP) Effluent Report. April.

OPG (Ontario Power Generation), 2024i. 2023 Pickering Nuclear Groundwater Monitoring Program Results. Report No. P-REP-10120-10052. April.

OPG (Ontario Power Generation), 2024j. PNGS-A Detailed Decommissioning Plan Volume 0 - Program Overview. Report No. NA44-PLAN-00960-00004–00. December.

OPG (Ontario Power Generation), 2025. Pickering Nuclear Generating Station B Preliminary Decommissioning Plan. Report No. NK30-PLAN-00960–00001 R000.

Ortech (Ortech Consulting Inc.), 2019a. 2017/2018 (Reg 345 Version) Emission Summary and Dispersion Modelling Report. Report No. P-REP-00541-10008-R002. February.

Ortech (Ortech Consulting Inc.), 2019b. 2018 Emission Summary and Dispersion Modelling Report (AERMOD) for Pickering Nuclear Generating Station. Report No. P-REP-00541-10013-R000. February.

Ortech (Ortech Consulting Inc.), 2020. 2019 Emission Summary and Dispersion Modelling Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10019-R000 P. June.

Ortech (Ortech Consulting Inc.), 2021. 2020 Emission Summary and Dispersion Modelling Report for Pickering Nuclear Generating Station. Report No. P-REP-00541-10025-R003. August.

Patrick, P.H., 2020. Analysis of 2018 and 2019 Two-Year Impingement Threshold Exceedances at PNGS. February.

Patrick, P.H., Powell, J., Mason, E., Tai, M.-K., Stanko, T., Dziedzic, H.D., 2018. Size distribution of larvae entrained and the role of fine mesh screening in excluding larvae at an operating power plant. Lake and Reservoir Management 34, 306–319. March. https://doi.org/10.1080/10402381.2018.1436625

Peterson, D.L., Vecsei, P., Jennings, C.A., 2007. Ecology and biology of the lake sturgeon: a synthesis of current knowledge of a threatened North American Acipenseridae. Rev Fish Biol Fisheries 17, 59–76. February. https://doi.org/10.1007/s11160-006-9018-6

Petrudev (Petrudev Incorporated), 2022. Round Whitefish Action Plan (RWAP) Update and Recommendation for Closure of Darlington New Nuclear Project Deliverable D-P-15.1. Report No. NK054-REP-07730–0942713. June.

Pilla, R.M., Williamson, C.E., Adamovich, B.V., Adrian, R., Anneville, O., Chandra, S., Colom-Montero, W., Devlin, S.P., Dix, M.A., Dokulil, M.T., Gaiser, E.E., Girdner, S.F., Hambright, K.D., Hamilton, D.P., Havens, K., Hessen, D.O., Higgins, S.N., Huttula, T.H., Huuskonen, H., Isles, P.D.F., Joehnk, K.D., Jones, I.D., Keller, W.B., Knoll, L.B., Korhonen, J., Kraemer, B.M., Leavitt, P.R., Lepori, F., Luger, M.S., Maberly, S.C., Melack, J.M., Melles, S.J., Müller-Navarra, D.C., Pierson, D.C., Pislegina, H.V., Plisnier, P.-D., Richardson, D.C., Rimmer, A., Rogora, M., Rusak, J.A., Sadro, S., Salmaso, N., Saros, J.E., Saulnier-Talbot, É., Schindler, D.E., Schmid, M., Shimaraeva, S.V., Silow, E.A., Sitoki, L.M., Sommaruga, R., Straile, D., Strock, K.E., Thiery, W., Timofeyev, M.A., Verburg, P., Vinebrooke, R.D., Weyhenmeyer, G.A., Zadereev, E., 2020. Deeper waters are changing less consistently than surface waters in a global analysis of 102 lakes. Sci Rep 10, 20514. November. https://doi.org/10.1038/s41598-020-76873-x

Reefmaster, 2024. Reefmaster v 2.2.57.0. Reefmaster Software Ltd. 2012-2024.

Richardson, D.C., Melles, S.J., Pilla, R.M., Hetherington, A.L., Knoll, L.B., Williamson, C.E., Kraemer, B.M., Jackson, J.R., Long, E.C., Moore, K., Rudstam, L.G., Rusak, J.A., Saros, J.E., Sharma, S., Strock, K.E., Weathers, K.C., Wigdahl-Perry, C.R., 2017. Transparency, Geomorphology and Mixing Regime Explain Variability in Trends in Lake Temperature and Stratification across Northeastern North America (1975–2014). Water 9, 442. June. https://doi.org/10.3390/w9060442

Rose, K.C., Winslow, L.A., Read, J.S., Hansen, G.J.A., 2016. Climate-induced warming of lakes can be either amplified or suppressed by trends in water clarity. Limnology and Oceanography Letters 1, 44–53. October. https://doi.org/10.1002/lol2.10027

Schaefer, H.M., Honsey, A.E., Bunnell, D.B., Weidel, B.C., DeBruyne, R., Diana, J.S., Gorksy, D., Roseman, E.F., 2022. Predicting physical and geomorphic habitat associated with historical

lake whitefish and cisco spawning locations in Lakes Erie and Ontario. Journal of Great Lakes Research 48, 1636–1646. December. https://doi.org/10.1016/j.jglr.2022.08.014

SENES & MMM (SENES Consultants Limited and MMM Group), 2009. Environmental Impact Statement New Nuclear – Darlington Environmental Assessment. Report No. NK054-REP-07730–00029.

SENES (SENES Consultants Limited), 2007. Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30-REP-07701–00002. December.

SENES (SENES Consultants Limited), 2011a. Fall 2010 Fish Community Sampling Program Final Report. Report No. NK054-REP-07730–0388705. January.

SENES (SENES Consultants Limited), 2011b. Spring 2011 Fish Community and Larval Sampling Program. Report No. NK054-REP-07730–00047. October.

Statistics Canada (Statistics Canada), 2004. Canadian Community Health Survey, Cycle 2.2, Nutrition. URL https://www.canada.ca/en/health-canada/services/food-nutrition/food-nutrition-surveillance/health-nutrition-surveys/canadian-community-health-survey-cchs/canadian-community-health-survey-cycle-2-2-nutrition-focus-food-nutrition-surveillance-health-canada.html

Stephenson, M., Mackie, G.L., 1988. Multivariate Analysis of Correlations Between Environmental Parameters and Cadmium Concentrations in Hyalella azteca (Crustacea: Amphipoda) from Central Ontario Lakes. Can. J. Fish. Aquat. Sci. 45, 1705–1710. October. https://doi.org/10.1139/f88-202

Stephenson, T.D., 1990. Fish Reproductive Utilization of Coastal Marshes of Lake Ontario Near Toronto. Journal of Great Lakes Research 16, 71–81. January. https://doi.org/10.1016/S0380-1330(90)71399-8

Stewart, T., Todd, A., LaPan, S., 2012. Fish-Community Objectives for Lake Ontario. Public Consultation Draft-2012.

TRCA (Toronto and Region Conservation Authority), 2009. Frenchman's Bay Harbour Entrance Environmental Impact Study. March. URL http://www.trca.on.ca/dotAsset/50330.pdf

TRCA (Toronto and Region Conservation Authority), 2013. Ontario Power Generation Landfill. Terrestrial Biological Inventory and Assessment. Report No. P-REP-07811-0508418. December.

TRCA (Toronto and Region Conservation Authority), 2015a. Terrestrial Long-Term Monitoring Project (2014 Monitoring Season). Report No. P-REP-07811-00012. February.

TRCA (Toronto and Region Conservation Authority), 2015b. Ontario Power Generation Terrestrial Long-Term Monitoring Project (2015 Monitoring Season). Report No. P-REP-07811-0584553. December.

TRCA (Toronto and Region Conservation Authority), 2022. TRCA Electrofishing Data in Areas near OPG PNGS Thermal Discharges (1997-2022 data). Provided to OPG through data sharing agreement. November.

Trumpickas, J., Shuter, B.J., Minns, C.K., 2009. Forecasting impacts of climate change on Great Lakes surface water temperatures. Journal of Great Lakes Research 35, 454–463. September. https://doi.org/10.1016/j.jglr.2009.04.005

UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation), 2008. Sources and Effects of Ionizing Radiation. URL https://www.unscear.org/docs/reports/2008/09-86753_Report_2008_GA_Report_corr2.pdf

US EPA (U.S. Environmental Protection Agency), 1986. National Recommended Water Quality Criteria - Aquatic Life Criteria Table. URL https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table

US EPA (U.S. Environmental Protection Agency), 1988. Chemical Assessment Summary - Hydrazine/Hydrazine sulfate; CASRN 302-01-2. Drinking Water Concentration with 1 in 100,000 risk level. URL https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0352_summary.pdf#nameddest=canceroral

US EPA (U.S. Environmental Protection Agency), 2014. National pollutant discharge elimination system – Final regulations to establish requirements for cooling water intake structures at existing facilities and amend requirements at Phase I facilities. Report No. Federal Register, Vol. 79, No. 158. URL https://www.federalregister.gov/documents/2014/08/15/2014-12164/national-pollutant-discharge-elimination-system-final-regulations-to-establish-requirements-for

Welsh, A.B., Carlson, D.M., Schlueter, S.L., Jackson, J.R., 2020. Tracking Stocking Success in a Long-Lived Species through Genetics and Demographics: Evidence of Natural Reproduction in Lake Sturgeon after Twenty-Two Years. Transactions of the American Fisheries Society 149, 121–130. January. https://doi.org/10.1002/tafs.10214

WHO (WHO Regional Office for Europe), 2000. Air Quality Guidelines - Second Edition. Chapter 10 - Effects of sulphur dioxide on vegetation: critical levels. URL https://www.who.int/publications/i/item/9789289013581

Winter, J.G., Howell, E.T., Nakamoto, L.K., 2012. Trends in nutrients, phytoplankton, and chloride in nearshore waters of Lake Ontario: Synchrony and relationships with physical conditions. Journal of Great Lakes Research, The Lake Ontario Nearshore Zone: A Binational Study 38, 124–132. January. https://doi.org/10.1016/j.jglr.2011.09.003

Woolway, R.I., Merchant, C.J., 2019. Worldwide alteration of lake mixing regimes in response to climate change. Nat. Geosci. 12, 271–276. April. https://doi.org/10.1038/s41561-019-0322-x

Appendix A Screening Tables

A.1 Surface water

Table A-1: Screening of Surface Water Quality Parameters in Spring 2024 samples

Parameter	Detection Limit	Units	CCME (1)	PWQO (2)	Interim PWQO (2)	Health Canada (3)	Station																					
							Lake Ontario																		Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Field Measurements																												
Temperature	N/A	Celsius	-	-	-	-	10.1	9.4	17.6	13.5	10.6	20.9	13.4	10.4	11.9	9.9	12.3	9.0	12.5	9.2	12.3	8.7	17.6	17.4	17.3	17.3	15.8	13.6
pH	N/A	pH	6.5-9.0	6.5-8.5	-	-	8.12	8.12	8.29	8.35	8.31	8.23	8.40	8.42	8.27	8.35	8.35	8.36	8.25	8.33	8.32	8.35	**8.56**	**8.51**	8.34	**8.59**	8.50	8.44
Specific Conductivity	N/A	µs/cm	-	-	-	-	303.0	303.1	321.0	323.9	335.8	334.7	399.0	318.9	339.7	319.8	330.2	315.8	339.6	421.0	334.6	310.2	796.0	843.0	869.0	744.0	625.0	704.0
Conductivity	N/A	µs/cm	-	-	-	-	217.9	217.5	280.4	284.4	243.2	308.4	311.0	230.7	254.9	225.0	248.8	219.9	258.2	217.9	253.2	213.7	685.0	721.0	739.0	639.0	516.0	604.0
DO	N/A	%	-	-	-	-	107.9	108.2	124.0	116.4	113.0	132.2	113.2	115.3	114.6	109.8	114.7	110.1	115.1	109.1	115.1	109.5	122.8	115.8	102.4	122.9	114.5	118.7
DO	N/A	mg/L	-	-	-	-	12.13	12.37	11.92	12.15	12.58	12.24	11.81	12.59	12.33	12.44	12.32	12.34	12.25	12.54	12.30	12.74	11.69	11.06	10.25	11.74	11.31	11.52
Turbidity	N/A	NTU	-	-	-	-	-0.52	-0.53	-0.18	-0.43	-0.5	0.37	1.60	-0.34	-0.37	-0.48	-0.37	-0.48	-0.34	-0.46	-0.37	-0.48	6.50	11.90	9.72	4.68	10.34	5.26
Calculated Parameters																												
Dissolved Hardness (CaCO3)	0.50	mg/L	-	-	-	-	111	110	115	112	116	115	125	115	125	118	125	121	120	123	120	121	179	184	192	169	166	165
Total Un-ionized Ammonia	0.0015	mg/L	0.019	0.02	-	-	0.0000	0.0000	0.0000	0.0000	0.0027	0.0098	0.0045	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Chromium (+3)	0.5	ug/L	8.9	8.9	-	-	0.104	0.113	0.000	0.000	0.000	0.000	0.000	0.104	0.000	0.189	0.000	0.000	0.000	0.000	0.105	0.166	0.000	0.000	0.123	0.000	0.000	0.114
Unfiltered Chromium (+3)	0.99	ug/L	-	-	-	-	0.12	0.10	0.18	0.10	0.13	0.10	0.14	0.11	0.12	0.00	0.11	0.17	0.00	0.13	0.00	0.11	0.22	0.66	0.27	0.16	0.21	0.22
Total Hardness (CaCO3)	0.50	mg/L	-	-	-	-	120	119	117	114	117	117	120	117	120	116	118	117	116	121	120	114	187	161	161	177	138	138
Inorganics																												
Total Ammonia-N	0.050	mg/L	0.141-0.855**	-	-	-	0.0185	0.0405	0.0147	0.0494	0.059	0.12	0.064	0.0184	0.0188	0.0223	0.0178	0.0154	0.01	-0.0095	0.0172	0.0154	0.0031	0.0001	0.046	0.012	0.016	0.0244
Total Biochemical Oxygen Demand (BOD)	2	mg/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	4	3	3	3
Total Chemical Oxygen Demand (COD)	4.0	mg/L	-	-	-	-	4.3	5.7	4.3	7.8	5.7	4.3	9.2	4.6	5.5	4.7	5.1	5.5	8.3	4	5.5	5.5	19	19	24	15	13	18
Conductivity	1.0	umho/cm	-	-	-	-	300	310	330	330	340	340	350	330	340	330	330	340	330	360	350	340	810	880	920	780	660	730
Total Kjeldahl Nitrogen (TKN)	0.10	mg/L	-	-	-	-	0.15	0.17	0.2	0.3	0.17	0.24	0.29	0.24	0.25	0.23	0.26	0.28	0.26	0.27	0.2	0.28	0.36	0.42	0.42	0.36	0.39	0.32
Dissolved Organic Carbon	0.40	mg/L	-	-	-	-	1.9	1.9	1.9	2	1.9	1.9	1.9	1.9	1.8	1.9	1.9	1.8	1.8	1.9	2	1.8	3.9	4.1	3.9	3.5	3.2	3.4
Orthophosphate (P)	0.010	mg/L	-	-	-	-	0.0006	0.0001	0.0003	0.0001	0.0001	0.0002	-0.0001	0	0.0002	0.0002	0.0001	0	0	0.0001	0.0002	0	-0.0002	-0.0002	-0.0001	0.0001	0.0001	-0.0002
pH		pH	-	-	-	-	8.07	8.18	8.23	8.23	8.25	8.22	8.22	8.22	8.2	8.24	8.12	8.25	8.17	8.21	8.18	8.25	8.28	8.18	8.15	8.14	8.2	8.21
Total Phosphorus	0.020	mg/L	0.02-0.03	-	0.02	-	0.0001	-0.0002	0.0028	0.017	0.0102	0.0031	0.0126	0.003	0.0062	0.0076	0.0037	0.0015	0.0044	0.0013	0.0041	0.0015	0.0199	0.025	0.023	0.0132	0.0153	0.0168
Total Residual Chlorine	0.003	mg/L	0.0005	0.002	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Suspended Solids	1	mg/L	-	-	-	-	0	0.6	0.8	0.8	0.4	1	0.8	1	0.4	0.4	0.6	0.4	0.4	0.4	0.6	0.4	24	19	19	12	14	11
Turbidity	0.1	NTU	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.2	0.5	0.3	0.3	0.2	0.4	0.2	0.2	0.3	0.3	0.2	4.5	4.5	5.5	4	3.8	6.3
Alkalinity (Total as CaCO3)	1.0	mg/L	-	-	-	-	94	95	100	96	97	98	100	99	100	100	100	100	100	100	100	100	150	160	170	150	130	130
Nitrite (N)	0.010	mg/L	0.197	-	-	1	0.0007	0.0001	-0.0007	0.0001	0.0007	0.0015	-0.0005	-0.0002	0.0013	0.0009	0.0010	0.0005	-0.0004	0.0000	0.0018	0.0005	0.0005	0.0057	0.0076	0.0034	0.0029	0.0041
Nitrate (N)	0.10	mg/L	13	-	-	10	0.29	0.29	0.55	0.48	0.72	0.64	0.4	0.4	0.61	0.38	0.48	0.35	0.32	0.52	0.56	0.35	0	0	0	0	0	0
Nitrate + Nitrite (N)	0.10	mg/L	-	-	-	-	0.29	0.29	0.55	0.48	0.72	0.64	0.4	0.4	0.61	0.38	0.48	0.35	0.32	0.52	0.56	0.35	-0.0031	0.0227	-0.0218	-0.0037	0.0751	0.0561
Metals																												
Total Hexavalent Chromium (Cr 6+)	0.99	µg/L	-	-	-	50	0.58	0.96	0.1	0.24	0.23	0.36	0.21	0.48	-0.13	-0.1	-0.07	-0.2	0.35	-0.25	-0.24	-0.2	-0.55	-0.02	0	0.27	0.03	-0.21
Dissolved Aluminum (Al)	0.5	µg/L	-	75**	-	-	42.3	10.8	1.67	2.37	2.5	1.9	4.41	2.51	2.26	3.56	2	2.24	3.77	5.18	2.4	2.24	2.63	3.68	4.05	2.3	2.79	7.85
Total Aluminum (Al)	0.5	µg/L	100**	-	-	2900	2.63	5.59	3.93	4.41	36.6	4.31	11.3	6.18	5.41	3.37	6.19	6	6.2	2.23	4.71	6	**108**	**146**	**126**	56.5	81.4	84
Dissolved Antimony (Sb)	0.02	µg/L	-	-	-	-	0.149	0.143	0.13	0.132	0.141	0.131	0.148	0.127	0.137	0.131	0.134	0.136	0.155	0.136	0.133	0.136	0.24	0.245	0.28	0.232	0.227	0.243
Total Antimony (Sb)	0.02	µg/L	-	20	-	6	0.145	0.141	0.131	0.135	0.137	0.13	0.133	0.128	0.148	0.126	0.139	0.129	0.13	0.132	0.133	0.129	0.254	0.231	0.236	0.246	0.185	0.24
Dissolved Arsenic (As)	0.02	µg/L	-	-	-	-	0.78	0.827	0.704	0.708	0.711	0.688	0.66	0.692	0.701	0.713	0.716	0.721	0.766	0.714	0.71	0.721	0.528	0.551	0.561	0.536	0.593	0.616
Total Arsenic (As)	0.02	µg/L	5	100	5	10	0.818	0.842	0.718	0.714	0.692	0.688	0.715	0.715	0.689	0.692	0.706	0.703	0.716	0.684	0.681	0.703	0.625	0.578	0.544	0.654	0.576	0.794
Dissolved Barium (Ba)	0.02	µg/L	-	-	-	-	21.7	21.1	21.5	21.8	21.8	21.6	25.1	21.9	22.5	21.8	21.9	22.2	23.7	22	21.7	22.2	37.7	39.4	41.2	37.2	36.4	36.7
Total Barium (Ba)	0.02	µg/L	-	-	-	2000	23.1	23.1	21.6	21.6	21.4	21.4	23	22.1	21.7	21	21.6	21.6	21.2	21.5	21.2	21.6	42.2	37.1	37.2	40.3	30.5	32.4
Dissolved Beryllium (Be)	0.01	µg/L	-	-	-	-	0.0029	0.0046	-0.0001	-0.0011	0.0014	-0.0006	-0.0011	0.0004	0.0047	0.0011	0.0061	0.0097	-0.0002	-0.0014	0.001	0.0097	0.0006	-0.0015	0.0035	0.0023	-0.0015	-0.0002
Total Beryllium (Be)	0.01	µg/L	-	1100**	-	-	0.0056	0.0051	-0.0002	0.0025	-0.0002	-0.0003	-0.0007	-0.0007	0.0017	0.0044	0.0017	0.0033	0.0043	0.0069	0.0027	0.0033	-0.0002	0.016	0.012	0.0072	-0.0015	0.057
Dissolved Bismuth (Bi)	0.005	µg/L	-	-	-	-	0.0086	0.0003	0.0001	0.0005	0.0004	-0.0003	0.0003	0.0003	0.0013	0.0008	0.0006	0.0003	0.0019	0.0004	0.0012	0.0003	0.0001	0.001	0.0011	0.0002	0.0004	0.0008
Total Bismuth (Bi)	0.005	µg/L	-	-	-	-	-0.0008	0.0002	-0.0004	0.0001	0.0004	-0.0001	0.0003	-0.0001	0.0018	0.0003	0.002	0.0005	0.0005	0.0013	0.0015	0.0005	0.0056	0.0069	0.0052	0.0042	0.003	0.014
Dissolved Boron (B)	10	µg/L	-	-	-	-	22	22	24	24	26	24	25	22	25	24	26	24	24	27	26	24	35	37	39	34	32	32

Parameter	Detection Limit	Units	CCME (1)	PWQO (2)	Interim PWQO (2)	Health Canada (3)	Station																					
							Lake Ontario																Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Total Boron (B)	10	µg/L	1500	-	200	5000	25	24	23	22	24	24	21	21	25	23	25	23	23	26	27	23	37	40	42	35	41	40
Dissolved Cadmium (Cd)	0.005	µg/L	-	-	-	-	0.0066	0.004	0.0038	0.0029	0.0037	0.0039	0.0025	0.0034	0.0035	0.0024	0.0026	0.0025	0.0034	0.0032	0.0023	0.0025	0.0008	-0.0001	0	0.0008	0.0012	0.0008
Total Cadmium (Cd)	0.005	µg/L	0.17-0.30**	0.2	0.5**	7	0.0033	0.004	0.0035	0.0046	0.0031	0.0033	0.0038	0.0032	0.0046	0.0033	0.0041	0.0047	0.003	0.0066	0.0051	0.0047	0.0077	0.0298	0.0169	0.007	0.0066	0.0236
Dissolved Chromium (Cr)	0.1	µg/L	-	-	-	-	0.1	0.11	0.0803	0.0944	0.0913	0.0793	0.0771	0.1	0.0993	0.19	0.0926	0.0767	0.0884	0.0751	0.11	0.0767	0.0605	0.0514	0.12	0.0831	0.0432	0.11
Total Chromium (Cr)	0.1	µg/L	-	-	-	50	0.12	0.1	0.18	0.1	0.13	0.1	0.14	0.11	0.12	0.0796	0.11	0.17	0.0905	0.13	0.0921	0.17	0.22	0.66	0.27	0.16	0.21	0.22
Dissolved Cobalt (Co)	0.005	µg/L	-	-	-	-	0.0165	0.0113	0.0171	0.0139	0.0209	0.0187	0.0175	0.0136	0.0228	0.0146	0.0197	0.0116	0.0105	0.0229	0.0194	0.0116	0.032	0.0363	0.0379	0.0303	0.0321	0.0334
Total Cobalt (Co)	0.005	µg/L	-	-	0.9	-	0.0096	0.0096	0.0176	0.0146	0.0227	0.0181	0.0182	0.0146	0.0225	0.0111	0.0269	0.0135	0.0113	0.0237	0.0213	0.0135	0.107	0.139	0.105	0.0758	0.069	0.087
Dissolved Copper (Cu)	0.05	µg/L	-	-	-	-	0.925	0.721	0.777	0.762	0.714	0.736	0.711	0.693	0.751	0.664	0.707	0.725	0.79	0.834	0.72	0.725	0.602	0.627	0.578	0.627	0.693	1.11
Total Copper (Cu)	0.05	µg/L	2.6-4.0**	5	5.0**	2000	0.733	0.77	1.25	0.776	0.825	0.887	0.775	0.712	0.778	0.631	0.78	0.664	0.642	0.769	0.746	0.664	1.25	1.29	1.09	1.04	1.03	1.78
Dissolved Iron (Fe)	1	µg/L	-	-	-	-	6.3	8.8	1.5	2.2	3.2	1.3	4	5.8	1.8	3.7	2	1.6	2.1	9.2	2.2	1.6	6.4	8.5	10.9	6.4	11.4	11.4
Total Iron (Fe)	1	µg/L	300	300	-	-	2.5	3.5	8.8	6.6	8.4	7.3	15.3	12.2	9.6	4.9	9.4	4.6	3.7	2.7	10.5	4.6	**309**	**324**	**320**	177	187	212
Dissolved Lead (Pb)	0.005	µg/L	-	-	-	-	0.279	0.111	0.0093	0.0162	0.0095	0.0074	0.0161	0.0116	0.0165	0.0169	0.0072	0.0074	0.02	0.0129	0.0116	0.0074	0.0162	0.0268	0.0671	0.0154	0.0281	0.0385
Total Lead (Pb)	0.005	µg/L	3.6-7.0**	25	5.0**	5	0.0213	0.0336	0.0145	0.0317	0.0254	0.0134	0.0358	0.0245	0.0193	0.008	0.0229	0.016	0.009	0.0103	0.0191	0.016	0.612	0.605	0.554	0.385	0.369	0.42
Dissolved Lithium (Li)	0.5	µg/L	-	-	-	-	1.63	1.47	1.72	1.69	1.8	1.73	1.83	1.65	1.78	1.64	1.68	1.65	1.67	1.72	1.73	1.65	2.29	2.25	2.31	2.35	2.15	2.42
Total Lithium (Li)	0.5	µg/L	-	-	-	-	1.59	1.62	1.66	1.48	1.6	1.59	1.62	1.56	1.74	1.75	1.77	1.79	1.68	1.78	1.75	1.79	2.31	2.43	2.36	2.25	2.27	2.64
Dissolved Manganese (Mn)	0.05	µg/L	180-270**	-	-	-	1.02	0.675	1.31	1.01	1.59	1.36	2.05	0.978	1.63	0.834	1.31	0.637	0.744	2.02	1.53	0.637	4.34	8.07	9.19	2.28	3.92	12
Total Manganese (Mn)	0.05	µg/L	-	-	-	120	0.474	0.538	1.59	1.35	2.09	1.65	2.68	2.31	2	0.798	1.63	0.73	0.651	1.65	1.73	0.73	79.5	66.4	66.7	64.1	49.7	57.6
Dissolved Molybdenum (Mo)	0.05	µg/L	-	-	-	-	1.17	1.12	1.19	1.18	1.29	1.2	1.21	1.17	1.19	1.16	1.17	1.14	1.28	1.21	1.22	1.14	1.33	1.34	1.35	1.33	1.35	1.38
Total Molybdenum (Mo)	0.05	µg/L	73	-	40	-	1.23	1.22	1.21	1.17	1.26	1.21	1.16	1.15	1.17	1.11	1.21	1.14	1.12	1.2	1.18	1.14	1.37	1.15	1.11	1.36	1.09	1.12
Dissolved Nickel (Ni)	0.02	µg/L	-	-	-	-	0.668	0.536	0.838	0.549	0.606	0.562	0.495	0.505	0.574	0.513	0.495	0.548	0.592	0.567	0.523	0.548	0.521	0.553	0.535	0.533	0.533	0.557
Total Nickel (Ni)	0.02	µg/L	103-150**	25	-	-	0.553	0.565	0.794	0.541	0.685	0.724	0.591	0.507	0.569	0.484	0.571	0.529	0.503	0.562	0.549	0.529	0.752	0.73	0.63	0.609	0.61	0.69
Dissolved Selenium (Se)	0.04	µg/L	-	-	-	-	0.124	0.136	0.136	0.128	0.148	0.135	0.12	0.119	0.131	0.131	0.126	0.118	0.119	0.123	0.138	0.118	0.105	0.094	0.095	0.099	0.105	0.117
Total Selenium (Se)	0.04	µg/L	1	100	-	50	0.143	0.149	0.137	0.113	0.131	0.142	0.127	0.122	0.132	0.132	0.125	0.108	0.123	0.138	0.139	0.117	0.131	0.101	0.124	0.125	0.094	0.123
Total Silicon (Si)	50	µg/L	-	-	-	-	359	325	270	266	278	278	258	264	263	216	236	224	216	265	250	253	1230	1140	1070	1080	821	721
Dissolved Silicon (Si)	50	µg/L	-	-	-	-	332	304	268	267	290	279	354	265	260	217	256	226	224	280	251	226	1090	1090	1090	987	856	742
Dissolved Silver (Ag)	0.005	µg/L	-	-	-	-	0.0029	0.0015	0.0019	0.0043	0.0017	0.0015	0.001	0.0023	0.0012	0.0003	0.0008	0.0019	0.0003	0.0007	0.0004	0.0019	0	0.0003	0	0.0008	0.0005	0.0023
Total Silver (Ag)	0.005	µg/L	0.25	0.1	-	-	0.0006	-0.0002	0.0006	0.001	0.0019	0.0009	0.0009	0.0013	0.0008	-0.0001	0.0005	0.0013	0.0002	0.0012	0.0006	0.0013	0.0031	0.0023	0.0019	0.0012	0.0033	0.0082
Dissolved Strontium (Sr)	0.050	µg/L	-	-	-	-	175	174	176	174	181	177	197	176	198	190	191	195	207	193	193	195	273	298	304	260	276	296
Total Strontium (Sr)	0.050	µg/L	-	-	-	7000	189	192	176	173	176	172	178	175	178	172	175	174	174	178	175	174	294	256	258	297	226	250
Dissolved Thallium (Tl)	0.002	µg/L	-	-	-	-	0.0058	0.0049	0.0058	0.007	0.0081	0.0055	0.0052	0.0066	0.0071	0.0065	0.0063	0.0072	0.0077	0.0063	0.0058	0.0072	-0.0009	0.0004	0.0008	-0.0004	0.0014	0.0019
Total Thallium (Tl)	0.002	µg/L	0.8	-	0.3	-	0.0059	0.0067	0.0062	0.0069	0.0059	0.0049	0.0067	0.0067	0.004	0.0057	0.0051	0.0047	0.0048	0.0059	0.0047	0.0047	0.0036	0.0065	0.004	0.0024	0.0028	0.0043
Dissolved Tin (Sn)	0.2	µg/L	-	-	-	-	0.031	0.0834	0.0406	1.13	0.0429	0.0213	0.0102	0.0369	0.0208	0.0283	0.0167	0.0505	0.0658	0.0093	0.0268	0.0505	0.019	0.0296	0.0293	0.0811	0.0184	0.1225
Total Tin (Sn)	0.2	µg/L	-	-	-	-	0.013	0.0279	0.0241	0.0124	0.38	0.0132	0.0096	0.0119	0.0096	0.0078	0.0166	0.1852	0.0107	0.0147	0.0037	0.1852	0.0318	0.0355	0.0337	0.0257	0.0224	0.0417
Dissolved Titanium (Ti)	0.5	µg/L	-	-	-	-	0.3063	0.2555	0.1184	0.1526	0.2131	0.1485	0.1473	0.1592	0.1981	0.2782	0.1431	0.2062	0.2464	0.3436	0.1599	0.2062	-0.1561	0.1546	0.1401	-0.1118	0.1868	0.2667
Total Titanium (Ti)	0.5	µg/L	-	-	-	-	0.0156	0.024	0.1706	0.0824	0.1901	0.0725	0.3345	0.2404	0.1354	0.0316	0.0355	-0.007	-0.0405	-0.1137	0.0314	-0.007	5.78	6.4	5.6	3.09	3.9	3.7
Dissolved Uranium (U)	0.002	µg/L	-	-	-	-	0.369	0.36	0.365	0.353	0.368	0.34	0.387	0.364	0.379	0.363	0.361	0.37	0.407	0.365	0.366	0.37	0.525	0.511	0.529	0.519	0.469	0.441
Total Uranium (U)	0.002	µg/L	1.5	5	5	20	0.379	0.379	0.362	0.369	0.368	0.352	0.385	0.363	0.373	0.366	0.375	0.367	0.371	0.379	0.372	0.367	0.504	0.451	0.474	0.491	0.4	0.388
Dissolved Vanadium (V)	0.2	µg/L	-	-	-	-	0.45	0.1926	0.1957	0.1838	0.1913	0.1962	0.23	0.1945	0.21	0.25	0.21	0.22	0.24	0.21	0.21	0.22	0.37	0.47	0.45	0.36	0.38	0.36
Total Vanadium (V)	0.2	µg/L	-	6	6	-	0.1724	0.21	0.1258	0.1397	0.1935	0.1326	0.23	0.1352	0.1529	0.1387	0.1498	0.38	0.1487	0.1442	0.1501	0.38	0.86	0.8	0.76	0.66	0.54	0.52
Dissolved Zinc (Zn)	0.1	µg/L	15**	-	-	-	4.38	7.54	5.02	0.65	1.46	0.77	0.63	1.66	0.6	1.8	0.67	0.76	0.92	0.58	0.92	0.76	0.35	1.52	0.8	0.22	0.28	0.87
Total Zinc (Zn)	0.1	µg/L	-	30	20	-	0.38	5.24	2.42	1	1.62	0.77	0.81	0.55	0.9	0.41	4.76	8.72	0.84	0.61	1.4	8.72	2.83	4.8	3.4	1.65	2.2	6.5
Dissolved Zirconium (Zr)	0.1	µg/L	-	-	-	-	0.0104	0.01	0.0137	0.0393	0.0375	0.0129	0.0129	0.0203	0.0183	0.0063	0.0125	0.0107	0.0124	0.0115	0.01	0.0107	0.0205	0.0193	0.0189	0.0164	0.022	0.0166
Total Zirconium (Zr)	0.1	µg/L	-	-	4	-	0.0085	0.004	0.0063	0.0154	0.0112	0.0185	0.0179	0.0129	0.0091	0.0158	0.0106	0.0137	0.0059	0.0136	0.016	0.0137	0.0351	0.0722	0.0595	0.0439	0.0324	0.0427
Dissolved Calcium (Ca)	10	µg/L	-	-	-	-	31100	31000	33100	32100	33100	33100	36800	33200	35800	33800	36100	34200	33400	35000	34300	34200	56800	58400	61800	52600	51700	51500
Total Calcium (Ca)	10	µg/L	-	-	-	-	33800	33600	33000	32000	33200	33100	34200	33200	34000	32900	33300	33000	32300	33900	34000	33000	60000	51300	51500	56200	42600	42800
Dissolved Cesium (Cs)	0.05	µg/L	-	-	-	-	0.0036	0.002	0.0029	0.0026	0.0032	0.0027	0.0026	0.0023	0.0028	0.0009	0.0051	0.0006	0.0022	0.0043	0.0009	0.0006	0.0012	0.0015	-0.0008	0.0011	-0.0005	0.0002
Total Cesium (Cs)	0.05	µg/L	-	-	-	-	0.0029	0.0029	0.002	0.0025	0.0039	0.0021	0.0022	0.0019	0.004	0.0017	0.063	0.0035	0.0029	0.0051	0.0048	0.0035	0.0077	0.0204	0.0182	0.0058	0.0093	0.0111
Dissolved Magnesium (Mg)	10	µg/L	-	-	-	-	8000	7900	7980	7800	8060	7940	8070	7760	8670	8200	8380	8600	8890	8510	8320	8600	9150	9150	9190	9160	8870	8920
Total Magnesium (Mg)	10	µg/L	-	-	-	-	8620	8630	8350	8220	8340	8280	8430	8170	8540	8280	8520	8400	8560	8740	8480	8400	9040	7890	7850	8970	7680	7600
Dissolved Potassium (K)	10	µg/L	-	-	-	-	1470	1480	1700	1640	1830	1770	1680	1590	1860	1580	1680	1640	1700	1790	1720	1640	2120	2160	2210	2050	2030	2050

Parameter	Detection Limit	Units	CCME (1)	PWQO (2)	Interim PWQO (2)	Health Canada (3)	Station																			
							Lake Ontario																Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Total Potassium (K)	10	µg/L	-	-	-	-	1570	1610	1680	1650	1840	1760	1660	1570	1800	1570	1680	1600	1580	1750	1770	1600	2160	1910	1870	2130	1730	1760
Dissolved Sodium (Na)	10	µg/L	-	-	-	-	12700	12500	15800	14900	16700	16300	30100	15600	17300	14600	16200	15100	15500	17200	16400	15100	85100	87200	92900	78000	66700	66700
Total Sodium (Na)	10	µg/L	-	-	-	-	13600	13600	15700	15200	16700	16000	17600	15600	17000	14700	16300	14800	14700	17000	16700	14800	84000	74600	78300	77600	52500	58600
Dissolved Thorium (Th)	0.05	µg/L	-	-	-	-	0.0035	0.0029	-0.0033	0.0041	0.013	-0.0016	-0.0006	-0.0005	0.0059	0.006	0.0034	0.0032	-0.0012	0.0033	0.002	0.0032	-0.0018	0.0054	0.0028	-0.0016	0.0047	0.0012
Total Thorium (Th)	0.05	µg/L	-	-	-	-	0.0039	0.004	0.0099	0.0046	0.0052	0.0072	0.0069	0.0125	-0.0013	0.0031	0.0008	-0.0014	-0.0027	-0.0003	-0.0018	-0.0014	0.0247	0.0225	0.0265	0.0197	0.0172	0.0137
Dissolved Tungsten (W)	0.01	µg/L	-	-	-	-	0.073	0.076	0.08	0.071	0.089	0.076	0.071	0.078	0.074	0.077	0.075	0.079	0.083	0.073	0.076	0.079	0.046	0.048	0.053	0.048	0.06	0.065
Total Tungsten (W)	0.01	µg/L	-	-	30	-	0.077	0.082	0.078	0.071	0.08	0.073	0.071	0.071	0.071	0.07	0.07	0.074	0.069	0.072	0.072	0.074	0.056	0.044	0.051	0.059	0.056	0.056
Chromium (VI)	0.50	ug/L	1	1	-	50	0.1955	0.1935	0.2596	0.1465	0.2148	0.2131	0.2383	0.1869	0.2094	0.2011	0.2053	0.2183	0.2303	0.233	0.2251	0.1752	0.1724	0.1765	0.145	0.1502	0.1747	0.1591
Mercury (Hg)	0.01	ug/L	0.026	-	-	1	0.0007	0.0003	0.0009	0.0018	0.0016	0.0012	0.0012	0.0005	0.0031	0.0018	0.0017	0.0021	0.0033	0.0024	0.0031	0.0028	0.0024	0.0019	0.0027	0.0017	0.0026	0.002
Dissolved Mercury (Hg)	0.01	ug/L	-	0.2	-	-	0.0026	0.0019	0.0011	0.002	0.0017	0.0024	0.002	0.0014	0.0022	0.0018	0.0027	0.0023	0.0024	0.0012	0.002	0.0023	0.0014	0.0025	0.001	0.0018	0.0023	0.0017
Volatile Organics																												
Benzene	0.10	ug/L	370	-	100	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromodichloromethane	0.10	ug/L	-	-	200	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromoform	0.20	ug/L	-	-	60	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloroform	0.10	ug/L	1.8	-	-	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethylbenzene	0.10	ug/L	90	-	8	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocarbons																												
F1 (C6-C10)	25	ug/L	167	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F1 (C6-C10) - BTEX	25	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F2 (C10-C16 Hydrocarbons)	100	ug/L	42	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F3 (C16-C34 Hydrocarbons)	200	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F4 (C34-C50 Hydrocarbons)	200	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reached Baseline at C50		ug/L	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Surrogate Recovery (%)																												
1,4-Difluorobenzene		%	-	-	-	-	107	107	110	109	108	114	109	108	100	101	101	99	101	100	102	102	104	100	101	101	105	103
4-Bromofluorobenzene		%	-	-	-	-	96	101	94	90	97	93	93	95	90	94	96	95	90	96	94	94	90	96	96	92	94	96
D10-o-Xylene		%	-	-	-	-	117	114	109	107	111	111	111	109	86	90	86	85	91	81	91	90	95	89	91	91	89	86
D4-1,2-Dichloroethane		%	-	-	-	-	101	99	96	97	96	92	95	97	101	100	101	105	100	100	98	101	102	100	101	100	97	100
o-Terphenyl		%	-	-	-	-	104	103	99	102	99	102	100	100	103	103	103	105	102	101	99	100	96	98	98	95	103	99
4-Bromofluorobenzene		%	-	-	-	-	92	93	94	103	92	92	93	92	99	97	96	95	94	103	98	99	99	96	97	97	97	99
D4-1,2-Dichloroethane		%	-	-	-	-	93	95	74	77	98	77	77	77	94	94	92	89	95	97	96	93	91	94	93	91	92	93
D8-Toluene		%	-	-	-	-	101	102	102	97	100	101	103	103	99	100	97	97	96	98	99	99	100	99	99	100	98	99
Microbiological																												
Background	10	CFU/100mL	-	-	-	-	<10	320.00	440.00	680.00	200.00	190.00	420.00	440.00	1200	840	680	440	310.00	360	620	420	2600	3100	2200	2100	2600	38000
Fecal coliform	10	CFU/100mL	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	10.00	10	<10	20	<10	10.00	<10	<10	<10	10	20	<10	10	10	780
Total Coliforms	10	CFU/100mL	-	-	-	10	<10	<10	**520**	**30**	**30**	**20**	**20**	10	**510**	10	**140**	10	**50**	**40**	**60**	<10	**940**	**3400**	**1500**	**30**	**70**	**14000**
Escherichia coli	10	CFU/100mL	-	100	-	10	<10	<10	<10	<10	<10	<10	<10	10	<10	<10	<10	<10	10	<10	<10	<10	<10	**20**	10	<10	<10	**480**
Radionuclides																												
H-3	14	Bq/kg	-	7000	-	7000	-5.27	15.9	31.7	21.2	0	15.9	26.5	15.8	5.3	0	5.3	5.31	5.31	5.28	5.3	0	31.8	37.1	31.8	37	31.8	31.6
C-14	0.027	Bq/g	-	-	-	-	-0.0498	-0.0472	-0.0371	-0.0341	-0.0451	-0.0458	-0.0312	-0.0407	-0.0426	-0.0421	-0.0432	-0.0535	-0.0389	-0.0447	-0.0444	-0.0375	-0.0313	-0.0271	-0.0327	-0.036	-0.037	-0.0455
Co-60	0.73	Bq/kg	-	-	-	-	-0.352	0.513	-0.197	0.0501	0.298	-0.253	0.163	0.0538	0.0534	0.149	-0.0672	-0.079	0.0363	0.389	-0.182	0.0688	0.0797	-0.147	-0.0869	-0.17	-0.133	-0.0857
Cs-134	0.75	Bq/g	-	-	-	-	0.145	-0.11	-0.0795	-0.07	-0.226	0.199	-0.0844	0.309	-0.11	-0.232	0.373	0.231	0.111	0.173	0.211	-0.151	0.129	-0.127	-0.281	0.121	0.146	-0.0704
Cs-137	0.6	Bq/kg	-	50	-	10	0.275	-0.214	0.353	0.0574	0.0421	0.306	-0.506	0.19	-0.11	0.258	-0.361	0.174	0.129	-0.0437	0.271	0.209	-0.653	-0.369	0.314	-0.464	0.196	0.105
I-131	1.2	Bq/kg	-	10	-	6	0.198	0.0293	1.08	0.719	-0.332	-1.03	0.73	-0.938	0.0647	0.0511	-0.85	0.428	-0.0426	-0.986	-0.0026	-0.517	0.373	-0.291	0.333	0.58	-0.334	0.29
K-40	7.1	Bq/g	-	-	-	-	2.67	-0.125	2.76	1.52	-3.4	3.09	0.999	2.82	2.49	4.96	-0.924	0.00429	-0.757	1.09	2.41	8.37	0.96	-1.71	5.8	22.3	-2.07	-4.05
Th-Series	1.8	Bq/kg	-	-	-	-	-2.04	-0.468	1.47	-0.295	-1.98	0.551	0.618	-1.43	-0.691	-0.866	-0.563	-1.39	-0.122	0.731	0.271	-0.425	-0.0855	1.25	-0.501	1.54	0.44	-0.577
U-Series	1.5	Bq/kg	-	-	-	-	0.911	1.34	0.452	0.292	-0.901	0.587	-0.454	-1.02	-0.0158	0.566	1.1	0.154	0.274	1.22	0.213	0.173	0.149	0.0759	-0.331	-0.245	0.228	0.0872
Miscellaneous Parameters																												
Hydrazine	0.1	ug/L	2.6	-	-	-	<0.1	<0.1	**4.2**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Monomethyl Hydrazine	0.25	ug/L	-	-	-	-	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25

Parameter	Detection Limit	Units	CCME (1)	PWQO (2)	Interim PWQO (2)	Health Canada (3)	Station																				
							Lake Ontario																		Frenchman's Bay		
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
1,1-Dimethylhydrazine	0.25	ug/L	-	-	-	-	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Chlorophyll a	1.3	ug/L	-	-	-	-	1.400	0.019	2.000	1.500	2.400	2.300	2.200	4.100	1.241	2.200	1.300	1.600	1.232	1.300	1.500	1.600	27.000	24.000	27.000	24.000	31.000	27.000
Morpholine	4	ug/L	-	-	4	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dissolved Methyl Mercury	0.050	ng/L	-	-	-	-	0.066	0.048	0.030	0.022	0.021	0.011	0.010	0.010	0.031	0.013	0.014	0.016	0.039	0.024	0.025	0.017	0.027	0.012	0.024	0.060	0.015	0.014
Total Methyl Mercury	0.050	ng/L	4	-	-	-	0.032	0.012	0.013	0.019	0.032	0.053	0.022	0.016	0.018	0.015	0.014	0.008	0.014	0.070	0.012	0.001	0.005	0.001	0.001	0.026	0.022	0.011

Notes:

Bold Exceeded Interim PWQO
Bold Exceeded PWQO
Bold Exceeded CCME
Bold Exceeded Health Canada Guidelines
Bold Exceeded more than one guideline

Surface water samples from Lake Ontario were collected at a depth of 0.5 meters (denoted by "S" in the sample name), while bottom samples were taken 0.5 meters above the lakebed (denoted by "B"). Mid-depth samples were collected in Frenchman's Bay, as thermal stratification is unlikely in the shallow depths observed in this area. Sampling locations presented in Figure 4-3 and Figure 4-4.

* Only censored results provided by lab.

** Calculated values. The value for Hardness (as CaCO3) dissolved was used to estimate hardness-dependent guidelines.

a – Total Ammonia guideline (Long Term Concentration (mg/L) Table): Retrieved from: https://ccme.ca/en/chemical/5#_aql_fresh_concentration

b – Dissolved Aluminum guideline: The Interim PWQO is 15 µg/L between pH 4.5 to 5.5, and 75 µg/L between pH 6.5 to 9.0. Between pH 5.5 - 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than 10% above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs.

c – Total Aluminum guideline (Long Term Concentration (µg/L) Variable): If pH < 6.5, the CWQG is 5 µg/L. If pH ≥ 6.5, the guideline is 100 µg/L.

d – Total Beryllium guideline (µg/L): If Hardness < 75 mg/L, the PWQO is 11 µg/L. If Hardness > 75 mg/L, then the PWQO is 1100 µg/L.

e – Total Cadmium guideline (Long Term concentration (µg/L) equation): When the water hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L. At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated as 10{0.83(log[hardness]) – 2.46}. At hardness > CWQG (µg/L) = 10{0.83(log[hardness]) – 2.46} At hardness > 280 mg/L, the guideline is 0.37 µg/L.

f – Total Cadmium guideline (µg/L): If Hardness 0-100 mg/L, the Interim PWQO is 0.1 µg/L. If Hardness > 100 mg/L, then the Interim PWQO is 0.5 µg/L.

g – Total Copper guideline (Long Term concentration (µg/L) equation): When the water hardness is 0 to < 82 mg/L, the CWQG is 2 µg/L. At hardness ≥82 to ≤180 mg/L the CWQG is calculated using this equation: 0.2 * e{0.8545[ln(hardness)]-1.465}. At hardness >180 mg/L, the CWQG is 4 µg/L.

h - Total Copper guideline (µg/L): If Hardness 0-20 mg/L, the Interim PWQO is 1 µg/L. If Hardness > 20 mg/L, then the Interim PWQO is 5 µg/L.

i – Total Lead guideline (Long Term concentration (µg/L) equation): When the hardness is 0 to ≤ 60 mg/L, the CWQG is 1 µg/L. At hardness >60 to ≤ 180 mg/L the CWQG is calculated as e{1.273[ln(hardness)]-4.705}. At hardness >180 mg/L, the CWQG is 7 µg/L. At hardness >180 mg/L, the CWQG is 7 µg/L.

j – Total Lead guideline: If Hardness is 30-80 mg/L, then the Interim PWQO is 3 µg/L. If Hardness is > 80 mg/L, then the Interim PWQO is 5 µg/L.

k – Dissolved Manganese concentration (Long Term concentration (µg/L) equation): Calculated using the CWQG calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese. Retrieved from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fccme.ca%2Fen%2Fres%2F2019-manganese-cwqg-scd-appendix-b-en.xlsx&wdOrigin=BROWSELINK

l – Total Nickel guideline (Long Term concentration (µg/L) equation): When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 25 µg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated as e{0.76[ln(hardness)]+1.06}. At hardness >180 mg/L, the CWQG is 150 µg/L.

m – Dissolved Zinc guideline (Long Term concentration (µg/L) equation): The CWQG is calculated as exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625).
This equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1, which is the range of data used to derive the hardness, pH and DOC slopes.

n – Radionuclides are not screened as their levels should be as low as reasonably achievable (ALARA).

References:

1. CCME. n.d. Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in September 2024.
2. Ministry of Environment and Climate Change. MOECC. 1994. Water management: policies, guidelines, provincial water quality objectives.
3. Health Canada. 2019. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Table A-2: Screening of Surface Water Quality Parameters in Summer 2024 samples

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																			
							Lake Ontario																Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Field Measurements																										
Temperature	N/A	Celsius	-	-	-	-	18.1	13.3	27.2	29.4	17.8	27.7	20.5	17.1	22.8	15.6	22.8	15.6	24.4	16.6	23.6	15.4	24.9	24.5	24	25.1	23.6	23.2
pH	N/A	pH	6.5-9.0	6.5-8.5	-	-	8.32	8.21	8.17	**8.54**	**8.63**	8.36	8.31	8.34	8.51	8.1	**8.51**	8.1	8.36	7.94	8.48	8.12	8.13	8.06	7.69	8.3	7.99	7.91
Specific Conductivity	N/A	µs/cm	-	-	-	-	261.8	235.2	317.6	312.5	308.8	311.4	301.6	304	307.7	306.1	306.2	307.2	309.5	307.3	307.5	304.5	462.5	471.5	562	455.4	394.4	395.7
Conductivity	N/A	µs/cm	-	-	-	-	301.6	302.3	325.9	339.6	259.3	327.4	275.5	257.2	294.3	251.8	287.5	253.7	306.1	254.6	299.3	252.1	461.1	468.2	582	294.3	382.6	378.1
DO	N/A	%	-	-	-	-	104.5	96.6	119.9	129.4	117.6	124.6	117.8	102.7	120.9	90.7	123.2	94.9	122.1	96.8	122.3	94.2	89.1	87	72.5	95.6	99.3	96.6
DO	N/A	mg/L	-	-	-	-	9.86	10.09	9.64	9.94	11.15	9.86	10.62	9.85	10.43	9.03	10.72	9.37	10.17	9.55	10.3	9.26	7.36	7.14	6.04	7.89	8.44	8.25
Turbidity	N/A	NTU	-	-	-	-	-0.44	-0.16	-0.13	-0.27	-0.22	-0.13	-0.23	0.48	-0.39	-0.17	-0.39	-0.1	-0.38	-0.27	-0.39	-0.37	5.77	7.15	9.71	5.65	1.32	1.95
Calculated Parameters																										
Dissolved Hardness (CaCO3)	0.50	mg/L	-	-	-	-	112	113	104	104	114	104	111	111	111	112	110	114	113	108	112	110	132	131	136	135	106	125
Total Un-ionized Ammonia	0.0015	mg/L	0.019	0.02	-	-	0.0074	0.0083	**0.021**	**0.048**	**0.022**	0.012	**0.038**	0.004	**0.031**	0.005	**0.044**	0.0054	0.012	**0.048**	**0.029**	0.0084	0.018	**0.027**	0.0091	**0.038**	0.003	0.005
Chromium (+3)	0.5	ug/L	8.9	8.9	-	-	0.103	0.147	0.000	0.181	0.138	0.130	0.000	0.104	0.118	0.000	0.178	0.102	0.200	0.000	0.000	0.105	0.000	0.170	0.174	0.108	0.156	0.145
Unfiltered Chromium (+3)	0.99	ug/L	-	-	-	-	0.00	0.11	0.11	0.12	0.10	0.00	0.00	0.13	0.00	0.11	0.00	0.00	0.11	0.00	0.11	0.00	0.28	0.54	0.37	0.25	0.10	0.14
Total Hardness (CaCO3)	0.50	mg/L	-	-	-	-	115	118	95	108	113	101	95	106	106	107	110	104	107	110	108	110	127	118	128	120	97	100
Inorganics																										
Total Ammonia-N	0.050	mg/L	0.077-0.888**	-	-	-	0.090	0.180	0.190	**0.190**	**0.150**	0.072	**0.410**	0.055	**0.190**	0.120	**0.270**	0.130	0.090	**1.500**	**0.180**	0.190	0.210	**0.370**	0.300	**0.300**	0.051	0.100
Total Biochemical Oxygen Demand (BOD)	2	mg/L	-	-	-	-	0	0	0	0	0	4	5	4	0	0	0	2	0	0	3	0	3	4	11	3	3	6
Total Chemical Oxygen Demand (COD)	4.0	mg/L	-	-	-	-	4.7	7.2	-3.4112	-3.1907	2.7996	-3.0262	-3.3897	-2.545	-1.1185	-3.4114	-1.4873	-3.0301	-1.0387	-3.5615	-3.5951	-2.7451	-3.5789	-3.2805	0.8863	-0.6195	-3.001	-2.636
Conductivity	1.0	umho/cm	-	-	-	-	300	310	310	310	310	300	300	300	310	310	310	310	310	310	310	310	460	460	550	450	390	400
Total Kjeldahl Nitrogen (TKN)	0.10	mg/L	-	-	-	-	0.17	0.23	0.22	0.23	0.17	0.18	0.64	0.18	0.2	0.27	0.87	0.35	0.18	1.3	0.37	0.18	0.94	0.55	0.56	0.33	0.29	0.36
Dissolved Organic Carbon	0.40	mg/L	-	-	-	-	2	1.9	2.1	2.1	2.1	2.1	2	2.1	2	2.1	2	2.1	1.9	2	2	2.1	3.4	3.4	4.4	3.3	2.9	3
Orthophosphate (P)	0.010	mg/L	-	-	-	-	0.0008	0.0005	0.0001	0.0001	0	0.0002	0.0001	-0.0001	0.0001	0.0006	0.0005	0.0001	-0.0001	-0.0001	0.0005	-0.0001	0.0012	0.0011	0.003	0.0021	0.0021	0.005
pH		pH	-	-	-	-	8.28	8.06	8.22	8.32	8.29	8.06	8.34	8.35	8.35	7.97	8.37	8.19	8.33	8.18	8.33	8.16	8.19	8.11	8.01	8.24	8.19	8.14
Total Phosphorus	0.020	mg/L	0.02-0.03	-	0.02	-	0.0122	0.005	0.002	0.004	0.0101	0.0058	0.0023	0.0037	0.0008	0.006	0.0015	0.0021	0.0034	0.0099	-0.0027	0.004	**0.026**	**0.036**	**0.045**	**0.03**	0.0194	**0.034**
Total Residual Chlorine	0.003	mg/L	0.0005	0.002	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Suspended Solids	1	mg/L	-	-	-	-	0.4	0.8	2	0.8	1	2	1	2	0.8	1	0.6	2	0.8	1	0.4	3	11	12	14	9	5	4
Turbidity	0.1	NTU	-	-	-	-	0.3	0.3	0.6	1.5	0.4	0.5	0.4	0.7	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.3	6.7	11	10	6.1	2.4	2.6
Alkalinity (Total as CaCO3)	1.0	mg/L	-	-	-	-	98	98	96	99	99	95	97	100	96	94	98	99	110	97	99	96	120	120	120	120	110	110
Nitrite (N)	0.01	mg/L	0.197	-	-	1	0.0003	0.0000	0.0033	0.0025	0.0051	0.0026	0.0022	0.0026	0.0028	0.0059	0.0025	0.0027	0.0024	0.0019	0.0025	-0.0063	0.0075	0.0110	0.0099	0.0054	0.0079	0.0072
Nitrate (N)	0.1	mg/L	13	-	-	10	0.18	0.22	0.34	0.17	0.16	0.28	0.17	0.15	0.17	0.26	0.16	0.28	0.19	0.29	0.18	0.21	0	0	0.1	0	0	0
Nitrate + Nitrite (N)	0.1	mg/L	-	-	-	-	0.18	0.22	0.34	0.17	0.16	0.28	0.17	0.15	0.17	0.26	0.16	0.28	0.19	0.29	0.18	0.21	0.0379	0.0831	0.1	0.0292	0.074	0.0758
Metals																										
Total Hexavalent Chromium (Cr 6+)	0.99	µg/L	-	-	-	50	0.21	0.02	-0.49	-0.6	-0.26	0.89	0.18	0.23	-0.41	-0.09	-0.7	-0.36	-1.2	-0.37	-0.6	-0.21	-0.03	0.28	2.65	1.8	-0.5	-1.4
Dissolved Aluminum (Al)	0.5	µg/L	-	75**	-	-	1.39	1.27	42	22.3	2.22	34.1	1.95	2.8	8.33	1.98	9.04	5.38	2.34	8.53	8.53	5.15	10.1	7.44	51.4	5.63	55.3	4.79
Total Aluminum (Al)	0.5	µg/L	100**	-	-	2900	4.28	4.28	54.2	12.1	3.55	33.4	26.9	9.5	21.6	10.1	6.88	8.95	21.4	4.56	6.82	6.11	93.3	**204**	**136**	94.1	27.5	26.5
Dissolved Antimony (Sb)	0.02	µg/L	-	-	-	-	0.13	0.119	0.111	0.122	0.122	0.123	0.127	0.124	0.13	0.127	0.133	0.122	0.12	0.127	0.129	0.119	0.191	0.19	0.216	0.203	0.152	0.172
Total Antimony (Sb)	0.02	µg/L	-	-	20	6	0.122	0.119	0.111	0.122	0.128	0.119	0.106	0.117	0.121	0.12	0.124	0.121	0.124	0.12	0.121	0.125	0.194	0.196	0.224	0.173	0.139	0.135
Dissolved Arsenic (As)	0.02	µg/L	-	-	-	-	0.73	0.692	0.665	0.675	0.707	0.678	0.723	0.739	0.697	0.737	0.726	0.755	0.727	0.729	0.74	0.736	0.879	0.86	0.813	0.891	0.737	0.875
Total Arsenic (As)	0.02	µg/L	5	100	5	10	0.689	0.728	0.639	0.768	0.741	0.675	0.632	0.72	0.711	0.76	0.746	0.774	0.735	0.774	0.737	0.783	0.922	0.844	0.923	0.867	0.715	0.729
Dissolved Barium (Ba)	0.02	µg/L	-	-	-	-	18.7	19.2	18.8	19.5	20	19.3	20.4	20.7	21	21.7	20.4	22.3	20.5	21.1	21.1	21.7	26.7	26.6	28.2	26.8	21.6	24.9
Total Barium (Ba)	0.02	µg/L	-	-	-	2000	20.4	21.3	18.4	20.1	19.3	19.1	17.6	20.5	20.5	22.6	20.5	22.6	20.9	21.6	20.2	23.1	27	25.4	28.5	25.2	20.2	20.5
Dissolved Beryllium (Be)	0.01	µg/L	-	-	-	-	-0.002	-0.001	-0.0011	0.0021	-0.0022	-0.0023	-0.0034	-0.0022	-0.0012	-0.0022	0.0019	-0.0022	-0.0001	-0.0011	-0.0011	-0.0011	0.0001	0.0023	0	-0.0023	0	-0.0023
Total Beryllium (Be)	0.01	µg/L	-	1100**	-	-	0.0008	0.0015	0.0008	0.003	0.0017	0.008	0.0034	0.0007	0	0.0004	0	0.0008	0	0.0004	0.0017	0.0004	0.0048	0.014	0.009	0.0026	0.0017	-0.0001
Dissolved Bismuth (Bi)	0.005	µg/L	-	-	-	-	-0.001	0	0.0005	0.0008	0.0002	0.0005	0.0005	0.0004	0.0004	0	0.0011	0.0001	-0.0002	0.0001	0.0003	0.0002	0.0002	0.0002	0.0005	0.0004	0.0012	0.0012
Total Bismuth (Bi)	0.005	µg/L	-	-	-	-	0.0007	0.0008	0.0014	-0.0002	-0.0007	0.0015	0.0012	0.0011	0.0002	0	-0.0001	0.0001	-0.0004	-0.0005	-0.0001	-0.0003	0.0038	0.0075	0.006	0.0036	0.0015	0.0024
Dissolved Boron (B)	10	µg/L	-	-	-	-	19	19	23	23	25	22	22	22	21	23	23	24	24	24	25	23	32	30	35	31	24	28
Total Boron (B)	10	µg/L	1500	-	200	5000	22	22	21	20	20	22	19	21	19	20	20	20	21	20	20	20	32	29	33	28	23	23
Dissolved Cadmium (Cd)	0.005	µg/L	-	-	-	-	0.0020	0.0030	0.0044	0.0043	0.0015	0.0049	0.0017	0.0015	0.0025	0.0046	0.0023	0.0024	0.0026	0.0020	0.0018	0.0038	0.0010	0.0007	0.0038	0.0000	0.0044	0.0012

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																	
							Lake Ontario														Frenchman's Bay			
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Total Cadmium (Cd)	0.005	µg/L	0.16-0.20**	0.2	0.5**	7	0.0029	0.0036	0.0056	0.0028	0.0027	0.0054	0.0041	0.0039	0.0028	0.004	0.0023	0.0035	0.0027	0.0037	0.0023	0.004	0.0056	0.0078	0.0054	0.0064	0.0025	0.0024
Dissolved Chromium (Cr)	0.1	µg/L	-	-	-	-	0.1	0.15	0.0817	0.18	0.14	0.13	0.0831	0.1	0.12	0.072	0.18	0.1	0.2	0.0732	0.0919	0.1	0.0757	0.17	0.17	0.11	0.16	0.15
Total Chromium (Cr)	0.1	µg/L	-	-	-	50	0.0461	0.11	0.11	0.12	0.1	0.0902	0.0854	0.13	0.0885	0.11	0.0695	0.0785	0.11	0.0856	0.11	0.0748	0.28	0.54	0.37	0.25	0.1	0.14
Dissolved Cobalt (Co)	0.005	µg/L	-	-	-	-	0.01	0.008	0.0181	0.0184	0.0097	0.014	0.0091	0.0121	0.0126	0.0121	0.0112	0.0123	0.0102	0.0162	0.0113	0.0108	0.0346	0.0321	0.0419	0.0299	0.0198	0.024
Total Cobalt (Co)	0.005	µg/L	-	-	0.9	-	0.0086	0.01	0.022	0.014	0.0106	0.019	0.013	0.016	0.0145	0.0184	0.0105	0.0177	0.0259	0.0143	0.013	0.0146	0.075	0.148	0.111	0.071	0.026	0.03
Dissolved Copper (Cu)	0.05	µg/L	-	-	-	-	0.591	0.57	0.856	0.974	0.585	0.88	0.594	0.622	0.704	0.629	0.679	0.642	0.696	0.813	0.723	0.677	0.867	0.816	0.98	0.826	1.46	1.24
Total Copper (Cu)	0.05	µg/L	2.4-3.1**	5	5.0**	2000	0.679	0.655	1.1	0.782	0.651	0.91	0.73	0.64	0.74	0.715	0.645	0.718	0.83	0.694	0.704	0.661	1.36	1.65	1.45	1.17	1.31	1.4
Dissolved Iron (Fe)	1	µg/L	-	-	-	-	1.5	1.9	2.3	7.8	2.5	3.1	0.7153	2.6	4.6	1.4	3.5	2.6	2.6	2.9	2.7	2.8	17.2	18.5	29.9	20.6	8.8	13
Total Iron (Fe)	1	µg/L	300	300	-	-	2.2	4.8	10.6	10	4.5	9.6	7.8	17.5	6	9.9	3.8	8.2	18.4	5.3	5.5	9.4	207	**393**	**349**	189	75.4	78.5
Dissolved Lead (Pb)	0.005	µg/L	-	-	-	-	0.004	0.012	0.0506	0.137	0.0036	0.0881	0.0062	0.0157	0.02	0.0068	0.0412	0.0182	0.0052	0.0795	0.034	0.0363	0.0559	0.0312	0.112	0.0489	0.0854	0.0321
Total Lead (Pb)	0.005	µg/L	3.4-4.7**	25	5.0**	5	0.0137	0.0146	0.091	0.0372	0.0091	0.074	0.054	0.034	0.0352	0.0339	0.0141	0.0227	0.0387	0.0125	0.0159	0.0181	0.406	0.553	0.463	0.325	0.12	0.127
Dissolved Lithium (Li)	0.5	µg/L	-	-	-	-	1.64	1.73	1.78	1.71	1.75	1.79	1.62	1.71	1.65	1.71	1.7	1.75	1.69	1.7	1.77	1.69	2.02	1.85	2.13	1.89	1.76	1.76
Total Lithium (Li)	0.5	µg/L	-	-	-	-	1.72	1.71	1.74	1.66	1.65	1.79	1.61	1.67	1.55	1.56	1.59	1.58	1.7	1.58	1.62	1.63	2.07	1.9	2.06	1.82	1.55	1.64
Dissolved Manganese (Mn)	0.05	µg/L	170-570**	-	-	-	0.193	0.279	1.19	1.39	0.334	1.39	0.457	1.82	0.384	0.761	0.408	0.972	0.253	1.06	0.437	1.47	10.4	11.6	36.2	10	6.57	8.84
Total Manganese (Mn)	0.05	µg/L	-	-	-	120	0.461	0.65	2.74	2.01	1.52	2.56	2.45	5.17	1.17	2.37	0.762	2.71	1.43	1.67	1.05	2.58	47.4	55.3	66	41.4	22.7	21.9
Dissolved Molybdenum (Mo)	0.05	µg/L	-	-	-	-	1.07	1.03	1.27	1.25	1.12	1.44	1.06	1.13	1.14	1.14	1.15	1.14	1.13	1.16	1.14	1.12	2.57	2.56	1.16	1.19	1.53	1.18
Total Molybdenum (Mo)	0.05	µg/L	73	-	40	-	1.08	1.05	1.27	1.15	1.14	1.29	1.14	1.09	1.13	1.17	1.16	1.16	1.22	1.16	1.17	1.1	1.1	0.929	0.919	1.03	0.89	0.907
Dissolved Nickel (Ni)	0.02	µg/L	-	-	-	-	0.462	0.491	0.551	0.628	0.468	0.554	0.468	0.434	0.554	0.507	0.515	0.511	0.503	0.59	0.529	0.559	0.845	0.484	0.491	0.497	0.49	0.466
Total Nickel (Ni)	0.02	µg/L	98-121**	25	-	-	0.504	0.525	0.55	0.533	0.479	0.55	0.46	0.48	0.546	0.577	0.507	0.56	0.609	0.565	0.512	0.528	0.56	0.7	0.62	0.58	0.44	1.28
Dissolved Selenium (Se)	0.04	µg/L	-	-	-	-	0.111	0.121	0.11	0.108	0.114	0.109	0.11	0.126	0.113	0.119	0.117	0.132	0.112	0.109	0.121	0.106	0.129	0.129	0.095	0.121	0.114	0.111
Total Selenium (Se)	0.04	µg/L	1	100	-	50	0.11	0.115	0.121	0.11	0.128	0.098	0.098	0.112	0.108	0.123	0.124	0.116	0.121	0.129	0.122	0.123	0.113	0.104	0.105	0.12	0.087	0.094
Total Silicon (Si)	50	µg/L	-	-	-	-	161	261	113	106	86	111	82	119	82	198	68	203	133	176	87	221	1820	1820	1690	1760	798	791
Dissolved Silicon (Si)	50	µg/L	-	-	-	-	146	240	112	99	85	105	75	107	76	188	64	213	86	169	82	210	1820	1810	1710	1820	803	1040
Dissolved Silver (Ag)	0.005	µg/L	-	-	-	-	0.004	-0.001	0.0001	0.0044	0.0004	0.001	0.0011	0.0005	0.0008	0.0004	0.0007	0.0015	0.0004	0.0018	0.0002	0.0011	0	0.0009	0	0.0005	0.0015	0.0006
Total Silver (Ag)	0.005	µg/L	0.25	0.1	-	-	-0.0007	0.0007	0.0029	0.0009	0.0007	0.0033	0.0012	0.0002	0.0009	0.0012	0.0008	0.0008	0.0005	0.0002	0.0005	0.0011	0.0023	0.0025	0.0018	0.002	0.0007	0.0005
Dissolved Strontium (Sr)	0.050	µg/L	-	-	-	-	156	157	152	156	191	154	166	169	184	189	180	189	189	170	188	181	221	217	222	221	159	207
Total Strontium (Sr)	0.050	µg/L	-	-	-	7000	182	184	160	172	170	169	158	180	172	172	176	174	173	176	176	171	212	194	214	202	165	171
Dissolved Thallium (Tl)	0.002	µg/L	-	-	-	-	0.005	0.005	0.0058	0.0057	0.0053	0.006	0.007	0.0069	0.0063	0.0063	0.0062	0.0065	0.0071	0.0055	0.0062	0.0058	0.0016	0.0018	0.0017	0.0016	0.0026	0.0026
Total Thallium (Tl)	0.002	µg/L	0.8	-	0.3	-	0.0062	0.0058	0.0047	0.0072	0.0069	0.0062	0.005	0.0059	0.007	0.007	0.0064	0.0079	0.0073	0.0072	0.006	0.0074	0.0032	0.0054	0.0043	0.0034	0.0028	0.0027
Dissolved Tin (Sn)	0.2	µg/L	-	-	-	-	0.027	0.019	0.0683	2.23	0.0216	0.0604	0.0066	0.0134	0.0285	0.0117	0.0456	0.0178	0.0081	0.0992	0.0368	0.0936	0.0172	0.014	0.0407	0.012	0.1121	0.0152
Total Tin (Sn)	0.2	µg/L	-	-	-	-	0.0103	0.01	0.0848	0.0183	0.011	0.0548	0.078	0.017	0.0521	0.1979	0.0174	0.0173	0.0202	0.0174	0.0119	0.0125	0.0359	0.0428	0.036	0.0294	0.018	0.0288
Dissolved Titanium (Ti)	0.5	µg/L	-	-	-	-	0.085	-0.026	0.2441	0.286	0.0548	0.2537	0.0612	0.1627	0.1656	0.0487	0.1733	0.0743	0.0568	0.111	0.1714	0.0846	0.2039	0.2693	0.3953	0.1641	0.4483	0.1503
Total Titanium (Ti)	0.5	µg/L	-	-	-	-	-0.0352	0.0411	0.3548	0.0535	-0.0494	0.1984	0.2481	0.2853	-0.0613	-0.0285	-0.1167	-0.0066	1.24	-0.0967	-0.1331	0.0524	3.9	9	5.9	3.6	0.8983	0.9566
Dissolved Uranium (U)	0.002	µg/L	-	-	-	-	0.297	0.286	0.286	0.32	0.347	0.284	0.318	0.314	0.341	0.344	0.349	0.344	0.361	0.334	0.364	0.337	0.288	0.278	0.256	0.296	0.253	0.283
Total Uranium (U)	0.002	µg/L	1.5	5	5	20	0.347	0.36	0.264	0.331	0.316	0.296	0.277	0.308	0.325	0.308	0.315	0.321	0.326	0.31	0.321	0.326	0.296	0.244	0.255	0.271	0.246	0.26
Dissolved Vanadium (V)	0.2	µg/L	-	-	-	-	0.145	0.157	1.47	1.07	0.1521	1.86	0.1702	0.24	0.32	0.1932	0.35	0.26	0.1681	0.49	0.26	0.26	0.54	0.55	1.42	0.52	2.3	0.43
Total Vanadium (V)	0.2	µg/L	-	6	6	-	0.1574	0.1464	1.64	0.27	0.1271	1.4	1.12	0.1784	0.38	0.29	0.1671	0.24	0.42	0.1543	0.24	0.1372	0.7	0.98	0.89	0.64	0.36	0.34
Dissolved Zinc (Zn)	0.1	µg/L	16-42**	-	-	-	1.03	0.86	2.64	4.43	0.32	2.32	0.15	0.37	0.86	0.4	2.35	0.88	0.2	3.4	1.24	1.24	8.27	0.48	1.79	1.32	2.28	1.4
Total Zinc (Zn)	0.1	µg/L	-	30	20	-	0.59	1.16	3.2	2.52	0.51	2	1.6	0.9088	1.35	1.75	0.59	0.7	1.11	1.76	0.48	0.86	2.5	4.2	3.6	1.8	0.9604	0.857
Dissolved Zirconium (Zr)	0.1	µg/L	-	-	-	-	0.004	0	0.0156	0.0171	0.0048	0.0071	0.0015	0.0012	0.0067	0.014	0.0138	0.0008	0.0061	0.005	0.0036	-0.001	0.0125	0.0166	0.0237	0.0103	0.0085	0.0107
Total Zirconium (Zr)	0.1	µg/L	-	-	4	-	0.0048	0.0139	0.0153	0.0121	0.0102	0.0176	0.0061	0.0081	0.0274	0.0145	0.0094	0.0143	0.0136	0.0082	0.0131	0.006	0.39	0.29	0.0894	0.0774	0.0142	0.0176
Dissolved Calcium (Ca)	10	µg/L	-	-	-	-	31700	32000	29500	29100	32000	29100	30800	31200	30800	31200	30900	32000	31900	30400	31000	30800	39600	40000	42000	40800	31200	36900
Total Calcium (Ca)	10	µg/L	-	-	-	-	32200	33200	26400	29400	31200	27900	26100	29000	29400	29500	30200	27800	29300	30200	29600	30200	37700	35800	39000	35600	28100	28600
Dissolved Cesium (Cs)	0.05	µg/L	-	-	-	-	0.002	0.001	0.0038	0.0025	0.0024	0.0032	0.0042	0.0021	0.0018	0.0041	0.0021	0.0041	0.0018	0.0026	0.0034	0.0022	0.0014	0.001	0.0027	0.0011	0.0029	0.0031
Total Cesium (Cs)	0.05	µg/L	-	-	-	-	0.002	0.0024	0.0045	0.0027	0.0023	0.0049	0.0031	0.0038	0.0027	0.004	0.0027	0.0043	0.0044	0.0034	0.0033	0.0027	0.0098	0.0187	0.0128	0.008	0.0043	0.0027
Dissolved Magnesium (Mg)	10	µg/L	-	-	-	-	8010	8090	7450	7570	8180	7600	8200	8060	8240	8220	7980	8240	8110	7900	8440	8060	7950	7610	7430	8130	6790	8000
Total Magnesium (Mg)	10	µg/L	-	-	-	-	8440	8590	7090	8310	8390	7660	7200	8090	7900	8090	8350	8290	8210	8270	8360	8440	7950	6960	7420	7530	6560	6900
Dissolved Potassium (K)	10	µg/L	-	-	-	-	1320	1360	1550	1490	1560	1500	1510	1510	1590	1650	1540	1650	1570	1590	1550	1540	1750	1820	1860	1820	1440	1800
Total Potassium (K)	10	µg/L	-	-	-	-	1520	1530	1460	1500	1440	1460	1280	1410	1470	1580	1500	1610	1550	1590	1500	1520	1700	1680	1780	1610	1330	1350
Dissolved Sodium (Na)	10	µg/L	-	-	-	-	12400	12500	12500	12100	12400	12100	12400	12600	13000	12900	12300	12900	12800	12300	12600	12100	32500	34500	45500	32400	21100	26100

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																	
							Lake Ontario													Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Total Sodium (Na)	10	µg/L	-	-	-	-	12800	12700	12000	13500	12900	12300	11100	12500	13000	13200	12900	13600	13500	13500	13000	12900	31900	34200	44400	29600	20700	20300
Dissolved Thorium (Th)	0.05	µg/L	-	-	-	-	-0.001	-0.001	0.004	0.0048	0.0044	0.007	0.0036	-0.0006	0.0004	0.0029	0.0052	0.0019	0.0018	0.0019	0.0028	0.003	0.0072	0.0071	0.0018	0.0077	0.0037	0.0076
Total Thorium (Th)	0.05	µg/L	-	-	-	-	0.0028	0.0062	0.0008	0.0035	0.001	0.0059	0.0038	0.003	0.0053	-0.0012	0.0002	0.0028	0.0013	-0.0002	0.0006	0.0029	0.0147	0.0193	0.0181	0.012	0.0073	0.0074
Dissolved Tungsten (W)	0.01	µg/L	-	-	-	-	0.065	0.06	0.086	0.077	0.073	0.098	0.066	0.073	0.071	0.074	0.077	0.078	0.071	0.074	0.076	0.068	0.075	0.077	0.077	0.069	0.092	0.082
Total Tungsten (W)	0.01	µg/L	-	-	30	-	0.073	0.071	0.078	0.075	0.076	0.075	0.072	0.063	0.074	0.075	0.073	0.074	0.075	0.074	0.075	0.072	0.07	0.064	0.172	0.071	0.06	0.065
Chromium (VI)	0.50	ug/L	1	1	-	50	0.0034	0	0	0.0018	0	0	0	0	0	0	0	0	0	0	0	0.0081	0	0.0079	0	0	0	0
Mercury (Hg)	0.01	ug/L	0.026	-	-	1	0.0014	-0.0002	0.0009	0.0011	0.0013	0.0007	0.0004	-0.0001	0.0001	0.0004	-0.0001	0.0009	0.0015	0.0008	0.0008	0.0011	0.0012	0.0015	0.0029	0.0017	0.0014	0.0002
Dissolved Mercury (Hg)	0.01	ug/L	-	0.2	-	-	-0.0003	0.0003	0.0009	0.0013	0.001	0.0006	0.0009	0.0006	0.0009	0.001	0.0004	0.0006	0.0012	0.0011	0.0005	0.0005	0.0012	0.0009	0.001	0.0003	0.0011	0.0003
Volatile Organics																												
Benzene	0.10	ug/L	370	-	100	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromodichloromethane	0.10	ug/L	-	-	200	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromoform	0.20	ug/L	-	-	60	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloroform	0.10	ug/L	1.8	-	-	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethylbenzene	0.10	ug/L	90	-	8	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocarbons																												
F1 (C6-C10)	25	ug/L	167	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F1 (C6-C10) - BTEX	25	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F2 (C10-C16 Hydrocarbons)	100	ug/L	42	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F3 (C16-C34 Hydrocarbons)	200	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F4 (C34-C50 Hydrocarbons)	200	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reached Baseline at C50		ug/L	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Surrogate Recovery (%)																												
1,4-Difluorobenzene		%	-	-	-	-	100	105	99	103	112	100	101	100	105	105	108	106	112	112	105	110	102	99	100	99	101	101
4-Bromofluorobenzene		%	-	-	-	-	86	90	97	95	89	98	96	91	91	90	91	95	80	93	97	85	89	95	94	93	93	96
D10-o-Xylene		%	-	-	-	-	96	99	87	98	103	92	89	87	101	99	102	100	105	102	101	100	95	97	96	91	93	90
D4-1,2-Dichloroethane		%	-	-	-	-	97	101	104	107	97	104	104	108	104	102	100	103	99	116	106	110	106	109	104	106	106	110
o-Terphenyl		%	-	-	-	-	102	101	93	92	92	93	93	91	93	94	94	94	92	95	96	94	94	92	93	93	94	95
4-Bromofluorobenzene		%	-	-	-	-	95	95	99	100	100	100	99	99	101	101	100	101	100	100	102	100	101	100	100	100	101	102
D4-1,2-Dichloroethane		%	-	-	-	-	96	96	105	106	105	103	106	105	104	105	106	107	105	107	108	105	106	105	105	105	105	104
D8-Toluene		%	-	-	-	-	101	102	97	97	97	97	97	98	96	98	97	97	96	97	96	97	97	97	96	96	97	97
Microbiological																												
Background	10	CFU/100mL	-	-	-	-	260	970	48000	16000	2100	53000	5000	2800	240	760	380	1300	160	820	920	680	120000	63000	29000	8400	5100	16000
Fecal coliform	10	CFU/100mL	-	-	-	-	<10	<10	20	10	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	13000	560	2700	<10	90	240
Total Coliforms	10	CFU/100mL	-	-	-	10	**250**	**2200**	**2500**	**50**	**410**	**640**	**80**	**80**	10	**460**	**60**	**740**	<10	**880**	**80**	**640**	**85000**	**11000**	**2900**	<10	**280**	**2600**
Escherichia coli	10	CFU/100mL	-	100	-	10	<10	<10	**20**	10	<10	10	10	10	<10	<10	<10	<10	<10	<10	<10	<10	**6100**	**560**	**120**	<10	**50**	**60**
Radionuclides																												
H-3	14	Bq/kg	-	7000	-	7000	5.25	5.27	42.4	106	5.3	47.8	21.2	5.31	10.6	0	0	10.5	21.2	0	10.6	-5.33	26.4	15.9	21.1	20.9	21.2	21.4
C-14	0.027	Bq/g	-	-	-	-	-0.0512	-0.0205	-0.0225	0.0115	-0.0302	0.059	0.241	0.0394	-0.0199	-0.0397	-0.045	-0.0466	-0.0241	-0.0326	-0.0303	-0.0403	-0.0289	-0.0228	0.79	-0.0217	-0.018	-0.0281
Co-60	0.73	Bq/kg	-	-	-	-	0.16	-0.0244	0.455	0.497	0.0614	0.147	-0.146	0.0696	0.0324	0.0915	0.657	0.171	0.149	0.556	-0.162	0.0514	0.289	0.316	0.0916	0.191	-0.481	0.0691
Cs-134	0.75	Bq/g	-	-	-	-	0.48	0.119	0.244	0.0292	0.117	-0.101	0.128	-0.0169	0.293	0.292	0.0249	-0.0581	0.111	0.126	0.12	-0.043	-0.157	0.143	0.0167	-0.207	0.106	-0.124
Cs-137	0.6	Bq/kg	-	50	-	10	0.297	0.249	-0.228	0.102	-0.0569	0.281	0.0631	0.505	-0.0462	0.0572	-0.0678	-0.236	-0.21	0.294	-0.0213	0.0254	-0.0251	0.418	0.0966	-0.0266	0.0542	-0.0355
I-131	1.2	Bq/kg	-	10	-	6	0.022	0.212	0.222	1.12	0.485	-0.679	0.882	-0.909	0.351	-0.143	-1.33	0.0523	-0.278	-0.565	0.27	0.591	0.0767	-0.206	2.66	-1.08	-0.819	0.661
K-40	7.1	Bq/g	-	-	-	-	1.75	0.525	-0.208	0.568	-0.32	-0.392	-1.03	-0.459	2.64	-0.946	2.24	-0.172	-0.174	1.37	0.127	0.241	2.87	-2.5	0.484	0.242	1.71	0.746
Th-Series	1.8	Bq/kg	-	-	-	-	0.452	-1.09	0.332	0.459	-0.57	0.355	-0.329	-0.435	1.17	0.367	-1.42	-0.132	0.245	1.09	0.285	-0.0449	0.482	0.434	0.392	0.851	-0.416	0.125
U-Series	1.5	Bq/kg	-	-	-	-	-0.204	0.116	0.575	-0.275	0.671	-0.015	-0.024	-0.0357	-0.0785	0.702	-0.246	-0.00287	0.336	0.564	-0.0708	-0.285	-0.0693	0.421	-0.0261	0.159	-0.328	0.242
Miscellaneous Parameters																												
Hydrazine	0.1	ug/L	2.6	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Monomethyl Hydrazine	0.25	ug/L	-	-	-	-	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
1,1-Dimethylhydrazine	0.25	ug/L	-	-	-	-	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Chlorophyll a	1.3	ug/L	-	-	-	-	2.8	1.8	3.2	2.5	4.3	3.5	3.5	4.8	1.9	2.5	2.3	2.3	1.9	2.9	2.4	1.1	11.0	10.0	13.0	9.0	6.0	8.0

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																	
							Lake Ontario																Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Morpholine	4	ug/L	-	-	4	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved Methyl Mercury	0.050	ng/L	-	-	-	-	0.05500	0.01880	0.01589	0.01879	0.02088	0.01363	0.00912	0.01436	0.02081	0.01949	0.01484	0.01320	0.01974	0.03052	0.03019	0.01931	0.00158	0.00049	0.01654	0.01000	0.01858	0.02449
Total Methyl Mercury	0.050	ng/L	4	-	-	-	0.01146	0.01372	0.01037	0.01677	0.01335	0.01973	0.00080	0.01856	0.03742	0.01432	0.00795	0.01380	0.01599	0.02288	0.03742	0.03517	0.03797	0.01436	0.05100	0.03267	0.03253	0.05300

Notes:

Bold Exceeded Interim PWQO
Bold Exceeded PWQO
Bold Exceeded CCME
Bold Exceeded Health Canada Guidelines
Bold Exceeded more than one guideline

Surface water samples from Lake Ontario were collected at a depth of 0.5 meters (denoted by "S" in the sample name), while bottom samples were taken 0.5 meters above the lakebed (denoted by "B"). Mid-depth samples were collected in Frenchman's Bay, as thermal stratification is unlikely in the shallow depths observed in this area. Sampling locations presented in Figure 4-3 and Figure 4-4.

* Only censored results provided by lab.

** Calculated values. The value for Hardness (as CaCO3) dissolved was used to estimate hardness-dependent guidelines.

a – Total Ammonia guideline (Long Term Concentration (mg/L) Table): Retrieved from: https://ccme.ca/en/chemical/5#_aql_fresh_concentration

b – Dissolved Aluminum guideline: The Interim PWQO is 15 µg/L between pH 4.5 to 5.5, and 75 µg/L between pH 6.5 to 9.0. Between pH 5.5 - 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than 10% above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs.

c – Total Aluminum guideline (Long Term Concentration (µg/L) Variable): If pH < 6.5, the CWQG is 5 µg/L. If pH ≥ 6.5, the guideline is 100 µg/L.

d – Total Beryllium guideline (µg/L): If Hardness < 75 mg/L, the PWQO is 11 µg/L. If Hardness > 75 mg/L, then the PWQO is 1100 µg/L.

e – Total Cadmium guideline (Long Term concentration (µg/L) equation): When the water hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L. At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated as 10{0.83(log[hardness]) – 2.46}. At hardness > CWQG (µg/L) = 10{0.83(log[hardness]) – 2.46} At hardness > 280 mg/L, the guideline is 0.37 µg/L.

f – Total Cadmium guideline (µg/L): If Hardness 0-100 mg/L, the Interim PWQO is 0.1 µg/L. If Hardness > 100 mg/L, then the Interim PWQO is 0.5 µg/L.

g – Total Copper guideline (Long Term concentration (µg/L) equation): When the water hardness is 0 to < 82 mg/L, the CWQG is 2 µg/L. At hardness ≥82 to ≤180 mg/L the CWQG is calculated using this equation: 0.2 * e{0.8545[ln(hardness)]-1.465}. At hardness >180 mg/L, the CWQG is 4 µg/L.

h - Total Copper guideline (µg/L): If Hardness 0-20 mg/L, the Interim PWQO is 1 µg/L. If Hardness > 20 mg/L, then the Interim PWQO is 5 µg/L.

i – Total Lead guideline (Long Term concentration (µg/L) equation): When the hardness is 0 to ≤ 60 mg/L, the CWQG is 1 µg/L. At hardness >60 to ≤ 180 mg/L the CWQG is calculated as e{1.273[ln(hardness)]-4.705}. At hardness >180 mg/L, the CWQG is 7 µg/L. At hardness >180 mg/L, the CWQG is 7 µg/L.

j – Total Lead guideline: If Hardness is 30-80 mg/L, then the Interim PWQO is 3 µg/L. If Hardness is > 80 mg/L, then the Interim PWQO is 5 µg/L.

k – Dissolved Manganese concentration (Long Term concentration (µg/L) equation): Calculated using the CWQG calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese. Retrieved from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fccme.ca%2Fen%2Fres%2F2019-manganese-cwqg-scd-appendix-b-en.xlsx&wdOrigin=BROWSELINK

l – Total Nickel guideline (Long Term concentration (µg/L) equation): When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 25 µg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated as e{0.76[ln(hardness)]+1.06}. At hardness >180 mg/L, the CWQG is 150 µg/L.

m – Dissolved Zinc guideline (Long Term concentration (µg/L) equation): The CWQG is calculated as exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625).
This equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1, which is the range of data used to derive the hardness, pH and DOC slopes.

n – Radionuclides are not screened as their levels should be as low as reasonably achievable (ALARA).

References:

4. CCME. n.d. Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in September 2024.
5. Ministry of Environment and Climate Change. MOECC. 1994. Water management: policies, guidelines, provincial water quality objectives.
6. Health Canada. 2019. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Table A-3: Screening of Surface Water Quality Parameters in Fall 2024 samples

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																			
							Lake Ontario																Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Field Measurements																												
Temperature	N/A	Celsius	-	-	-	-	7.5	6.2	31.6	15	9	18.6	18.1	17.8	13.9	9.6	13.6	9.4	14.3	9.7	12.9	9.6	16.9	13.8	12.2	14.7	12.6	12.5
pH	N/A	pH	6.5-9.0	6.5-8.5	-	-	7.42	7.54	8.12	7.87	7.6	7.61	7.82	7.67	7.6	7.62	7.68	7.69	7.83	7.8	7.69	7.65	8.17	8.25	7.56	8.13	8.15	7.97
Specific Conductivity	N/A	µs/cm	-	-	-	-	203.1	305.5	308.7	308	307.1	311.4	309.1	313.5	306.9	304.6	307.2	303.8	306.6	303.9	305.9	304.6	494.7	518	792	473.8	460.5	469.6
Conductivity	N/A	µs/cm	-	-	-	-	-	-	-	249.1	214.4	273	268.1	268.2	-	-	-	-	-	-	-	-	418.5	407.5	598	396.2	-	-
DO	N/A	%	-	-	-	-	83.7	81.4	102.7	92.8	85	92.6	97.8	95.7	103	94.9	102.3	91.6	103.80	94	103	94.7	95.8	97.3	83	94.7	102.4	99.3
DO	N/A	mg/L	-	-	-	-	10.03	10.09	7.54	9.35	9.75	9.34	9.2	9.1	10.61	10.79	10.62	10.49	10.56	10.71	10.72	10.75	9.24	10.05	8.85	9.8	10.93	10.58
Turbidity	N/A	NTU	-	-	-	-	-0.38	-0.43	0.68	754	754	754	753.6	753.3	-0.39	0.1	-0.42	-0.05	-0.39	NA	-0.41	-0.24	753.5	758.3	754.7	754.3	2.58	2.37
Calculated Parameters																												
Dissolved Hardness (CaCO3)	0.50	mg/L	-	-	-	-	112	108	106	115	114	113	115	114	119	114	117	116	117	114	117	115	147	142	166	138	130	134
Total Un-ionized Ammonia	0.0015	mg/L	0.019	0.02	-	-	0.0008	0.0015	0.0083	0.0013	0.0011	0.0000	0.0045	0.0033	0.0000	0.0000	0.0010	0.0011	0.0000	0.0015	0.0014	0.0007	**0.0370**	**0.0220**	0.0051	**0.0210**	0.0130	0.0081
Chromium (+3)	0.5	ug/L	8.9	8.9	-	-	0.252	0.000	0.000	0.174	0.000	0.000	0.118	0.135	0.149	0.185	0.165	0.109	0.173	0.115	0.146	0.171	0.159	0.000	0.000	0.000	0.000	0.108
Unfiltered Chromium (+3)	0.99	ug/L	-	-	-	-	0.00	0.12	0.18	0.00	-1.24	0.00	0.21	0.00	0.00	-1.18	0.11	0.12	0.12	0.00	0.13	-1.45	0.00	0.28	0.16	0.18	0.00	0.14
Total Hardness (CaCO3)	0.50	mg/L	-	-	-	-	117	117	99	114	105	92	111	112	116	115	116	116	117	130	116	114	140	138	137	141	140	141
Inorganics																												
Total Ammonia-N	0.050	mg/L	0.196-3.98**	-	-	-	0.1500	0.2600	0.0650	0.0550	0.1400	0.0249	0.1600	0.1700	0.0481	0.0154	0.0670	0.1100	0.0453	0.1100	0.0990	0.0740	**0.6700**	**0.4200**	0.5300	0.4900	0.3500	0.3200
Total Biochemical Oxygen Demand (BOD)	2	mg/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Total Chemical Oxygen Demand (COD)	4.0	mg/L	-	-	-	-	5.5	6.2	14	0.43	0.77	-0.6	4.6	3.18	6.2	3.34	5.5	1.56	5.1	3.69	6.2	5.8	6.6	10	18	4.5	12	6.5
Conductivity	1.0	umho/cm	-	-	-	-	310	300	300	320	320	320	310	320	320	320	320	310	310	310	320	320	500	540	820	510	460	480
Total Kjeldahl Nitrogen (TKN)	0.10	mg/L	-	-	-	-	0.42	0.43	0.3	0.38	0.33	0.32	0.39	0.27	0.16	0.22	0.27	0.18	0.23	0.16	0.24	0.33	0.72	0.86	0.83	0.57	0.89	0.65
Dissolved Organic Carbon	0.40	mg/L	-	-	-	-	1.9	1.9	2.3	2.1	2	2	2.2	2.2	2.1	1.9	2	1.9	2.1	1.9	2.1	1.9	3.7	3.9	5.2	3.7	3.3	4.5
Orthophosphate (P)	0.010	mg/L	-	-	-	-	0.0012	0.0009	0.0032	0.0005	0.0006	0.0012	-0.0017	-0.0015	-0.0016	0.0002	-0.0007	-0.0017	-0.0014	-0.0016	-0.0017	-0.0016	-0.0033	-0.0005	0.0029	0.0003	-0.0002	0.0011
pH		pH	-	-	-	-	8.11	8.13	8.13	8.15	8.09	8.1	8.16	8.09	8.1	8.13	8.06	8.15	8.1	8.12	7.85	8.15	8.12	8.2	8	8.21	8.16	8.06
Total Phosphorus	0.020	mg/L	0.02-0.03	-	0.02	-	0.0009	0.0003	0.0173	-0.0038	0.0014	0.0029	0.0096	0.005	0.007	0.0015	0.0056	-0.0003	0.0017	-0.0022	0.0014	-0.0004	**0.027**	**0.023**	**0.024**	**0.024**	0.0164	0.019
Total Residual Chlorine	0.003	mg/L	0.0005	0.002	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Suspended Solids	1	mg/L	-	-	-	-	0.2	0.2	1	0.6	0.8	1	1	33	0.4	0.4	1	5	0.2	0.4	0	0.4	35	11	4	9	4	5
Turbidity	0.1	NTU	-	-	-	-	0.1	0.1	0.9	0.3	0.3	0.2	0.4	0.5	0.2	0.2	0.2	0.2	0.2	0.1	0.3	0.1	9.5	8.3	3.4	6.2	3	2.9
Alkalinity (Total as CaCO3)	1.0	mg/L	-	-	-	-	98	100	98	98	99	99	98	96	96	96	95	92	96	96	95	96	120	130	150	120	120	120
Nitrite (N)	0.01	mg/L	0.197	-	-	1	0.0054	0.0035	0.0044	0.01	0.007	0.0063	0.017	0.013	0.0013	0.00036514	0.0012	-0.0003025	-0.0124	0.0025	0.0018	-0.0000963	0.00097002	-0.0000649	0.0091	0.0028	0.0029	0.0056
Nitrate (N)	0.1	mg/L	13	-	-	10	0.34	0.34	0.19	0.23	0.3	0.3	0.17	0.17	0.3	0.3	0.31	0.28	0.3	0.3	0.3	0.28	0	0	0	0	0	0
Nitrate + Nitrite (N)	0.1	mg/L	-	-	-	-	0.34	0.34	0.19	0.24	0.3	0.3	0.19	0.18	0.3	0.3	0.31	0.28	0.3	0.3	0.3	0.28	0.02	0.0141	0.0944	0.0181	0.0969	0.0956
Metals																												
Total Hexavalent Chromium (Cr 6+)	0.99	µg/L	-	-	-	50	0.59	0.7	0.79	0.62	1.2	0.79	0.77	0.81	0.46	1.3	0.34	0.57	0.53	0.62	0.65	1.5	0.36	0.83	2.89	3.18	1.15	0.67
Dissolved Aluminum (Al)	0.5	µg/L	-	75**	-	-	4.23	5.69	11.5	10.5	2.42	12.1	13.8	11.5	7.3	3.49	24.2	2.89	4.18	3.99	11.9	2.38	**98.8**	6.52	6.25	5.24	5.02	14.4
Total Aluminum (Al)	0.5	µg/L	100**	-	-	2900	6.76	7.8	20.5	8.6	7.8	8.1	6.03	3.41	12.1	21.7	7.77	24.4	7.82	3.96	5.83	2.94	4.47	**128**	34.8	54.1	27.4	33
Dissolved Antimony (Sb)	0.02	µg/L	-	-	-	-	0.128	0.124	0.216	0.139	0.134	0.133	0.133	0.128	0.129	0.127	0.143	0.135	0.128	0.127	0.125	0.128	0.203	0.203	0.282	0.195	0.171	0.19
Total Antimony (Sb)	0.02	µg/L	-	-	20	6	0.126	0.126	0.194	0.129	0.123	0.102	0.128	0.128	0.133	0.131	0.128	0.132	0.135	0.132	0.141	0.13	0.177	0.193	0.229	0.188	0.176	0.184
Dissolved Arsenic (As)	0.02	µg/L	-	-	-	-	0.783	0.778	0.782	0.781	0.768	0.769	0.783	0.799	0.719	0.718	0.746	0.731	0.73	0.709	0.728	0.743	0.852	0.72	0.668	0.714	0.712	0.742
Total Arsenic (As)	0.02	µg/L	5	100	5	10	0.797	0.795	0.728	0.756	0.899	0.623	0.702	0.706	0.756	0.79	0.738	0.764	0.734	0.734	0.742	0.723	0.649	0.773	0.59	0.798	0.744	0.741
Dissolved Barium (Ba)	0.02	µg/L	-	-	-	-	19.7	19.4	20.6	19.8	19.7	19.7	21.4	21.2	21.1	20.7	20.8	20.6	20.5	20.3	20.6	20.3	32.6	18.6	20	20.7	21	23.4
Total Barium (Ba)	0.02	µg/L	-	-	-	2000	22.9	22.2	19	21.4	20.2	16.1	19.9	20.4	21.3	20.8	21	20.9	21.3	20.9	20.9	21	20.4	25.6	17.4	27.8	27.4	29.2
Dissolved Beryllium (Be)	0.01	µg/L	-	-	-	-	0.0021	0.0026	0.0022	0.0000	0.0067	-0.0004	0.0001	0.0001	0.0049	0.0034	0.0099	0.0021	0.0048	0.0048	0.0046	0.0060	0.0089	0.0011	0.0033	0.0060	0.0017	0.0048
Total Beryllium (Be)	0.01	µg/L	-	1100**	-	-	0.0000	0.0012	0.0030	0.0056	0.0001	0.0019	-0.0005	0.0015	0.0027	0.0051	-0.0021	-0.0008	-0.0009	0.0015	-0.0008	0.0027	-0.0015	0.0095	0.0059	0.0002	0.0047	-0.0011
Dissolved Bismuth (Bi)	0.005	µg/L	-	-	-	-	0.0005	0.0004	0.0001	0.0005	-0.0002	0.0003	0.0012	0.0004	0.0012	0.0006	0.0017	0.0005	0.0009	0.0006	0.0008	0.0005	0.0029	0.0001	-0.0001	0.0007	-0.0001	0.0017
Total Bismuth (Bi)	0.005	µg/L	-	-	-	-	0.0005	0.0003	0.0020	0.0003	0.0031	0.0002	0.0002	0.0004	0.0011	0.0087	0.0011	0.0008	0.0008	0.0002	0.0007	-0.0001	-0.0002	0.0043	0.0022	0.0026	0.0011	0.0007
Dissolved Boron (B)	10	µg/L	-	-	-	-	23	23	22	23	23	23	26	25	22	22	24	23	23	23	22	22	42	42	81	39	37	37
Total Boron (B)	10	µg/L	1500	-	200	5000	27	26	20	22	20	20	24	23	25	25	26	25	24	24	24	23	38	41	68	39	41	39
Dissolved Cadmium (Cd)	0.005	µg/L	-	-	-	-	0.0059	0.0046	-0.0097	0.0028	0.006	0.0025	-0.0093	-0.0079	0.0083	0.0057	0.0084	0.0069	0.0063	0.0054	0.0066	0.0066	-0.0065	0.001	0	0.0026	0.001	0.0047

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																		
							Lake Ontario															Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Total Cadmium (Cd)	0.005	µg/L	0.16-0.24**	0.2	0.5**	7	0.0062	0.0058	0.001	0.0023	0.0048	0.0031	-0.0086	-0.0091	0.0125	0.0625	0.0035	0.0082	0.004	0.0038	0.004	0.0038	-0.0098	0.0107	0.0026	0.0027	0.0023	0.0028
Dissolved Chromium (Cr)	0.1	µg/L	-	-	-	-	0.25	0.0988	0.084	0.17	0.0916	0.074	0.12	0.13	0.15	0.19	0.17	0.11	0.17	0.11	0.15	0.17	0.16	0.0468	0.0694	0.0595	0.0514	0.11
Total Chromium (Cr)	0.1	µg/L	-	-	-	50	0.0936	0.12	0.18	0.087	0.0998	0.072	0.21	0.0567	0.0968	0.11	0.11	0.12	0.12	0.0731	0.13	0.0773	0.0593	0.28	0.16	0.18	0.0871	0.14
Dissolved Cobalt (Co)	0.005	µg/L	-	-	-	-	0.0094	0.0096	0.0153	0.0157	0.0106	0.0078	0.0175	0.017	0.0165	0.0128	0.025	0.0128	0.0144	0.0121	0.0177	0.0113	0.0846	0.0303	0.0485	0.0269	0.0231	0.0286
Total Cobalt (Co)	0.005	µg/L	-	-	0.9	-	0.011	0.0074	0.026	0.013	**4.14**	0.012	0.0135	0.0114	0.0186	0.0403	0.0144	0.0238	0.0139	0.0099	0.0124	0.0102	0.0283	0.102	0.054	0.058	0.0366	0.0407
Dissolved Copper (Cu)	0.05	µg/L	-	-	-	-	0.926	0.616	1.03	0.621	0.59	0.601	0.638	0.698	0.892	0.602	1.9	0.642	0.734	0.64	0.787	0.615	1.04	0.678	0.55	0.606	1.05	2.16
Total Copper (Cu)	0.05	µg/L	2.5-3.7**	5	5.0**	2000	1.47	0.72	1.09	0.78	**24**	0.8	0.978	0.623	0.861	0.799	0.996	0.937	0.865	0.684	0.802	0.638	0.8	1.21	0.8	1.55	0.875	1.72
Dissolved Iron (Fe)	1	µg/L	-	-	-	-	6.5	6.1	4	11.1	1.7	1.2	18.4	19.7	6.2	3.9	16.1	2.9	3.6	5	3.3	3.4	262	15.3	21.2	9.2	10.2	15.8
Total Iron (Fe)	1	µg/L	300	300	-	-	7.5	8.1	27.8	8.6	10.9	10.8	6.3	1.4	14.1	58.1	9.4	35.3	7.6	6.7	6	2.5	10.6	297	165	170	110	118
Dissolved Lead (Pb)	0.005	µg/L	-	-	-	-	0.0221	0.0145	0.0368	0.0847	0.0082	0.004	0.0249	0.0306	0.0458	0.0474	0.367	0.0144	0.0183	0.0229	0.037	0.0082	0.44	0.019	0.0171	0.0249	0.0191	0.0714
Total Lead (Pb)	0.005	µg/L	3.4-6.1**	25	5.0**	5	0.0467	0.018	0.108	0.027	0.027	0.03	0.0517	0.0091	0.0637	0.127	0.0299	0.103	0.0206	0.0143	0.0207	0.0073	0.0296	0.49	0.205	0.389	0.2	0.213
Dissolved Lithium (Li)	0.5	µg/L	-	-	-	-	1.8	1.87	1.5	1.73	1.68	1.74	1.68	1.7	1.76	1.73	1.74	1.68	1.73	1.72	1.73	1.75	2.07	2.19	2.9	2.14	2.16	2.42
Total Lithium (Li)	0.5	µg/L	-	-	-	-	1.74	1.74	1.4	1.89	1.82	1.52	1.49	1.48	1.7	1.7	1.71	1.72	1.73	1.69	1.77	1.7	1.87	2.4	2.57	2.51	2.16	2.23
Dissolved Manganese (Mn)	0.05	µg/L	250-530**	-	-	-	0.505	0.341	3.08	1.61	0.767	0.908	2.29	2.77	0.89	0.483	3.19	0.435	0.669	0.872	0.747	0.407	102	6.11	49.7	1.08	2.61	4.58
Total Manganese (Mn)	0.05	µg/L	-	-	-	120	0.75	0.519	4.63	1.61	4.72	1.44	0.915	0.686	1.61	2.12	1.17	3.57	0.847	0.545	0.781	0.552	2.01	86	52.5	81.9	52.4	43.6
Dissolved Molybdenum (Mo)	0.05	µg/L	-	-	-	-	1.16	1.15	1.13	1.18	1.15	1.18	1.17	1.16	1.18	1.14	1.27	1.18	1.18	1.12	1.22	1.13	1.1	1.09	1.1	1.12	1.13	1.12
Total Molybdenum (Mo)	0.05	µg/L	73	-	40	-	1.13	1.17	1.08	1.05	1.04	0.935	1.14	1.11	1.22	1.13	1.21	1.12	1.17	1.15	1.23	1.12	1.06	0.892	0.886	1.02	1.06	1.12
Dissolved Nickel (Ni)	0.02	µg/L	-	-	-	-	1.14	1.48	0.804	0.622	0.588	0.604	0.49	1.57	0.832	0.85	1.67	1.26	0.701	0.791	0.876	1.6	0.635	0.464	0.53	0.53	0.889	0.602
Total Nickel (Ni)	0.02	µg/L	99-140**	25	-	-	1.88	0.612	0.62	0.64	12	0.84	0.922	0.65	6.41	1.16	0.81	0.822	0.73	2.25	0.565	0.488	0.557	0.75	0.69	0.74	0.531	0.658
Dissolved Selenium (Se)	0.04	µg/L	-	-	-	-	0.123	0.13	0.115	0.109	0.117	0.131	0.128	0.119	0.126	0.133	0.141	0.127	0.133	0.132	0.134	0.129	0.109	0.103	0.1	0.097	0.1	0.106
Total Selenium (Se)	0.04	µg/L	1	100	-	50	0.118	0.136	0.114	0.132	0.197	0.108	0.116	0.105	0.135	0.124	0.141	0.131	0.125	0.155	0.133	0.135	0.092	0.113	0.093	0.105	0.114	0.102
Total Silicon (Si)	50	µg/L	-	-	-	-	561	573	272	350	412	377	238	265	371	400	360	436	363	471	366	398	2550	2630	2330	2520	1940	1710
Dissolved Silicon (Si)	50	µg/L	-	-	-	-	561	570	258	353	450	449	270	294	409	394	359	412	359	388	354	397	2890	2480	2660	2380	1800	1620
Dissolved Silver (Ag)	0.005	µg/L	-	-	-	-	0.0003	0.0011	0.0014	0.0003	0.0005	0.0004	0.0019	0.0005	0.001	0.0006	0.0011	0.0012	0	0.001	0.0009	0.0001	0.0023	-0.0002	0	0.0006	0.0003	0.0011
Total Silver (Ag)	0.005	µg/L	0.25	0.1	-	-	0.0016	0.0003	0.005	0.001	**0.448**	0.0004	0.0007	0.0003	0	0.0068	0.0012	0.0014	0.0012	0.0009	0.0008	0.0004	0.0008	0.0016	0.0014	0.002	0.0007	0.0019
Dissolved Strontium (Sr)	0.050	µg/L	-	-	-	-	164	164	165	169	172	170	178	178	173	164	171	172	172	164	170	169	225	217	257	216	205	226
Total Strontium (Sr)	0.050	µg/L	-	-	-	7000	179	173	145	177	158	134	163	162	174	172	174	169	174	172	178	171	208	215	210	218	210	235
Dissolved Thallium (Tl)	0.002	µg/L	-	-	-	-	0.0066	0.0067	0.0062	0.0066	0.0069	0.0064	0.0065	0.0065	0.0065	0.0075	0.009	0.0069	0.0069	0.0071	0.0073	0.0078	0.0021	0.0008	0.0007	0.0011	0.0022	0.0019
Total Thallium (Tl)	0.002	µg/L	0.8	-	0.3	-	0.007	0.0072	0.006	0.0065	0.0066	0.0052	0.0071	0.0067	0.0076	0.0149	0.0077	0.0061	0.0066	0.0065	0.0066	0.0078	0.0011	0.0021	0.001	0.0016	0.0025	0.0021
Dissolved Tin (Sn)	0.2	µg/L	-	-	-	-	0.0858	0.0393	0.0493	0.0275	0.0252	0.0135	0.0119	0.0171	0.0332	0.0242	0.1092	0.0196	0.0199	0.0312	0.0237	0.1058	0.0329	0.0093	0.0141	0.0218	0.0518	0.0867
Total Tin (Sn)	0.2	µg/L	-	-	-	-	0.0151	0.0491	0.03	0.0528	0.0395	0.0504	0.2	0.019	0.0323	0.0568	0.0258	0.0196	0.0354	0.0282	0.0195	0.0266	0.0219	0.049	0.0517	0.0405	0.0325	0.0302
Dissolved Titanium (Ti)	0.5	µg/L	-	-	-	-	0.1496	0.1823	0.2014	0.2318	0.1048	0.0617	0.5	0.53	0.1622	4.48	0.2085	0.1269	0.1281	0.2927	0.1076	0.0863	3.84	0.2351	0.1304	0.0959	0.379	0.15375
Total Titanium (Ti)	0.5	µg/L	-	-	-	-	0.1842	0.0695	0.694	0.1916	0.2606	0.2042	0.0159	0.0026	0.3209	0.1773	0.1508	0.72	0.1689	0.0932	0.1649	0.1337	0	5.6	1.4158	2.1	1.24	1.72
Dissolved Uranium (U)	0.002	µg/L	-	-	-	-	0.317	0.316	0.338	0.317	0.325	0.324	0.308	0.302	0.343	0.339	0.341	0.34	0.337	0.327	0.336	0.344	0.286	0.289	0.307	0.29	0.294	0.301
Total Uranium (U)	0.002	µg/L	1.5	5	5	20	0.339	0.33	0.297	0.301	0.376	0.258	0.377	0.409	0.347	0.367	0.324	0.324	0.333	0.327	0.335	0.337	0.356	0.264	0.272	0.287	0.327	0.32
Dissolved Vanadium (V)	0.2	µg/L	-	-	-	-	0.21	0.26	0.46	0.24	0.23	0.23	0.1981	0.21	0.23	0.1477	0.37	0.1513	0.2	0.1335	0.28	0.1369	0.73	0.54	0.53	0.49	0.4	0.41
Total Vanadium (V)	0.2	µg/L	-	6	6	-	0.1728	0.22	0.25	0.1666	0.1368	0.1356	0.125	0.1511	0.21	0.186	0.1754	0.1854	0.1539	0.132	0.1526	0.1429	0.42	0.76	0.53	0.62	0.5	0.51
Dissolved Zinc (Zn)	0.1	µg/L	16-53**	-	-	-	2.5	1.01	2.58	1.55	0.91	0.52	0.28	1.09	2.48	0.68	6.09	0.51	1.18	0.58	1.81	1.2	1.87	0.51	0.67	0.51	0.9	5.6
Total Zinc (Zn)	0.1	µg/L	-	30	20	-	1.02	1.83	2.5	0.7132	1.4	1	1.19	1.06	2.43	1.23	1.16	1.79	1.49	0.65	1.43	0.38	1.72	3.1	1.6	1.8	1.26	1.51
Dissolved Zirconium (Zr)	0.1	µg/L	-	-	-	-	0.0085	0.0073	0.0065	0.0118	0.0084	0.006	0.0078	0.0079	0.0133	0.0149	0.0152	0.0073	0.0165	0.0081	0.0121	0.0011	0.0192	0.0146	0.0198	0.0098	0.0095	0.0159
Total Zirconium (Zr)	0.1	µg/L	-	-	4	-	0.0056	0.0036	0.015	0.0046	0.0028	0.0083	0.0066	0.0067	0.0186	0.0187	0.0195	0.0121	0.0109	0.0175	0.015	0.0058	0.0108	0.0382	0.0319	0.0177	0.0179	0.0168
Dissolved Calcium (Ca)	10	µg/L	-	-	-	-	31500	30300	29400	31700	31500	31600	32100	32100	34200	32700	33800	33200	33500	32800	33500	33000	44400	43100	51500	41500	38700	40100
Total Calcium (Ca)	10	µg/L	-	-	-	-	32800	32700	27900	31600	29100	25700	31800	31900	32600	32500	32800	33200	33100	38600	32800	32500	43400	41500	42700	41900	41200	41600
Dissolved Cesium (Cs)	0.05	µg/L	-	-	-	-	0.0018	0.0022	0.0027	0.0025	0.0028	0.0022	0.0043	0.0038	0.0038	0.0036	0.0039	0.0036	0.0028	0.0031	0.0044	0.0037	0.0084	0.0008	0.001	0.0017	0.0013	0.0023
Total Cesium (Cs)	0.05	µg/L	-	-	-	-	0.0027	0.0022	0.006	0.0024	0.0022	0.0023	0.0014	0.0016	0.0036	0.0296	0.0026	0.0037	0.0022	0.0031	0.0027	0.0021	-0.0002	0.0117	0.0034	0.0059	0.003	0.0049
Dissolved Magnesium (Mg)	10	µg/L	-	-	-	-	8070	7980	7780	8700	8570	8250	8390	8220	8090	7820	7970	7960	7960	7840	7980	7910	8690	8270	9060	8400	8070	8360
Total Magnesium (Mg)	10	µg/L	-	-	-	-	8590	8670	7180	8470	7900	6650	7590	7860	8290	8230	8220	7930	8260	8220	8230	8090	7750	8370	7460	8960	8940	8930
Dissolved Potassium (K)	10	µg/L	-	-	-	-	1440	1430	1510	1490	1480	1480	1560	1550	1620	1520	1540	1510	1530	1480	1580	1450	1920	1870	2350	1790	1740	1920
Total Potassium (K)	10	µg/L	-	-	-	-	1510	1470	1330	1530	1420	1200	1510	1450	1580	1550	1570	1490	1580	1530	1580	1530	1760	1840	1920	1940	1820	1870
Dissolved Sodium (Na)	10	µg/L	-	-	-	-	12600	12500	12300	14000	13700	13700	13300	13600	13500	13000	13300	12900	13200	12700	13300	12800	38100	42700	84100	39700	33300	36400

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																			
							Lake Ontario																Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Total Sodium (Na)	10	µg/L	-	-	-	-	13100	13200	11500	13200	12400	11000	11900	12900	13300	13200	13200	12500	13400	13000	13100	12800	34000	39500	68000	38700	34000	36900
Dissolved Thorium (Th)	0.05	µg/L	-	-	-	-	-0.0012	-0.002	0.0061	0.001	-0.001	0.0014	0.0029	0.0039	0.0058	0.0102	0.0059	0.0027	0.0053	0.0029	0.0017	0.0023	0.0206	0.0027	0.0008	0.0027	-0.0013	0.0027
Total Thorium (Th)	0.05	µg/L	-	-	-	-	0.0011	0.0023	0.02	-0.0028	-0.0008	0.0023	0.0105	0.0136	0.201	0.0133	0.0054	0.0117	0.003	0.004	0.004	0.004	0.0096	0.0122	0.0102	0.0028	0.0111	0.0136
Dissolved Tungsten (W)	0.01	µg/L	-	-	-	-	0.072	0.074	0.07	0.071	0.072	0.07	0.074	0.074	0.075	0.072	0.079	0.074	0.082	0.074	0.076	0.075	0.071	0.063	0.051	0.062	0.066	0.066
Total Tungsten (W)	0.01	µg/L	-	-	30	-	0.068	0.076	0.061	0.067	0.068	0.055	0.076	0.071	0.078	0.096	0.073	0.078	0.075	0.073	0.076	0.07	0.065	0.057	0.045	0.063	0.061	0.071
Chromium (VI)	0.50	ug/L	1	1	-	50	0.0965	0.0679	0.1727	0.0853	0.1378	0.0875	0.2058	0.1775	0.0366	0.0975	0.1006	0.0027	0.1107	0.0873	0.0602	0.0632	0.1556	0.0515	0.0302	0.0827	0.0385	0.0588
Mercury (Hg)	0.01	ug/L	0.026	-	-	1	0.001	0.001	0.00104568	0.0004	0.0003	0.0001	0.0007	-0.0003	0.0022	0.0024	0.0016	0.0017	0.0011	0.0009	0.0031	0.0017	0.0004	0.0013	0.0001	0.0001	0.0012	0.0023
Dissolved Mercury (Hg)	0.01	ug/L	-	0.2	-	-	0.0018	0.0027	0.001	-0.001	-0.0008	0.0000	0.0003	0.0011	0.0016	0.0013	0.0004	0.0008	-0.0007	0.0012	0.0005	0.0007	0.0002	-0.0001	-0.0002	-0.0011	0.0025	0.0027
Volatile Organics																												
Benzene	0.10	ug/L	370	-	100	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromodichloromethane	0.10	ug/L	-	-	200	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromoform	0.20	ug/L	-	-	60	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloroform	0.10	ug/L	1.8	-	-	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethylbenzene	0.10	ug/L	90	-	8	140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocarbons																												
F1 (C6-C10)	25	ug/L	167	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F1 (C6-C10) - BTEX	25	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F2 (C10-C16 Hydrocarbons)	100	ug/L	42				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F3 (C16-C34 Hydrocarbons)	200	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F4 (C34-C50 Hydrocarbons)	200	ug/L	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reached Baseline at C50	-	ug/L	-	-	-	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Surrogate Recovery (%)																												
1,4-Difluorobenzene	-	%	-	-	-	-	100	100	100	102	101	104	117	117	98	99	98	103	98	99	98	97	117	102	103	102	100	100
4-Bromofluorobenzene	-	%	-	-	-	-	98	98	109	103	102	101	87	87	96	98	91	93	93	95	95	96	87	102	100	102	98	98
D10-o-Xylene	-	%	-	-	-	-	100	100	103	102	95	100		107	95	87	90	93	88	90	95	92	107	98	101	97	95	99
D4-1,2-Dichloroethane	-	%	-	-	-	-	107	106	96	95	97	91	106	103	99	106	104	98	102	101	95	99	107	93	93	95	107	107
o-Terphenyl	-	%	-	-	-	-	92	91	96	92	93	91	94	91	97	96	93	92	93	95	91	92	90	94	93	94	108	91
4-Bromofluorobenzene	-	%	-	-	-	-	92	92	100	97	99	99	99	98	101	101	102	101	101	100	100	103	101	91	101	101	91	92
D4-1,2-Dichloroethane	-	%	-	-	-	-	102	106	103	102	103	100	99	99	105	103	103	104	106	106	105	107	102	102	102	102	103	104
D8-Toluene	-	%	-	-	-	-	101	103	102	99	100	102	100	102	95	96	96	96	95	97	95	97	101	102	101	100	103	101
Microbiological																												
Background	10	CFU/100mL	-	-	-	-	380	4800	60000	440	540	880	880	8000	1100	1100	780	1200	2600	2500	1200	1200	3200	5200	6600	4000	8000	6200
Fecal coliform	10	CFU/100mL	-	-	-	-	<10	20	650	<10	10	<10	20	10	20	<10	110	<10	120	<10	60	<10	20	90	220	<10	10	10
Total Coliforms	10	CFU/100mL	-	-	-	10	10	**30**	**2400**	**40**	10	10	**120**	**80**	**200**	**60**	**260**	**40**	**470**	**60**	**150**	**50**	**50**	**640**	**540**	**50**	**50**	**280**
Escherichia coli	10	CFU/100mL	-	100	-	10	<10	**20**	**240**	<10	<10	<10	<10	10	<10	<10	<10	<10	<10	<10	<10	<10	10	**60**	**200**	10	<10	10
Radionuclides																												
H-3	14	Bq/kg	-	7000	-	-	-10.5	-10.5	31.7	-10.5	-10.4	10.5	-10.6	-5.24	10.5	5.26	15.8	0	10.5	5.27	15.8	0	-5.26	30.8	20.7	31.2	26	21
C-14	0.027	Bq/g	-	-	-	-	-0.266	-0.0431	0.012	-0.0439	-0.0432	-0.346	0.197	0.332	0.00301	0.0028	0.0191	-0.0649	-0.0511	-0.0151	-0.0364	0.0857	0.0873	-0.0622	-0.154	-0.184	-0.273	0.0323
Co-60	0.73	Bq/kg	-	-	-	-	0.309	0.337	0.493	-0.252	-0.0625	0.573	-0.32	0.0024	0.317	-0.121	0.177	-0.184	0.331	0.229	0.00977	-0.2	0.21	0.325	-0.635	0.267	0.332	-0.687
Cs-134	0.75	Bq/g	-	-	-	-	0.233	0.116	0.0442	-0.174	0.262	-0.27	-0.448	-0.00336	0.128	0.269	0.0443	0.184	-0.187	-0.544	-0.261	0.027	0.0359	0.0312	0.493	0.234	0.128	-0.139
Cs-137	0.6	Bq/kg	-	50	-	10	0.265	-0.0635	0.265	-0.0345	0.41	0.0321	0.224	-0.646	0.261	-0.521	-0.283	-0.37	-0.12	0.203	-0.582	-0.263	-0.0762	-0.201	0.42	-0.308	0.0623	0.0672
I-131	1.2	Bq/kg	-	10	-	6	0.318	0.0444	2.19	-0.507	-0.564	0.127	-0.159	0.386	0.738	-0.272	-0.69	0.169	0.457	1.32	-0.0151	-0.672	0.131	0.0859	-0.142	0.0322	0.346	0.415
K-40	7.1	Bq/g	-	-	-	-	2.28	2.15	2.49	4.7	-4.69	-1.4	0.177	-0.912	-7.45	-0.279	-0.371	-0.387	-1.73	-2.32	0.36	-5.01	1.07	0.781	-0.0788	-0.483	1.42	1.81
Th-Series	1.8	Bq/kg	-	-	-	-	-1.14	-1.32	-1.42	0.509	0.925	0.484	-0.314	0.859	0.226	-1.08	-0.941	0.693	0.672	-0.581	-0.495	0.0944	-0.269	-0.0161	1.1	1.26	0.261	-0.737
U-Series	1.5	Bq/kg	-	-	-	-	0.0513	1.77	1.01	0.845	0.174	-0.137	-0.335	0.744	-0.11	0.018	0.0091	0.196	-0.469	-0.884	-0.621	0.292	0.377	0.351	0.0954	0.215	0	0.299
Miscellaneous Parameters																												
Hydrazine	0.1	ug/L	2.6	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Monomethyl Hydrazine	0.25	ug/L	-	-	-	-	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
1,1-Dimethylhydrazine	0.25	ug/L	-	-	-	-	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Chlorophyll a	1.3	ug/L	-	-	-	-	0.4	0.1	0.8	2.6	1.8	1.2	3.0	4.5	0.4	0.5	0.7	0.5	0.3	0.6	0.4	0.3	12.0	12.0	5.9	8.5	9.9	11.0

Parameter	Detection Limit	Units	CCME (1)	PWQG (2)	Interim PWQO (2)	Health Canada (3)	Station																	
							Lake Ontario													Frenchman's Bay					
							LWC1-S	LWC1-B	LW21-M	LW9-S	LW9-B	LW10	FB1-S	FB1-B	LW2401-S	LW2401-B	LW2402-S	LW2402-B	LW2403-S	LW2403-B	LW2404-S	LW2404-B	LOC1	LOC2	LOC3	PN5-1	PN10	PN9
Morpholine	4	ug/L	-	-	4	-	0	0	2.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dissolved Methyl Mercury	0.050	ng/L	-	-	-	-	0.02173	0.01839	0.06600	0.01959	0.01620	0.00609	0.03136	0.00692	0.10000	0.08300	0.38000	0.08800	0.04275	0.06700	0.05100	0.07000	0.01149	0.00422	0.01149	0.00568	0.01901	0.02700
Total Methyl Mercury	0.050	ng/L	4	-	-	-	0.02880	0.02753	0.10000	0.06200	0.04105	0.03774	0.02641	0.01135	0.06200	0.02387	0.11000	0.02317	0.02317	0.01911	0.06700	0.05800	0.01735	0.23000	0.01735	0.03906	0.02638	0.05400

Notes:

Bold	Exceeded Interim PWQO
Bold	Exceeded PWQO
Bold	Exceeded CCME
Bold	Exceeded Health Canada Guidelines
Bold	Exceeded more than one guideline

Surface water samples from Lake Ontario were collected at a depth of 0.5 meters (denoted by "S" in the sample name), while bottom samples were taken 0.5 meters above the lakebed (denoted by "B"). Mid-depth samples were collected in Frenchman's Bay, as thermal stratification is unlikely in the shallow depths observed in this area. Sampling locations presented in Figure 4-3 and Figure 4-4.

* Only censored results provided by lab.

** Calculated values. The value for Hardness (as CaCO3) dissolved was used to estimate hardness-dependent guidelines.

a – Total Ammonia guideline (Long Term Concentration (mg/L) Table): Retrieved from: https://ccme.ca/en/chemical/5#_aql_fresh_concentration

b – Dissolved Aluminum guideline: The Interim PWQO is 15 µg/L between pH 4.5 to 5.5, and 75 µg/L between pH 6.5 to 9.0. Between pH 5.5 - 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than 10% above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs.

c – Total Aluminum guideline (Long Term Concentration (µg/L) Variable): If pH < 6.5, the CWQG is 5 µg/L. If pH ≥ 6.5, the guideline is 100 µg/L.

d – Total Beryllium guideline (µg/L): If Hardness < 75 mg/L, the PWQO is 11 µg/L. If Hardness > 75 mg/L, then the PWQO is 1100 µg/L.

e – Total Cadmium guideline (Long Term concentration (µg/L) equation): When the water hardness is > 0 to < 17 mg/L, the CWQG is 0.04 µg/L. At hardness ≥ 17 to ≤ 280 mg/L, the CWQG is calculated as 10{0.83(log[hardness]) – 2.46}. At hardness > CWQG (µg/L) = 10{0.83(log[hardness]) – 2.46} At hardness > 280 mg/L, the guideline is 0.37 µg/L.

f – Total Cadmium guideline (µg/L): If Hardness 0-100 mg/L, the Interim PWQO is 0.1 µg/L. If Hardness > 100 mg/L, then the Interim PWQO is 0.5 µg/L.

g – Total Copper guideline (Long Term concentration (µg/L) equation): When the water hardness is 0 to < 82 mg/L, the CWQG is 2 µg/L. At hardness ≥82 to ≤180 mg/L the CWQG is calculated using this equation: 0.2 * e{0.8545[ln(hardness)]-1.465}. At hardness >180 mg/L, the CWQG is 4 µg/L.

h - Total Copper guideline (µg/L): If Hardness 0-20 mg/L, the Interim PWQO is 1 µg/L. If Hardness > 20 mg/L, then the Interim PWQO is 5 µg/L.

i – Total Lead guideline (Long Term concentration (µg/L) equation): When the hardness is 0 to ≤ 60 mg/L, the CWQG is 1 µg/L. At hardness >60 to ≤ 180 mg/L the CWQG is calculated as e{1.273[ln(hardness)]-4.705}. At hardness >180 mg/L, the CWQG is 7 µg/L. At hardness >180 mg/L, the CWQG is 7 µg/L.

j – Total Lead guideline: If Hardness is 30-80 mg/L, then the Interim PWQO is 3 µg/L. If Hardness is > 80 mg/L, then the Interim PWQO is 5 µg/L.

k – Dissolved Manganese concentration (Long Term concentration (µg/L) equation): Calculated using the CWQG calculator in Appendix B of the Scientific Criteria Document for the Development of the Canadian Water Quality Guidelines for the Protection of Aquatic Life: Manganese. Retrieved from: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fccme.ca%2Fen%2Fres%2F2019-manganese-cwqg-scd-appendix-b-en.xlsx&wdOrigin=BROWSELINK

l – Total Nickel guideline (Long Term concentration (µg/L) equation): When the water hardness is 0 to ≤ 60 mg/L, the CWQG is 25 µg/L. At hardness > 60 to ≤ 180 mg/L the CWQG is calculated as e{0.76[ln(hardness)]+1.06}. At hardness >180 mg/L, the CWQG is 150 µg/L.

m – Dissolved Zinc guideline (Long Term concentration (µg/L) equation): The CWQG is calculated as exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625).
This equation is valid between hardness 23.4 and 399 mg CaCO3·L−1, pH 6.5 and 8.13 and DOC 0.3 to 22.9 mg·L−1, which is the range of data used to derive the hardness, pH and DOC slopes.

n – Radionuclides are not screened as their levels should be as low as reasonably achievable (ALARA).

References:

7. CCME. n.d. Canadian Water Quality Guidelines for Protection of Aquatic Life. Accessed in September 2024.
8. Ministry of Environment and Climate Change. MOECC. 1994. Water management: policies, guidelines, provincial water quality objectives.
9. Health Canada. 2019. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

A.2 Sediment

Table A-4: Screening of Sediment Quality Parameters in 2024 samples

Parameter	Detection Limit	Units	PSQG - LELs (1)	PSQG - SELs (1)	CCME SQG - ISQG (2)	CCME SQG - PEL (2)	Guideline from Other Sources (3-6, 9)		Background Concentration (Dragun & Chiasson, 1991) (7)	Station																				
										Frenchman's Bay																Infill area						
							Value	Source		FB-2	Location 3	FB-4	FB-5	FB-7	FB-8	FB-9	FB-10	PN-1-1	PN-2-1	PN-5-1	PN-6-1	PN-7-1	PN-8-1	PN-9-1	PN-10-1	INFILL-01	INFILL-02	INFILL-03	INFILL-04	INFILL-05	INFILL-06	INFILL-07
Calculated Parameters																																
Total (Dry Wt) Methyl Mercury	0.084 - 0.24	ng/g	-	-	-	-	-	-	-	-	0.350	0.000	-	0.000	-	-	-	0.170	-	0.000	0.000	-	-	-	-	0.200	0.000	0.000	0.000	0.000	0.000	0.000
Total (Wet Wt) Methyl Mercury	0.05	ng/g	-	-	-	-	-	-	-	-	0.072	0.031	-	0.011	-	-	-	0.064	-	0.013	0.043	-	-	-	-	0.160	0.047	0.046	0.024	0.029	0.046	0.033
Inorganics																																
Moisture	1	%	-	-	-	-	-	-	-	44.000	80.000	40.000	74.000	77.000	78.000	77.000	61.000	59.000	77.000	78.000	48.000	67.000	48.000	72.000	56.000	-	-	-	-	-	-	-
Nitrogen (N)	0.01	%	-	-	-	-	-	-	-	0.170	0.890	0.180	0.630	0.780	0.810	0.740	0.410	0.310	0.670	0.660	0.180	0.400	0.160	0.550	0.290	-	-	-	-	-	-	-
Total Organic Carbon	500	mg/kg	10000 [a]	100000 [a]	-	-	-	-	-	**14000.000**	**94000.000**	**19000.000**	**76000.000**	**75000.000**	**100000.000**	**86000.000**	**46000.000**	**24000.000**	**66000.000**	**60000.000**	**14000.000**	**36000.000**	**13000.000**	**53000.000**	**26000.000**	2500.000	459.000	1100.000	483.000	670.000	860.000	630.000
Calculated Total Kjeldahl Nitrogen	100	µg/g	550	4800	-	-	-	-	-	**1700.000**	**8900.000**	**1800.000**	**6300.000**	**7800.000**	**8100.000**	**7400.000**	**4100.000**	**3100.000**	**6700.000**	**6600.000**	**1800.000**	**4000.000**	**1600.000**	**5500.000**	**2900.000**	-	-	-	-	-	-	-
Total Phosphorus (P)	10.00	mg/kg	600	2000	-	-	-	-	-	**787.000**	**869.000**	**782.000**	**1000.000**	**884.000**	**875.000**	**1050.000**	**1040.000**	**800.000**	**951.000**	**935.000**	**604.000**	**870.000**	597.000	**1110.000**	**808.000**	**986.000**	528.000	**619.000**	459.000	429.000	**979.000**	491.000
Nitrite (N)	0.5	µg/g	-	-	-	-	-	-	-	0.016	0.091	0.005	0.035	0.066	0.069	0.003	0.038	0.361	0.165	0.053	0.024	0.044	0.006	0.034	0.014	-	-	-	-	-	-	-
Nitrate (N)	2	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Nitrate + Nitrite (N)	3	µg/g	-	-	-	-	-	-	-	0.283	0.462	0.173	0.112	0.414	0.341	0.275	0.149	1.609	0.477	0.346	0.361	0.361	0.245	0.357	0.262	-	-	-	-	-	-	-
Metals																																
Total Aluminum (Al)	100.00	mg/kg	-	-	-	-	58030	(3)	-	4210.000	9220.000	5740.000	12300.000	10100.000	9720.000	11300.000	10100.000	6260.000	10600.000	11600.000	3620.000	7000.000	4110.000	11400.000	6170.000	1760.000	1070.000	1240.000	992.000	1160.000	1460.000	1120.000
Total Antimony (Sb)	0.10	mg/kg	-	-	-	-	2	(6)	-	0.260	0.780	0.420	0.930	0.630	0.710	0.640	0.840	0.240	0.490	0.460	0.160	0.330	0.170	0.530	0.230	0.038	0.024	0.028	0.026	0.035	0.041	0.023
Total Arsenic (As)	0.20	mg/kg	6	33	5.9	17	-	-	-	1.220	2.610	1.610	3.050	3.670	3.170	2.440	2.610	2.720	4.070	3.830	2.200	2.970	2.370	4.150	2.880	1.500	1.370	1.340	1.290	1.390	2.630	1.410
Total Barium (Ba)	0.10	mg/kg	-	-	-	-	-	-	10 - 5000	32.000	71.700	37.700	93.100	92.300	80.000	97.300	74.100	50.600	93.400	106.000	28.300	63.800	30.400	95.200	43.800	10.400	6.110	6.260	6.130	6.400	7.350	6.170
Total Beryllium (Be)	0.20	mg/kg	-	-	-	-	-	-	<1.0 - 15	0.195	0.440	0.300	0.520	0.440	0.450	0.500	0.430	0.320	0.450	0.490	0.193	0.370	0.210	0.510	0.300	0.125	0.068	0.158	0.102	0.103	0.120	0.115
Total Bismuth (Bi)	0.10	mg/kg	-	-	-	-	-	-	<10 - 15	0.100	0.160	0.110	0.230	0.160	0.150	0.190	0.220	0.079	0.150	0.150	0.044	0.110	0.054	0.180	0.071	0.025	0.012	0.015	0.012	0.015	0.017	0.014
Total Boron (B)	1.00	mg/kg	-	-	-	-	-	-	<20 - 300	4.500	11.100	6.300	10.200	8.200	10.000	9.000	9.000	6.400	9.000	7.400	3.900	6.000	4.400	9.400	6.000	3.300	2.100	3.700	3.100	2.700	2.900	2.600
Hot Water Ext. Boron (B)	0.05	µg/g	-	-	-	-	0.5	(8)	-	0.350	0.310	0.410	**0.610**	0.220	0.200	0.350	0.350	0.300	0.260	0.240	0.230	0.330	0.290	0.320	0.310	0.270	0.060	0.079	0.045	0.053	0.053	0.043
Total Cadmium (Cd)	0.05	mg/kg	0.6	10	0.6	3.5	-	-	-	0.153	0.388	0.212	0.526	0.472	0.386	0.444	**0.601**	0.363	**0.604**	**0.610**	0.171	0.328	0.235	0.556	0.293	0.037	0.019	0.041	0.029	0.038	0.049	0.019
Total Calcium (Ca)	100.00	mg/kg	-	-	-	-	-	-	100 - 320,000	56200.000	71000.000	72400.000	92900.000	118000.000	87500.000	97000.000	97100.000	104000.000	122000.000	134000.000	91000.000	106000.000	92100.000	115000.000	94400.000	79100.000	76100.000	79900.000	76000.000	81000.000	83000.000	81500.000
Total Cesium (Cs)	1.00	mg/kg	-	-	-	-	-	-	0.25 - 25	0.286	0.605	0.463	0.822	0.665	0.620	0.653	0.635	0.460	0.619	0.645	0.319	0.529	0.357	0.735	0.457	0.143	0.066	0.084	0.082	0.097	0.097	0.099
Total Chromium (Cr)	0.50	mg/kg	26	110	37.3	90	-	-	-	11.200	20.400	16.100	**29.800**	23.600	22.800	25.200	**30.100**	15.400	25.200	25.300	9.150	17.600	9.710	**27.400**	14.800	8.320	3.640	4.110	4.040	3.410	6.950	3.850
Total Cobalt (Co)	0.10	mg/kg	-	-	-	-	50	(4)	-	3.240	5.780	5.710	7.910	6.820	6.160	6.750	7.860	5.690	7.180	7.670	4.290	5.690	4.460	8.680	5.560	2.240	1.170	1.400	1.270	1.310	1.870	1.370
Total Copper (Cu)	0.50	mg/kg	16	110	35.7	197	-	-	-	15.300	**38.600**	**24.300**	**54.100**	**45.200**	**41.400**	**48.500**	**57.100**	**35.800**	**60.400**	**56.000**	**16.100**	**38.600**	**16.600**	**73.900**	**31.800**	3.270	1.650	1.700	1.530	1.830	2.460	1.560
Total Iron (Fe)	100.00	mg/kg	20000 [a]	40000 [a]	-	-	-	-	-	8660.000	15000.000	12300.000	19800.000	17300.000	16300.000	18800.000	18000.000	13100.000	17900.000	19700.000	8350.000	14100.000	9090.000	19200.000	12000.000	13200.000	5470.000	6880.000	7400.000	5440.000	12000.000	6710.000
Total Lead (Pb)	0.10	mg/kg	31	250	35	91.3	-	-	-	9.020	24.900	14.600	**33.600**	30.000	25.900	28.300	**31.800**	17.500	**34.600**	**35.200**	10.100	17.900	9.720	**31.900**	17.400	2.520	1.850	1.910	1.800	2.140	2.230	1.980
Total Lithium (Li)	0.50	mg/kg	-	-	-	-	-	-	<5.0 - 140	4.930	10.300	8.060	14.600	11.600	10.800	13.000	11.800	8.510	12.200	13.000	5.520	9.240	6.270	13.700	8.170	2.530	1.670	1.960	1.810	2.140	2.210	1.870
Total Magnesium (Mg)	100.00	mg/kg	-	-	-	-	-	-	50 - >100,000	4650.000	5730.000	5940.000	8120.000	6870.000	7150.000	7550.000	9080.000	7710.000	8280.000	8580.000	5320.000	8310.000	5520.000	9920.000	6850.000	4320.000	3280.000	3340.000	2670.000	2790.000	3740.000	2820.000
Total Manganese (Mn)	0.20	mg/kg	460	1100	-	-	-	-	-	214.000	369.000	261.000	**522.000**	**538.000**	436.000	**534.000**	**463.000**	423.000	**632.000**	**599.000**	268.000	430.000	296.000	**593.000**	342.000	185.000	129.000	148.000	131.000	142.000	161.000	138.000
Total Mercury (Hg)	0.05	mg/kg	0.2	2	0.17	0.486	-	-	-	0.025	0.085	0.040	0.078	0.073	0.058	0.069	0.065	0.045	0.080	0.067	0.028	0.043	0.025	0.069	0.043	0.001	0.001	0.029	0.016	0.009	0.010	0.004
Total Molybdenum (Mo)	0.10	mg/kg	-	-	-	-	13.8	(5)	-	0.280	0.780	0.460	0.910	0.700	0.810	0.800	0.840	0.430	0.760	0.850	0.230	0.640	0.310	0.980	0.440	0.190	0.100	0.140	0.160	0.120	0.160	0.120
Total Nickel (Ni)	0.50	mg/kg	16	75	-	-	-	-	-	7.130	14.400	11.900	**19.900**	**17.400**	15.600	**17.800**	**19.200**	14.400	**20.000**	**21.800**	9.830	15.100	10.300	**22.400**	13.600	4.300	2.330	2.770	2.500	2.900	3.340	2.500
Total Potassium (K)	100.00	mg/kg	-	-	-	-	-	-	50 - 63,000	530.000	1180.000	859.000	1610.000	1290.000	1230.000	1370.000	1250.000	919.000	1420.000	1520.000	579.000	1090.000	632.000	1590.000	918.000	291.000	169.000	192.000	177.000	214.000	232.000	185.000
Total Selenium (Se)	0.50	mg/kg	-	-	-	-	1.9	(5)	-	0.228	0.840	0.246	0.770	0.850	0.890	0.660	0.497	0.476	0.950	0.870	0.268	0.560	0.326	0.850	0.420	0.084	0.029	0.079	0.044	0.048	0.044	0.036
Total Silver (Ag)	0.05	mg/kg	-	-	-	-	0.5	(4)	-	0.032	0.083	0.036	0.103	0.095	0.078	0.107	0.107	0.087	0.158	0.183	0.047	0.082	0.037	0.173	0.070	0.012	0.008	0.009	0.011	0.009	0.009	0.008
Total Sodium (Na)	100.00	mg/kg	-	-	-	-	-	-	<500 - 100,000	221.000	513.000	349.000	429.000	385.000	427.000	521.000	503.000	260.000	401.000	403.000	169.000	281.000	167.000	400.000	240.000	112.000	78.576	92.540	82.244	80.984	103.000	75.449
Total Strontium (Sr)	0.10	mg/kg	-	-	-	-	-	-	<5 - 3000	95.600	139.000	123.000	172.000	207.000	167.000	180.000	174.000	187.000	233.000	237.000	161.000	196.000	159.000	223.000	166.000	125.000	118.000	127.000	117.000	125.000	131.000	125.000
Total Thallium (Tl)	0.05	mg/kg	-	-	-	-	-	-	<0.25 - 10	0.066	0.154	0.116	0.200	0.195	0.163	0.165	0.189	0.153	0.209	0.182	0.134	0.154	0.121	0.222	0.145	0.049	0.035	0.029	0.025	0.026	0.027	0.020
Total Thorium (Th)	0.10	mg/kg	-	-	-	-	-	-	2.2 - 31	1.480	1.970	1.760	2.470	2.230	2.010	2.330	2.280	2.060	2.410	2.480	1.500	2.010	1.530	2.610	1.920	1.780	1.340	1.420	0.900	1.950	1.430	1.020
Total Tin (Sn)	0.10	mg/kg	-	-	-	-	-	-	<0.1 - 10	0.910	2.000	1.340	2.940	2.250	2.150	2.410	3.750	1.350	2.660	2.410	0.760	1.590	0.800	2.360	1.210	0.350	0.160	0.210	0.190	0.170	0.270	0.180
Total Titanium (Ti)	1.00	mg/kg	-	-	-	-	-	-	70 - 20,000	271.000	286.000	260.000	333.000	295.000	312.000	260.000	331.000	256.000	325.000	285.000	202.000	267.000	203.000	358.000	277.000	276.000	132.000	183.000	158.000	121.000	252.000	150.000
Total Tungsten (W)	0.50	mg/kg	-	-	-	-	-	-	<100 - 1000	0.220	0.483	0.320	0.680	0.399	0.440	0.489	0.800	0.224	0.347	0.374	0.124	0.237	0.149	0.380	0.169	0.214	0.125	0.109	0.118	0.112	0.157	0.137
Total Uranium (U)	0.05	mg/kg	-	-	-	-	104.4	(5)	-	0.358	0.624	0.414	0.580	0.539	0.656	0.542	0.539	0.501	0.617	0.638	0.381	0.551	0.400	0.639	0.485	0.448	0.264	0.374	0.307	0.261	0.410	0.337
Total Vanadium (V)	1.00	mg/kg	-	-	-	-	35.2	(5)	-	13.600	21.100	16.800	26.300	23.700	23.200	22.800	23.200	17.100	24.000	23.400	11.500	18.300	12.000	25.600	17.000	24.200	8.800	11.300	13.000	8.500	21.800	10.900

Parameter	Detection Limit	Units	PSQG - LELs (1)	PSQG - SELs (1)	CCME SQG - ISQG (2)	CCME SQG - PEL (2)	Guideline from Other Sources (3-6, 9)		Background Concentration (Dragun & Chiasson, 1991) (7)	Station																					
										Frenchman's Bay																Infill area						
							Value	Source		FB-2	Location 3	FB-4	FB-5	FB-7	FB-8	FB-9	FB-10	PN-1-1	PN-2-1	PN-5-1	PN-6-1	PN-7-1	PN-8-1	PN-9-1	PN-10-1	INFILL-01	INFILL-02	INFILL-03	INFILL-04	INFILL-05	INFILL-06	INFILL-07
Total Zinc (Zn)	1.00	mg/kg	120	820	123	315	-	-	-	81.600	**161.000**	119.000	**240.000**	**171.000**	**170.000**	**211.000**	**271.000**	104.000	**156.000**	**162.000**	51.900	105.000	60.100	**177.000**	82.700	16.800	9.400	10.300	8.800	11.700	13.300	10.300
Total Zirconium (Zr)	0.50	mg/kg	-	-	-	-	-	-	<20 - 2000	0.730	2.150	0.920	1.930	1.800	2.050	2.120	2.000	1.420	2.200	1.910	1.020	1.410	0.770	2.150	1.390	1.360	0.960	1.240	0.990	1.050	1.510	1.060
PCBs																																
Aroclor 1016	0.02	µg/g	0.007	53	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aroclor 1221	0.02	µg/g	-	-	-	-	0.12	(3)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aroclor 1232	0.02	µg/g	-	-	-	-	0.6	(3)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aroclor 1242	0.02	µg/g	-	-	-	-	0.17	(3)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aroclor 1248	0.02	µg/g	0.03	150	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aroclor 1254	0.02	µg/g	0.06	34	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.018	0.011	0.000	0.017	0.000	-	-	-	-	-	-	-
Aroclor 1260	0.02	µg/g	0.005	24	-	-	-	-	-	0.003	**0.012**	0.000	**0.024**	**0.019**	**0.013**	**0.019**	**0.016**	0.000	**0.019**	**0.036**	**0.009**	**0.010**	**0.006**	**0.016**	0.000	-	-	-	-	-	-	-
Aroclor 1262	0.02	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aroclor 1268	0.02	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Total PCB	0.02	µg/g	0.07	530	-	-	-	-	-	0.000	0.012	0.000	0.024	0.019	0.013	0.020	0.016	0.000	0.019	0.036	0.018	0.011	0.000	0.033	0.000	-	-	-	-	-	-	-
Polyaromatic Hydrocarbons																																
Anthracene	0.01	µg/g	0.22	370	0.0469	0.245	-	-	-	0.040	0.022	0.029	0.034	0.029	0.030	0.033	0.019	0.021	0.024	0.028	0.016	0.027	0.008	0.022	0.018	-	-	-	-	-	-	-
Benzo(a)anthracene	0.01	µg/g	0.32	1480	0.0317	0.385	-	-	-	**0.150**	**0.088**	**0.190**	**0.170**	**0.130**	**0.150**	**0.140**	**0.140**	**0.074**	**0.073**	**0.078**	**0.050**	**0.081**	0.022	**0.077**	**0.048**	-	-	-	-	-	-	-
Benzo(a)pyrene	0.01	µg/g	0.37	1440	0.0319	0.782	-	-	-	**0.210**	**0.150**	**0.260**	**0.300**	**0.230**	**0.260**	**0.240**	**0.210**	**0.093**	**0.110**	**0.140**	**0.065**	**0.110**	0.030	**0.110**	**0.062**	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	0.01	µg/g	0.17	320	-	-	-	-	-	**0.180**	0.160	**0.210**	**0.290**	**0.220**	**0.230**	**0.230**	**0.190**	0.076	0.110	0.150	0.046	0.089	0.027	0.096	0.050	-	-	-	-	-	-	-
Benzo(k)fluoranthene	0.01	µg/g	0.24	1340	-	-	-	-	-	0.120	0.089	0.140	0.180	0.130	0.150	0.130	0.120	0.055	0.065	0.091	0.042	0.065	0.017	0.070	0.035	-	-	-	-	-	-	-
Chrysene	0.01	µg/g	0.34	460	0.0571	0.862	-	-	-	**0.210**	**0.140**	**0.280**	**0.290**	**0.210**	**0.220**	**0.240**	**0.210**	**0.093**	**0.093**	**0.120**	**0.093**	**0.110**	0.030	**0.110**	**0.065**	-	-	-	-	-	-	-
Dibenzo(a,h)anthracene	0.01	µg/g	0.06	130	0.00622	0.135	-	-	-	**0.035**	**0.026**	**0.044**	**0.045**	**0.036**	**0.037**	**0.040**	**0.035**	**0.016**	**0.020**	**0.024**	**0.010**	**0.017**	0.000	**0.017**	**0.009**	-	-	-	-	-	-	-
Fluoranthene	0.01	µg/g	0.75	1020	0.111	2.355	-	-	-	**0.460**	**0.300**	**0.580**	**0.580**	**0.430**	**0.510**	**0.470**	**0.460**	**0.200**	**0.220**	**0.240**	**0.220**	**0.230**	0.066	**0.220**	**0.140**	-	-	-	-	-	-	-
Fluorene	0.01	µg/g	0.19	160	0.0212	0.144	-	-	-	**0.064**	0.015	**0.026**	0.015	0.017	0.019	0.016	0.011	0.009	0.000	0.010	0.011	0.010	0.004	0.009	0.007	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	0.01	µg/g	0.2	320	-	-	-	-	-	0.180	0.150	**0.210**	**0.270**	**0.220**	**0.220**	**0.220**	0.180	0.077	0.110	0.150	0.047	0.089	0.027	0.090	0.051	-	-	-	-	-	-	-
Phenanthrene	0.01	µg/g	0.56	950	0.0419	0.515	-	-	-	**0.230**	**0.073**	**0.220**	**0.140**	**0.110**	**0.130**	**0.140**	**0.130**	**0.064**	**0.054**	**0.060**	**0.190**	**0.084**	0.018	**0.065**	**0.047**	-	-	-	-	-	-	-
Pyrene	0.01	µg/g	0.49	850	0.053	0.875	-	-	-	**0.360**	**0.260**	**0.480**	**0.510**	**0.380**	**0.420**	**0.410**	**0.390**	**0.180**	**0.200**	**0.220**	**0.180**	**0.210**	**0.063**	**0.210**	**0.130**	-	-	-	-	-	-	-
BTEX & F1 Hydrocarbons																																
Benzene	0.02	µg/g	-	-	-	-	1.24	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Toluene	0.02	µg/g	-	-	-	-	1.4	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	0.000	-	-	-	-	-	-	-
Ethylbenzene	0.02	µg/g	-	-	-	-	1.16	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
o-Xylene	0.02	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
p+m-Xylene	0.04	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Total Xylenes	0.04	µg/g	-	-	-	-	1.28	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
F1 (C6-C10)*	10	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aliphatic C6-C8	-	-	-	-	-	-	14	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aliphatic C>8-C10	-	-	-	-	-	-	10.5	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Aromatic C>8-C10	-	-	-	-	-	-	11.6	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
F1 (C6-C10) - BTEX	11	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
F2-F4 Hydrocarbons*																																
F2 (C10-C16 Hydrocarbons)	7.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.000	0.000	0.000	0.000	8.100	-	-	-	-	-	-	-
Aliphatic C>10-C12	-	µg/g	-	-	-	-	8.7	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.520	0.000	0.000	0.000	2.916	-	-	-	-	-	-	-
Aliphatic C>12-C16	-	µg/g	-	-	-	-	>1000 [b]	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.080	0.000	0.000	0.000	3.564	-	-	-	-	-	-	-
Aromatic C>10-C12	-	µg/g	-	-	-	-	5.7	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.630	0.000	0.000	0.000	0.729	-	-	-	-	-	-	-
Aromatic C>12-C16	-	µg/g	-	-	-	-	2.5	(9)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.770	0.000	0.000	0.000	0.891	-	-	-	-	-	-	-
F3 (C16-C34 Hydrocarbons)	50.00	µg/g	-	-	-	-	-	-	-	160.000	160.000	360.000	350.000	170.000	56.000	200.000	500.000	140.000	56.000	67.000	130.000	120.000	120.000	300.000	170.000	-	-	-	-	-	-	-
Aliphatic C>16-C21	-	µg/g	-	-	-	-	>1000 [b]	(9)	-	89.600	89.600	201.600	196.000	95.200	31.360	112.000	280.000	78.400	31.360	37.520	72.800	67.200	67.200	168.000	95.200	-	-	-	-	-	-	-
Aliphatic C>21-C34	-	µg/g	-	-	-	-	>1000 [b]	(9)	-	38.400	38.400	86.400	84.000	40.800	13.440	48.000	120.000	33.600	13.440	16.080	31.200	28.800	28.800	72.000	40.800	-	-	-	-	-	-	-
Aromatic C>16-C21	-	µg/g	-	-	-	-	1.7	(9)	-	**22.400**	**22.400**	**50.400**	**49.000**	**23.800**	**7.840**	**28.000**	**70.000**	**19.600**	**7.840**	**9.380**	**18.200**	**16.800**	**16.800**	**42.000**	**23.800**	-	-	-	-	-	-	-
Aromatic C>21-C34	-	µg/g	-	-	-	-	5.4	(9)	-	**9.600**	**9.600**	**21.600**	**21.000**	**10.200**	3.360	**12.000**	**30.000**	**8.400**	3.360	4.020	**7.800**	**7.200**	**7.200**	**18.000**	**10.200**	-	-	-	-	-	-	-
F4 (C34-C50 Hydrocarbons)	50.00	µg/g	-	-	-	-	-	-	-	110.000	98.000	290.000	270.000	120.000	0.000	160.000	420.000	82.000	0.000	0.000	0.000	61.000	0.000	160.000	76.000	-	-	-	-	-	-	-

Parameter	Detection Limit	Units	PSQG - LELs (1)	PSQG - SELs (1)	CCME SQG - ISQG (2)	CCME SQG - PEL (2)	Guideline from Other Sources (3-6, 9)		Background Concentration (Dragun & Chiasson, 1991) (7)	Station																					
										Frenchman's Bay																Infill area						
							Value	Source		FB-2	Location 3	FB-4	FB-5	FB-7	FB-8	FB-9	FB-10	PN-1-1	PN-2-1	PN-5-1	PN-6-1	PN-7-1	PN-8-1	PN-9-1	PN-10-1	INFILL-01	INFILL-02	INFILL-03	INFILL-04	INFILL-05	INFILL-06	INFILL-07
Aliphatic C>34	-	µg/g	-	-	-	-	98.8[c]	(9)	-	88.000	78.400	**232.000**	**216.000**	96.000	0.000	**128.000**	**336.000**	65.600	0.000	0.000	0.000	48.800	0.000	**128.000**	60.800	-	-	-	-	-	-	-
Aromatic C>34	-	µg/g	-	-	-	-	0.4[c]	(9)	-	**22.000**	**19.600**	**58.000**	**54.000**	**24.000**	0.000	**32.000**	**84.000**	**16.400**	0.000	0.000	0.000	**12.200**	0.000	**32.000**	**15.200**	-	-	-	-	-	-	-
Calculated Parameters																															
Aldrin + Dieldrin	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Chlordane (Total)	0.00	µg/g	0.007	6	0.0045	0.00887	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Heptachlor + Heptachlor epoxide	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
o,p-DDT + p,p-DDT	0.00	µg/g	0.008	71	0.00119	0.00477	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Pesticides & Herbicides																															
Aldrin	0.00	µg/g	0.002	8	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
a-Chlordane	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
g-Chlordane	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
o,p-DDT	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
p,p-DDT	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	-	-	-	-	-	-	-
Dieldrin	0.00	µg/g	0.002	91	0.0029	0.00667	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Lindane	0.00	µg/g	-	-	0.0009	0.00138	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Endrin	0.00	µg/g	0.003	130	0.0027	0.0624	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Heptachlor	0.00	µg/g	-	-	0.0006	0.00274	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Heptachlor epoxide	0.00	µg/g	0.005	5	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
alpha-BHC	0.00	µg/g	0.006	10	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
beta-BHC	0.00	µg/g	0.005	21	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
delta-BHC	0.00	µg/g	-	-	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Mirex	0.00	µg/g	0.007	130	-	-	-	-	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-
Radionuclides [d]																															
Co-60	0.09	Bq/kg	-	-	-	-	-	-	-	0.050	0.527	0.171	0.622	0.586	0.146	0.076	0.158	0.211	0.447	0.728	-0.022	-0.029	0.415	0.082	-0.192	-	-	-	-	-	-	-
Cs-134	0.18	Bq/kg	-	-	-	-	-	-	-	0.155	-0.029	0.209	-0.381	0.009	0.128	0.176	0.252	-0.051	0.073	0.265	0.089	0.076	-0.090	0.344	-0.126	-	-	-	-	-	-	-
Cs-137	0.16	Bq/kg	-	-	-	-	-	-	-	0.625	0.563	0.823	1.470	1.450	1.130	0.967	0.731	2.200	1.890	2.420	1.240	2.230	1.550	2.190	1.270	-	-	-	-	-	-	-
I-131	2.70	Bq/kg	-	-	-	-	-	-	-	-0.785	-1.850	3.310	-0.337	-0.426	3.390	3.070	-1.630	1.040	0.479	-0.850	1.100	0.773	0.790	-0.797	0.362	-	-	-	-	-	-	-
K-40	1.30	Bq/kg	-	-	-	-	-	-	-	353.000	105.000	106.000	138.000	106.000	104.000	117.000	207.000	202.000	110.000	117.000	236.000	192.000	237.000	152.000	235.000	-	-	-	-	-	-	-
Th-Series	0.51	Bq/kg	-	-	-	-	-	-	-	7.720	-0.366	4.560	0.256	-3.670	0.677	5.230	-0.561	5.620	4.830	4.840	1.250	5.750	4.800	6.000	6.780	-	-	-	-	-	-	-
U-Series	0.33	Bq/kg	-	-	-	-	-	-	-	8.740	3.810	4.200	6.680	4.850	3.350	5.530	7.340	5.670	4.510	6.310	5.860	7.030	5.330	5.330	6.350	-	-	-	-	-	-	-
H-3	24.00	Bq/kg	-	-	-	-	-	-	-	227.000	99.500	94.800	177.000	28.500	20.500	20.600	68.600	22.300	19.600	30.400	20.700	29.000	28.800	26.800	30.500	-	-	-	-	-	-	-
C-14	0.010	Bq/g	-	-	-	-	-	-	-	0.008	-0.016	-0.003	0.002	-0.013	0.012	-0.011	-0.003	-0.009	0.002	-0.002	-0.003	-0.009	-0.008	-0.001	0.003	-	-	-	-	-	-	-

Notes:

Bold	Exceeded PSQG - LEL
Bold	Exceeded PSQG - SEL
Bold	Exceeded CCME SQG - ISQG
Bold	Exceeded CCME SQG - PEL
Bold	Exceeded guidelines from other sources
Bold	Exceeded background concentration
Bold	Exceeded more than one guideline

Sampling locations presented in Figure 4-5 and Figure 4-6.
The symbol '-' denotes no value was determined and/or required.
* The concentrations of PHC subfractions were obtained by dividing the concentration of total fraction (F1-F4) by the ratios of the subfractions provided in CCME (2008). The concentrations of the subfractions were then compared to their equivalent guidelines from Atlantic PIRI (2012).
a – Converted from % to mg/kg.
b – ">1000" indicates that the sediment criteria could not be calculated based on a toxic endpoint to aquatic species due to the low solubility of the fraction in water.
Notes:
c – based on the Chronic benchmarks for aliphatic C19-C36 and aromatic C16-C36 calculated by Atlantic PIRI (2012) using the model developed by DiToro and McGrath (2000) using the benchmarks from Batelle (2007).
d – Radionuclides are not screened as their levels should be as low as reasonably achievable (ALARA).
LEL – Lowest Effect Level
SEL – Severe Effect Level
ISQG – Interim Sediment Quality Guideline
PEL – Probable Effects Level

References:
1. MECP (2008). Guidelines for Identifying, Assessing and Managing Contaminated Sediments in Ontario. Queen's Printer for Ontario.
2. CCME (1999). Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Updated 2001.
3. Jones, Suter, (1997). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment - Associated Biota: 1997 Revision. The probable effect concentration was adopted.
4. MECP (1993). Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Benchmarks were carried forward from the Open Water Disposal Guideline published in 1976.
5. P. A. Thompson, J. Kurias and S. Mihok (2005). Derivation and use of sediment quality guidelines for ecological risk assessment of metals and radionuclides released to the environment from uranium mining and milling activities in Canada. Environmental Monitoring and Assessment (110): 71-85. Weighted method was adopted in the table.
6. Long, E. R. and Morgan L. G. (1991), The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA. August.
7. Dragun, J. & Chiasson, A.D. (1991). Elements in North American Soils.
8. MECP (2011). Background Concentration of Hot Water Soluble Boron in Soil. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario. Standards Development Branch. April.
9. Atlantic PIRI (2012). ATLANTIC RBCA (Risk-Based Corrective Action) Version 3 Ecological Screening Protocol for Petroleum Impacted Sites in Atlantic Canada, Scientific Rationale to support the Adoption/Development of Tier 1 Ecological Screening Levels for Soil, Surface Water, Groundwater and Sediment. July 2012. http://www.atlanticrbca.com/wp-content/files_mf/1398280422EcoRBCA_Scientific_Rationale_Aug_1.pdf
10. DiToro, D.M. and J.A. McGrath (2000). Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. II. Mixtures and sediments. Environ. Toxicol. Chem. 19: 1971-1982.
11. Battelle (2007). Sediment Toxicity of Petroleum Hydrocarbon Fractions. Prepared for Massachusetts Department of Environmental Protection Office of Research and Standards,1 Winter Street 8th Floor Boston, MA 02108. September 2007. https://www.mass.gov/doc/sediment-toxicity-of-petroleum-hydrocarbon-fractions/download
12. CCME. (2008). Canada-wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale: Supporting Technical Document. Canadian Council of Ministers of the Environment.

A.3 Soil

Table A-5: Screening of Soil Quality Parameters in 2024 samples

Parameter	Detection Limit	Units	Table 3 ICC Coarse (1)	Table 9 RPIICC (1)	CCME Soil Agri Coarse Surface 10NV5 (2)	Station																
						GMS-28-1	GMS-28-2	GMS-28-3	GMS-31-1	GMS-31-2	GMS-31-3	GMS - 26	GMS - 38	SITE 14-SS5-1	SITE 14-SS5-2	SITE 14-SS5-3	SITE 14-SS6-1	SITE 14-SS6-2	SITE 14-SS6-3	SITE 15-1	SITE 15-2	SITE 15-3	SITE 7 - SS4
Metals																						
Aluminum	50	µg/g	NV	NV	NV	2200	3200	3200	3000	6200	16000	19000	18000	3900	3900	2900	2400	3200	2900	4100	7900	6100	7600
Antimony	0.2	µg/g	40	1.3	20	0.117113	0.55	0.36	0.195417	0.29	0.192684	0.148608	0.17626	0.27	0.9	0.3	0.48	1.1	0.48	0.180305	0.59	0.53	0.185422
Arsenic	1	µg/g	18	18	12	1	1.7	1.3	1.7	2.3	2.6	2.2	2.4	1.9	5.3	1.7	2.2	5.1	2.2	1.2	3.6	3.6	1.9
Barium	0.5	µg/g	670	220	750	13	19	23	18	40	84	130	110	30	88	19	24	51	44	25	42	42	48
Beryllium	0.2	µg/g	8	2.5	4	0.118876	0.156072	0.15845	0.151433	0.28	0.65	0.69	0.69	0.199574	0.196886	0.12982	0.121457	0.163851	0.147049	0.195197	0.31	0.25	0.32
Bismuth	1	µg/g	NV	NV	NV	0.029566	0.047217	0.0303	0.0455	0.06049	0.104254	0.098957	0.096984	0.062868	0.07582	0.029529	0.053377	0.064478	0.036806	0.047591	0.095557	0.237605	0.078156
Boron	5	µg/g	120	36	NV	2.229387	6	6.7	3.806344	4.862406	5.1	4.580761	6.8	8.3	7.4	3.860754	4.265377	5.2	4.512741	7.2	8.6	6.1	5.7
Cadmium	0.1	µg/g	1.9	1.2	1.4	0.036642	0.066484	0.052764	0.084144	0.81	0.23	0.18	0.23	0.1	0.22	0.093704	0.12	0.24	0.14	0.066416	0.22	0.15	0.11
Calcium	50	µg/g	NV	NV	NV	140000	140000	160000	130000	110000	20000	9600	24000	260000	240000	170000	200000	150000	140000	130000	120000	130000	110000
Chromium	1	µg/g	160	70	64	7.2	10	8.8	13	19	21	26	28	29	18	8.9	29	23	11	8.4	30	17	18
Cobalt	0.1	µg/g	80	22	40	1.8	2.4	2.6	2.6	5.3	7.2	8.5	8.8	2.6	6.5	3.1	2.9	6.4	3.5	4.3	7.1	5.9	5.3
Copper	0.5	µg/g	230	92	63	5.7	11	8.1	9.1	21	16	19	19	13	62	22	25	**69**	29	26	52	39	14
Iron	50	µg/g	NV	NV	NV	8700	11000	9700	9000	15000	21000	24000	23000	9400	11000	9300	9800	15000	11000	8400	16000	14000	15000
Lead	1	µg/g	120	120	70	2.4	6.8	6.4	5.4	10	15	12	16	11	24	9.5	11	32	17	6.8	40	20	12
Lithium	1	µg/g	NV	NV	NV	2.9	4.7	4.9	4.3	7.6	14	17	16	6.4	6	3.9	3.4	4.3	4.1	5.6	9.5	7.4	9.2
Magnesium	50	µg/g	NV	NV	NV	5300	11000	13000	7400	9400	4800	5400	6200	8900	11000	6200	8700	7000	7700	12000	11000	11000	8700
Manganese	1	µg/g	NV	NV	NV	200	240	290	260	360	360	420	560	390	370	210	310	280	240	240	370	340	330
Molybdenum	0.5	µg/g	40	2	5	0.224903	0.312862	0.298907	0.33666	0.74	0.446075	0.387123	0.421086	0.61	1.3	0.36203	1.3	**3**	0.71	0.296694	0.77	0.74	0.51
Nickel	0.5	µg/g	270	82	45	3.4	6	6.1	6.6	14	17	19	19	7.5	7.6	5.4	12	13	6.6	**47**	23	15	12
Phosphorous	50	µg/g	NV	NV	NV	670	660	540	590	1300	730	790	1000	500	510	600	510	600	540	680	930	760	820
Potassium	200	µg/g	NV	NV	NV	430	810	990	590	1300	1800	2300	3000	1100	970	660	490	720	720	840	1600	1200	1500
Selenium	0.5	µg/g	5.5	1.5	1	0.030076	0.075979	0.046236	0.13598	0.136815	0.281947	0.285436	0.299313	0.073868	0.205447	0.068279	0.063427	0.174247	0.090472	0.155839	0.281874	0.214031	0.130775
Silver	0.2	µg/g	40	0.5	20	0.016615	0.023471	0.017109	0.029158	0.028906	0.047931	0.06628	0.063013	0.035736	0.066383	0.027501	0.047872	0.103955	0.051165	0.032194	0.073614	0.050657	0.028835
Sodium	50	µg/g	NV	NV	NV	99	150	120	790	140	130	150	570	970	1100	250	920	160	220	160	160	170	170
Strontium	1	µg/g	NV	NV	NV	180	180	210	180	150	37	25	48	340	360	220	270	200	190	170	170	170	150
Thallium	0.05	µg/g	3.3	1	1	0.030258	0.058	0.07	0.05	0.11	0.15	0.16	0.16	0.086	0.066	0.055	0.031143	0.063	0.055	0.056	0.11	0.086	0.12
Tin	1	µg/g	NV	NV	5	0.479391	0.638702	0.401801	0.593036	0.136815	0.936885	0.825836	0.867254	0.715216	3.3	1.2	1.5	3.4	1.4	0.747311	2.3	2	4
Titanium	5	µg/g	NV	NV	NV	260	240	230	230	320	400	680	660	98	120	230	210	250	220	190	280	280	350
Uranium	0.05	µg/g	33	2.5	23	0.33	0.52	0.3	0.64	0.4	0.53	0.67	0.59	0.37	0.44	0.34	0.34	0.35	0.31	0.49	0.53	0.43	0.48
Vanadium	5	µg/g	86	86	130	15	18	15	14	20	33	38	38	13	12	16	13	18	15	13	22	20	22
Zinc	5	µg/g	340	290	250	28	56	41	39	67	110	66	70	73	**270**	85	110	**350**	130	46	200	160	140
Inorganics																							
Hexavalent Chromium	0.18	µg/g	8	0.66	0.4	0.03503	0.02075	0.01362	0.03755	0	0	0	0	0.1798	0.07478	0.03997	0.12166	0.05638	0.04933	0	0	0.01845	0
Mercury	0.05	µg/g	3.9	0.27	6.6	0.003749	0.015629	0.00097	0.014912	0.012471	0.030845	0.042643	0.025467	0.000427	0.004109	0.002183	0.02384	0.006822	0.00806	0.02166	0.03078	0.010828	0.013969
pH	0	pH units	NV	5 - 9	6 - 8	7.78	7.64	7.67	7.94	7.59	7.19	7.34	7.4	**8.06**	**8.02**	7.66	**8.27**	7.78	7.87	7.4	7.39	7.58	7.49
Sodium Adsorption Ratio	N/A	Ratio	12	5	5	0.38	0.31	0.3	**13**	0.27	0.24	0.22	3.7	4	**7.8**	2.5	**31**	0.38	2.2	0.33	0.21	0.26	0.22
Electrical Conductivity	0.002	mS/cm	1.4	0.7	2	0.075	0.13	0.13	**1.2**	0.13	0.28	0.19	0.31	**2.6**	**2.3**	0.42	**1.5**	0.091	0.24	0.29	0.26	0.15	0.23
Boron, Hot Water Soluble	0.05	µg/g	2	1.5	2	0.069	0.18	0.19	0.55	0.36	0.39	0.19	0.28	0.45	0.51	0.19	0.42	0.25	0.21	0.56	0.7	0.31	0.28
Cyanide (WAD)	0.01	µg/g	0.051	0.051	0.9	0.00104	0.00108	0.00203	0.00323	0.00106	0	0	0	0.00093	0.00108	0.00111	0.00219	0.00184	0.00105	0.00228	0.00116	0	0
PHCs & BTEX																							
Petroleum Hydrocarbons - F1 (C6-C10)-BTEX	10	µg/g	55	25	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum Hydrocarbons - F1 (C6-C10)	10	µg/g	55	25	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum Hydrocarbons - F2 (C10-C16)	7	µg/g	230	10	150	0	0	8.5	7	0	0	0	0	0	0	0	0	0	0	0	0	0	9.8
Petroleum Hydrocarbons - F3 (C16-C34)	50	µg/g	1700	240	300	0	53	68	110	70	53	0	55	150	79	200	**300**	89	78	77	85	83	120
Petroleum Hydrocarbons - F4 (C34-C50)	50	µg/g	3300	120	2800	0	0	0	**130**	51	0	0	0	**400**	**140**	**540**	**660**	**170**	110	79	97	100	110
Reached Baseline at C50	0	None	NV	NV	NV	YES	YES	YES	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	YES	YES	NO	YES

Parameter	Detection Limit	Units	Table 3 ICC Coarse (1)	Table 9 RPIICC (1)	CCME Soil Agri Coarse Surface 10NV5 (2)	Station																
						GMS-28-1	GMS-28-2	GMS-28-3	GMS-31-1	GMS-31-2	GMS-31-3	GMS - 26	GMS - 38	SITE 14-SS5-1	SITE 14-SS5-2	SITE 14-SS5-3	SITE 14-SS6-1	SITE 14-SS6-2	SITE 14-SS6-3	SITE 15-1	SITE 15-2	SITE 15-3	SITE 7 - SS4
Benzene	0.006	µg/g	0.32	0.02	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethylbenzene	0.01	µg/g	9.5	0.05	0.082	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
m,p-Xylenes	0.02	µg/g	NV	NV	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
o-Xylene	0.02	µg/g	NV	NV	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toluene	0.02	µg/g	68	0.2	0.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xylenes, Total	0.02	µg/g	26	0.05	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VOCs																						
1,1,1,2-Tetrachloroethane	0.04	µg/g	0.087	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,1,1-Trichloroethane	0.04	µg/g	6.1	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	0.04	µg/g	0.05	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,1,2-Trichloroethane	0.04	µg/g	0.05	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,1-Dichloroethane	0.04	µg/g	17	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,1-Dichloroethene	0.04	µg/g	0.064	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,2-Dibromoethane	0.04	µg/g	0.05	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,2-Dichlorobenzene	0.04	µg/g	6.8	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,2-Dichloroethane	0.049	µg/g	0.05	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,2-Dichloropropane	0.04	µg/g	0.16	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,3-Dichlorobenzene	0.04	µg/g	9.6	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,3-Dichloropropene, Total	0.05	µg/g	0.18	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1,4-Dichlorobenzene	0.04	µg/g	0.2	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl Ethyl Ketone	0.4	µg/g	70	0.5	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl Isobutyl Ketone	0.4	µg/g	31	0.5	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acetone	0.49	µg/g	16	0.5	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Benzene	0.006	µg/g	0.32	0.02	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromodichloromethane	0.04	µg/g	18	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromoform	0.04	µg/g	0.61	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bromomethane	0.04	µg/g	0.05	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbon Tetrachloride	0.04	µg/g	0.21	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chlorobenzene	0.04	µg/g	2.4	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloroform	0.04	µg/g	0.47	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cis-1,2-Dichloroethene	0.04	µg/g	55	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
cis-1,3-Dichloropropene	0.03	µg/g	NV	NV	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dibromochloromethane	0.04	µg/g	13	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichlorodifluoromethane	0.04	µg/g	16	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethylbenzene	0.01	µg/g	9.5	0.05	0.082	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
m,p-Xylenes	0.02	µg/g	NV	NV	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methyl tert-Butyl Ether	0.04	µg/g	11	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methylene Chloride	0.049	µg/g	1.6	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-Hexane	0.04	µg/g	46	0.05	0.49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
o-Xylene	0.02	µg/g	NV	NV	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styrene	0.04	µg/g	34	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tetrachloroethene	0.04	µg/g	4.5	0.05	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Toluene	0.02	µg/g	68	0.2	0.37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
trans-1,2-Dichloroethene	0.04	µg/g	1.3	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
trans-1,3-Dichloropropene	0.04	µg/g	NV	NV	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichloroethene	0.01	µg/g	0.91	0.05	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichlorofluoromethane	0.04	µg/g	4	0.25	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vinyl Chloride	0.019	µg/g	0.032	0.02	NV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Xylenes, Total	0.02	µg/g	26	0.05	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Parameter	Detection Limit	Units	Table 3 ICC Coarse (1)	Table 9 RPIICC (1)	CCME Soil Agri Coarse Surface 10NV5 (2)	Station																
						GMS-28-1	GMS-28-2	GMS-28-3	GMS-31-1	GMS-31-2	GMS-31-3	GMS - 26	GMS - 38	SITE 14-SS5-1	SITE 14-SS5-2	SITE 14-SS5-3	SITE 14-SS6-1	SITE 14-SS6-2	SITE 14-SS6-3	SITE 15-1	SITE 15-2	SITE 15-3	SITE 7 - SS4
Radionuclides																						
Carbon-14	0	Bq/g	NA	NA	NA	NV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon-14	106	Bq/kg-C	NA	NA	NA	< 157	< 200	< 161	< 229	< 170	< 232	1193	904	< 108	< 165	< 182	< 155	< 228	< 175	< 106	215	< 145	258
Cesium-134	0.42	Bq/kg	NA	NA	NA	0.35	0.299	0.197	0.218	0.465	0.801	0.225	0.579	0.284	0.0635	0.0486	0.191	0.126	0.149	0.374	0.3	0.152	0.37
Cesium-137	0.37	Bq/kg	NA	NA	NA	-0.0689	0.231	0.0526	1.27	0.111	2.25	2.95	1.66	0.116	0.702	0.471	0.144	0.321	0.0154	0.13	0.773	0.556	0.671
Cobalt-60	0.44	Bq/kg	NA	NA	NA	0.193	0.876	0.133	0.308	0.299	0.428	0.371	0.455	0.382	0.65	0.0239	0.34	0.162	0.508	1.34	0.0356	0.926	0.0282
Iodine-131	1.9	Bq/kg	NA	NA	NA	-0.528	1.94	1.03	0.26	2.6	0.785	0.865	2.56	1.22	2.38	3.15	0.289	1.43	2.05	0.686	0.905	0.346	0.791
Potassium-40	3.4	Bq/kg	NA	NA	NA	293	286	304	368	447	657	674	682	273	175	236	190	253	236	268	305	310	493
Thorium - Series	1.1	Bq/kg	NA	NA	NA	6.75	8.13	5.52	1.2	13.6	25.2	25.4	24.9	3.8	5.78	5.96	4.5	8.56	4.61	5.03	9.62	11.2	15.5
Tritium (Hydrogen-3)	14	Bq/kg	NA	NA	NA	11.8	17.4	16.1	11.1	19.7	32.8	154	140	57.7	30.3	103	133	10.1	9.97	42.3	40.4	30.4	31
Uranium - Series	0.63	Bq/kg	NA	NA	NA	8	9.48	7.77	9.22	15.8	23	22.8	22.9	11	7.38	7.39	5.11	7.08	6.82	8.9	10.3	12.2	16
Other parameters																						
Total Carbon	0.5	mg/kg	NA	NA	NA	42000	55000	57000	42000	53000	41000	41000	45000	76000	79000	50000	71000	57000	57000	72000	68000	60000	59000
Total Organic Carbon	0.5	mg/kg	NA	NA	NA	5600	10000	9300	6800	21000	33000	26000	40000	7200	8700	11000	11000	10000	10000	28000	34000	22000	24000

Notes:

Bold	Exceeded Table 3 ICC Coarse Standards
Bold	Exceeded Table 9 Soil Standards
Bold	Exceeded CCME Soil Agricultural Coarse Surface 10-5 Standards
Bold	Exceeded more than one guideline

Samples were taken at a depth of 0.2 mbgs (metres below ground surface). Sampling locations presented in Figure 4-20.
5 - 9 (5 - 11) = standards for pH: 5 to 9 for surface soil, defined as soil from ground surface and 1.5 mbgs; 5 to 11 for subsurface soil, defined as soil from depths deeper than 1.5 mbgs
NV = no value
- = not analyzed
NA = not applicable

References:

1. Ontario Ministry of the Environment (MOE). 2011. Rationale for the Development of Soil and Ground Water Standards for Use at Contaminated Sites in Ontario. Standards Development Branch. April.
2. CCME. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health. Accessed July 2021.

Appendix B Results of 2024 Aquatic Studies

B.1 Deepwater Fish Community Studies Results

Table B-1: Morphometrics of Fish Caught during 2024 Deepwater Fish Community Study

Sampling Event	Parameter	Species	Count	Measured	Mean	Standard Deviation	Minimum	Maximum
Spring	Total Length (cm)	Alewife	161.0	32.0	17.1	1.4	13.6	20.8
		Lake Trout	12.0	12.0	50.5	8.7	41.9	71.0
		Round Whitefish	1.0	1.0	50.8	-	50.8	50.8
	Weight (g)	Alewife	161.0	32.0	33.9	7.7	16.0	60.0
		Lake Trout	12.0	12.0	1434.2	1017.7	779.0	4155.0
		Round Whitefish	1.0	1.0	1185.0	-	1185.0	1185.0
Summer	Total Length (cm)	Alewife	392.0	30.0	16.5	0.7	14.3	17.6
		Brown Trout	1.0	1.0	50.5	-	50.5	50.5
		Burbot	1.0	1.0	81.1	-	81.1	81.1
		Lake Trout	2.0	2.0	23.0	6.0	18.7	27.2
		Round Goby	7.0	7.0	13.5	1.0	11.5	14.8
		Round Whitefish	1.0	1.0	38.2	-	38.2	38.2
		White Sucker	1.0	1.0	24.9	-	24.9	24.9
	Weight (g)	Alewife	392.0	30.0	30.0	3.1	23.0	34.0
		Brown Trout	1.0	1.0	1925.0	-	1925.0	1925.0
		Burbot	1.0	1.0	4525.0	-	4525.0	4525.0
		Lake Trout	2.0	2.0	2502.5	2188.5	955.0	4050.0
		Round Goby	7.0	7.0	36.4	7.2	21.5	43.0
		Round Whitefish	1.0	1.0	510.0	-	510.0	510.0
		White Sucker	1.0	1.0	175.0	-	175.0	175.0
Fall	Total Length (cm)	Lake Sturgeon	1.0	-[1]	-	-	-	-
		Lake Trout	64.0	32.0	63.4	10.1	48.2	87.5
		Lake Whitefish	57.0	39.0	73.3	90.1	41.5	546.0
		Rainbow Smelt	2.0	1.0	15.3	-	15.3	15.3
		Rock Bass	4.0	4.0	18.8	5.4	12.4	24.0
		Round Goby	3.0	3.0	13.8	1.0	13.0	14.9
		Round Whitefish	7.0	7.0	49.6	3.9	43.3	53.4
		Sea Lamprey	1.0	1.0	62.0	-	62.0	62.0
		Walleye	2.0	2.0	55.4	4.1	52.5	58.3
	Weight (g)	Lake Sturgeon	1.0	1.0	31751.5	-	31751.5	31751.5
		Lake Trout	64.0	32.0	2750.1	2243.3	1.0	8900.0
		Lake Whitefish	57.0	39.0	1367.8	525.2	1.3	2240.0
		Rainbow Smelt	2.0	1.0	20.0	-	20.0	20.0
		Rock Bass	4.0	4.0	197.5	143.6	45.0	325.0
		Round Goby	3.0	3.0	42.7	10.0	35.0	54.0
		Round Whitefish	7.0	7.0	896.6	463.6	1.4	1345.0
		Sea Lamprey	1.0	1.0	45.0	-	45.0	45.0
		Walleye	2.0	2.0	1260.9	1780.6	1.9	2520.0

Notes:
Sampling locations are presented in Figure 4-7.
Individual fish not measured in the field were assigned average species weight values for BPUE calculations.
1 - To prevent undo harm, the Lake Sturgeon was removed from the gillnet and returned to the water without measurement and the size was estimated.

Table B-2: Mean CPUE (fish/24-hr) by Sampling Location of Fish Caught during 2024 Deepwater Fish Community Study

Spring											
Fish Species	**Grid 2**	**Grid 3**	**Grid 3 Dup**	**Grid 4**	**Grid 4 Dup**	**Grid 5**	**Grid 7**	**Grid 8**	**Grid 9**	**Total**	**Mean**
Alewife	118.6	127.6	47.8	87.5	52.9	22.1	4.3	53.5	13.5	**527.8**	**58.6**
Lake Trout	0	0	0	0	0	1.1	3	3.1	5.1	**12.3**	**1.4**
Round Whitefish	0	0	0	1.1	0	0	0	0	0	**1.1**	**0.1**
Total	118.6	127.6	47.8	88.6	52.9	23.2	7.3	56.6	18.5	**541.1**	**60.1**
Summer											
Fish Species	**Grid 1**	**Grid 1 Dup**	**Grid 2**	**Grid 4**	**Grid 5**	**Grid 6**	**Grid 6 Dup**	**Grid 7**	**Grid 8**	**Total**	**Mean**
Alewife	46.9	61.1	77.8	36.3	61.1	41.5	78.7	32.8	32.4	**468.6**	**52.1**
Brown Trout	1.3	0	0	0	0	0	0	0	0	**1.3**	**0.1**
Burbot	0	0	0	0	0	0	1.1	0	0	**1.1**	**0.1**
Lake Trout	0	0	0	0	0	0	0	0	2	**2**	**0.2**
Round Goby	1.3	1.1	3.8	0	0	0	2.2	0	0	**8.4**	**0.9**
Round Whitefish	0	0	0	0	1.2	0	0	0	0	**1.2**	**0.1**
White Sucker	0	0	0	0	0	0	3.6	0	0	**3.6**	**0.4**
Total	**49.4**	**62.2**	**81.5**	**36.3**	**62.3**	**41.5**	**85.7**	**32.8**	**34.4**	**486.1**	**54**
Fall											
Grid	**Grid 1**	**Grid 2**	**Grid 2 Dup**	**Grid 4**	**Grid 4 Dup**	**Grid 6**	**Grid 8**	**Grid 9**	**Grid 9 Dup**	**Total**	**Mean**
Lake Sturgeon	0	0	0	0	0	0	1.1	0	0	**1.1**	**0.1**
Lake Trout	0	4	6	5.3	0	16	17.6	15.6	1.2	**65.7**	**7.3**
Lake Whitefish	5.5	0	3	5.3	2	18.1	5.5	10.1	9.2	**58.7**	**6.5**
Rainbow Smelt	0	0	0	0	0	0	1.1	0.9	0	**2**	**0.2**
Rock Bass	0	0	1	0	0	3.2	0	0	0	**4.2**	**0.5**
Round Goby	0	0	0	0	0	5.7	0	0	0	**5.7**	**0.6**
Round Whitefish	0	2	0	2.1	0	0	2.2	0.9	0	**7.2**	**0.8**
Sea Lamprey	0	0	1	0	0	0	0	0	0	**1**	**0.1**
Walleye	0	1	0	0	0	1.1	0	0	0	**2.1**	**0.2**
Total	**5.5**	**7**	**10.9**	**12.7**	**2**	**44.1**	**27.5**	**27.6**	**10.4**	**147.7**	**16.4**

Notes:
Sampling locations are presented in Figure 4-7.
Standardized fish counts are based on an extrapolated catch from the 15 m 1 ½" mesh panel to the standard 50 m length and therefore fish counts can result in partial numbers.

Table B-3: BPUE (grams/24-hr) by Sampling Location of Fish Caught during 2024 Deepwater Fish Community Study

Spring											
Fish Species	**Grid 2**	**Grid 3**	**Grid 3 Dup**	**Grid 4**	**Grid 4 Dup**	**Grid 5**	**Grid 7**	**Grid 8**	**Grid 9**	**Total**	**Mean**
Alewife	4030.0	4339.9	1624.1	3005.2	1798.2	754.5	148.2	1796.1	457.3	**17953.5**	**1994.8**
Lake Trout	0.0	0.0	0.0	0.0	0.0	977.7	3051.0	8080.7	5592.1	**17701.5**	**1966.8**
Round Whitefish	0.0	0.0	0.0	1260.3	0.0	0.0	0.0	0.0	0.0	**1260.3**	**140.0**
Total	**4030.0**	**4339.9**	**1624.1**	**4265.5**	**1798.2**	**1732.2**	**3199.2**	**9876.8**	**6049.4**	**36915.3**	**4101.7**
Summer											
Fish Species	**Grid 2**	**Grid 3**	**Grid 3 Dup**	**Grid 4**	**Grid 4 Dup**	**Grid 5**	**Grid 7**	**Grid 8**	**Grid 9**	**Total**	**Mean**
Alewife	1421.4	1830.1	2329.5	1086.2	1902.8	1241.9	2359.8	983.0	971.1	14125.8	**1569.5**
Brown Trout	2464.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2464.0	**273.8**
Burbot	0.0	0.0	0.0	0.0	0.0	0.0	4955.1	0.0	0.0	4955.1	**550.6**
Lake Trout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5129.7	5129.7	**570.0**
Round Goby	53.8	38.7	122.9	0.0	0.0	0.0	86.5	0.0	0.0	301.9	**33.5**
Round Whitefish	0.0	0.0	0.0	0.0	597.1	0.0	0.0	0.0	0.0	597.1	**66.3**
White Sucker	0.0	0.0	0.0	0.0	0.0	0.0	633.2	0.0	0.0	633.2	**70.4**
Total	**3939.2**	**1868.8**	**2452.4**	**1086.2**	**2499.9**	**1241.9**	**8034.7**	**983.0**	**6100.8**	**28206.8**	**3134.1**
Fall											
Fish Species	**Grid 1**	**Grid 2**	**Grid 2 Dup**	**Grid 4**	**Grid 4 Dup**	**Grid 6**	**Grid 8**	**Grid 9**	**Grid 9 Dup**	**Total**	**Mean**
Lake Sturgeon	0.0	0.0	0.0	0.0	0.0	0.0	34902.4	0.0	0.0	**34902.4**	**3878.0**
Lake Trout	0.0	11674.8	15395.6	21105.4	0.0	47299.5	43490.0	31611.4	2384.6	**172961.3**	**19217.9**
Lake Whitefish	8018.0	0.0	2104.4	7897.8	2754.6	24363.0	8288.2	12712.7	12408.2	**78546.9**	**8727.4**
Rainbow Smelt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.4	0.0	**18.4**	**2.0**
Rock Bass	0.0	0.0	44.7	0.0	0.0	794.7	0.0	0.0	0.0	**839.4**	**93.3**
Round Goby	0.0	0.0	0.0	0.0	0.0	232.4	0.0	0.0	0.0	**232.4**	**25.8**
Round Whitefish	0.0	1937.1	0.0	2685.5	0.0	0.0	990.8	837.3	0.0	**6450.7**	**716.7**
Sea Lamprey	0.0	0.0	44.7	0.0	0.0	0.0	0.0	0.0	0.0	**44.7**	**5.0**
Walleye	0.0	1.9	0.0	0.0	0.0	2688.0	0.0	0.0	0.0	**2689.9**	**298.9**
Total	**8018.0**	**13613.8**	**17589.4**	**31688.6**	**2754.6**	**75377.6**	**87671.4**	**45179.8**	**14792.8**	**296686.0**	**32965.1**

Notes:
Sampling locations are presented in Figure 4-7.

Table B-4: Summary of GLM modelling results for 2024 Deepwater Fish Community Study

Parameter	R^2 for Model	Effect	P-value	Significant Effect	Estimates				Comparison		P-value	Interpretation
					Season	Mean	Lower Confidence Limit	Upper Confidence Limit				
Richness	0.19	Depth	0.387	No	Spring	1.5	0.9	2.6	-	-	-	-
		Season	0.080	No	Summer	2.0	1.3	3.2	-	-		
					Fall	3.1	2.1	4.5	-	-		
CPUE - log10(x + 1)	0.45	Depth	0.688	No	Spring	44.4	26.0	75.6	Spring	Summer	0.926	(Spring = Summer) > Fall
		Season	<0.001	Yes	Summer	50.9	29.8	86.5	Spring	Fall	0.005	
					Fall	12.0	6.7	20.9	Summer	Fall	0.002	
BPUE - $\log_{10}(x+1)$	0.76	Depth	0.065	No	Spring	3451.9	1974.1	6035.4	Spring	Summer	0.630	Fall > (Summer = Spring)
		Season	<0.001	Yes	Summer	2423.9	1386.1	4238.1	Spring	Fall	<0.001	
					Fall	20959.8	11988.6	36643.7	Summer	Fall	<0.001	
Diversity - Shannon, $\log_{10}(x+1)$	0.46	Depth	0.114	No	Spring	0.168	0.001	0.363	Spring	Summer	0.936	Fall > (Summer = Spring)
		Season	<0.001	Yes	Summer	0.126	-0.035	0.314	Spring	Fall	0.007	
					Fall	0.675	0.435	0.955	Summer	Fall	0.003	
CPUE_SB - $\log_{10}(x+1)$	0.87	Depth	0.075	No	Spring	40.4	24.4	66.4	Spring	Summer	0.805	(Spring = Summer) > Fall
		Season	<0.001	Yes	Summer	50.1	30.4	82.1	Spring	Fall	<0.001	
					Fall	0.2	-0.2	1.0	Summer	Fall	<0.001	
BPUE_SB - $\log_{10}(x+1)$	0.88	Depth	0.396	No	Spring	1346.6	566.7	3197.6	Spring	Summer	0.979	(Spring = Summer) > Fall
		Season	<0.001	Yes	Summer	1510.8	636.0	3587.5	Spring	Fall	<0.001	
					Fall	0.8	-0.2	3.3	Summer	Fall	<0.001	

Notes:
Shaded cells indicates p-value < 0.05, which was considered significant.
CPUE – Catch-per-unit effort, BPUE – biomass-per-unit effort, SB – small-bodied. These comparisons are shown in Figure 4-.
Depending on the metric, a different error distribution family of GLM was used appropriate to the data and model fit (richness: Poisson; diversity, BPUE, and CPUE: Gaussian with log10(x+1)). Residual plots were examined to assess model fit. Analysis of Deviance (analysis to ANOVA in classic regression) tables were used to determine overall effects of depth and season at the p = 0.05 statistical significance level. Post-hoc Tukey multiple comparisons were used to determine if and how seasons were statistically different. For consistency across model types, the Cox and Snell pseudo-R^2 GLMs used as an assessment of the proportion of variation explained by the depth and season effects. For non-gaussian GLMs, although pseudo R^2 are analogous to R^2 in regression, they are not directly interpretable as the proportion of explained variance. GLMs for CPUE and BPUE were run on a small-bodied fish species (i.e., here, only Alewife and Round Goby) using the same approach above as it is anticipated they may be more susceptible to impingement.

B.2 Nearshore Fish Community Studies Results

Table B-5: Morphometric Summary Statistics for all Fish Caught in Broadscale Monitoring (BSM) Nets during the 2024 Nearshore Fish Community Study

Sampling Event	Fish Species		Alewife	Brown Bullhead	Chinook Salmon	Coho Salmon	Largemouth Bass	Log Perch	Longnose Sucker	Rainbow Smelt	Rock Bass	Round Goby	Sculpin	Threespine Stickleback	Yellow Perch
Spring	Count		36.0	-	1.0	-	-	-	-	-	-	88.0	-	1.0	-
	Total Length (cm)	Mean	16.4	-	8.6	-	-	-	-	-	-	8.2	-	5.7	-
		Standard deviation	0.9	-	-	-	-	-	-	-	-	1.3	-	-	-
		Maximum	17.9	-	8.6	-	-	-	-	-	-	13.2	-	5.7	-
		Minimum	14.7	-	8.6	-	-	-	-	-	-	5.6	-	5.7	-
	Weight (g)	Mean	30.6	-	6.0	-	-	-	-	-	-	9.1	-	1.5	-
		Standard deviation	5.7	-	-	-	-	-	-	-	-	5.0	-	-	-
		Maximum	45.0	-	6.0	-	-	-	-	-	-	34.0	-	1.5	-
		Minimum	19.0	-	6.0	-	-	-	-	-	-	1.0	-	1.5	-
Summer	Count		134.0	1.0	-	1.0	-	-	-	-	-	81.0	-	-	-
	Total Length (cm)	Mean	15.7	26.4	-	8.9	-	-	-	-	-	7.7	-	-	-
		Standard deviation	1.0	-	-	-	-	-	-	-	-	1.6	-	-	-
		Maximum	19.3	26.4	-	8.9	-	-	-	-	-	12.4	-	-	-
		Minimum	13.2	26.4	-	8.9	-	-	-	-	-	5.0	-	-	-
	Weight (g)	Mean	28.5	230.0	-	-	-	-	-	-	-	7.7	-	-	-
		Standard deviation	5.0	-	-	-	-	-	-	-	-	4.9	-	-	-
		Maximum	45.0	230.0	-	-	-	-	-	-	-	30.0	-	-	-
		Minimum	16.0	230.0	-	-	-	-	-	-	-	1.0	-	-	-
Fall	Count		3.0	1.0	-	-	1.0	1.0	2.0	1.0	2.0	27.0	3.0	-	1.0
	Total Length (cm)	Mean	11.2	16.9	-	-	10.1	7.6	11.5	11.7	11.9	10.0	7.1	-	9.2
		Standard deviation	4.2	-	-	-	-	-	0.5	-	4.5	2.9	0.8	-	-
		Maximum	14.6	169.0	-	-	10.1	7.6	11.8	11.7	150.0	15.4	8.0	-	9.2
		Minimum	6.5	16.9	-	-	10.1	7.6	11.1	11.7	8.7	5.2	6.4	-	9.2
	Weight (g)	Mean	14.8	53.0	-	-	11.0	2.0	15.5	36.0	12.0	18.7	4.8	-	8.0
		Standard deviation	12.4	-	-	-	-	-	0.7	-	0.0	13.7	1.8	-	-
		Maximum	26.0	53.0	-	-	11.0	2.0	16.0	36.0	12.0	51.0	6.5	-	8.0
		Minimum	1.5	53.0	-	-	11.0	2.0	15.0	36.0	12.0	1.0	3.0	-	8.0

Notes:
Sampling locations are presented in Figure 4-10.

Table B-6: Morphometric Summary Statistics for all Fish Caught in Experimental (EXP) Nets Across during the 2024 Nearshore Fish Community Study

Sampling Event	Fish Species		Atlantic Salmon	Alewife	Brown Bullhead	Brown Trout	Common Carp	Pumpkinseed	Rainbow Trout	Rock Bass	Round Goby	Walleye	White Sucker
Spring	Count		2.0	98.0	-	2.0	-	-	2.0	-	10.0	-	-
	Total Length (cm)	Mean	47.6	16.8	-	54.8	-	-	46.1	-	9.0	-	-
		Standard deviation	2.5	0.6	-	3.5	-	-	1.9	-	0.3	-	-
		Maximum	49.4	17.8	-	57.3	-	-	47.4	-	9.1	-	-
		Minimum	45.8	12.3	-	52.3	-	-	44.7	-	8.2	-	-
	Weight (g)	Mean	1437.5	34.0	-	2573.5	-	-	1075.0	-	11.8	-	-
		Standard deviation	647.0	24.0	-	1666.7	-	-	212.1	-	1.0	-	-
		Maximum	1895.0	44.0	-	3752.0	-	-	1225.0	-	12.1	-	-
		Minimum	980.0	14.0	-	1395.0	-	-	925.0	-	9.0	-	-
Summer	Count		-	48.0	-	-	-	-	-	1.0	11.0	-	-
	Total Length (cm)	Mean	-	16.7	-	-	-	-	-	22.6	9.3	-	-
		Standard deviation	-	0.3	-	-	-	-	-	-	0.2	-	-
		Maximum	-	18.3	-	-	-	-	-	22.6	9.9	-	-
		Minimum	-	15.8	-	-	-	-	-	22.6	9.0	-	-
	Weight (g)	Mean	-	34.3	-	-	-	-	-	245.0	13.4	-	-
		Standard deviation	-	1.3	-	-	-	-	-	-	1.1	-	-
		Maximum	-	41.0	-	-	-	-	-	245.0	15.0	-	-
		Minimum	-	31.0	-	-	-	-	-	245.0	11.0	-	-
Fall	Count		-	-	2.0	1.0	1.0	1.0	-	-	4.0	3.0	2.0
	Total Length (cm)	Mean	-	-	27.2	47.3	65.1	12.2	-	-	9.9	57.5	32.4
		Standard deviation	-	-	0.7	-	-	-	-	-	0.4	9.5	11.8
		Maximum	-	-	27.7	47.3	65.1	12.2	-	-	10.4	64.3	40.7
		Minimum	-	-	26.7	47.3	65.1	12.2	-	-	9.4	46.6	24.0
	Weight (g)	Mean	-	-	262.0	1345.0	4680.0	43.0	-	-	9.8	2355.0	445.0
		Standard deviation	-	-	2.8	-	-	-	-	-	3.9	1248.5	360.6
		Maximum	-	-	264.0	1345.0	4680.0	43.0	-	-	13.0	3135.0	700.0
		Minimum	-	-	260.0	1345.0	4680.0	43.0	-	-	5.0	915.0	190.0

Notes:
Sampling locations are presented in Figure 4-10.

Table B-7: CPUE (fish/24-hr) of Fish Collected from Experimental (EXP) and Broadscale Monitoring (BSM) Nets during the 2024 Nearshore Fish Community Study

Sampling Event	Fish Species	EXP Nets				BSM Nets			
		West Infill Area	Shoreline Erosion Mitigation Area	Total[1]	Mean[1]	West Infill Area	Shoreline Erosion Mitigation Area	Total[1]	Mean[1]
Spring	Atlantic Salmon	2.8	-	2.8	2.8	-	-	-	-
	Alewife	133.6	3	136.5	68.3	19.2	5.8	25	12.5
	Brown Trout	-	3	3	3	-	-	-	-
	Chinook Salmon	-	-	-	-	0.7	-	0.7	0.7
	Rainbow Trout	1.4	1.5	2.9	1.4	-	-	-	-
	Round Goby	12.5	1.5	14	7	33.6	28.1	61.7	30.8
	Threespine Stickleback	-	-	-	-	0.7	-	0.7	0.7
	Total	**150.3**	**8.9**	**159.2**	**79.6**	**54.2**	**33.8**	**88**	**44**
Summer	Alewife	-	55.1	55.1	55.1	11	66.5	77.3	38.7
	Brown Bullhead	-	-	-	-	-	0.6	0.6	0.6
	Coho Salmon	-	-	-	-	-	0.6	0.6	0.6
	Rock Bass	-	1.1	1.1	1.1	-	-	-	-
	Round Goby	1.1	11.5	12.5	6.3	12	34.4	46.4	23.2
	Total	**1.1**	**67.7**	**68.8**	**34.4**	**22.8**	**102**	**124.9**	**62.4**
Fall	Alewife	-	-	-	-	1.6	-	1.6	1.6
	Brown Bullhead	-	2.1	2.1	2.1	0.5	-	0.5	0.5
	Brown Trout	1.1	-	1.1	1.1	-	-	-	-
	Common Carp	-	1.1	1.1	1.1	-	-	-	-
	Largemouth Bass	-	-	-	-	0.5	-	0.5	0.5
	Log Perch	-	-	-	-	0.5	-	0.5	0.5
	Longnose Sucker	1.1		1.1	1.1	1.1	-	1.1	1.1
	Pumpkinseed	-	1.1	1.1	-	-	-	-	-
	Rainbow Trout	-	-	-	-	-	0.5	0.5	0.5
	Rock Bass	-	-	-	-	0.5	0.5	1	0.5
	Round Goby	-	4.3	4.3	4.3	8	6.2	14.2	7.1
	Sculpin	-	-	-	-	1.6	-	1.6	1.6
	Walleye	1.1	2.1	3.2	1.6	-	-	-	-
	White Sucker	1.1	1.1	2.2	1.1	-	-	-	-
	Yellow Perch	-	-	-	-	0.5	-	0.5	0.5
	Total	**4.4**	**9.7**	**14.1**	**7.1**	**14.8**	**7.2**	**22**	**11**

Note:
CPUE calculated using individual net set duration.
Sampling locations are presented in Figure 4-10.
Total and mean CPUE are derived from the combined totals of both nearshore study areas for each net type.

B.3 Fish Tissue

Table B-8: Fish Tissue Analysis Results, 2024

Parameter	Units	Detection Limit	Nearshore Lake Ontario								Deepwater Intake Area													
			Rainbow Trout		Atlantic Salmon	Walleye					Lake Trout								Alewife					
			RT-1	RT-2	AS-1	WE-1	WE-2	WE-3	WE-4	WE-5	LT-1	LT-2	LT-3	LT-4	LT-5	LT-6	LT-7	LT-8	LWF-1	LWF-2	LWF-3	LWF-4	LWF-5	LWF-6
Metals																								
Aluminum (Al)	mg/kg (wt)	0.2	0.38	0.17665	0.25	0.33	0.27	0.33	0.3	0.12735	0.4	0.14252	0.31	0.26	4.17	0.22	0.19308	0.15673	0.33	0.18528	0.38	0.18974	0.16808	0.12048
Antimony (Sb)	mg/kg (wt)	0.001	0.0002	0.00014	0.00025	0.00024	0.00031	0.00037	0.00033	0.00011	0.00026	0.00025	0.00027	0.00032	0.00045	0.00031	0.00066	0.0018	0.00069	0.00039	0.00036	0.00036	-0.00025	-0.0004
Arsenic (As)	mg/kg (wt)	0.004	0.0592	0.0503	0.144	0.095	0.097	0.127	0.132	0.197	0.0802	0.187	0.216	0.176	0.124	0.0991	0.119	0.312	0.145	0.0754	0.114	0.114	0.13	0.0884
Barium (Ba)	mg/kg (wt)	0.01	0.018	0.0087	0.012	0.00429	0.00242	0.00329	0.01	0.00223	0.014	0.00297	0.016	0.018	0.013	0.00486	0.00481	0.00696	0.011	0.00919	0.0095	0.00603	0.01	0.00926
Beryllium (Be)	mg/kg (wt)	0.001	-0.00022	-0.00018	-0.00016	-0.00018	-0.00013	-0.00018	-0.00012	-0.00021	-0.00015	-0.00016	-0.0002	-0.00016	-0.00017	-0.00018	-0.00017	-0.00019	-0.00024	-0.00024	-0.00016	-0.00024	-0.00039	-0.00046
Bismuth (Bi)	mg/kg (wt)	0.001	0.00046	0.00026	0.00028	0.00054	0.00068	0.00056	0.00014	0.00026	0.00021	0.00011	0.00024	0.00039	0.00058	0.00042	0.00049	0.00007	0.0044	0.0018	0.0024	0.0015	0.0015	0.0016
Boron (B)	mg/kg (wt)	0.2	-0.00767	-0.01545	-0.00183	-0.02175	-0.02727	-0.02075	-0.00947	-0.01585	-0.0255	-0.0248	-0.02382	-0.02199	-0.0211	-0.02474	0.13142	-0.02435	-0.02502	-0.02006	0.25	-0.01441	-0.01259	-0.03474
Cadmium (Cd)	mg/kg (wt)	0.001	0.00057	0.00009	0.00033	0.0001	0.00005	0.00066	0.0011	0.00009	0.00011	-0.00003	0.00006	0.00031	0.00015	-0.00001	-0.00005	0.00002	0.00002	0	0.00011	0.0001	-0.00005	-0.00017
Calcium (Ca)	mg/kg (wt)	2	180	138	82.3	116	115	106	209	115	243	71.3	169	173	121	75.9	203	63.6	188	132	181	97.4	122	80.7
Chromium (Cr)	mg/kg (wt)	0.01	0.00663	0.00443	0.00884	0.00744	0.00622	0.0081	0.0078	0.00657	0.00592	0.00784	0.00523	0.011	0.0072	0.00466	0.00495	0.0055	0.00934	0.00716	0.012	0.00796	0.00275	0.00358
Cobalt (Co)	mg/kg (wt)	0.0013	0.0045	0.004	0.0018	0.00052	0.00027	0.00039	0.00051	0.00051	0.002	0.0013	0.0021	0.0021	0.0023	0.0017	0.0019	0.0015	0.0029	0.0133	0.0044	0.0065	0.0057	0.002
Copper (Cu)	mg/kg (wt)	0.01	0.188	0.206	0.297	0.113	0.118	0.133	0.217	0.294	0.23	0.238	0.355	0.293	0.242	0.353	0.264	0.284	0.201	0.192	0.271	0.423		0.234
Iron (Fe)	mg/kg (wt)	0.25	3.5	2.53	2.58	1.08	0.78	1.09	1.82	2.13	2.14	1.81	3.23	3.4	2.43	2.29	1.71	2.54	2.71	3.54	3.46	6.68	2.83	5.76
Lead (Pb)	mg/kg (wt)	0.001	0.006	0.0014	0.0026	0.00047	0.00016	0.00017	0.00042	0.0011	0.00093	0.00049	0.0021	0.002	0.0066	0.0011	0.00055	0.00076	0.0028	0.001	0.0018	0.00072	0.0012	0.0019
Magnesium (Mg)	mg/kg (wt)	0.4	303	306	305	324	345	348	306	318	280	282	282	281	286	237	272	215	263	276	250	263	222	247
Manganese (Mn)	mg/kg (wt)	0.01	0.109	0.081	0.091	0.087	0.091	0.103	0.081	0.069	0.108	0.077	0.098	0.113	0.095	0.072	0.091	0.067	0.127	0.12	0.131	0.126	0.138	0.118
Mercury (Hg)	mg/kg (wt)	0.002	0.0378	0.0348	0.0509	0.0983	0.156	0.353	0.167	0.267	0.11	0.0853	0.0777	0.0677	0.095	0.119	0.116	0.191	0.0224	0.0559	0.0196	0.0371	0.0471	0.0397
Molybdenum (Mo)	mg/kg (wt)	0.004	0.00196	0.00155	0.0018	0.00073	0.00102	0.0009	0.00078	0.00062	0.00081	0.00068	0.00089	0.00097	0.00066	0.00131	0.00117	0.00223	0.00097	0.00043	0.00103	0.00101	0.00175	0.00059
Nickel (Ni)	mg/kg (wt)	0.01	0.00944	0.00637	0.00775	0.0056	0.00312	0.00343	0.00528	0.00317	0.00521	0.00788	0.022	0.00545	0.00627	0.0048	0.00461	0.00601	0.00693	0.01	0.00645	0.00577	0.00551	0.00545
Phosphorus (P)	mg/kg (wt)	2	2830	2940	2860	2580	2770	2630	2560	2530	2670	2590	2740	2700	2740	2340	2520	2090	2570	2430	2520	2560	2070	2300
Potassium (K)	mg/kg (wt)	2	4680	4990	4690	4790	5060	4760	4430	4520	4220	4070	4160	4080	4650	3920	4090	3420	4080	4000	4170	4260	3660	4150
Selenium (Se)	mg/kg (wt)	0.01	0.353	0.502	0.348	0.39	0.459	0.526	0.42	0.395	0.629	0.544	0.416	0.524	0.549	0.33	0.437	0.344	0.636	0.61	0.594	0.62	0.485	0.546
Silver (Ag)	mg/kg (wt)	0.001	0.00003	0.00009	0.00005	0.0001	0	0.00009	0.00004	-0.00005	0.00005	0.00012	0.00006	0.00007	0.00007	0.00012	0.00021	0.00012	0.0002	0.00005	0.00018	0.00003	0.00013	0.00011
Sodium (Na)	mg/kg (wt)	2	250	240	260	501	350	373	401	413	260	210	263	215	326	418	440	354	392	397	344	430	522	338
Strontium (Sr)	mg/kg (wt)	0.01	0.216	0.127	0.057	0.051	0.054	0.042	0.117	0.052	0.214	0.042	0.149	0.177	0.083	0.063	0.197	0.055	0.285	0.168	0.313	0.123	0.176	0.105
Thallium (Tl)	mg/kg (wt)	0.0004	0.00818	0.0101	0.0187	0.0106	0.0145	0.0183	0.0146	0.0118	0.0389	0.0228	0.027	0.0203	0.0213	0.0107	0.0149	0.012	0.00046	0.00066	0.00106	0.00484	0.00118	0.00222
Tin (Sn)	mg/kg (wt)	0.02	0.00752	0.00247	0.00428	0.00437	0.00365	0.0047	0.00564	0.00122	0.00223	0.00158	0.00301	0.0035	0.00171	0.00169	0.00264	0.0038	0.00104	0.00198	0.00278	0.00273	-0.00172	-0.00264
Titanium (Ti)	mg/kg (wt)	0.02	0.296	0.299	0.301	0.294	0.305	0.285	0.265	0.277	0.284	0.269	0.297	0.273	0.309	0.266	0.259	0.243	0.268	0.27	0.272	0.274	0.235	0.237
Uranium (U)	mg/kg (wt)	0.0004	-0.00013	-0.00018	-0.00017	-0.00022	-0.00022	-0.00017	-0.0002	-0.00019	-0.0002	-0.00021	-0.00019	-0.00018	-0.00017	-0.00021	-0.00019	-0.00018	-0.00016	-0.00021	-0.00017	-0.0002	-0.00042	-0.00047
Vanadium (V)	mg/kg (wt)	0.02	-0.00059	-0.00169	-0.00139	0.00067	0.00008	0.00076	0.00188	0.00114	-0.00094	-0.00026	0.00062	-0.00044	-0.00005	0.00003	0.00069	0.00081	0.00147	0.00179	0.00443	0.00354	-0.00141	0.00034
Zinc (Zn)	mg/kg (wt)	0.04	4.08	3.92	3.77	4.13	3.66	4.22	4.17	3.47	3.48	3.19	3.56	4	3.17	2.89	3.45	2.84	3.31	3.59	3.85	3.65	3.1	3.28
Physical Properties																								
Moisture	%	0.3	74	74	72	76	76	76	75	75	77	75	74	76	77	78	78	70	76	68	76	71	74	74
Elements																								
Methyl Mercury	ng/g (wt)	10	0.7056777	0.8507743	1.05713	81	150	350	110	270	120	66	79	66	80	160	100	210	16	39	16	29	38	33
Radionuclides																								
C-14	Bq/kg	0	53.6	55.4	41.1	<31	80.8	44.6	50.8	33	<33	<32	<33	<41	<31	<33	42.5	<49	<41	<36	<60	<33	<38	242.3
Co-60	Bq/kg	0	0.692	-2.03	0.296	-0.127	0.199	-1.1	-37.1	0.784	-0.25	-0.348	-1.11	-1.52	1	-18.4	1.64	-1.48	-1.69	-0.922	0.915	0.623	1.32	1.09
Cs-134	Bq/kg	0	1.01	0.39	0.21	-2.43	-2.62	1.54	0.959	-1.37	-1.95	-1.43	2.04	0.0973	0.962	-0.99	0.606	-1.42	-0.388	0.105	0.943	-1.96	1.27	3.59
Cs-137	Bq/kg	0	-0.114	0.857	0.677	0.259	1.24	-1.63	0.646	-1.61	0.251	0.132	-0.425	-0.719	0.244	1.55	2.59	-0.3	1.73	1.1	-0.354	1.02	-1.31	-0.281
I-131	Bq/kg	0	0.237	0.682	0.681	2.39	-0.222	0.186	0.811	0.929	0.42	1.62	1.5	-2.02	-1.1	-0.404	-1.46	-0.627	-0.796	-0.701	-0.687	-0.77	0.195	1.65
K-40	Bq/kg	0	182	122	248	298	243	84.3	147	191	192	78.6	148	226	143	-3.61	89	78.7	76.5	-69	64.4	176	123	113
Th-Series	Bq/kg	0	-0.701	-1.26	1.92	0.357	0.426	1.7	0.338	-0.143	0.84	1.03	-0.223	-1.21	-1.8	0.118	-0.785	-22.5	-33	3.15	-4.39	1	0.806	1.13
U-Series	Bq/kg	0	0.268	1.38	1.18	1.79	0.735	1.71	2.05	2.96	1.29	0.299	1.92	-0.881	3.2	-0.177	-0.225	2.32	-4.44	3.28	-0.356	1.79	-0.499	0.757
H-3	Bq/kg	0	27.5	14.3	9.42	<8	<8.1	<8.2	<8.1	<8.3	<7.9	<8.1	<8	<7.3	<8.2	<8	<7.6	<7	<7.2	<7.9	<8.3	<8	<7.7	<7.8
H-3 OBT		0	190	902	580	117	<43	231	<62	<48	93.7	137	164	1500	<129	204	<99	<87	<58	228	232	223	212	<48
% Moisture	%	0	62.64	62.95	61.23	63.88	64.51	65.9	62.89	66.32	61.85	64.51	61.97	54.68	65.11	63.02	58.42	50.87	53.94	60.76	66.05	63.52	59.38	59.89

Notes:

Sampling locations are presented in Figure 4-7 and Figure 4-10. Negative values indicate uncensored values that are less than the detection limit.

Highlighted values indicate the sample exceeded the 33 ng/g ww guideline for methylmercury (CCME, 2000)

Highlighted values indicate the sample exceeded the 3.5 mg/kg dw guideline for arsenic (Health Canada, 2024)

Highlighted values indicate the sample exceeded the 6.7 mg/kg dw guideline for selenium (ECCC, 2022)

B.4 Benthic Macroinvertebrate Community Study Results

Table B-9: Raw Benthic Invertebrate Community Data at the Lowest Practical Level, Fall 2024

Phylum	Class	Subclass	Order	Family	Subfamily	Species	Deepwater				Nearshore Area									
							SED-1	SED-2	SED-3	SED-4	1	2	3	4	5	6	7	8	9	10
ROUNDWORMS																				
P. Nemata	-	-	-	-	-	-	344	663	408	153	38	6	51	19	0	0	13	0	77	6
ANNELIDS																				
WORMS																				
P. Annelida	Cl. Oligochaeta	-	-	F. Enchytraeidae	-	-	0	0	13	0	13	0	0	0	0	0	6	0	26	0
P. Annelida	-	-	-	F. Naididae	S.F. Naidinae	*Dero*	0	0	0	0	0	0	26	0	0	0	0	0	0	0
P. Annelida	-	-	-	F. Naididae	S.F. Naidinae	*Nais bretscheri*	0	0	0	0	0	0	0	0	0	0	0	0	70	0
P. Annelida	-	-	-	F. Naididae	S.F. Naidinae	*Nais pardalis*	0	0	0	0	0	0	0	0	0	0	26	0	13	0
P. Annelida	-	-	-	F. Naididae	S.F. Naidinae	*Nais variabilis*	0	0	0	0	0	0	0	6	0	0	0	0	0	0
P. Annelida	-	-	-	F. Naididae	S.F. Tubificinae	*Limnodrilus hoffmeisteri*	0	0	0	0	0	0	77	0	0	0	0	0	0	0
P. Annelida	-	-	-	F. Naididae	S.F. Tubificinae	*Limnodrilus udekemianus*	19	0	57	0	0	0	26	0	0	0	0	0	6	0
P. Annelida	-	-	-	F. Naididae	S.F. Tubificinae	*Psammoryctides barbatus*	0	1021	0	657	0	0	0	0	0	0	0	0	6	0
P. Annelida	-	-	-	F. Naididae	S.F. Tubificinae	*Potamothrix moldaviensis*	6	0	0	147	332	319	51	0	0	0	0	0	0	0
P. Annelida	-	-	-	F. Naididae	S.F. Tubificinae	immatures with hair chaetae	38	51	364	293	13	0	0	0	0	0	0	0	0	0
P. Annelida	-	-	-	F. Naididae	S.F. Tubificinae	immatures without hair chaetae	19	51	57	587	1493	772	230	389	0	19	26	0	64	0
P. Annelida	-	-	-	F. Naididae	S.F. Rhyacodrilinae	*Bothrioneurum vejdovskyanum*	0	102	32	0	0	0	0	19	0	0	0	0	26	0
P. Annelida	-	-	-	F. Lumbriculidae	-	*Stylodrilus heringianus*	6	0	0	0	0	0	0	0	0	0	0	0	0	6
ARTHROPODS																				
MITES																				
P. Arthropoda	Cl. Arachnida	Subcl. Acari immature	-	-	-	-	0	0	0	0	0	0	0	0	6	0	0	0	0	6
P. Arthropoda	Cl. Arachnida	Subcl. Acari immature	O. Trombidiformes	F. Hygrobatidae	-	*Hygrobates*	0	0	0	0	0	0	0	0	0	0	0	0	0	13
P. Arthropoda	Cl. Arachnida	Subcl. Acari immature	O. Trombidiformes	F. Lebertiidae	-	*Lebertia*	0	0	0	0	0	6	0	0	0	0	6	0	0	0
P. Arthropoda	Cl. Arachnida	Subcl. Acari	O. Trombidiformes	F. Limnesiidae	-	*Limnesia*	57	255	13	26	0	0	0	0	19	13	0	6	13	45
P. Arthropoda	Cl. Arachnida	Subcl. Acari	O. Trombidiformes	F. Pionidae	-	indeterminate	0	51	0	0	-	-	-	-	-	-	-	-	-	-
HARPACTICOIDS																				
P. Arthropoda	-	-	O. Harpacticoida	-	-	-	1524	3215	1378	1021	0	0	0	0	0	0	0	0	0	0
SEED SHRIMPS																				
P. Arthropoda	Cl. Ostracoda	-	-	-	-	-	96	714	13	306	0	0	102	13	13	0	0	0	0	0
WATER SCUDS																				
P. Arthropoda	Cl. Ostracoda	-	O. Amphipoda	F. Gammaridae	-	*Gammarus*	0	0	0	0	0	0	0	6	0	0	0	0	0	0
SPRINGTAILS																				
P. Arthropoda	Cl. Entognatha	-	O. Collembola	-	-	-	0	0	13	0	0	0	0	0	0	0	6	0	0	0
INSECTS																				
TRUE FLIES																				
MIDGES																				
Cl. Insecta	O. Diptera	-	-	F. Chironomidae		chironomid pupae	0	0	0	0	13	0	0	0	0	0	0	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Chironomus*	51	0	255	51	13	13	0	0	0	51	0	0	13	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Cryptochironomus*	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Dicrotendipes*	6	0	13	0	13	0	26	6	0	13	89	0	77	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Micropsectra*	26	153	38	204	0	0	0	0	0	0	0	0	0	0

Phylum	Class	Subclass	Order	Family	Subfamily	Species	Deepwater				Nearshore Area									
							SED-1	SED-2	SED-3	SED-4	1	2	3	4	5	6	7	8	9	10
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Paratanytarsus*	0	0	0	0	0	0	26	0	0	0	0	0	6	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Polypedilum halterale*	0	0	0	0	0	0	0	0	0	0	0	0	6	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Polypedilum scalaenum*	0	0	0	26	0	0	0	0	0	0	0	0	6	6
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Rheotanytarsus*	0	0	0	0	0	0	77	0	0	0	0	0	51	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Saetheria*	0	0	0	0	0	0	0	0	0	0	0	0	6	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Sergentia*	32	51	0	0	0	0	0	0	0	0	0	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Stictochironomus*	6	0	38	51	13	6	0	26	0	13	0	0	32	6
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Chironominae	*Tanytarsus*	6	0	13	0	0	0	0	0	0	0	0	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Diamesinae	*Potthastia*	0	0	38	26	0	0	0	0	0	0	0	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Orthocladiinae	*Cricotopus*	0	0	0	0	0	0	0	0	0	0	32	0	6	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Orthocladiinae	*Cricotopus/Orthocladius*	6	0	0	0	0	0	0	0	0	0	13	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Orthocladiinae	*Heterotrissocladius*	32	255	38	77	0	0	0	0	0	0	0	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Orthocladiinae	*Parakiefferiella*	0	0	0	0	0	0	0	0	0	0	0	0	6	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Orthocladiinae	indeterminate	13	0	0	0	0	0	0	0	0	0	0	0	0	0
Cl. Insecta	O. Diptera	-	-	F. Chironomidae	S.F. Prodiamesinae	*Monodiamesa*	13	0	0	0	13	0	0	0	0	0	0	0	0	0
MOLLUSCS																				
SNAILS																				
P. Mollusca	Cl. Gastropoda	-	-	F. Hydrobiidae	-	*Potamopyrgus antipodarum*	13	0	0	0	-	-	-	-	-	-	-	-	-	-
CLAMS																				
P. Mollusca	Cl. Bivalvia	-	-	F. Dreissenidae	-	*Dreissena bugensis*	147	970	140	0	0	0	51	0	0	13	0	0	19	19
P. Mollusca	Cl. Bivalvia	-	-	F. Dreissenidae	-	*Dreissena* immature	0	0	0	0	38	6	561	6	0	32	32	6	19	70
TOTAL DENSITY (org/m^2)							**2462**	**7552**	**2921**	**3623**	**1990**	**1129**	**1301**	**491**	**38**	**153**	**249**	**19**	**549**	**179**
TOTAL NUMBER OF TAXA							**21**	**13**	**18**	**14**	**10**	**7**	**12**	**9**	**2**	**6**	**10**	**3**	**20**	**7**

Notes:
Sampling locations are presented in Figure 4-6 and Figure 4-7.

B.5 Macrozooplankton Community Study Results

Table B-10: Macrozooplankton Community Composition from samples collected in 2024

Spring								
Major Group	**Family**	**Taxon**	**Grid 3**	**Grid 2**	**Grid 5**	**Grid 4**	**Grid 7**	**Grid 9**
		Station Depth (m)	12.4	14.5	16.9	17.4	19.3	19.4
Cladocera	Bosminidae	Bosminidae indet. [1]						X
	Bosminidae	Eubosmina sp.	X	X	X	X	X	
	Cercopagididae	Cercopagis sp.	X	X	X	X	X	X
	Daphniidae	Daphnia sp.	X	X	X	X	X	X
	Leptodoridae	Leptodora sp.	X	X	X	X	X	X
	Polyphemidae	Polyphemus pediculus			X		X	X
	Total Cladocera		**4**	**4**	**5**	**4**	**5**	**4**
Copepoda Calanoida	Centropagidae	Limnocalanus macrurus		X	X	X	X	X
	Diaptomidae	Diaptomidae indet. [1]	X	X	X	X	X	X
	Diaptomidae	Leptodiaptomus sicilis	X	X	X	X	X	X
	Total Calanoida		**1**	**2**	**2**	**2**	**2**	**2**
Copepoda Cyclopoida	Cyclopidae	Acanthocyclops sp.			X		X	
	Cyclopidae	Diacyclops sp.		X	X	X	X	X
	Cyclopidae	Mesocyclops edax			X		X	
	Total Cyclopoida		**0**	**1**	**3**	**1**	**3**	**1**
Mysida	Mysidae	Mysidae indet.				X	X	
	Total Mysida		**0**	**0**	**0**	**1**	**1**	**0**
Taxa Richness			**5**	**7**	**10**	**8**	**11**	**7**
Overall Richness			**10**					

Summer								
Major Group	**Family**	**Taxon**	**Grid 3**	**Grid 2**	**Grid 6**	**Grid 4**	**Grid 8**	**Grid 9**
		Station Depth (m)	11.4	12.5	16.4	16.6	19	20
Cladocera	Bosminidae	Bosmina longirostris					X	
	Bosminidae	Eubosmina coregoni	X	X	X	X	X	X
	Bosminidae	Eubosmina longispina				X	X	
	Cercopagididae	Bythotrephes sp.	X		X		X	X
	Cercopagididae	Cercopagis sp.	X	X	X	X	X	X
	Chydoridae	Acroperus sp.			X			
	Chydoridae	Camptocercus sp.	X	X	X			X
	Chydoridae	Eurycercus sp.	X	X	X	X	X	X
	Chydoridae	Oxyurella sp.	X		X	X	X	X
	Daphniidae	Ceriodaphnia sp.	X	X	X		X	
	Daphniidae	Daphnia sp.	X	X	X	X	X	X
	Holopediidae	Holopedium gibberum	X	X	X	X	X	X
	Leptodoridae	Leptodora sp.	X	X	X	X	X	X
	Polyphemidae	Polyphemus pediculus	X	X	X	X	X	X

Summer								
Major Group	**Family**	**Taxon**	**Grid 3**	**Grid 2**	**Grid 6**	**Grid 4**	**Grid 8**	**Grid 9**
		Station Depth (m)	11.4	12.5	16.4	16.6	19	20
Cladocera	Sididae	Sida crystallina					X	
	Total Cladocera		**11**	**9**	**12**	**9**	**13**	**10**
Copepoda Calanoida	Diaptomidae	Diaptomidae indet. [1]					X	X
	Diaptomidae	Leptodiaptomus minutus	X		X	X		
	Diaptomidae	Skistodiaptomus oregonensis				X		
	Temoridae	Epischura sp.	X	X	X	X	X	X
		Calanoida indet. [1]				X		
	Total Calanoida		**2**	**1**	**2**	**3**	**1**	**1**

Summer								
Major Group	**Family**	**Taxon**	**Grid 3**	**Grid 2**	**Grid 6**	**Grid 4**	**Grid 8**	**Grid 9**
Copepoda Cyclopoida	Cyclopidae	Acanthocyclops sp.	X					X
	Cyclopidae	Diacyclops sp.		X			X	X
	Cyclopidae	Eucyclops sp.			X			
		Cyclopoida indet. [1]	X					X
	Total Cyclopoida		**1**	**1**	**1**	**0**	**1**	**2**
Taxa Richness			**14**	**11**	**15**	**12**	**15**	**13**
Overall Richness			**21**					

Fall								
Major Group	**Family**	**Taxon**	**Grid 3**	**Grid 1**	**Grid 5**	**Grid 4**	**Grid 8**	**Grid 9**
		Station Depth (m)	10.5	10.6	15	16.8	18.7	19.7
Cladocera	Bosminidae	Eubosmina coregoni		X	X			
	Cercopagididae	Bythotrephes sp.	X	X	X	X	X	X
	Daphniidae	Daphnia sp.			X			
	Total Cladocera		**1**	**2**	**3**	**1**	**1**	**1**
Copepoda Calanoida	Centropagidae	Limnocalanus macrurus				X		X
	Diaptomidae	Diaptomidae indet. [1]	X		X	X	X	X
	Diaptomidae	Leptodiaptomus sicilis	X	X	X	X	X	X
	Diaptomidae	Skistodiaptomus oregonensis		X				
	Temoridae	Epischura sp.	X	X	X	X	X	X
		Calanoida indet. [1]	X	X	X		X	X
	Total Calanoida		**2**	**3**	**2**	**3**	**2**	**3**
Total Zooplankton (excluding algae)			**3**	**5**	**5**	**4**	**3**	**4**
Total Unique Taxa			**7**					

Notes:
[1] Indet = indeterminant. As there was uncertainty over the identification of these organisms, they were excluded from the richness count.
Sampling locations are presented in Figure 4-7.
X – indicates taxon was present in the sample, "-" indicates taxon was not present in the sample. Taxa Richness is calculated for each station individually based on the sum of all the taxa (excluding indets.) present in the column, whereas Overall Richness is the sum of all taxa (excluding indets) across stations.

Table B-11: Summary of GLM Modelling Results to identify effects of season and depth on Macrozooplankton Community Parameters

Parameter		R^2 for Model	Effect	P-value	Significant Effect	Estimates				Comparison		P-value	Interpretation
						Season	Mean	Lower Confidence Limit	Upper Confidence Limit				
Richness - LPL		0.77	Depth	0.48	No	Spring	7.9	5.9	10.5	Spring	Summer	0.012	Summer > Spring > Fall
			Season	<0.001	Yes	Summer	13.3	10.6	16.5	Spring	Fall	0.027	
						Fall	4.1	2.7	6.1	Summer	Fall	<0.001	
Richness - Family		0.61	Depth	0.458	No	Spring	7.3	5.5	9.9	Spring	Summer	0.324	Summer = Spring > Fall
			Season	<0.001	Yes	Summer	9.8	7.6	12.6	Spring	Fall	0.043	
						Fall	3.9	2.6	5.9	Summer	Fall	<0.001	
Algae excluded	Diversity - Family	0.9	Depth	0.053	No	Spring	1.024	0.887	1.161	Spring	Summer	<0.001	Summer > Spring = Fall
			Season	<0.001	Yes	Summer	1.742	1.607	1.878	Spring	Fall	0.116	
						Fall	0.826	0.688	0.964	Summer	Fall	<0.001	
	Density	0.58	Depth	0.651	No	Spring	0.047	0.028	0.15	Spring	Summer	0.104	Summer = Spring = Fall
			Season	0.002	Yes	Summer	0.176	0.105	0.554	Spring	Fall	0.063	
						Fall	0.252	0.147	0.882	Summer	Fall	0.725	
	Biomass	0.9	Depth	0.264	No	Spring	0.0003	0.0002	0.0009	Spring	Summer	0.045	Fall > Summer > Spring
			Season	<0.001	Yes	Summer	0.0016	0.001	0.0042	Spring	Fall	0.012	
						Fall	0.017	0.01	0.0554	Summer	Fall	0.02	
Algae included	Diversity - Family	0.8	Depth	0.006	Yes	Spring	1.014	0.869	1.158	Spring	Summer	0.001	Summer > Spring = Fall
			Season	<0.001	Yes	Summer	1.446	1.304	1.589	Spring	Fall	0.207	
						Fall	0.839	0.693	0.985	Summer	Fall	<0.001	
	Density	0.65	Depth	0.412	No	Spring	0.047	0.028	0.143	Spring	Summer	0.045	Summer > Spring Fall > Spring Fall = Summer
			Season	<0.001	Yes	Summer	0.306	0.184	0.89	Spring	Fall	0.058	
						Fall	0.245	0.147	0.733	Summer	Fall	0.862	
	Biomass	0.88	Depth	0.234	No	Spring	0.0003	0.0002	0.0009	Spring	Summer	0.025	Fall > Summer > Spring
			Season	<0.001	Yes	Summer	0.0026	0.0016	0.007	Spring	Fall	0.012	
						Fall	0.0167	0.0098	0.0552	Summer	Fall	0.032	
						Depth*	0.034	0.01	0.0587	-	-	-	

Notes:
Shaded cells indicates p-value < 0.05, which was considered significant.

B.6 Aquatic Habitat Characterization

Table B-12: Results of Underwater Video Substrate Analysis for transects in Shoreline Erosion Mitigation Area and West Infill Areas

Infill Area	Transect Number	Transect	Video Title	Image	Direction Travelled	Timestamp (mm:ss)	Distance (m)	Substrate	Substrate Coverage Type	Veg Coverage (%)	Veg Coverage Value	Mussel Coverage (%)	Mussel Coverage Value	Fish Presence (Y/N)
SHORELINE EROSION MITIGATION AREA	1	SHORELINE_EROSION_MITIGATION_AREA__EASTWRD1	GX010002	0	East	00:06	0	Sand	2	0	0	0	0	N
				1		00:51	76.72	Sand	2	0	0	0	0	N
				2		01:42	153.44	Sand	2	35	3	0	0	N
				3		02:33	230.16	Sand	2	0	0	0	0	N
				4		03:25	306.88	Sand	2	25	2	0	0	N
				5		04:16	383.6	Sand	2	25	2	0	0	N
				6		05:07	460.32	Sand	2	35	3	0	0	N
				7		05:58	537.04	Sand	2	50	5	0	0	N
				8		06:49	613.76	Sand, Cobbles	3	45	5	0	0	N
				9		07:40	690.48	Sand	2	30	3	0	0	N
				10		08:31	767.2	Cobbles	4	70	7	0	0	N
	2	SHORELINE_EROSION_MITIGATION_AREA__WESTWRD1	GX010003	0	West	00:02	0	Sand, Boulders	5	100	10	0	0	N
				1		00:46	83.29	Gravel, Boulders	5	100	10	0	0	N
				2		01:34	166.58	Sand, Gravel, Boulders	4	90	9	0	0	N
				3		02:20	249.87	Sand, Boulders	5	100	10	0	0	N
				4		03:07	333.16	Cobbles	3	100	10	0	0	N
				5		03:54	416.45	Boulders, Sand, Cobbles	4	100	10	0	0	N
				6		04:41	499.74	Boulders, Sand, Cobbles	4	100	10	0	0	N
				7		05:28	583.03	Sand, Boulders	5	30	3	0	0	N
				8		06:14	666.32	Sand, Boulders	5	40	4	0	0	N
				9		07:01	749.61	Sand	2	10	1	0	0	N
				10		07:48	832.90	Sand, Boulders	5	20	2	0	0	N
	3	SHORELINE_EROSION_MITIGATION_AREA__EASTWRD2	GX010004	0	East	00:03	0.00	Boulders, Cobbles	6	100	100	5	1	N
				1		00:43	88.19	Sand	2	80	8	0	0	N
				2		01:27	176.38	Boulders, Cobbles	6	100	10	0	0	N
				3		02:10	264.57	Boulders, Cobbles	6	100	10	0	0	N
				4		02:54	352.76	Boulders, Cobbles	6	80	8	20	2	N
SHORELINE EROSION MITIGATION AREA	3	SHORELINE_EROSION_MITIGATION_AREA__EASTWRD2	GX010004	5	East	03:37	440.95	Boulders, Cobbles	5	90	9	10	1	N
				6		04:21	529.14	Boulders, Cobbles	5	90	9	10	1	N
				7		05:04	617.33	Boulders, Cobbles	5	80	8	5	1	N
				8		05:48	705.52	Boulders, Cobbles	6	80	8	20	2	N
				9		06:31	793.71	Boulders, Cobbles	6	90	9	20	2	N
				10		07:14	881.90	Boulders, Cobbles, Gravel	5	30	3	0	0	N
	4	SHORELINE_EROSION_MITIGATION_AREA__WESTWRD2	GX010005	0	West	00:03	0.00	Cobbles, Boulders	3	100	10	10	1	N
				1		00:52	88.71	Sand, Boulders	2	5	1	0	0	N
				2		01:45	177.42	Cobbles, Boulders	3	100	10	10	1	N
				3		02:37	266.13	Sand	2	5	1	0	0	N
				4		03:30	354.84	Cobbles, Boulders	6	90	9	0	0	N

Infill Area	Transect Number	Transect	Video Title	Image	Direction Travelled	Timestamp (mm:ss)	Distance (m)	Substrate	Substrate Coverage Type	Veg Coverage (%)	Veg Coverage Value	Mussel Coverage (%)	Mussel Coverage Value	Fish Presence (Y/N)
INFILL WEST				5		04:22	443.55	Cobbles, Boulders	6	100	10	30	3	N
				6		05:15	532.26	Cobbles, Boulders	6	80	8	0	0	N
				7		06:07	620.97	Sand, Cobbles, Boulders	6 and 2	50	5	0	0	N
				8		07:00	709.68	Boulders, Cobbles	5	90	9	40	4	N
				9		07:52	798.39	Sand	2	0	0	0	0	N
				10		08:45	887.10	Boulders, Cobbles	6	100	10	20	2	N
	5	SHORELINE_EROSION_MITIGATION_AREA__EASTWRD3	GX010006	0	East	00:04	0.00	Boulders, Cobbles, Gravel	4	80	8	50	5	N
				1		00:48	90.44	Boulders, Cobbles, Gravel	4	30	3	0	0	N
				2		01:35	180.88	Sand	2	0	0	0	0	N
				3		02:23	271.32	Sand, Cobbles, Boulders	4	20	2	0	0	N
				4		03:10	361.76	Sand, Cobbles, Boulders	4	10	1	0	0	N
				5		03:58	452.2	Cobbles, Boulders	6	90	9	40	4	N
				6		04:46	542.64	Sand	2	0	0	0	0	N
				7		05:33	633.08	Cobbles, Boulders	6	35	4	15	2	N
				8		06:21	723.52	Boulders, Cobbles	6	70	7	60	6	N
				9		07:08	813.96	Boulders, Cobbles	6	40	4	10	1	N
				10		07:56	904.4	Sand. Boulders	5	5	1	0	0	N
	1	INFILL_WEST_WESTWRD 1	GX010007	0	West	00:09	0	Sand	2	0	0	0	0	N
				1		00:39	64.04	Sand	2	0	0	0	0	N
				2		01:18	128.08	Sand	2	0	0	0	0	N
				3		01:57	192.12	Sand	2	0	0	0	0	N
				4		02:36	256.16	Sand	2	0	0	0	0	N
				5		03:15	320.20	Sand	2	0	0	0	0	N
				6		03:54	384.24	Sand	2	0	0	0	0	N
				7		04:33	448.28	Sand	2	0	0	0	0	N
				8		05:12	512.32	Sand	2	0	0	0	0	N
				9		05:51	576.36	Sand	2	0	0	0	0	N
				10		06:30	640.40	Sand	2	0	0	0	0	N
	2	INFILL_WEST_EASTWRD1	GX010008	0	East	00:09	0.00	Sand	2	0	0	5	0	N
				1		00:37	65.00	Sand	2	0	0	0	0	N
				2		01:14	130.00	Sand	2	0	0	0	0	N
				3		01:51	195.00	Sand	2	0	0	0	0	N
				4		02:29	260.00	Cobbles, Boulders, Gavel, Sand	5	5	1	0	0	N
				5		03:06	325.00	Sand	2	5	1	0	0	N
				6		03:43	390.00	Cobbles, Boulders	6	70	7	20	2	N
				7		04:20	455.00	Boulders, Sand	5	15	2	5	1	N
				8		04:57	520.00	Sand, Boulders	5	0	0	0	0	N
				9		05:34	585.00	Sand	2	5	1	0	0	N
				10		06:11	650.00	Boulders, Sand	5	70	7	10	1	N
	3	INFILL_WEST_WESTWRD 2	GX010009	0	West	00:04	0.00	Boulders, Cobbles, Sand	5	80	8	40	4	N

Infill Area	Transect Number	Transect	Video Title	Image	Direction Travelled	Timestamp (mm:ss)	Distance (m)	Substrate	Substrate Coverage Type	Veg Coverage (%)	Veg Coverage Value	Mussel Coverage (%)	Mussel Coverage Value	Fish Presence (Y/N)
				1		00:40	69.67	Boulders, Cobbles, Sand	5	90	9	5	1	N
				2		01:20	139.34	Sand	2	0	0	0	0	N
				3		01:59	209.01	Boulders, Cobbles, Sand	5	30	3	10	1	N
				4		02:39	278.68	Boulders, Cobbles	6	100	10	60	6	N
				5		03:19	348.35	Boulders, Cobbles, Sand	5	40	4	20	2	N
	3	INFILL_WEST_WESTWRD 2	GX010009	6	West	03:59	418.02	Sand	2	0	0	0	0	N
				7		04:39	487.69	Boulders, Cobbles, Sand	5	0	0	0	0	N
				8		05:18	557.36	Sand	2	0	0	0	0	N
				9		05:58	627.03	Sand	2	0	0	0	0	N
				10		06:38	696.70	Sand	2	0	0	0	0	N
	4	INFILL_WEST_EASTWRD2	GX010010	0	East	00:03	0.00	sand	2	0	0	0	0	N
				1		00:38	67.00	Sand	2	0	0	0	0	N
				2		01:15	134.00	Sand	2	0	0	0	0	N
				3		01:53	201.00	Sand	2	0	0	0	0	N
				4		02:31	268.00	Sand	2	0	0	0	0	N
				5		03:08	335.00	Sand	2	0	0	0	0	N
				6		03:46	402.00	Boulders, Cobble, Sand	5	90	9	70	7	N
				7		04:23	469.00	Sand	2	10	1	0	0	N
				8		05:01	536.00	Sand	2	10	1	0	0	N
				9		05:39	603.00	Boulders, Cobbles, Sand	5	90	9	50	5	N
				10		06:16	670.00	Boulders, Cobbles, Sand	5	70	7	40	4	N
	5	INFILL_WEST_WESTWRD 3	GX010011	0	West	00:01	0.00	Boulders, Cobbles, Sand	5	80	8	20	2	N
				1		00:02	62.67	Boulders, Sand	5	80	8	10	1	N
				2		00:04	125.34	Boulders, Sand	5	90	9	10	1	N
				3		00:06	188.01	Boulders, Sand	5	90	9	10	1	N
				4		00:08	250.68	Boulders, Cobbles, Sand	5	95	9	10	1	N
				5		00:10	313.35	Boulders, Cobbles, Sand	5	95	9	10	1	N
				6		00:12	376.02	Sand	2	0	0	0	0	N
				7		00:14	438.69	Sand	2	0	0	0	0	N
				8		00:16	501.36	Sand	2	0	0	0	0	N
				9		00:18	564.03	Sand	2	0	0	0	0	N
				10		00:20	626.70	Sand	2	0	0	0	0	N

Notes:
Sampling area presented in Figure 4-18.

Appendix C Predicted Radiation Dose to Human Receptors

Table C-1: Estimated Radiation Dose by Pathway to Human Receptors

Human Receptor	COPC	Radiological Dose by Pathway during Project Phases (uSv/a)												
		Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic plants	Aquatic animals	Terrestrial plants	Terrestrial animals	Total by COPC
Farm NE - Adult	C-14	4.97E-06	5.71E-09	1.31E-06	1.33E-10	8.36E-14	3.78E-12	5.22E-10	2.78E-10	0.00E+00	4.27E-04	8.23E-04	3.39E-04	1.60E-03
	Cs-134	0.00E+00	0.00E+00	6.96E-05	1.40E-05	1.80E-10	5.22E-05	6.50E-06	1.55E-02	0.00E+00	1.29E-02	1.10E-05	1.16E-07	2.85E-02
	HTO	7.39E-02	0.00E+00	2.66E-02	8.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.26E-05	5.17E-02	4.08E-03	1.57E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-05	6.76E-03	6.62E-04	7.44E-03
	Total by pathway	7.39E-02	5.71E-09	2.67E-02	8.88E-04	1.80E-10	5.22E-05	6.50E-06	1.55E-02	0.00E+00	1.34E-02	5.93E-02	5.08E-03	1.95E-01
Farm NE - Child 10y	C-14	7.09E-06	5.71E-09	7.21E-07	1.33E-10	1.58E-12	3.78E-12	9.90E-09	2.78E-10	0.00E+00	4.14E-04	8.01E-04	2.57E-04	1.48E-03
	Cs-134	0.00E+00	0.00E+00	2.04E-05	1.40E-05	1.83E-09	5.22E-05	6.58E-05	1.55E-02	0.00E+00	6.67E-03	5.40E-06	4.63E-08	2.23E-02
	HTO	8.78E-02	0.00E+00	1.32E-02	7.28E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.74E-05	4.39E-02	2.80E-03	1.49E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.76E-05	6.53E-03	5.01E-04	7.05E-03
	Total by pathway	8.78E-02	5.71E-09	1.32E-02	7.42E-04	1.83E-09	5.22E-05	6.58E-05	1.55E-02	0.00E+00	7.14E-03	5.12E-02	3.56E-03	1.79E-01
Farm NE - Infant 1y	C-14	4.84E-06	5.71E-09	0.00E+00	5.42E-12	3.52E-12	3.78E-12	2.20E-08	2.78E-10	0.00E+00	2.89E-04	6.78E-04	1.72E-04	1.14E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	5.94E-07	2.31E-09	6.79E-05	8.34E-05	2.02E-02	0.00E+00	2.66E-03	2.81E-06	1.71E-08	2.30E-02
	HTO	6.06E-02	0.00E+00	0.00E+00	3.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.76E-05	4.14E-02	2.14E-03	1.04E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-05	5.71E-03	3.90E-04	6.11E-03
	Total by pathway	6.06E-02	5.71E-09	0.00E+00	3.41E-04	2.32E-09	6.79E-05	8.35E-05	2.02E-02	0.00E+00	2.99E-03	4.78E-02	2.70E-03	1.35E-01
Dairy Farm - Adult	C-14	2.11E-06	2.43E-09	1.80E-07	1.28E-10	0.00E+00	0.00E+00	5.22E-10	2.78E-10	0.00E+00	0.00E+00	3.08E-04	7.46E-04	1.06E-03
	Cs-134	0.00E+00	0.00E+00	8.65E-06	1.35E-05	0.00E+00	0.00E+00	6.50E-06	1.55E-02	0.00E+00	0.00E+00	0.00E+00	1.70E-09	1.55E-02
	HTO	3.17E-02	0.00E+00	9.18E-03	5.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-02	1.51E-02	6.72E-02
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-03	1.02E-03	2.51E-03
	Total by pathway	3.17E-02	2.43E-09	9.19E-03	5.22E-04	0.00E+00	0.00E+00	6.50E-06	1.55E-02	0.00E+00	0.00E+00	1.25E-02	1.69E-02	8.63E-02
Dairy Farm - Child 10y	C-14	3.02E-06	2.43E-09	9.88E-08	1.28E-10	0.00E+00	0.00E+00	9.90E-09	2.78E-10	0.00E+00	0.00E+00	3.00E-04	8.30E-04	1.13E-03
	Cs-134	0.00E+00	0.00E+00	2.54E-06	1.35E-05	0.00E+00	0.00E+00	6.58E-05	1.55E-02	0.00E+00	0.00E+00	0.00E+00	5.94E-10	1.56E-02
	HTO	3.77E-02	0.00E+00	4.57E-03	4.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.03E-03	2.02E-02	7.19E-02
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.44E-03	1.00E-03	2.44E-03
	Total by pathway	3.77E-02	2.43E-09	4.57E-03	4.37E-04	0.00E+00	0.00E+00	6.58E-05	1.55E-02	0.00E+00	0.00E+00	1.08E-02	2.21E-02	9.11E-02
Dairy Farm - Infant 1y	C-14	2.06E-06	2.43E-09	0.00E+00	1.36E-13	0.00E+00	0.00E+00	2.20E-08	2.78E-10	0.00E+00	0.00E+00	2.23E-04	1.16E-03	1.38E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.34E-05	2.02E-02	0.00E+00	0.00E+00	0.00E+00	4.35E-10	2.02E-02
	HTO	2.60E-02	0.00E+00	0.00E+00	1.36E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.20E-03	3.81E-02	7.14E-02
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-03	1.31E-03	2.41E-03
	Total by pathway	2.60E-02	2.43E-09	0.00E+00	1.36E-04	0.00E+00	0.00E+00	8.35E-05	2.02E-02	0.00E+00	0.00E+00	8.53E-03	4.05E-02	9.54E-02
FSHR - Adult	C-14	4.46E-06	5.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.07E-03	0.00E+00	0.00E+00	9.08E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-01	0.00E+00	0.00E+00	2.74E-01
	HTO	6.74E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.03E-04	0.00E+00	0.00E+00	6.83E-02
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.88E-04	0.00E+00	0.00E+00	3.88E-04
	Total by pathway	6.74E-02	5.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-01	0.00E+00	0.00E+00	3.51E-01
FSHR - Child 10y	C-14	6.36E-06	5.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.79E-03	0.00E+00	0.00E+00	8.80E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-01	0.00E+00	0.00E+00	1.42E-01
	HTO	8.01E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.93E-04	0.00E+00	0.00E+00	8.09E-02
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.73E-04	0.00E+00	0.00E+00	3.73E-04

Human Receptor	COPC	Radiological Dose by Pathway during Project Phases (uSv/a)												
		Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic plants	Aquatic animals	Terrestrial plants	Terrestrial animals	Total by COPC
FSHR - Infant 1y	Total by pathway	8.01E-02	5.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-01	0.00E+00	0.00E+00	2.32E-01
	C-14	4.34E-06	5.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.13E-03	0.00E+00	0.00E+00	6.13E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.64E-02	0.00E+00	0.00E+00	5.64E-02
	HTO	5.53E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.86E-04	0.00E+00	0.00E+00	5.59E-02
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-04	0.00E+00	0.00E+00	2.68E-04
Urban Resident WNW - Adult	Total by pathway	5.53E-02	5.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.34E-02	0.00E+00	0.00E+00	1.19E-01
	C-14	5.44E-05	6.26E-08	5.49E-06	2.30E-10	9.19E-13	4.16E-11	5.22E-10	2.78E-10	0.00E+00	6.35E-06	7.22E-04	6.57E-08	7.89E-04
	Cs-134	0.00E+00	0.00E+00	2.99E-04	2.26E-05	1.98E-09	5.74E-04	6.50E-06	1.55E-02	0.00E+00	1.92E-04	8.97E-06	5.05E-12	1.66E-02
	HTO	7.99E-01	0.00E+00	1.11E-02	5.44E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.32E-07	2.65E-02	1.84E-06	8.37E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-07	3.57E-03	4.14E-07	3.57E-03
	Total by pathway	7.99E-01	6.26E-08	1.14E-02	5.67E-04	1.98E-09	5.74E-04	6.50E-06	1.55E-02	0.00E+00	1.99E-04	3.08E-02	2.32E-06	8.58E-01
Urban Resident WNW - Child 10y	C-14	7.76E-05	6.26E-08	3.01E-06	2.30E-10	1.74E-11	4.16E-11	9.90E-09	2.78E-10	0.00E+00	6.15E-06	7.05E-04	6.97E-08	7.92E-04
	Cs-134	0.00E+00	0.00E+00	8.78E-05	2.26E-05	2.01E-08	5.74E-04	6.58E-05	1.55E-02	0.00E+00	9.92E-05	4.36E-06	2.19E-12	1.64E-02
	HTO	9.50E-01	0.00E+00	5.52E-03	4.54E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.55E-07	2.24E-02	1.65E-06	9.78E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.61E-07	3.46E-03	4.08E-07	3.46E-03
	Total by pathway	9.50E-01	6.26E-08	5.61E-03	4.76E-04	2.01E-08	5.74E-04	6.58E-05	1.55E-02	0.00E+00	1.06E-04	2.65E-02	2.13E-06	9.99E-01
Urban Resident WNW - Infant 1y	C-14	5.30E-05	6.26E-08	0.00E+00	2.62E-11	3.87E-11	4.16E-11	2.20E-08	2.78E-10	0.00E+00	4.29E-06	5.52E-04	9.87E-08	6.09E-04
	Cs-134	0.00E+00	0.00E+00	0.00E+00	3.01E-06	2.55E-08	7.47E-04	8.34E-05	2.02E-02	0.00E+00	3.95E-05	2.05E-06	1.26E-12	2.10E-02
	HTO	6.55E-01	0.00E+00	0.00E+00	2.08E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E-07	1.93E-02	2.32E-06	6.75E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-07	2.81E-03	5.57E-07	2.81E-03
	Total by pathway	6.55E-01	6.26E-08	0.00E+00	2.11E-04	2.55E-08	7.47E-04	8.35E-05	2.02E-02	0.00E+00	4.44E-05	2.27E-02	2.97E-06	6.99E-01
Harvester -Adult	C-14	6.29E-05	7.23E-08	5.49E-06	2.30E-10	9.19E-13	4.16E-11	5.22E-10	2.78E-10	0.00E+00	5.00E-03	6.16E-04	5.08E-03	1.08E-02
	Cs-134	0.00E+00	0.00E+00	2.99E-04	2.26E-05	1.98E-09	5.74E-04	6.50E-06	1.55E-02	0.00E+00	1.51E-01	1.16E-05	4.92E-04	1.68E-01
	HTO	9.21E-01	0.00E+00	1.21E-02	5.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.98E-04	2.95E-02	1.98E-02	9.84E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-04	2.95E-03	3.11E-03	6.28E-03
	Total by pathway	9.21E-01	7.23E-08	1.24E-02	5.97E-04	1.98E-09	5.74E-04	6.50E-06	1.55E-02	0.00E+00	1.56E-01	3.31E-02	2.85E-02	1.17E+00
Harvester - Child 10y	C-14	8.97E-05	7.23E-08	3.01E-06	2.30E-10	1.74E-11	4.16E-11	9.90E-09	2.78E-10	0.00E+00	4.84E-03	4.61E-04	3.49E-03	8.88E-03
	Cs-134	0.00E+00	0.00E+00	8.78E-05	2.26E-05	2.01E-08	5.74E-04	6.58E-05	1.55E-02	0.00E+00	7.80E-02	4.64E-06	2.02E-04	9.44E-02
	HTO	1.10E+00	0.00E+00	6.02E-03	4.78E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.37E-04	2.00E-02	1.09E-02	1.13E+00
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-04	2.20E-03	1.87E-03	4.27E-03
	Total by pathway	1.10E+00	7.23E-08	6.11E-03	5.01E-04	2.01E-08	5.74E-04	6.58E-05	1.55E-02	0.00E+00	8.35E-02	2.27E-02	1.65E-02	1.24E+00
Harvester - Infant 1y	C-14	6.12E-05	7.23E-08	0.00E+00	2.63E-11	3.87E-11	4.16E-11	2.20E-08	2.78E-10	0.00E+00	3.37E-03	3.36E-05	2.52E-03	5.99E-03
	Cs-134	0.00E+00	0.00E+00	0.00E+00	3.01E-06	2.55E-08	7.47E-04	8.34E-05	2.02E-02	0.00E+00	3.11E-02	1.93E-07	8.46E-05	5.21E-02
	HTO	7.55E-01	0.00E+00	0.00E+00	2.34E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.23E-04	1.54E-03	8.18E-03	7.66E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.48E-04	1.65E-04	1.36E-03	1.67E-03
	Total by pathway	7.56E-01	7.23E-08	0.00E+00	2.37E-04	2.55E-08	7.47E-04	8.35E-05	2.02E-02	0.00E+00	3.49E-02	1.74E-03	1.21E-02	8.26E-01
Industrial - Adult	C-14	2.05E-05	2.36E-08	1.52E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-05
	Cs-134	0.00E+00	0.00E+00	8.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.29E-05
	HTO	3.03E-01	0.00E+00	1.24E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.05E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Human Receptor	COPC	Radiological Dose by Pathway during Project Phases (uSv/a)												
		Air (internal)	Air (external)	Water (internal)	Water (external)	Soil (internal)	Soil (external)	Sediment (internal)	Sediment (external)	Aquatic plants	Aquatic animals	Terrestrial plants	Terrestrial animals	Total by COPC
C2 - Adult	Total by pathway	3.03E-01	2.36E-08	1.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.05E-01
	C-14	1.59E-05	1.82E-08	6.61E-06	2.67E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-05
	Cs-134	0.00E+00	0.00E+00	3.61E-04	2.37E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-04
	HTO	2.37E-01	0.00E+00	5.39E-03	4.57E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
C2 - Child 10y	Total by pathway	2.37E-01	1.82E-08	5.76E-03	4.81E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.42E-01
	C-14	2.26E-05	1.82E-08	3.63E-06	2.67E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-05
	Cs-134	0.00E+00	0.00E+00	1.06E-04	2.37E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-04
	HTO	2.81E-01	0.00E+00	2.68E-03	3.81E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-01
	OBT	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Total by pathway	2.81E-01	1.82E-08	2.79E-03	4.05E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-01

Table C-2: Concentrations of Radionuclides in Environmental Media

Environmental Media	Location	Unit	Estimated Point Concentrations of Radionuclides			
			C-14	Cs-134	HTO	OBT
Outdoor air	Farm NE	Bq/m^3	6.96E-05	0.00E+00	4.14E-01	0.00E+00
	Dairy Farm	Bq/m^3	2.96E-05	0.00E+00	1.77E-01	0.00E+00
	Sport Fisher	Bq/m^3	6.24E-03	0.00E+00	3.78E+01	0.00E+00
	Urban Resident WNW	Bq/m^3	7.62E-04	0.00E+00	4.47E+00	0.00E+00
	Harvester	Bq/m^3	8.80E-04	0.00E+00	5.16E+00	0.00E+00
	Industrial	Bq/m^3	1.25E-03	0.00E+00	7.39E+00	0.00E+00
	C2	Bq/m^3	2.22E-04	0.00E+00	1.33E+00	0.00E+00
Loam	Farm NE	Bq/kg(dw)	2.67E-07	1.76E-05	0.00E+00	0.00E+00
	Dairy Farm	Bq/kg(dw)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Urban Resident WNW	Bq/kg(dw)	2.93E-06	1.93E-04	0.00E+00	0.00E+00
	Harvester	Bq/kg(dw)	2.93E-06	1.93E-04	0.00E+00	0.00E+00
	C2	Bq/kg(dw)	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Deep Well	Well (11.3) in Farm NE	Bq/L	3.76E-07	0.00E+00	9.55E+00	0.00E+00
	Well (22.2) in Farm NE	Bq/L	3.56E-07	0.00E+00	4.96E+00	0.00E+00
	Well (25.1) in Farm NE	Bq/L	3.51E-07	0.00E+00	4.17E+00	0.00E+00
	Well (40.6) in Farm NE	Bq/L	3.25E-07	0.00E+00	1.64E+00	0.00E+00
Loam PoreWater	Dairy Farm	Bq/L	1.69E-07	0.00E+00	8.06E+00	0.00E+00
Deep Well	Well (21.6) in Dairy Farm	Bq/L	1.52E-07	0.00E+00	2.21E+00	0.00E+00
	Well (22.1) in Dairy Farm	Bq/L	1.51E-07	0.00E+00	2.14E+00	0.00E+00
	Well (24.7) in Dairy Farm	Bq/L	1.50E-07	0.00E+00	1.83E+00	0.00E+00
LakeShore Water	Outfall	Bq/L	4.00E-04	6.00E-04	8.78E+00	0.00E+00
Lake Sediment	Outfall	Bq/kg(dw)	2.00E-02	5.70E+00	0.00E+00	0.00E+00
LakeShore Water	A-WSP	Bq/L	3.00E-05	5.00E-05	7.10E-01	0.00E+00

Table C-3: Concentrations of Radionuclides in Food Items

Food Item	Location	Unit	Estimated Point Concentrations of Radionuclides in Food Items for Human Receptors			
			C-14	Cs-134	HTO	OBT
Beef(meat)	Farm NE	Bq/kg(fw)	6.61E-02	8.51E-07	2.39E+01	1.52E+00
Deer	Farm NE	Bq/kg(fw)	6.66E-02	4.82E-07	1.47E+01	1.01E+00
Poultry(egg)	Farm NE	Bq/kg(fw)	1.39E-02	4.94E-08	1.29E+01	1.26E+00
Poultry(meat)	Farm NE	Bq/kg(fw)	2.16E-02	3.33E-07	1.28E+01	1.51E+00
Fruits	Farm NE	Bq/kg(fw)	1.66E-02	9.75E-06	3.94E+01	1.72E+00
Potatoes	Farm NE	Bq/kg(fw)	3.48E-02	4.79E-06	3.46E+01	3.60E+00
Garden Vegetables	Farm NE	Bq/kg(fw)	1.66E-02	9.75E-06	3.94E+01	1.72E+00
Honey Bee	Farm NE	Bq/kg(fw)	1.66E-01	5.30E-08	1.02E+02	1.00E+01
Beef(meat)	Dairy Farm	Bq/kg(fw)	2.66E-02	0.00E+00	8.30E+00	4.37E-01
Poultry(egg)	Dairy Farm	Bq/kg(fw)	0.00E+00	0.00E+00	1.71E+00	1.49E-01
Poultry(meat)	Dairy Farm	Bq/kg(fw)	0.00E+00	0.00E+00	1.71E+00	1.88E-01
Cow(milk)	Dairy Farm	Bq/kg(fw)	8.60E-03	0.00E+00	1.01E+01	1.00E-01
Fruits	Dairy Farm	Bq/kg(fw)	7.05E-03	0.00E+00	9.87E+00	4.30E-01
Potatoes	Dairy Farm	Bq/kg(fw)	1.48E-02	0.00E+00	8.66E+00	9.03E-01
Garden Vegetables	Dairy Farm	Bq/kg(fw)	7.05E-03	0.00E+00	9.87E+00	4.30E-01
Fruits	Urban Resident WNW	Bq/kg(fw)	1.81E-01	1.04E-04	2.52E+02	1.10E+01
Potatoes	Urban Resident WNW	Bq/kg(fw)	3.81E-01	5.13E-05	2.21E+02	2.30E+01
Garden Vegetables	Urban Resident WNW	Bq/kg(fw)	1.81E-01	1.04E-04	2.52E+02	1.10E+01
Deer	Harvester	Bq/kg(fw)	8.43E-01	5.30E-06	1.83E+02	1.26E+01
Deer Organ	Harvester	Bq/kg(fw)	8.43E-01	4.80E-06	1.83E+02	1.26E+01
Canada Goose	Harvester	Bq/kg(fw)	1.02E+00	2.56E-06	1.85E+02	1.12E+01
Mallard	Harvester	Bq/kg(fw)	1.61E+01	1.00E-01	1.27E+01	8.10E-01
Rabbit	Harvester	Bq/kg(fw)	8.43E-01	5.06E-04	1.81E+02	1.35E+01
Freshwater plant	Outfall	Bq/kg(fw)	2.36E+00	1.32E-01	6.59E+00	9.66E-01
Freshwater Invertebrate	Outfall	Bq/kg(fw)	2.24E+00	5.94E-02	6.59E+00	1.23E+00
Walleye	Outfall	Bq/kg(fw)	2.28E+00	2.10E+00	6.59E+00	1.23E+00

DETAILED BREAKDOWN OF EVIDENCE STRUCTURE

The Pickering Refurbishment Program ("PRP") evidence is organized into ten different Schedules as follows:

Ex. D2-3-1: Pickering Refurbishment Program Overview

1.0 Summary
2.0 Approvals Sought
3.0 Evidence Roadmap
4.0 Regulatory and Planning Framework
    4.1 Ontario Regulation 53/05 and Financing Mechanisms
    4.2 Government Support
    4.3 CNSC Regulatory Framework

Attachments:

Attachment 1:	CNSC Regulatory Document REGDOC-2.3.3: Periodic Safety Reviews
Attachment 2:	Predictive Environmental Risk Assessment for Pickering Refurbishment, Decommissioning, and Continued Operations (P-REP-07701-00014)
Attachment 3:	Detailed Breakdown of Evidence Structure

Ex. D2-3-2: PRP Program Structure

1.0 Overview
2.0 Commercial and Contracting Strategies
3.0 OPG Structure as Owner
    3.1 Project Management Teams
    3.2 Functional Support Groups
        3.2.1 Project Execution Support Function
        3.2.2 Work Management Function
        3.2.3 Engineering Function
        3.2.4 Nuclear Safety Function

3.2.5 Procurement Engineering Function
3.2.6 Planning and Controls Function
3.2.7 Managed System Oversight Function
3.2.8 Supply Chain Function
3.2.9 Contract Management Function
3.2.10 Program Fees and Other Support Function
3.2.11 Functional Operations and Maintenance

Attachments:

Attachment 1: Program Management System Structure and Program Charter

Ex. D2-3-3: PRP Work Bundle Structure and Contracts

1.0 Overview
2.0 Structure of Major Work Bundles
3.0 Contracts for Major Work Bundles
3.1 Contracting Overview
3.1.1 Overview of Contracting for Major Work Bundles
3.1.2. Current Status of Contracting Process
3.2 Pricing
3.2.1 Contract Terms and Conditions
3.3 Retube Feeder and Boiler Replacement
3.3.1 Contract Phases
3.3.2 Target Price Contract Structure
3.3.3 Materials and Commissioning Work
3.3.4 Current Status
3.4 Turbine Generator
3.4.1 Hardware Supply
3.4.2 Definition Phase and Installation
3.4.3 Static and Dynamic Commissioning
3.4.4 Warranty
3.4.5 Reimbursable Costs
3.5 Deep Water Intake

3.5.1 Request-For-Market-Information
3.5.2 Contracting Model
3.5.3 Request-For-Prequalifications, Request-For-Proposals, and Contract Award
3.5.4 Pricing Model
3.5.5 Incentive and Disincentives – Costs and Schedule
3.5.5.1 Definition Phase – Cost Incentives and Disincentives
3.5.5.2 Execution Phase – Cost Incentives and Disincentives
3.5.5.3 Execution Phase – Milestone Schedule Incentives and Disincentives
3.6 Balance of Plant
3.7 Facilities & Infrastructure
3.7.1 Contract Strategy
3.8 Operations and Maintenance
3.8.1 Design Contract Strategy
3.8.2 Material Contract Strategy

Attachments:

Attachment 1: Contract Summary for RFBR with Atkins/Aecon JV
Attachment 2: Contract Summary for Turbine Generators with the TG Consortium
Attachment 3: Contract Summary for DWI
Attachment 4: ESMSA Contract Summary and ESMSA Worksheet Template

Ex. D2-3-4: PRP Program Planning

1.0 Overview
2.0 Planning
2.1 Investment in Planning
2.1.1 Feasibility Phase
2.1.2 Initiation Phase
2.1.3 Definition Phase
2.1.4 Execution Phase

2.2 Workforce Strategy
2.3 Lessons Learned
2.4 Engineering Completion
2.5 Reactor Mock-up, Tool Fabrication and Testing

Ex. D2-3-5: PRP Program Scope

1.0 Overview
2.0 Importance of Scoping
3.0 Approach to Work Scope Definition
3.1 Engineering Modifications
3.2 Regulatory Scope
3.3 Work Bundles
4.0 Scope for Major Work Bundles
4.1 Retube Feeder and Boiler Replacement
4.2 Turbine Generators
4.3 Balance of Plant
4.3.1 Conventional, Electrical & Nuclear System Modifications
4.3.2 Specialized Projects
4.4 Operations & Maintenance
4.4.1 Shutdown/Layup
4.4.2 Plant Systems
4.4.3 Valves
4.4.4 Fuel Handling and Defueling
4.4.4.1 Defuel the Reactors
4.4.4.2 New Fuel Load
4.4.4.3 Removal & Re-installation of Fueling Machine & Carriage
4.4.4.4 Overhaul of Fuel Handling Components
4.4.4.5 Service Room Changes & Bridge Movement
4.5 Facilities and Infrastructure
4.5.1 Traffic Study and Capacity Management
4.5.2 Site Preparation and Service Upgrades
4.5.3 Renovations and Upgrades to Existing Buildings

4.5.4 Construction of New Buildings
4.5.4.1 New Warehouse Lease (Church Street)
4.5.4.2 Common Services Building and Retube Feeder Replacement Island Storage Annex
4.5.4.3 Main Security and Auxiliary Security Building
4.5.4.4 Pickering Maintenance Facility
4.6 Deep Water Intake

Attachments:
Attachment 1: Scope Differences Between Darlington Refurbishment and Pickering Refurbishment

Ex. D2-3-6: PRP Program Schedule
1.0 Overview
2.0 Schedule Development
3.0 Multi-Level Scheduling Approach
4.0 Critical Path and Schedule Overview
5.0 Working Schedule versus High Confidence Schedule

Attachments:
Attachment 1: Pickering Refurbishment Outage Schedule – Level 1 Overview

Ex. D2-3-7: PRP Contingency
1.0 Overview
2.0 Contingency
3.0 Contingency Development
4.0 Contingency Amounts
4.1 PRP Contingency Amounts
4.2 Unit 5 Contingency Amounts

Ex. D2-3-8: PRP Cost and In-Service Amounts
1.0 Overview

2.0 Release Quality Estimate
2.1 Cost Estimating Structure
3.0 PRP Cost Breakdown
4.0 Unit 5 Cost and In-Service Amount Breakdown
4.1 Concurrent Cost Recovery
4.2 In-Service Envelope and Capacity Refurbishment Variance Account
5.0 Unit 5 Major Work Bundle Costs Breakdown
5.1 Retube, Feeder and Boiler Replacement
5.2 Turbine Generators
5.3 Balance of Plant
5.4 Operations and Maintenance
5.5 Facilities & Infrastructure
5.6 Deep Water Intake
6.0 IR Term Capital Expenditure and In-Service Amounts
6.1 Early In-Service Facilities and Infrastructure Project
6.1.1 Common Services Building
6.1.2 Pickering Maintenance Facility (“PMF”)
6.1.3 Engineering Services Building 1 & Engineering Service Building 2 Workplace Optimization
6.1.4 PN Campus Electrical Upgrades
6.1.5 PN Campus Parking Lots/Roads
6.1.6 Montgomery Park and Sandy Beach Road Upgrades
6.1.7 Early In-Service Projects <$10M

Attachments:

Attachment 1: Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release Board Memo

Attachment 2: KPMG Report on RQE

Ex. D2-3-9: PRP Program Execution

1.0 Overview

2.0 Project Execution Support Function
3.0 Work Management Function
4.0 Functional Operations and Maintenance
5.0 Planning and Controls
6.0 Cost and Schedule Performance Monitoring
7.0 Risk Management
8.0 Change Management
9.0 Reporting
10.0 Oversight
10.1 External Assurance
10.2 Internal Assurance

Attachments:
Attachment 1: Pickering Refurbishment Project Controls Program Management Plan – NK30-PLAN-00120-00003

Ex. D2-3-10: PRP Independent Studies

1.0 Independent Review of Plan and Approach to Program Execution

Attachments:
Attachment 1: Pegasus Global Holdings, Inc. – Testimony of Joe Miller
Attachment 2: Pegasus Global Holdings, Inc. Engagement Letter

Ex. F2-8-1: Pickering Refurbishment Program Project OM&A

1.0 Purpose
2.0 Overview
3.0 2022-2026 Expenditures
3.1 2024 OM&A Expenditures
3.2 2025 OM&A Expenditures
3.3 2026 OM&A Expenditures
4.0 Term-over-Term Analysis – IR Term

PICKERING REFURBISHMENT PROGRAM
PROGRAM STRUCTURE

1.0 OVERVIEW

This exhibit sets out the commercial strategy that establishes OPG as Owner and defines OPG's relationships with its external contractors for the Pickering Refurbishment Program ("PRP"). The exhibit also describes OPG's supporting organizational structure for the PRP. OPG's approach to its commercial strategy for the PRP was informed by operational experience and lessons learned from the Darlington Refurbishment Program ("DRP") and largely follows a similar approach.

2.0 COMMERCIAL AND CONTRACTING STRATEGIES

The PRP is a multi-phase project consisting of individual projects of varying sizes. While there are significant scope differences between the DRP and the PRP (see Ex. D2-3-5), the inherent nature of the core refurbishment work is similar, thereby providing an opportunity for the PRP to leverage and build on the DRP's successful program and commercial structure.

In an oversight role, OPG will be accountable for the safe and reliable design of the nuclear facilities, managing plant operations during the phased return of units, and ensuring compliance with Canadian Nuclear Safety Commission ("CNSC") licensing requirements. This strategy will allow OPG to effectively manage risks while ensuring the work is optimized and carried out in a way that preserves long-term operational integrity.

To effectively manage the work, OPG has developed a comprehensive commercial strategy along with tailored contracting strategies for the major work bundle. Like the DRP, OPG has chosen a "multi-prime contractor" model as the commercial framework, where multiple prime contractors are engaged for different portions of the work.

The multi-prime contractor model is particularly suited for projects like DRP and PRP, where the project scope definition is more defined, specific and detailed scope can be assigned to a single contractor, and low levels of contractor integration are required. OPG, as owner, holds separate contracts with each prime contractor, who is responsible for delivering the work within the scope of their specific agreement.

In this model, OPG retains control over the entire refurbishment program, including the deliverables, costs and schedule, and can assign risks to the parties best able to manage those risks, while also allowing for the cost-effective use of specialized contractors. This strategy further allows OPG to agree to a reasonable balance between the transfer of risk to contractors and the costs of the contracted services.

As part of the multi-prime contractor structure, OPG selected engineering, procurement and construction ("EPC") as the preferred delivery model for each of the prime contractors for the PRP. Integral to the DRP's success using the multi-prime EPC model was to maintain positive and productive long-term working relationships with all its contractors through a collaborative contract management approach,[1] namely, OPG's "One Team" approach. The "One Team" approach establishes a unified working model where OPG and contractors operate with shared control structures, integrated reporting systems and joint accountability for project outcomes.

Given inherent similarities in the nature of work between DRP and PRP, OPG determined that a collaborative EPC model is also best suited to the PRP, as it enables direct accountability for each contractor's specific deliverables, while utilizing existing proven commercial frameworks and collaborative principles of the One Team approach. Utilizing the collaborative EPC model across all prime contractors, rather than a combination of other approaches, also minimizes burden on OPG's organizational structure and substantively reduces interface management and schedule coordination challenges, cost control complexity and information asymmetry. Importantly, adopting this model allows OPG to leverage proven successful

[1] Collaborative contract management is an industry-recognized approach for mega-program owners that focuses on upholding the terms of a contract while also establishing mutual goals and guiding principles, creating structures for alignment of expectations and interests over the long-term life of the project, fostering trust and collaboration, and producing healthy and sustainable partnerships.

contractors and their respective contracts from the DRP to the PRP, creating significant efficiencies in planning and negotiating. This model also allows OPG to still engage newly qualified contractors where applicable, ensuring adequate capacity and expanded contractor base and capabilities to meet PRP project objectives.

OPG will act as the integrator, overseeing all prime contractors and managing the overall PRP. This is appropriate for several reasons, including the operational complexities of working in a nuclear power plant that will be transitioning from having all units offline to a combination of on- and offline units over time.

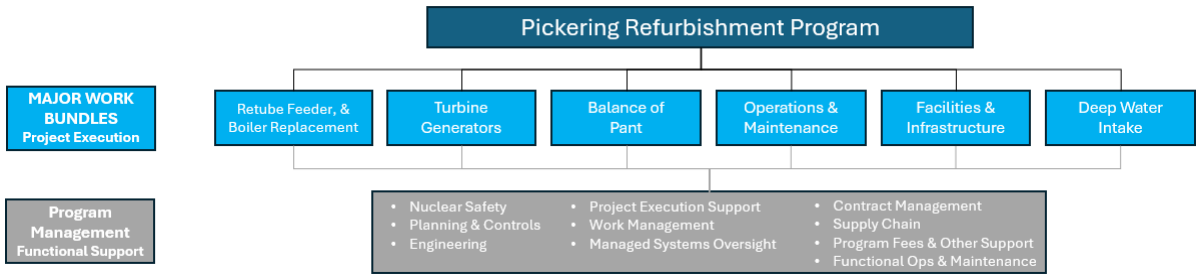
For each major work bundle, OPG is developing specific contracting strategies. A “contracting strategy” outlines the approach for successful project delivery for each major bundle within the PRP. These strategies consider factors such as the nature and scope of the work, the contractor marketplace, and potential long-term commercial relationships. Each strategy determines the most appropriate sourcing, contract structure, and pricing mechanism for the specific work bundle. The strategies also detail the work assignments for each contractor, allowing OPG to maintain flexibility in adapting to the work's unique requirements, market conditions, and post-refurbishment needs. The contracts for the major work bundles are outlined in Ex. D2-3-3.

3.0 OPG STRUCTURE AS OWNER

As the owner, OPG retains overall responsibility for deliverables, costs and schedule and continues to serve as the design authority for the PRP. OPG will at all times remain the license holder and operator of the plant in accordance with the CNSC regulations and license requirements. To effectively perform the various aspects of this role, OPG has established an organizational structure comprised of two primary aspects. First, OPG has established dedicated project management teams that are responsible for the management, oversight and delivery of specific major work bundles. Second, OPG has established functional support groups (“Functions”) that are dedicated to performing specific types of work to support the major work bundles and the integration of the overall PRP.

A diagram of how the organization is structured, considering both the dedicated project management teams and the Functions, is provided in Figure 1 below.

Figure 1 – PRP Organizational Structure



3.1 Project Management Teams

As described in Ex. D2-3-3, scopes of work have been grouped into six major work bundles. Each of the six major work bundles has OPG project directors. The project directors are responsible for ensuring the effective planning and successful execution of their major work bundle within the overall PRP, and for ensuring that the corresponding contractors deliver the contracted services safely, to the quality specified, on time and on budget. The project directors are supported by a dedicated project management team, as well as by OPG's Program Management Functional Support as noted in Figure 1 (above). As explained in Ex. D2-3-8, the costs associated with this project management role form part of the cost for each of the major work bundles.

3.2 Functional Support Groups

Functional Support Groups are teams within OPG that are responsible for performing specific types of support for the major work bundles and the PRP as a whole. Functions set standards, manage the PRP at the overall Program level and provide support in specific areas (such as engineering, oversight, and procurement). The Functions are responsible for providing the required support, coordination, integration and oversight of the work that will be performed by the project management teams and external contractors. Each Function is described below.

A description of OPG's Program Management System, which is a framework of controlled documents through which PRP objectives, plans, processes, roles, responsibilities and decision-making are documented, is set out in Attachment 1.

Exhibit D2-3-9 describes in greater detail the roles that the execution management and support functions will have in the Execution Phase, such as the Project Execution Support Function, Work Management Function, Functional Operations and Maintenance, and Planning and Controls Function.

3.2.1 Project Execution Support Function

This Function offers support across key work bundles, including (1) construction execution and field support, (2) quality management, (3) nuclear refurbishment project parts integration, and (4) program execution strategy. The activities in this Function are detailed further in Ex. D2-3-9.

3.2.2 Work Management Function

This Function is responsible for developing, monitoring, and controlling the integrated execution schedule. While each project and contractor is accountable for creating a valid and executable schedule, this Function validates these schedules and integrates them into the overall schedule. This Function ensures proper planning before execution, manages and controls unit scope, coordinates day-to-day work control and interface activities, resolves issues, initiates and oversee changes, and monitors and reports on risks, schedule status, and performance metrics. The activities in this Function are detailed further in Ex. D2-3-9.

3.2.3 Engineering Function

This Function has overall engineering and design authority and accountability for all work within the scope of the PRP, including all units while in their refurbishment state. Given that a significant portion of the plant modifications for the PRP will be executed by external contractors, an important aspect of the PRP is that this Function must authorize all associated permanent and temporary design changes. In doing so, this Function ensures that appropriate interfaces and oversight protocols are maintained throughout the design, procurement,

installation, commissioning and closeout processes to ensure compliance with design requirements. The group is organized into four departments:

- **Design Engineering** carries out the design authority role as delegated from the Chief Nuclear Engineer, which includes responsibilities for preparing, reviewing and approving all permanent and temporary design changes developed under OPG's Quality Assurance program. Design Engineering prepares and approves in-house design deliverables or collaborates with contractors to develop and accept contractor design deliverables. Design Engineering provides design completion assurance verification and review in accordance with design release of in-house modifications. Design Engineering provides inputs to project oversight plans to assure that engineering vendor partners are performing work in accordance with engineering change control as well as meeting design requirements and project scope. Design Engineering also includes support for procurement from the Procurement Engineering group, described as a distinct Function in Section 3.2.5 below.
- **Performance Engineering** is made up of System Engineering resources with matrix support from Components and Equipment, digital computer control and Major Components engineering departments. Performance Engineering initiates work requests and scope work orders and prepares need statements, scope of works and engineering change requests for PRP scope.
- **Components and Equipment Engineering** implements a component-based inspection program to assure the health of a select group of nuclear power plant components. The program consists of component inspection and testing as well as component health trending and aging management strategies to ensure the following considerations are addressed: nuclear reactor safety, production targets (reliability), compliance to regulatory standards and cost, conventional safety and environment.
- **Nuclear Safety Engineering** is described as a distinct Function in Section 3.2.4 below.

3.2.4 Nuclear Safety Function

This Function performs safety analysis, either directly or through the verification and/or acceptance of contracted nuclear safety analysis work. It also provides ongoing nuclear safety support for refurbishment-related regulatory issues. In addition, this Function provides nuclear safety support for safety improvement opportunities and the major work bundles, as well as

nuclear safety reviews of critical documents. This Function also ensures refurbishment work is completed in adherence with OPG's reactor safety program and risk and reliability program, including the management of refurbishment impacts on Pickering's operating policies and principles and probabilistic risk assessment.

3.2.5 Procurement Engineering Function

This Function involves pre-purchase technical review of items and services in order to establish purchasing and acceptance requirements that meet the design intent and to support plant operations in resolving technical issues related to purchases. Procurement Engineering provides services including assistance on design bill of materials, catalogue identifier creation and support to setting catalogue identifiers to ready for engineering vendor partners. Procurement Engineering collaborates with Design Engineering to update the master equipment list, bill of materials and engineering changes, and provides asset management system access to design service providers and performance quality assurance program selection adjustments.

3.2.6 Planning and Controls Function

This Function supports the PRP by establishing and applying project controls, such as cost management, reporting, and risk management, at both the Program and project levels. The Function applies industry best practices and recommendations to set standards. Specifically, its responsibilities include front-end planning, program-level scope control, project controls (including implementing a gated approval process for major work bundles), cost management, earned value management, forecasting, reporting, change control, and risk management. The Function also allocates funding for the information technology tools necessary for executing the refurbishment. As the PRP transitions from the Definition Phase to the Execution Phase, the focus will shift from establishing governance, tools, and processes to monitoring program performance through project controls, metrics, and reporting. Given its crucial role during the execution phase, its activities are also outlined in Ex. D2-3-9.

3.2.7 Managed System Oversight Function

This Function provides and coordinates performance assurance and oversight for the PRP-managed system. The oversight role includes managing the low-level reporting tool that enables OPG to track trends and implement corrective actions to address those trends. This involves conducting root cause analysis and introducing revised processes, training programs, or other measures as needed. The Function carries out oversight in accordance with the PRP's self-assessment plan and individual project oversight plans. Additionally, it coordinates and facilitates the oversight by OPG's internal audit group and all third parties, including the independent oversight for OPG's Board of Directors, namely, the Refurbishment Review Board, and the Ministry of Energy's oversight. See Ex. D2-3-9 for more information on the Pickering Oversight Assurance Framework.

Furthermore, this Function manages OPG's Nuclear Managed System, which is the governance framework and process support documentation implemented to manage all activities related to the PRP (see Attachment 1). One of the CNSC's conditions in the Power Reactor Operating License for Pickering requires OPG to comply with Canadian Standards Association N286, Management System Requirements for Nuclear Power Plants, in managing all aspects of its operations. The PRP Management System meets these Canadian Standards Association N286 requirements.

Additionally, this Function is responsible for monitoring the creation, revision, superseding, and obsolescence of controlled documentation and processes.

3.2.8 Supply Chain Function

This Function supports all procurement-related activities concerning the overall cost, schedule, and quality of the program, while providing oversight on procurement actions carried out by the Engineering, Procurement, and Construction contractors. The goals of this Function are to ensure: (1) cost certainty and the optimization of risk transfer for each contract, (2) value for money, and (3) that contractual commitments such as cost, quality and schedule are adhered to. Key responsibilities of this Function include awarding contracts through established procurement processes, assisting projects in identifying and assessing strategies for long-lead

and at-risk materials, ensuring compliance with relevant quality requirements and OPG policies in procurement processes, and overseeing contractor procurement activities using a risk-based approach.

3.2.9 Contract Management Function

This Function provides commercial support throughout the PRP by overseeing contract administration, ensuring consistency in the execution of agreements across projects, interpreting contract terms and conditions, developing contract management plans, facilitating change management processes, reviewing invoices, and monitoring compliance with contract requirements. It also tracks and reports on performance under master contracts, identifies commercial issues, and supports claims management and dispute resolution. Additionally, this Function focuses on establishing and maintaining strong commercial relationships with third-party contractors.

3.2.10 Program Fees and Other Support Function

This Function covers a diverse range of support to facilitate the execution of the PRP, including:

- Nuclear Refurbishment Finance organization;
- Nuclear Regulatory Affairs organization;
- CNSC fees, other licence fees and insurance costs for the PRP;
- Refurbishment Communications organization;
- Refurbishment Human Resources and Labour Relations organization; and
- other miscellaneous support costs, including information technology software fees.

3.2.11 Functional Operations and Maintenance

This Function is distinct from those set out above because it is both a functional and execution organization. This Function provides functional support to the major work bundles in respect of the unit(s) being refurbished and will also serves as the “custodian” of any operating unit(s) in the plant, as they return to service, by ensuring that the ongoing refurbishment work does not have any adverse impact. Importantly, this Function will serve as the “controlling authority” for the units undergoing refurbishment within the construction island. The Operations and

Maintenance Function will also plan and execute project work required to maintain the Pickering site throughout the refurbishment life cycle and operate as a Project Management team. As this Function plays a significant role during the Execution Phase, its activities are described in greater detail in Ex. D2-3-9.

PRP is leveraging a workforce strategy to blend OPG's existing workforce with contractor staff where appropriate. This strategy seeks to redeploy existing OPG operational staff with critical expertise and knowledge of the station to certain PRP work, such as radiation protection, maintenance and fuel handling. That strategy ensures timely access to sufficient and proficient labour to meet project schedules, fulfilling resource demands particularly during overlapping units, leverages skilled employees familiar with the station for safe and efficient execution, and mitigates the risk of potential labour shortages in the market. The PRP release quality estimate incorporates the cost and schedule benefits of this blended workforce strategy. Further description of this strategy is provided in Ex. D2-3-4, Section 2.3.

LIST OF ATTACHMENTS

Attachment 1: Program Management Governance Structure and Program Charter

Note: Program Charter included in Attachment 1 is marked “OPG Confidential”, however, OPG has determined it to be non-confidential in its entirety.

PROGRAM MANAGEMENT SYSTEM STRUCTURE AND PROGRAM CHARTER

An important component of OPG's role as Program owner is its program management system. The system is a controlled document framework for the Pickering Refurbishment Program ("PRP") through which program objectives, plans, processes, roles, responsibilities and decision-making are documented.

The overall structure of the program management system is described in a program management document entitled Pickering Refurbishment Program Structure (NK30-CHAR-09701-0001), which is included in this Attachment 1. This document establishes the framework for the Pickering Refurbishment Program Management Plans, which are a series of documents that describe how the PRP is organized to meet the intent of OPG's Nuclear Management System, while also establishing program-specific requirements. The Pickering Program Structure establishes the following hierarchy of documents:

- Tier 1 – the Pickering Refurbishment Program Charter ("Program Charter"), which is also included in this Attachment 1;
- Tier 2 - the Refurbishment Program Structure document and the Program Management Plans; and
- Tier 3 - numerous manuals, guides, instructions, plans, constructor/owner interface requirements and forms

ONTARIO POWER GENERATION

Program Charter

OPG Confidential

Document Number:
NK30-CHAR-09701-00001

Revision:
R000

Title:
PICKERING UNITS 5 TO 8 REFURBISHMENT

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The Project Charter describes the business vision and scope of the project as defined by the line of business. Sections 1.0 through 5.0 are mandatory. Sections 6.0 onwards are recommended however not compulsory. The sponsor should determine whether completion of these sections is required based on the project cost, complexity and needs.

General Project Information

Program Number:	N/A	**Program Level:**	S - Strategic
Program Name:	Pickering Refurbishment	**Facility/Site:**	PNGS
		Executing Org:	Pickering Refurbishment
		Sponsor:	Chief Projects Officer, Enterprise Projects

Program Charter Approval

Prepared by: Joanne Mercieca, Project Specialist	Joanne Mercieca 25Apr24
Reviewed by: Kevin Tse, Senior Manager Project Controls	Kevin Tse 25-Apr-24
Concurred by: Mehri Molanaie, Refurbishment Director Project Controls	M. Molanaie 25-Apr-24
Accepted by: John Blazanin, Vice President, Refurbishment Execution	25-April-24
Approved by: Subo Sinnathamby, Chief Projects Officer, Enterprise Projects **Project Sponsor**	26-April-24

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1.0 NEED BACKGROUND AND PROPOSAL

The IESO estimates that electricity demand in Ontario may more than double in upcoming years from current levels of system capacity, driven by electrification in the industrial, mining, agricultural and transportation sectors, and efforts to address climate change impacts.
In addition to the four Small Modular Reactors at the DNNP site, Pickering Units 5-8 provide the best alternative to meet Ontario's forecast electricity demand growth.

OPG's current CNSC approved licence states that the Pickering NGS 5-8 units will cease commercial operation by Dec 31, 2024. The generation loss of shutting down the four Pickering B units will result in the removal of approximately 2,100MW of emission free capacity annually to the electrical grid.

In September 2022, the Government of Ontario made two requests of OPG:

(a) Seek CNSC approval to continue operating Pickering's Units 5 through 8 to the end of September 2026 (if deemed safe).

(b) Conduct a feasibility assessment on the refurbishment of Pickering Units 5 – 8.

OPG undertook the task to complete a technical and economic assessment of refurbishing Pickering which included an assessment of regulatory requirements and risks commensurate with a project of this magnitude.

Based on OPG's assessment, refurbishment of Pickering Units 5-8 is the preferred alternative for the station to help meet Ontario's forecast electricity demand growth into the 2030s and beyond. The necessary studies and assessments undertaken in the Feasibility Assessment Report NK30-REP-09710-00005 [R1] determined that the PNGS Units 5-8 reactors can be safely and efficiently refurbished, addressing plant safety, reliability, regulatory requirements and outage/operating impacts. Additionally, Pickering Refurbishment provides significant environmental, societal, and economic benefits.

In August 2023, a recommendation was presented to the OPG Board and Shareholder for approval of the refurbishment of Pickering Units 5-8. The recommendation was approved by OPG's Board of Directors on August 11, 2023 and submitted to the Ministry of Energy for final approval which was granted by the Shareholder on January 30, 2024.

This Charter provides the summary of deliverables to complete the Refurbishment of Pickering units 5-8

1.1 Problem/Opportunity Statement

Table 1-1. Problem Statement

The problem:	Pickering Units 5-8 are to end commercial operation and go into safe storage state by December 2026. This will result in a loss of emission free generation for the province of Ontario
Affects/Impact:	Elimination of the generating capacity of the Pickering units affects the continued long-term supply of clean, economical, emission-free energy to the Ontario grid in a period of anticipated growth

A successful solution:	Refurbishment of Pickering Units 5-8, to enable long term operation for a minimum of 30 years. Successful execution of the refurbishment program would also enhance OPG's reputation as a world leader in the clean energy sector by demonstrating a robust and socially responsible plan for CANDU Refurbishment. This in turn supports and enables OPG's strategic plans for growth in new nuclear projects as well as contributing to achieving Net-Zero carbon goals in Ontario and Canada

1.2 Affected Business Drivers/Gap

The business driver for this project is to continue to provide approximately 2,100 MW of nuclear generation capacity to Ontario's electricity system. The original plan was to end commercial operations of Pickering units 5-8 in 2026. The IESO estimates that electricity demand in Ontario may more than double in 25 to 30 years from current levels of system capacity.

Pickering Refurbishment will result in another 30 years or more of emission-free, reliable energy production to the Ontario energy grid.

1.3 Preliminary Program Level (Cost and Complexity Assessment) and Gate Strategy

The Refurbishment program is categorized as a Strategic Project. Based on the complexity and estimated refurbishment program cost, this program and the underlying projects are classified as Scalability Level A.

1.3.1 Program Funding/Gating Release Strategy

Funding for the Pickering Refurbishment Program (PRP) will be released in phases using a gating methodology. i.e. The program will progress from one phase to the next after completing specific deliverables and updating cost and schedule estimates. Approvals, including a release of funds, are required to proceed to the next phase. This release strategy assumes a Q1 2027 start of Unit 5 construction pre-requisites with a year end 2030 unit in-service milestone.

Funding Release Plan:

Program Release	Applicable Gates	Scope	TCD
Release #1A-1	Bundle Gate 1	• Procurement of Major Long Lead Materials for U5/U6 • Completion of Scope Refinement • Advancement of Preliminary Engineering	Jan-24
Release #1A-2	Bundle Gate 2	• Procurement of materials for U5/U6 • Procurement of all materials for U7/U8 • Completion of Detailed Design	Nov-24
Release #1B RQE	Bundle Gate 2/ Gate 3	• Completion of Installation/Work Planning • Execution of Facilities, Defueling, U5/U6 Layup, and selected common work	Nov-25

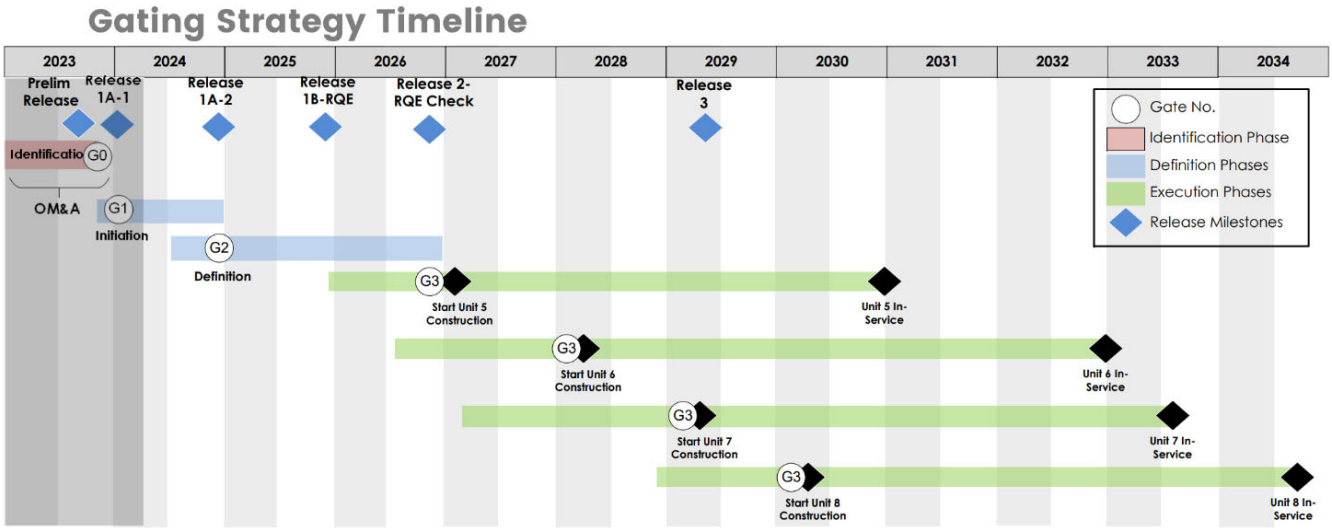
Program Release	Applicable Gates	Scope	TCD
Release #2-RQE check	Bundle Gate 3	• Full execution and close out of U5 and U6 (T/G, BOP, RFBR. SGs) • Execution of U7 T/G • Execution of U7/U8 Layup	Nov-26
Release #3	Gate 3	• Full execution and Close out of U7 and U8	May 29

1.3.2 Program Gating Strategy

A gate is a key decision and control point that occurs before the next phase begins. The gate represents a logical point at which senior management can determine whether and how to proceed. Gates also provide an opportunity to assess performance to date and to alter the course of a project and take remedial actions as necessary.

Each project in the Refurbishment program will follow the processes documented in OPG-MAN-00120-0019 Project Phase-Gate Management Strategy [R2] to acquire funding releases.

The Gating strategy for the PRP is demonstrated below:



2.0 PROGRAM OBJECTIVES (CRITICAL SUCCESS FACTORS)

Program objectives are to:

- Obtain the necessary corporate, government and regulatory approvals (e.g. Environmental Assessments, Integrated Safety Review, and Integrated Improvement Plan) for refurbishment in a timely and cost effective manner.
- Set the targets for a safe, scientifically-sound, sustainable, and fiscally responsible refurbishment plan.

- Execute front-end planning engaging Fit for Purpose strategies to develop cost, schedule, and resource targets for functional and project elements, including a full risk assessment.
- Establish contracts that incentivizes vendors collaboration and performance to execute the program including material supply, engineering, training, installation, commissioning for each of the underlying projects.
- Manage the pre-execution planning and preparation activities for the refurbishment scope.
- Execute the refurbishment work program.
- Complete all work and return units to service by mid-2030's.

2.1 Scope

The key scope items for refurbishment will include:

- Replacement of all Feeders and Fuel Channels
- Replacement of all Boilers
- Replacement and upgrades of the bulk of the Turbine & Generator centreline & auxiliary equipment and controls upgrade
- Re-design of the station's water intake structure
- Replacement of select Fuel Handling equipment and enhancement of maintenance capabilities
- Replacement and modifications of various Balance of Plant systems and equipment including Digital Control Computers, Main Power Output Transformers, Standby Generators and Emergency Power Generator #3
- Station modifications to further improve plant safety based on modern Laws (e.g., licensing requirements), Regulations, Codes, and Standards
- Facilities and infrastructure upgrades to support refurbishment activities.

A Project Scope Review Board is in place for approving original, new or modified scope. Reference NK30-PLAN-09701-10003 Pickering Refurbishment - Program Scope Review Board Terms of Reference [R3].

A Change Control Board with supporting governance will be established to manage cost, schedule, and scope baseline changes.

2.2 Critical Success Factors (Target Performance)

Table 2-1. Critical Success Factors

ID	Success Factor	Success Indicator
1.	All Major Components Order placed June 2024	Contracts awarded to Major Component vendors
2.	Licence Amended July 2026 (as required)	If required, would provide regulatory certainty to proceed with refurbishment scope prior to the final licence approval scheduled in 2028
3.	Unit 5 Construction start February 2027	Unit 5 de-fuelling complete, TG and Boiler Replacement start
4.	Pickering Units 5 to 8 In Service mid 2030s	Refurbishment scope is executed event free, on time and within the allocated budget.

3.0 PROGRAM MANAGEMENT PROCESSES

The Pickering Refurbishment Program will perform work in accordance with this charter which is developed following the principles of N-POL-0001, Nuclear Safety and Security Policy [R4] and N-CHAR-AS-0002, Nuclear Management System [R5], and meets the requirements of CSA N286 [R16].

OPG-PROG-0039, Project Management [R6], and its associated implementing standards, provide the principles and requirements for planning, organizing, executing, and controlling resources to ensure safe and effective execution and completion of the Refurbishment program. Safety and quality of work shall be the overriding priority and will not be compromised for cost or schedule.

A suite of Program Management Plans describing the high-level business level requirements and processes that will deliver the program benefits will be created. They take their authority from this program charter.

Project Management Plans will be prepared to describe how each project in the Program will develop and execute its work scope.

Refer to Appendix A for structure mapping.

4.0 COMMITMENTS, CONSIDERATIONS

For detailed information on the reviews performed for Regulatory, Environmental and Safety considerations for the Refurbishment program, refer to NK30-REP-09710-1255849 Pickering Refurbishment Feasibility - Licencing Basis Document [R7].

Additional studies will likely be required to further evaluate, validate, and refine scope during the project Definition Phase in support of regulatory and environment considerations of the program.

4.1 Regulatory Commitments

The program regulatory strategy focuses on compliance with REGDOC-2.3.3. (Periodic Safety Reviews) [R14] and REGDOC-2.9.1. (Environmental Protection) [R15] as required by the PNGS License Condition Handbook.

Regulatory commitments and the licensing approach will be further developed during the definition phase.

4.2 Safety Considerations

☑ No **additional safety considerations.**

The PRP will perform work in accordance with the managed systems defined in

- OPG-POL-0032, Safe Operations Policy, [R8]
- OPG-POL 0001 Employee Health and Safety Policy [R9]
- N-POL-0001, Nuclear Safety and Security Policy, [R4]
- N-CHAR-AS-0002, Nuclear Management System, [R5]

Any additional direction will be supplied in individual Program Management Plans. Listing of PgMPs is in Appendix A.

☐ Yes**, additional safety considerations (provide details).**

4.3 Environmental Considerations

☑ **No, environmental impact assessment is NOT required for the project.**

The Refurbishment Program will adhere to the obligations outlined in OPG-POL-0021, Environmental Policy [R10]

OPG previously explored Pickering B Refurbishment in the mid-2000s and as part of those activities, completed an Environmental Assessment (EA) in 2007. The EA concluded that a refurbishment project is not likely to cause significant adverse environmental effects and the CNSC agreed with that conclusion.

In accordance with REGDOC-2.9.1 [R15], an Environmental Risk Assessment (ERA) is required as a minimum, every 5 years or when a significant change occurs (or for planned activities). CSA N288.4, N288.5 and N288.6 standards establish the requirement for environmental and effluent monitoring programs and ERAs.

OPG will complete a new ERA to support potential licence amendments and the future 2028 relicensing submission for refurbishment and continued operations of PNGS and the NSS Pickering Waste Management Facility.

☐ **Yes, environmental impact assessment IS required for the project.**

5.0 MAJOR MILESTONES

Table 4-1. Program Major Milestones

The Unit Synchronized to Grid dates in the table below are tentative dates and subject to change. Final dates will be established as part of the definition phase planning and the program Release Quality Estimate.

Name	Deliverable	Date
Pickering B Shut Down	Units in shutdown state (GSS)	October 2026
Unit 5 Return to Service	Unit Synchronized to Grid	December 2030
Unit 6 Return to Service	Unit Synchronized to Grid	December 2032
Unit 7 Return to Service	Unit Synchronized to Grid	July 2033
Unit 8 Return to Service	Unit Synchronized to Grid	August 2034

6.0 RIGHTS HOLDERS AND STAKEHOLDER SUMMARY

Rights Holders:

- Indigenous Communities with interests in the site,

Stakeholders of the Pickering Refurbishment Program include:

- All levels of government (Province of Ontario, Pickering and Durham Region, Federal Government),
- OPG Pickering Nuclear Generating Station and Supporting Organizations
- Canadian Nuclear Safety Commission (CNSC)
- The general public (particularly residents and businesses in close proximity to the Pickering site),
- Ontario Power Authority (OPA), Independent Electricity System Operator (IESO), and Hydro One,
- Nuclear Waste Management Organization,
- Nuclear suppliers of goods and services.

Comprehensive stakeholder management plans will be available in individual Program and Project Management Plans.

7.0 RESOURCING (PROGRAM TEAM)

See Appendix B for the current Refurbishment organizational structure.
The chart below provides a high-level overview of the Refurbishment Program organization.

Detailed roles and responsibilities for station staff are documented in the N-MAN-08131-10000 [R11] series.

Table 7-1. Program Team

Role	Name/Title	Responsibilities
PN Refurbishment	John Blazanin VP Refurbishment Execution	Accountable for execution of the program, ensuring objectives and scope of work are delivered with quality, on schedule, within budget and safely
PN Refurb Ops & Mtce	Shawn David, Project Director Ops & Mtce	Ensure plans, procedures and qualified staff are in place to support & execute refurbishment activities
Retube and Feeder Replacement (RFR)	Samad Kasaai Director, RFR	Accountable for all project activities within the RFR scope. Provide oversight and leadership to project teams.
Turbine Generator	Brad Dennis Director TG Replacement	Accountable for all project activities within the Turbine Generator scope. Provide oversight and leadership to project teams.
Balance of Plant and Boiler Replacement	Pejman Asgaripour Director Projects	Accountable for all project activities within the Balance of Plant and Boiler Replacement scope. Provide oversight and leadership to project teams.
Planning & Controls	Mehri Molanaie Director Project Controls	Accountable for front-end planning of the program and associated projects, providing oversight and guidance as required. Monitor cost, schedule against approved work program
PN Refurb Engineering	Stephen Strickland Director, Engineering	Accountable for ensuring engineering and technical support services are provided to the program
PN Controllership	Derek Kindon, Director Controllership	Provide financial oversight and supports finance approval
PN Commercial - Darlington Refurbishment	Dennis Li Director Commercial Management	Support strategic and major contracts for execution of the PRP
PN Reg Affairs Strategy	Kristina Bramma Director, Reg Affairs	Provide oversight of the regulatory interface, compliance with regulatory requirements and regulatory issue resolution
EPO & Strategic Projects	Paul Mascarin Director, Supply Chain	Approve procurement strategy, ensure the integrity of OPG is managed to ensure the Code of Business Conduct and Supplier Code of Conduct is upheld and all suppliers and proponents are treated fairly, ethically and responsibly
Pickering Refurbishment	Reza Asadikia Director, Construction Services Execution	Accountable for providing construction planning support, and oversight during installation for contract adherence and safety issues.
Human Resources	Sandy Strecker, Manager Human Resources	Accountable for the definition, implementation and continual improvement of the Staffing Plan for the PRP

8.0 PROGRAM BOUNDARIES

Each Project Management Plan developed for the projects within the Refurbishment scope will list the Boundaries specific to the individual project.

Listed below are Overall Program Boundaries that potentially impact all or several of the individual projects and/or the program as a whole:

8.1 Assumptions

Table 8-1. Assumptions

ID	Description	Impact if Assumption is Invalid
1.	Any changes to the safety report and/or design basis will be considered in the Business Case only if imposed by the PSR, EA or other regulatory requirements or if approved by the Refurbishment program's Scope Review Board.	This could change the scope of the refurbishment program and thus the basis for the recommendation in the Feasibility Report could be incorrect.
2.	The refurbishment focuses on replacing the known age limiting components and equipment in the execution phase. The maintenance or replacement of other equipment should be part of the thirty-year life cycle plan for the station.	If additional equipment added the Refurbishment scope may significantly alter the basis for the recommendations in the Feasibility Report.
3.	The Clean Electricity Investment Tax Credit (ITC) for the project will be eligible through to 2034	Changes to the LCOE assumptions could impact the economic benefits of the program.
4.	Refurbishment of Pickering Units 5-8 start of execution will be dependent on regulatory approval and long lead materials availability. The units may need be placed in a Safe Storage condition prior to refurbishment if there are delays in either approval or materials availability.	The basis for the recommendation in the Feasibility Report, including the risk and economic analysis, could be impacted.
5.	Staggered start of removal phase on each of the four units to benefit from efficiencies in resources and equipment progressing from one unit to the next	Increased cost and schedule including delays to interfacing projects, additional equipment and reduced opportunity for unit to unit improvement.

8.2 Constraints

Table 8-2. Constraints

ID	Description	Impact of Constraint
1.	Government Approval of the Program	Government direction may change resulting in cancellation or scope reduction of program
2.	Licence approved by CNSC	Delay of approval my result in additional scope and impact the program schedule.

8.3 Dependencies

Table 8-3. Dependencies

ID	Description	Impact If Dependency Fails
1.	Two large elements in the cost model for the entire Fuel Channel and Boiler Replacement program will be the cost of tooling and equipment, and the direct cost of field labour	Misalignment between design and tooling/equipment will impact the cost of field labour
2.	Current site infrastructure has common elements to both Pickering A and Pickering B. These common elements will need to be separated to support Refurbishment activities as well as Pickering B future operations - Electrical grid, Information Technology Services, Roadways, Sites Services	Additional costs to program if site infrastructure is not sufficient or maintained to support Refurbishment activities
3.	Indigenous Relations - Duty to consult	Could result in changes to Refurbishment program scope and/or timeline
4.	NSS Waste Management – Pickering Contaminated Waste Building capacity to store refurb waste	Additional storage requirements may impact cost and schedule of refurbishment

8.4 Risks

Table 8-4. Risks

ID	Description	Impact If Risk Occurs
1.	Increased operational goals/parameters - The feasibility of meeting the station operational goals is based on future operations under similar reactor parameters	If power uprate is pursued, changes in operational parameters will necessitate analysis within the Definition Phase to confirm expected end of life
2.	Refurbishment Licence not issued	If the Licence renewal application is not approved in 2028, this would result in a delay to proceeding with P58 construction and corresponding delays to the planned return to service of the units.
3.	Impact Assessment Required - 2019 Impact Assessment Act	OPG has concurrence from the CNSC that the Pickering Refurbishment Project would follow the Nuclear Safety and Control Act's environmental protection review and is not subject to the IAA or any other appliable EA legislation. In future if it is decided that an assessment is required, it would result in significant impact to success of the program in increased cost/schedule delays.
4.	IFB Capacity - there is a risk that removing existing fuel to dry storage will not be able to be completed prior to restarting the first unit with sufficient space per the operating licence.	Securing additional storage facilities will impact program cost and schedule
5.	Technical complexity, changes for new or modified design because of OPEX, condition assessments, inventory assessments, or interface obstacles	If design modifications are significant, procurement of specialized material may impact approved program cost and schedule. Complexity may require greater engineering and planning efforts than currently anticipated

ID	Description	Impact If Risk Occurs
6.	Procurement risk – For many of the required components there are limited qualified, experienced manufacturers available. Example: Boilers are supplied by one company for multiple sites.	Delays in material manufacture/delivery, critical path progression/ reliance on materials, resulting in cost increases and increased schedule durations.
7.	Schedule Compliance - with all units offline together, a schedule delay in one unit can cascade into the others	Extended overlapping units may result in increased costs and productivity losses.
8.	Changes for new or modified design because of OPEX, condition assessments, inventory assessments, or interface obstacles	Increased program costs and schedule durations
9.	Availability of skilled trades and knowledge-based workers	Increased program costs and schedule durations
10.	Resources to support relicensing activities for Pickering Units 5-8 refurbishment may pose challenges to the refurbishment schedule due to overlapping initiatives within OPG.	Increased program costs and schedule durations

9.0 TECHNICAL CONSIDERATIONS

Technical considerations of extending the service life of Pickering were included in the Feasibility assessment performed following the September 2022 request by the Ministry of Energy

The following areas were evaluated to identify potential required scope to support life extension, either to be executed prior to, during or post-Refurbishment:

- Major Components (Fuel Channels, Feeders, Boilers, etc.).
- Station Systems, Structures, and Components (SSCs), 54 System Condition Assessments completed.
- Resiliency to potential impacts of Climate Change.
- Modern laws, regulatory requirements, codes & standards important to the safe operation of a nuclear power plant.

The technical reviews completed confirmed there is high confidence that Pickering Refurbishment and the long-term operation of Units 5-8 is feasible through the completion of key scope items. The replacement of life-limiting elements (i.e., Fuel Channel assemblies and Boilers) will support an additional 300,000 EFPH which corresponds to 38 years of operation at an assumed 90% Capacity Factor.

There is potential for increased unit power output as a result of efficiencies being gained from the Turbine / Generator centerline component replacements (up to 36MW/unit, depending on design capabilities). This incremental generation is to be confirmed upon further analysis in the Definition phases of the projects.

In addition, implementation of a deep-water intake will support improved water conditions / thermal performance, and potential exists for increases in reactor thermal power for additional MW output.

Turbine Generator and water intake scope are part of the reference scope for Pickering Refurbishment while increase of reactor power is undergoing further study to confirm feasibility and was not included in the feasibility study base case.

NK-30-REP-09710-00002 Pickering Refurbishment Retube and Feeder Replacement Feasibility Assessment [R12] was completed in June 2023. This assessment analyzed the OPEX from successful Fuel Channel Replacement Programs on 12 CANDU reactors world-wide. An assessment was conducted of the Darlington Refurbishment Program and the proposed Pickering program based on the differences between the reactor design, internal layout of the Reactor Building, radiological conditions, and available facilities on and off site.

Full-scale fuel channel replacement of Pickering A Units 1-4 was successfully completed in 1984. The replacement of all fuel channels and feeders on Pickering B will follow more than a dozen similar campaigns conducted on all classes of CANDU reactors over the prior 40 years.

Reference NK30-REP-09701-00006 Pickering Units 5-8 Refurbishment - Technical Feasibility Summary Report [R13]

10.0 ACRONYMS

CANDU	CANada Deuterium-Uranium [Reactor]
CNSC	Canadian Nuclear Safety Commission
DNNP	Darlington New Nuclear Project
EA	Environmental Assessment
EFPH	Effective Full Power Hours
ERA	Environmental Risk Assessment
MW	MegaWatts
NGS	Nuclear Generating Station
NR	Nuclear Refurb
NSS	Nuclear Sustainability Projects
OPEX	Operating Experience
OPG	Ontario Power Generation
P5-8	Pickering B units 5-8

P'A'	Pickering A - units 1-4
PNGS	Pickering Nuclear Generating Station
PRP	Pickering Refurbishment Program
PSR	Periodic Safety Review
RFR	Retube & Feeder Replacement
RQE	Release Quality Estimate
SSC	Station Systems, Structures, and Components

11.0 REFERENCES

[R 1] NK30-REP-09701-00005 – Pickering Units 5-8 Feasibility Assessment Final Report

[R 2] OPG-MAN-00120-0019 Project Phase-Gate Management

[R3] NK30-PLAN-09701-10003 Pickering Refurbishment - Program Scope Review Board Terms of Reference

[R 4] N-POL-0001, Nuclear Safety and Security Policy

[R 5] N-CHAR-AS-0002, Nuclear Management System

[R 6] OPG-PROG-0039, Project Management

[R 7] NK30-REP-09710-1255849 Pickering Refurbishment - Licensing Basis Document

[R 8] OPG-POL-0032, Safe Operations Policy,

[R 9] OPG-POL 0001 Employee Health and Safety Policy

[R10] OPG-POL-0021, Environmental Policy

[R11] N-MAN-08131-10000-Sheets – Accountabilities for Station Staff

[R12] NK-30-REP-09710-00002 PR Retube and Feeder Replacement Feasibility Assessment

[R13] NK30-REP-09701-00006 Pickering Units 5-8 Refurbishment - Technical Feasibility Summary Report

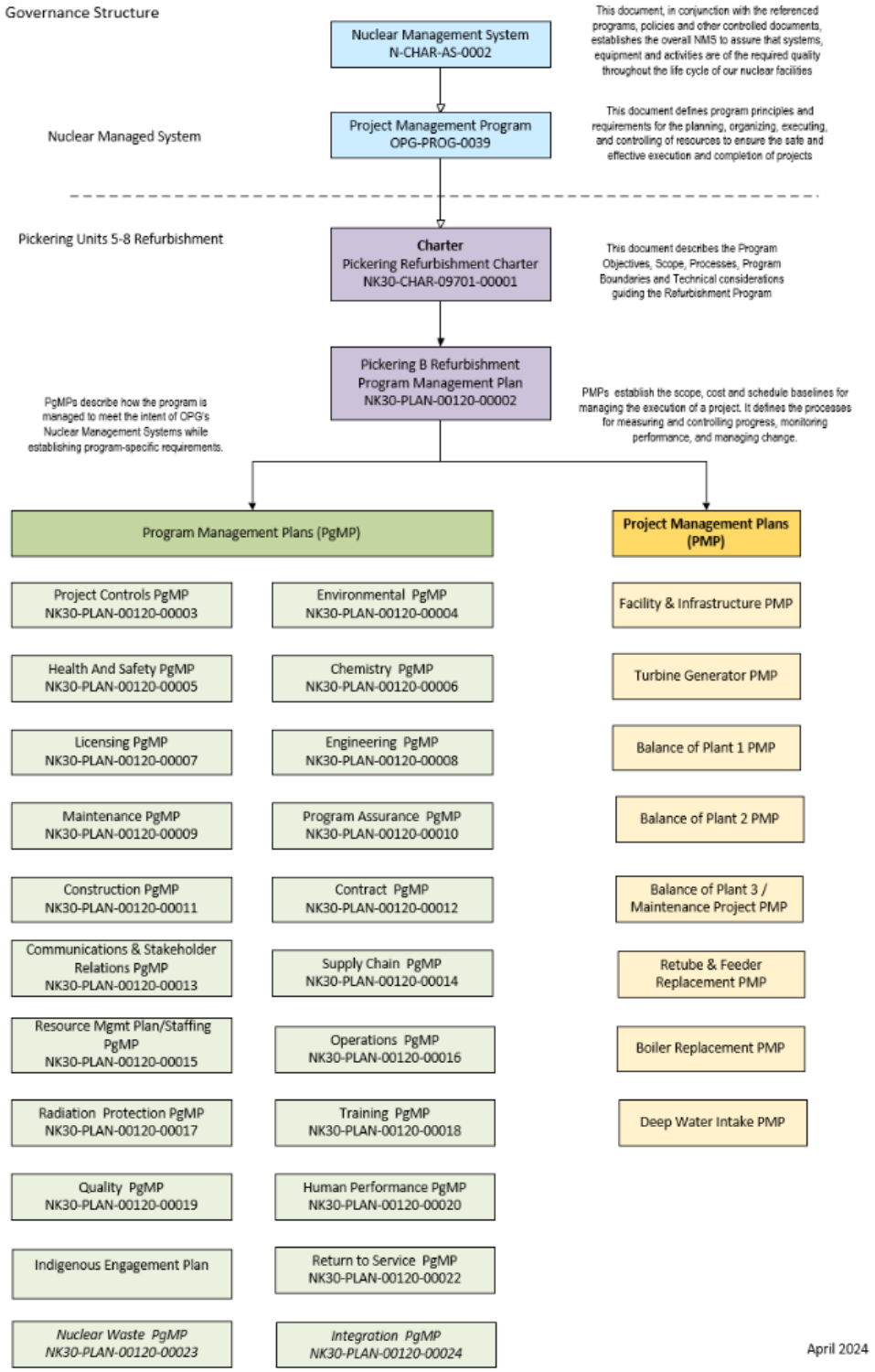
[R14] REGDOC-2.3.3. Periodic Safety Reviews

[R15] REGDOC-2.9.1. Environmental Protection

[R16] N286 Management System Requirements for Nuclear Power Plants

APPENDICES

Appendix A: Pickering Refurbishment Program governance framework



Program Charter

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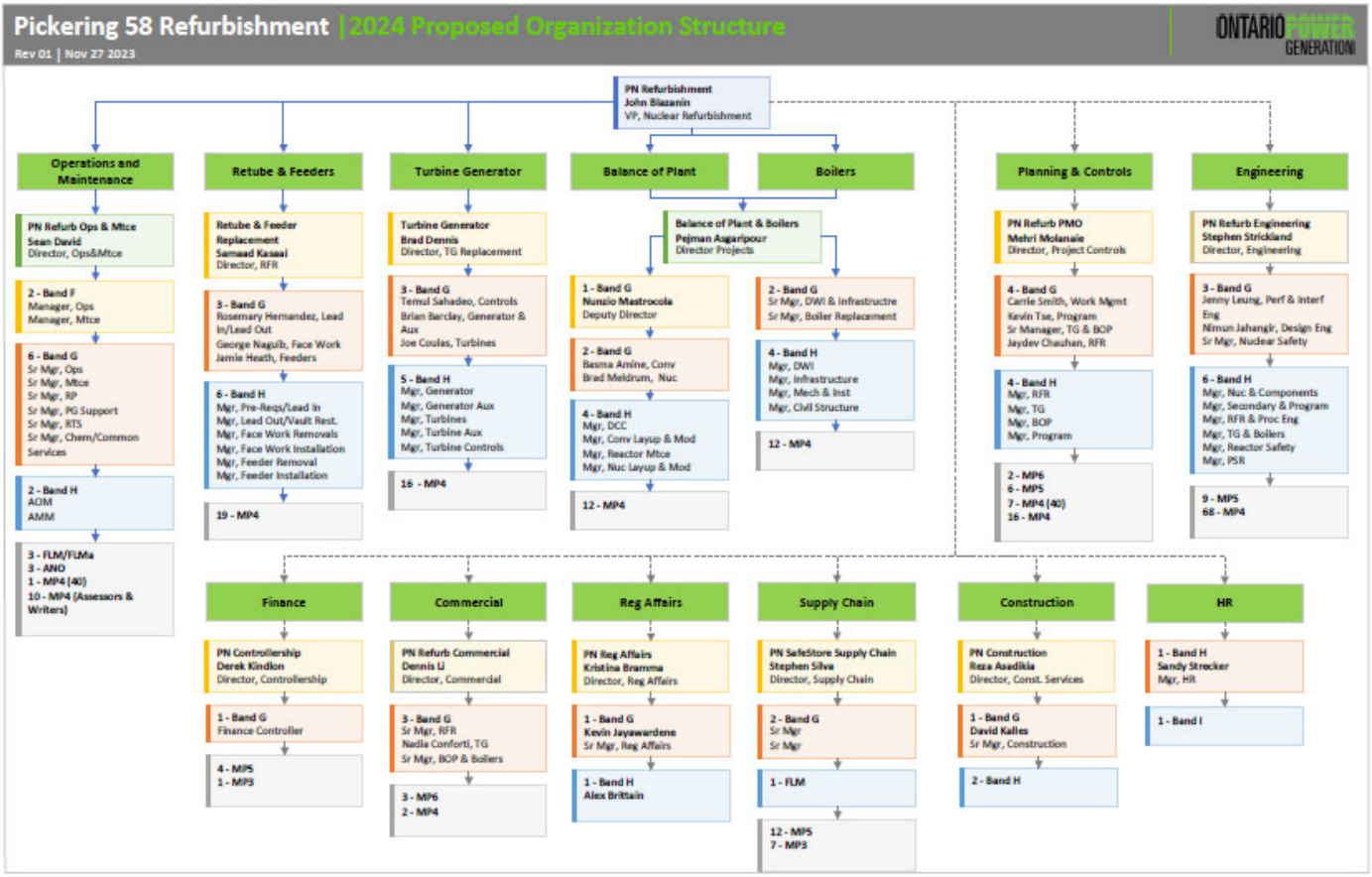
Title:
PICKERING UNITS 5 TO 8 REFURBISHMENT

Appendix B: Organizational Structure

This organizational chart provides a high level overview of the NR organization and also identifies the key functions and roles that provide direct service or support to the Refurbishment Program.



Pickering Refurbishment Program Governance Structure

Nuclear Managed System

Pickering Refurbishment Project

Nuclear Management System
N-CHAR-AS-0002

Project Management Program
OPG-PROG-0039

Pickering Refurbishment Charter
NK30-CHAR-09701-00001

PRP Program Management Plan
NK30-PLAN-00120-00002

Program Management Plans

- PRP Project Controls PgMP
  NK30-PLAN-00120-00003
- Chemistry Program Management Plan
  NK30-PLAN-00120-00006
- Program Assurance Program Management Plan
  NK30-PLAN-00120-00010
- Communications And Stakeholder Relations Program Management Plan
  NK30-PLAN-00120-00013
- Operations Program Management Plan
  NK30-PLAN-00120-00016
- PICKERING B REFURBISHMENT WORK MANAGEMENT PROGRAM MANAGEMENT PLAN
  NK30-PLAN-00120-00021
- Fire Protection PgMP
  NK30-PLAN-00120-10010
- Risk PgMP
  NK30-PLAN-00120-10014
- Pickering Indigenous Engagement Plan
  P-PLAN-07722.051-00001
- Environmental Program Management Plan
  NK30-PLAN-00120-00004
- Licensing Program Management Plan
  NK30-PLAN-00120-00007
- Construction Program Management Plan
  NK30-PLAN-00120-00011
- Supply Chain Program Management Plan
  NK30-PLAN-00120-00014
- Quality Program Management Plan
  NK30-PLAN-00120-00019
- Return To Service Program Management Plan
  NK30-PLAN-00120-00022
- Security Program Mgmt Plan
  NK30-PLAN-00120-10011
- Capacity and Resource Management Program Management Plan
  NK30-PLAN-00120-10015
- Health And Safety Program Management Plan
  NK30-PLAN-00120-00005
- Engineering Program Management Plan
  NK30-PLAN-00120-00008
- Contract Program Management Plan
  NK30-PLAN-00120-00012
- Resource Management And Staffing Plan
  NK30-PLAN-00120-00015
- Human Performance Program Management Plan
  NK30-PLAN-00120-00020
- Integration PgMP
  NK30-PLAN-00120-00024
- Performance Improvement PgMP
  NK30-PLAN-00120-10012
- Nuclear Waste PgMP
  P-PLAN-00120-00006

Project Management Plans

- Turbine Generator Project Management Plan
  NK30-PMP-41000-00001
- RETUBE, FEEDER, AND BOILER REPLACEMENT (RFBR) PROJECT MANAGEMENT PLAN
  NK30-PMP-09701-00005
- Pickering Refurbishment Balance Of Plant Program Management Plan
  NK30-PLAN-001200-00027
- Deep Water Intake
  NK30-PMP-09701-00007
- Engineering Functional Mgmt Plan
  NK30-PLAN-00120-00025
- Front End Engineering & Advancement of Procurement
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- PNGS Campus Plan
  P_PLAN_P-PLAN-00120-00003_000
- DWI and Site Improvements Modifications PMP
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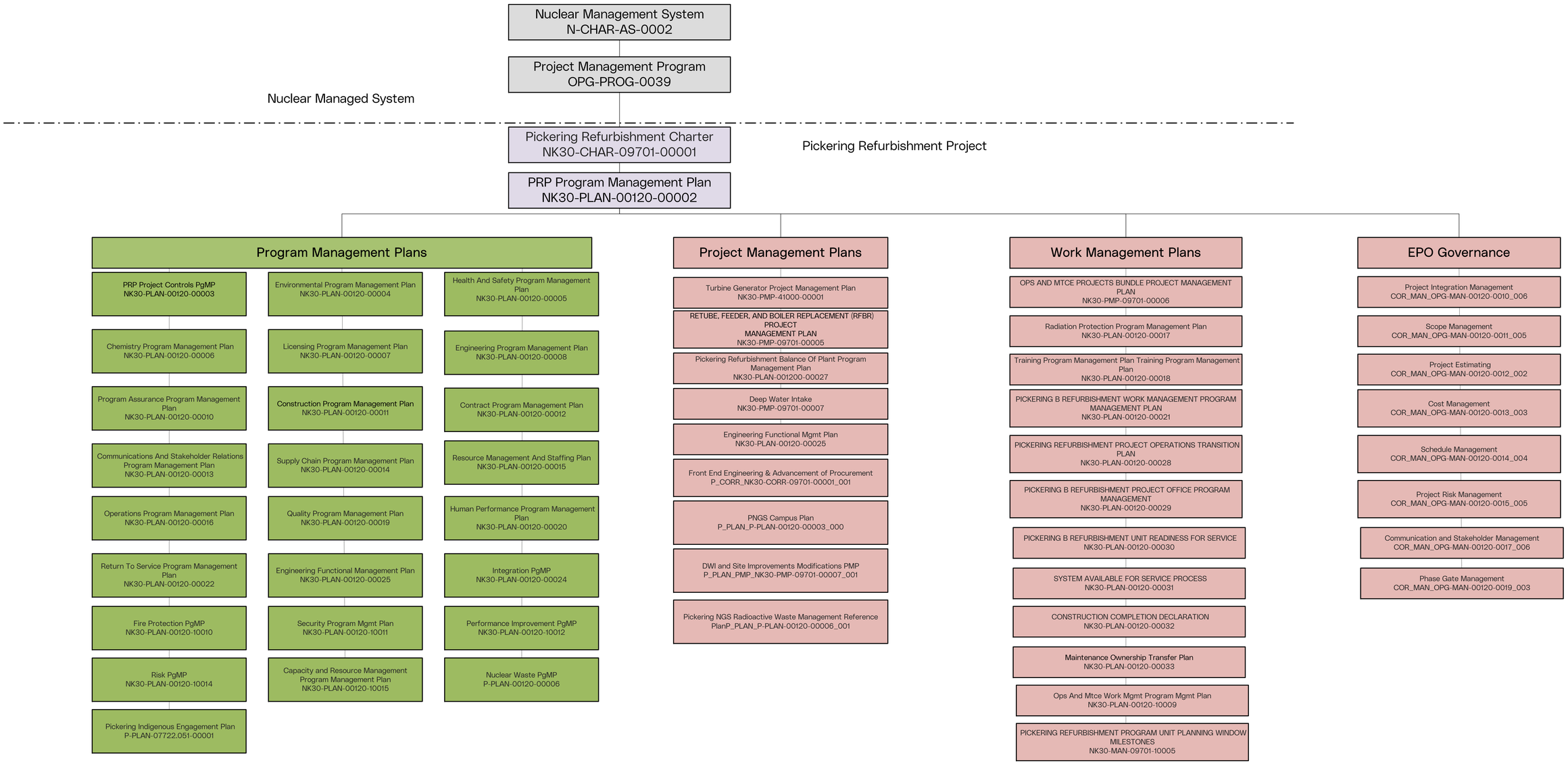
- Pickering NGS Radioactive Waste Management Reference PlanP_PLAN_P-PLAN-00120-00006_001

- Engineering Functional Management Plan
  NK30-PLAN-00120-00025

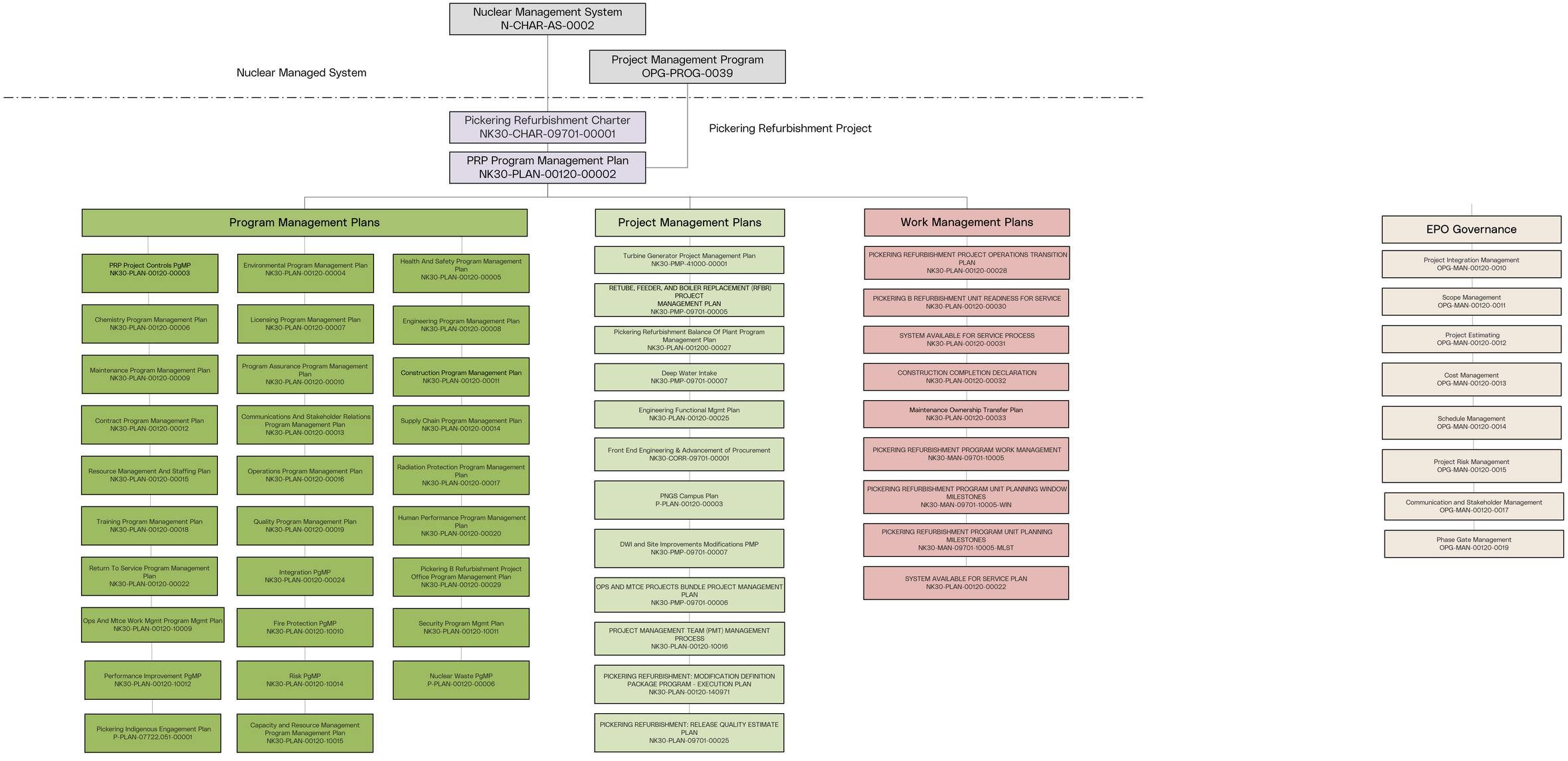
Work Management Plans

- OPS AND MTCE PROJECTS BUNDLE PROJECT MANAGEMENT PLAN
  NK30-PMP-09701-00006
- Radiation Protection Program Management Plan
  NK30-PLAN-00120-00017
- Training Program Management Plan Training Program Management Plan
  NK30-PLAN-00120-00018
- PICKERING B REFURBISHMENT WORK MANAGEMENT PROGRAM MANAGEMENT PLAN
  NK30-PLAN-00120-00021
- PICKERING REFURBISHMENT PROJECT OPERATIONS TRANSITION PLAN
  NK30-PLAN-00120-00028
- PICKERING B REFURBISHMENT PROJECT OFFICE PROGRAM MANAGEMENT
  NK30-PLAN-00120-00029
- PICKERING B REFURBISHMENT UNIT READINESS FOR SERVICE
  NK30-PLAN-00120-00030
- SYSTEM AVAILABLE FOR SERVICE PROCESS
  NK30-PLAN-00120-00031
- CONSTRUCTION COMPLETION DECLARATION
  NK30-PLAN-00120-00032
- Maintenance Ownership Transfer Plan
  NK30-PLAN-00120-00033
- Ops And Mtce Work Mgmt Program Mgmt Plan
  NK30-PLAN-00120-10009
- PICKERING REFURBISHMENT PROGRAM UNIT PLANNING WINDOW MILESTONES
  NK30-MAN-09701-10005

Pickering Refurbishment Program Governance Structure



Pickering Refurbishment Program Governance Structure



Pickering Refurbishment Program Governance Structure

The Charter, in conjunction with the referenced programs, policies and other controlled documents established the overall NIMS to assure that systems, equipment and activities are of the required quality throughout the life cycle of our nuclear facilities

Nuclear Management System
N-CHAR-AS-0002

Project Management Program
OPG-PROG-0039

This document defines the program principles and requirements for the planning, organizing, execution and control of resources to ensure the safe and effective execution and completion of projects

Nuclear Managed System

Pickering Refurbishment Project

This document describes the Program Objectives, Scope, Processes, Program Boundaries and Technical considerations guiding the Refurbishment Program

Pickering Refurbishment Charter
NK30-CHAR-09701-00001

PRP Program Management Plan
NK30-PLAN-00120-00002

PgMPs describe how the program is managed to meet the intent of OPG's Nuclear Management Systems while establishing program-specific requirements

PMPs establish the scope, cost and schedule baselines for managing the execution of a project. It defines the processes for measuring and controlling progress, monitoring performance and managing change

Program Management Plans

- PRP Project Controls PgMP NK30-PLAN-00120-00003
- Chemistry Program Management Plan NK30-PLAN-00120-00006
- Maintenance Program Management Plan NK30-PLAN-00120-00009
- Contract Program Management Plan NK30-PLAN-00120-00012
- Resource Management And Staffing Plan NK30-PLAN-00120-00015
- Training Program Management Plan NK30-PLAN-00120-00018
- Return To Service Program Management Plan NK30-PLAN-00120-00022
- Ops And Mtce Work Mgmt Program Mgmt Plan NK30-PLAN-00120-10009
- Performance Improvement PgMP NK30-PLAN-00120-10012
- Pickering Indigenous Engagement Plan P-PLAN-07722.051-00001
- Environmental Program Management Plan NK30-PLAN-00120-00004
- Licensing Program Management Plan NK30-PLAN-00120-00007
- Program Assurance Program Management Plan NK30-PLAN-00120-00010
- Communications And Stakeholder Relations Program Management Plan NK30-PLAN-00120-00013
- Operations Program Management Plan NK30-PLAN-00120-00016
- Quality Program Management Plan NK30-PLAN-00120-00019
- Integration PgMP NK30-PLAN-00120-00024
- Fire Protection PgMP NK30-PLAN-00120-10010
- Risk PgMP NK30-PLAN-00120-10014
- Capacity and Resource Management Program Management Plan NK30-PLAN-00120-10015
- Health And Safety Program Management Plan NK30-PLAN-00120-00005
- Engineering Program Management Plan NK30-PLAN-00120-00008
- Construction Program Management Plan NK30-PLAN-00120-00011
- Supply Chain Program Management Plan NK30-PLAN-00120-00014
- Radiation Protection Program Management Plan NK30-PLAN-00120-00017
- Human Performance Program Management Plan NK30-PLAN-00120-00020
- Pickering B Refurbishment Project Office Program Management Plan NK30-PLAN-00120-00029
- Security Program Mgmt Plan NK30-PLAN-00120-10011
- Nuclear Waste PgMP P-PLAN-00120-00006

Project Management Plans

- Turbine Generator Project Management Plan NK30-PMP-41000-00001
- RETUBE, FEEDER, AND BOILER REPLACEMENT (RFBR) PROJECT MANAGEMENT PLAN NK30-PMP-09701-00005
- Pickering Refurbishment Balance Of Plant Program Management Plan NK30-PLAN-001200-00027
- Deep Water Intake NK30-PMP-09701-00007
- Engineering Functional Mgmt Plan NK30-PLAN-00120-00025
- Front End Engineering & Advancement of Procurement NK30-CORR-09701-00001
- PNGS Campus Plan P-PLAN-00120-00003
- DWI and Site Improvements Modifications PMP NK30-PMP-09701-00007
- OPS AND MTCE PROJECTS BUNDLE PROJECT MANAGEMENT PLAN NK30-PMP-09701-00006
- PROJECT MANAGEMENT TEAM (PMT) MANAGEMENT PROCESS NK30-PLAN-00120-10016
- PICKERING REFURBISHMENT: MODIFICATION DEFINITION PACKAGE PROGRAM - EXECUTION PLAN NK30-PLAN-00120-140971
- PICKERING REFURBISHMENT: RELEASE QUALITY ESTIMATE PLAN NK30-PLAN-09701-00025

Work Management Plans

- PICKERING REFURBISHMENT PROJECT OPERATIONS TRANSITION PLAN NK30-PLAN-00120-00028
- PICKERING B REFURBISHMENT UNIT READINESS FOR SERVICE NK30-PLAN-00120-00030
- SYSTEM AVAILABLE FOR SERVICE PROCESS NK30-PLAN-00120-00031
- CONSTRUCTION COMPLETION DECLARATION NK30-PLAN-00120-00032
- Maintenance Ownership Transfer Plan NK30-PLAN-00120-00033
- PICKERING REFURBISHMENT PROGRAM WORK MANAGEMENT NK30-MAN-09701-10005
- PICKERING REFURBISHMENT PROGRAM UNIT PLANNING WINDOW MILESTONES NK30-MAN-09701-10005-WIN
- PICKERING REFURBISHMENT PROGRAM UNIT PLANNING MILESTONES NK30-MAN-09701-10005-MLST
- SYSTEM AVAILABLE FOR SERVICE PLAN NK30-PLAN-00120-10005 1

EPO Governance

- Project Integration Management OPG-MAN-00120-0010
- Scope Management OPG-MAN-00120-0011
- Project Estimating OPG-MAN-00120-0012
- Cost Management OPG-MAN-00120-0013
- Schedule Management OPG-MAN-00120-0014
- Project Risk Management OPG-MAN-00120-0015
- Communication and Stakeholder Management OPG-MAN-00120-0017
- Phase Gate Management OPG-MAN-00120-0019

PICKERING REFURBISHMENT PROGRAM
WORK BUNDLE STRUCTURE AND CONTRACTS

1.0 OVERVIEW

This schedule describes how OPG structured the major work bundles and developed the contracting approaches that it is using to execute each of the bundles.

2.0 STRUCTURE OF MAJOR WORK BUNDLES

Dividing the Pickering Refurbishment Program ("PRP") into individual projects is consistent with recommendations from the Project Management Institute ("PMI")[1] for large multi-faceted programs such as the PRP. The work bundles were developed as the most logical way to effectively execute the refurbishment scope, reflecting the knowledge and experience gained from the Darlington Refurbishment Program ("DRP").

Work bundles are used by OPG for purposes of assigning project management accountability, as well as for purposes of contracting PRP work to outside contractors. As noted in Ex. D2-3-2, OPG has established project management teams comprised of OPG staff within each of the six work bundles shown below. The manner in which OPG determined the scope of the PRP, including how it grouped that scope into the work bundles, is discussed in Ex. D2-3-5. A summary of the major work bundles is provided in Chart 1 below. The costs of the major work bundles are set out in Ex. D2-3-8. The execution strategy of each of the major work bundles is described in greater detail in Ex. D2-3-9.

[1] PMI is a leading international association for project, program and portfolio management.

Chart 1 – Summary of the Major Work Bundles

BUNDLE	SUMMARY DESCRIPTION
Major Work Bundles	
1. Retube, Feeder and Boiler Replacement ("RFBR")	**RFBR** is the largest work bundles and the work in this bundle is typically on critical path. It includes engineering, procurement and construction services for: • the replacement of fuel channels, feeders and supporting hardware and associated parts • the replacement of all boilers (steam generators) • internal inspection of calandria vessels • development of tooling and systems to perform replacement and inspection tasks • fuel channel and feeder mock-ups for tool testing and training • commissioning.
2. Turbine Generator ("TG")	The **TG** sets auxiliary systems and controls are highly specialized equipment designed and supplied as an integrated system for the Pickering station. This work bundle involves replacement of the high-pressure and low-pressure turbines, maintenance, refurbishment and modifications work to the generator, as well as installation of new electronic controls.
3. Balance of Plant ("BOP")	The **BOP** work bundle includes scope on both nuclear and conventional systems that could not be effectively grouped with other major work bundles. Balance of Plant work includes engineering modifications and many non-modification scopes of work (like-for-like replacements).
4. Facilities & Infrastructure ("F&I")	**Refurbishment Support Facilities** work is required to support the refurbishment scope and staff in and around the station. It includes common areas such as shops and storage, washrooms, and offices for refurbishment workers. This includes both the renewal of current infrastructure and building of new facilities, where appropriate.
5. Operations & Maintenance ("O&M")	**Shutdown, Layup and Services** work is required to establish specific conditions for the shutdown of the Pickering unit(s) and layup of systems to maintain a protected environment until the systems are returned to service following refurbishment activities. **Projects** work that is supported by OPG maintenance personnel. Similar to the BOP bundle, the O&M bundle includes project scope on both nuclear and conventional systems that could not be effectively grouped with other major work bundles. This includes

BUNDLE	SUMMARY DESCRIPTION
	engineering modifications and many non-modification scopes of work (like-for-like replacements). **Defueling** involves the safe removal of all fuel from each reactor core in order to minimize outage duration. Defueling is the first segment on critical path once the refurbishment breaker is open. **Fuel Handling** involves improvements to fuel handling reliability through inspections and replacement of critical components.
6. Deep Water Intake ("DWI")	The **DWI** work bundle involves the tunnelling and construction of an offshore intake tunnel, cofferdam and offshore intake shaft. The DWI system will draw deeper cooler water from Lake Ontario, which is expected to improve thermal efficiency, support increased electrical power output, reduce biofouling events, decrease fish impingement and entrainment, and enhance resilience to climate change.

3.0 CONTRACTS FOR MAJOR WORK BUNDLES

This section describes the contracts used for the major work bundles, as well as the Extended Services Master Services Agreement ("ESMSA"), which is the contract being used for the majority of the Balance of Plant work bundle.[2]

Section 3.1 provides an overview of the different forms of contracting and some of the common terms across the contracts. Sections 3.2-3.8 consider the contracts for each of the major work bundles.

3.1 Contracting Overview

3.1.1 Overview of Contracting for Major Work Bundles

Chart 2 below provides an overview of the contracts in place for each of the major work bundles.

[2] The ESMSA is also used for the majority of projects in the Nuclear Operations Project Portfolio. See Ex. D2-1-1 for consideration of the Nuclear Operations Project Portfolio.

Chart 2 – Overview of Major Work Bundle Contracts for PRP

Work Bundle (Contractor)	Description	Contract Model	Pricing Model
RFBR Atkins Realis[3]/Aecon Joint Venture ("Atkins/Aecon JV")	- Definition Phase work - Execution Phase work For each unit: - Removal/replacement of 380 pressure and calandria tubes - Replacement of 760 feeder pipes - Replacement of all 12 boilers (steam generators) General: - Prepare facilities - Design and production of tooling - Provide goods to support work	Engineering, Procurement and Construction ("EPC")	Target Price (with Fixed Fee)
	Owner Specified Materials ("OSM") Commissioning work	EPC	Cost + Markup
Turbine Generators Siemens Energy/Aecon	Hardware	EPC	Firm Price
	Definition Phase work, Execution Phase work	EPC	Target Price
	Commissioning work	EPC	Time and Materials
Balance of Plant ES Fox, Black&MacDonald, Framatome, MBJV, L3Harris	Various smaller equipment repair and replacement projects and system upgrades Includes: Refurbishment Support Facilities, and Shutdown Layup Services	Multiple Approaches (ESMSA, EPC, OPG Self Performance)	Multiple Approaches
Facilities & Infrastructure ES Fox, Black&MacDonald, Magil, TACC	Definition Phase Work Infrastructure upgrades to accommodate the personnel and heavy equipment that will support the refurbishment. This includes upgrades of current road, electrical work and building sites as well as erection of new buildings and infrastructure.	EPC	Multiple Approaches
Operations & Maintenance Tetra Tech, Framatome, Original Equipment Manufacturers	Definition Phase Work, Execution Phase Materials Design activities to propose material solutions to maintenance activities. Material procurement completed in-house to support OPG Self Performance.	EPC, and OPG Self Performance	Time and Materials, and Cost + Markup
Deep Water Intake Janin Atlas Inc./ Dodin Quebec Inc., Bessac Canada Limited (together, the Deep-Water Intake Group General Partnership "DIG GP")	Large underwater intake system that consists of a new offshore intake tunnel and offshore intake shaft to bring in deeper lake water from Lake Ontario to Pickering Units 5-8.	EPC	Target Price

[3] In 2023, SNC-Lavalin Group Inc. announced that it had rebranded to AtkinsRéalis. The legal entity in the RFBR agreement is SNC-Lavalin Nuclear Inc., a subsidiary of AtkinsRéalis.

3.1.2 Current Status of Contracting Process

As discussed in Ex. D2-3-4, OPG is currently in the Definition Phase, with the PRP Execution Phase expected to begin in January 2027. OPG has successfully awarded all major contracts. While final contract costs will be refined through completion of detailed engineering and refinement of schedule in the Definition Phase, OPG has already conducted detailed vetting processes to establish appropriate contractor estimates, which was used to inform the release quality estimate. OPG will confirm Execution Phase pricing and incentives and disincentives as applicable through the Execution Phase contract amendments for each work bundle, as discussed below.

For RFBR, final agreement with Atkins/Aecon JV was executed on January 18, 2025. Atkins was selected for the Pickering RFBR given Atkins is owner of the original design and has significant experience with CANDU refurbishment projects including DRP. The RFBR contract is currently in its Definition Phase which will continue through the fourth quarter of 2026. Upon completion of Definition Phase activities specified in the contract, OPG will issue a Notice to Proceed ("NTP") authorizing Execution Phase and establishing the target cost and milestone schedule.

For TG, final agreement with Siemens was executed on February 14, 2025. The TG contract is currently in its Definition Phase which will continue through fourth quarter of 2026. Upon completion of Definition Phase activities specified in the contract, OPG will issue an NTP authorizing Execution Phase and establishing the target cost and milestone schedule.

For BOP, the majority of the contracts are currently in Detailed Design phase, which includes long lead material procurements for the associated projects. Contract issuance and progression into the next phase of the contract (Engineering to Procurement to Construction) is based on which scopes will be executed first.

For the DWI, the final agreement with the DIG GP was executed on July 24, 2025. The DWI contract is currently in its Definition Phase which will continue through Q1 2027. Upon

completion of the Definition Phase Works, OPG will issue the Final Execution Phase Work NTP, with the concurrent execution of the Execution Phase Amendment.

3.2 Pricing

In determining the appropriate pricing model for each work bundle, the need and ability for OPG to transfer risk to its contractors was balanced against the benefit of achieving a lower contract price or target cost. For example, while fixed price contracts transfer the most risk to contractors, it would come at the highest price. High levels of complexity and uncertainty in certain work bundles (e.g., RFBR) made the transfer of most pricing risk to the contractor less commercially feasible.

OPG's major contracts for the PRP include the following pricing models:

- *Target Price* – Under target pricing, the contractor is paid its actual (allowed) costs (other than overhead costs) incurred in performing the work and is entitled to a fixed fee as compensation for all of its overhead costs and profit. The target price incentive and disincentive mechanism, which includes a neutral band, is structured to achieve alignment of all parties' interests in the completion of the work. Outside the neutral band, the parties share savings below targets and overruns above targets.
- *Fixed Price/Firm Price* – Contractors complete their work within a set budget and time period. Price only varies in specified circumstances or where OPG changes scope. The price of fixed price contracts is a defined value whereas firm price contracts allow an escalation for inflation.
- *Reimbursable Costs or Cost-Plus Mark-up* – Contractors are paid actual labour and materials with mark-ups for overhead and profit (as a percentage of costs).
- *Time and Materials* – Contractors are paid in accordance with predetermined hourly rates for work performed for OPG. The rates are inclusive of profit and overhead.

Incorporating lessons learned from the DRP, the pricing approach for the PRP was adjusted to include more cost categories in the target price component. This strategy was proven to effectively motivate contractor performance in the DRP and the intent is to leverage this tool further for the PRP.

3.2.1 Contract Terms and Conditions

A number of terms and conditions are consistent across the contracts. These are described below and not repeated in the detailed discussion of each major work bundle:

- *Project Change Directives* – The major work bundle contracts limit the ability for the contractors to initiate project change directives to only certain circumstances (e.g., change in law and regulatory codes and standards).[4] The limitation on contractors initiating the process for project change directives reduces OPG's risk exposure to changes in target costs, target schedules or fixed fees.
- *Excusable Delays and Force Majeure* – For a specific set of circumstances beyond its control, the contractor could receive schedule or cost relief.
- *Warranty Provisions* – The warranty periods are sufficiently long for OPG to identify any potential defects with work performed by the contractors or owner-specified materials supplied by the contractors.
- *"Open Book" Approach and OPG Audit Rights* – OPG may review, audit and dispute invoiced costs.
- *Termination for Convenience* – OPG may terminate the contracts for convenience at any time, providing OPG with the ability to exit its engagement with the contractor if required, subject to reimbursement of the contractor's reasonable costs.
- *Suspension of the Work* – OPG has the option to suspend the work at any point during the contract, subject to reimbursement of the contractor's reasonable costs. This provides an important cost-saving measure in the event of a delay in execution.

3.3 Retube Feeder and Boiler Replacement

The RFBR contracting process was initiated in 2023. As part of a strategic decision to mitigate critical path risks, the RFBR scope of work was directly awarded to Atkins/Aecon JV. This approach was chosen to leverage Atkins/Aecon JV's specialized knowledge and experience, especially that gained from working on the Darlington Refurbishment Retube and Feeder Replacement Project ("DRP RFR Project") as well as their key role in the Bruce Power Major Component Replacement Project. Atkins/Aecon JV has demonstrated, through both projects,

[4] The ESMSA does not include this limitation on project change directives.

its capability and capacity to execute the full scope of work while meeting demanding readiness and execution timelines.

The Class 3 Definition phase, encompassing the majority of high-value items such as reactor components, boilers, and specialized tooling, was thoroughly evaluated using both industry and DRP RFR Project benchmarks. For instance, the PRP tooling estimates were derived from the DRP RFR Project actuals, with appropriate adjustments for inflation and scope differences. Labour estimates for both the definition and execution phases were validated against historical actuals, with critical path direct field labour estimates benchmarked against previous retube schedules and crew sizes, ensuring alignment with industry standards and, where applicable, best practices.

Engaging the Atkins/Aecon JV takes full advantage of lessons learned from previous and relevant work in the province and benefits the RFBR project through the engagement of retained critical knowledge and skill of contractor personnel that delivered performance results in the other projects. Further, the Atkins/Aecon JV's familiarity with both OPG and the scope of work allowed them to begin work immediately, accelerating project progress. For example, the Atkins/Aecon JV is familiar with and has demonstrated alignment with OPG's One Team principles, which was key to the success of the DRP RFR Project. OPG also has insight into and experience with the Atkins/Aecon JV's rates, costing methodologies, resource allocation strategies, organizational capacity, time-on-tools metrics and productivity benchmarks, enabling informed commercial decisions and realistic cost validation for RFBR. OPG consolidated all boiler (steam generator) replacement work with the retube and feeder work to give a single contractor responsibility for overlapping work areas and work events. This allows the Atkins/Aecon JV to efficiently streamline and coordinate priorities, balance resources and risks, and maximize opportunities with respect to cost, schedule, and quality objectives.

OPG also leveraged the DRP RFR Project EPC agreement terms as a reference framework, along with its incentive and disincentive mechanisms, as they have contributed to the effective execution of the DRP. The cost and schedule frameworks for both the Definition Phase and the Execution Phase were negotiated in parallel, ensuring alignment and continuity between

project phases. OPG executed a final agreement with the contractor on January 18, 2025. A summary of the RFBR contract with the Atkins/Aecon JV is provided in Attachment 1.

3.3.1 Contract Phases

Under the RFBR agreement, the Definition Phase for the RFBR scope that was initiated at the end of 2023 will continue until the fourth quarter of 2026 when, subject to completion of Definition Phase activities outlined in the agreement, OPG will issue an NTP authorizing Execution Phase work for all units and setting the target cost and milestone schedule for Unit 5. OPG expects to further amend the agreement to set the target cost and milestone schedules for Units 6, 7, and 8 in the future. By staggering the setting of target cost and milestone schedules for the subsequent units, OPG is able to manage risk in stages and facilitate the application of lessons learned and innovation to subsequent units. This approach draws on insights from the DRP and helps mitigate the added complexity due to the inclusion of the boiler scope in the RFBR.

3.3.2 Target Price Contract Structure

In alignment with the collaborative EPC delivery model, the contracting strategy selected by OPG for the RFBR major work bundle is a “target” reimbursable cost model that incorporates target cost and target schedule incentives and disincentives for each of the (1) Definition Phase, (2) Execution Phase for Unit 5, and (3) Execution Phase for Units 6, 7, and 8. The target price incentive and disincentive mechanism is structured to achieve alignment between contractor interests and OPG’s objective of limiting cost increases and schedule delays.

During the Definition Phase, the target schedule and target price estimates will be established for the Execution Phase of the work. Following the Definition Phase work, the “Execution Phase target price” will be determined for Unit 5 (targeted for the fourth quarter of 2026) and then for Units 6, 7, and 8 (targeted for 2028), with the respective incentive and disincentive regime applying to cost and schedule performance for each. As a result, similar to the DRP, OPG and the Atkins/Aecon JV will jointly share in cost savings or overruns, by the respective party paying, as an incentive or a disincentive, a specified percentage of cost savings or overruns beyond the neutral band.

The financial incentives/disincentives mechanism is tied to the target cost and is also tied to the contractually negotiated "Fixed Fee".[5] The Fixed Fee is comprised of the contractor's profit and overhead on the labour portion of the target cost. If the contractor incurs cost disincentives, its maximum exposure is 50% of the Fixed Fee ("Fee at Risk"). As a result, the contractor's return on the project is diminished, which is significant to the contractor since it is motivated to earn its profit and not simply pass costs through to the Owner. As such, the contractor has the incentive to avoid this consequence.

In addition, the contract is structured to facilitate a phased risk allocation, with progressive transfer of risk to the contractor over time. The Definition Phase carries the lowest risk, allowing for knowledge development and refinement of project parameters. Unit 5, as the first unit to be executed, provides for intermediate risk transfer. For Units 6, 7, and 8, where the project enters into a greater degree of replication, the contractor assumes the greatest amount of risk as they are in a position to incorporate lessons learned from the first unit's execution. This structured approach allows for risks to be jointly shared at the outset but then to be increasingly transferred to the contractor as replication is expected. The use of target pricing promotes cost efficiency, transparency, and mitigates paying for a risk premium where appropriate (e.g., for Definition Phase work). Accordingly, 4% of the Fee at Risk is allocated to the Definition Phase, 18% of the Fee at Risk is allocated to Unit 5 work, and 78% of the Fee at Risk is allocated to Units 6, 7, and 8 work. Additionally, the contractor has an incentive opportunity of up to 25% of the Fixed Fee.

Under the target cost model, a neutral band is utilized within which there are no incentives or disincentives for deviations from the target cost. The neutral band minimizes administrative burden and potential disputes over minor cost variations, while ensuring both parties remain focused on overall project objectives, managing material cost overruns and achieving value.

[5] While Goods, Tooling and Reimbursable No Mark-up (pass through) costs are included within the target pricing framework, in order to align the contractor's performance with cost control objectives, they are not used in the calculation of the Fixed Fee.

Schedule incentives and disincentives are structured with a fixed cost-per-day rate applied to early or late performance. While the rate of early completion remains constant, the rate for delays is staged, increasing as the duration of the work extends.

Altogether, this incentive and disincentive model aligns the contractor's interests to performing optimally on all units of the refurbishment program, embedding expectations for learnings and unit-over-unit efficiencies along the way. The exact amount of the Fee at Risk and the specific incentive and disincentive details will be finalized through planned amendments to the project agreement once the target cost and target schedule durations are established.

3.3.3 Materials and Commissioning Work

Where the contractor has less impact on outcomes, OPG has excluded the work from the target pricing structure. Instead, cost plus mark-up pricing is used for Owner Specified Materials as well as for commissioning work.

The potential for cost fluctuations in Owner Specified Materials, largely driven by the global resurgence in nuclear construction and refurbishment activities, was deemed to be primarily beyond the control of either party, with variations that could range from minor to significant. To avoid the complexities of maintaining continuous adjustments to the target pricing structure to account for these unpredictable and variable cost changes, and to prevent adding undue risk to the target model, Owner Specified Materials were intentionally excluded from the target pricing structure. This decision also facilitated a reduction in the overhead rate applied to the boiler portion of the work, ensuring a more streamlined and cost-effective approach to pricing.

Commissioning work is also excluded from the target price model as it is limited in scope and largely managed by OPG as opposed to the contractor.

3.3.4 Current Status

OPG has conducted a vetting process to establish the Execution Phase contractor estimate for the RFBR for all units. The process included a detailed review of the elements of the estimate by the project management team and a strategy to validate elements of the estimate

and assess the gaps OPG identified in the original estimate submission. Further information on the vetting process is provided in Ex. D2-3-8.

By implementing the RFBR procurement process early in the Definition Phase, OPG and the Atkins/Aecon JV have been able to work together, on an open book basis in alignment with One Team principles, to develop the engineering, refine the schedule and budget estimates, and jointly identify, monitor and address risks as they arise.

3.4 Turbine Generator

The turbine generator sets are highly specialized machines designed and manufactured to order specifically for Pickering by C.A. Parsons and Co. A series of corporate mergers and acquisitions resulted in Siemens Energy ("Siemens") becoming the original equipment manufacturer ("OEM") in 1997. Siemens previously replaced the high-pressure turbines for Units 5 and 7 in 2019. This completed work therefore does not form part of refurbishment scope.

OPG began the contractor selection process in July 2023, with a focus on contractors that in OPG's assessment had the requisite expertise with nuclear power stations in Canada. OPG sought comprehensive proposals including technical specifications, key commercial terms and budgetary estimates from such vendors. After reviewing the proposals, OPG selected Siemens on the basis that its proposal was comparatively better for the majority of the assessment areas. In addition, there are a number of advantages that an OEM can offer over a third-party vendor, including reduced engineering effort, fewer potential compatibility issues, and consistent technology across all units for reduced operations and maintenance burden. All such advantages apply to the turbine generator scope of work.

In April 2024, OPG issued a Limited NTP to Siemens to start procurement of long lead materials and initial engineering. As part of the contract negotiations, OPG requested that Siemens consider potential constructors as the installation partner. After such consideration, Aecon Construction Group Inc. ("Aecon") was selected by Siemens for their project management capability and capacity to do the work. Aecon has a proven track record of

successfully executing nuclear mega-projects and, as a partner of the Atkins/Aecon JV on the RFBR work bundle, offers opportunities for resource cross-utilization to enhance efficiency.

OPG executed a final agreement with Siemens and Aecon (collectively the "TG Consortium") on February 14, 2025, establishing their joint responsibility for the execution of the Turbine Generator major work bundle.[6] A summary of the TG contract with the TG Consortium is provided in Attachment 2.

3.4.1 Hardware Supply

The hardware supply component of the work, including preliminary design and factory testing, is conducted using a firm price model and accounts for approximately half of the contract value. As discussed in Section 3.2, a firm price model allows the cost of each component to be escalated annually in accordance with agreed-upon indices applicable to the specific jurisdiction(s) where the component is manufactured.

3.4.2 Definition Phase and Installation

The Definition Phase, installation support work (Siemens) and installation work (Aecon) are executed under the "target" reimbursable cost model, where the TG Consortium assumes partial risk for cost and schedule overruns and shares any benefits of completing the work under budget or ahead of schedule. To promote efficiency across all units, a single cost incentive/disincentive target applies to the entire Execution Phase. The cost disincentives employ a rate reduction model. If the TG Consortium exceeds the target, they will credit back a percentage of the overage to OPG in increasing bands. There is no maximum cost disincentive, but if the target cost is exceeded by a defined percentage, the credit percentage stabilizes, and a larger suite of remedies becomes open to OPG. The schedule risk sharing model is unit-specific, with higher incentives and disincentives for Unit 5 and Unit 8 where the TG schedule is closer to the critical path and schedule adherence is critical. The schedule risk sharing model employs a common "liquidated damages" model, in which the TG Consortium would pay a predetermined daily amount for every day beyond the target schedule and neutral

[6] Siemens and Aecon have separately entered into a consortium agreement to create a clear framework for allocation of jointly held risks, including hardware supply, installation and commissioning.

band. Likewise, if the TG Consortium finished the work on a given unit early, OPG would pay an incentive for every day ahead of the target schedule.

OPG's Power Workers' Union ("PWU") represented personnel are experienced with the configuration, maintenance and operation of the TG. OPG has an arrangement with the TG Consortium in which such personnel will form part of an integrated team with the TG Consortium's trades under the TG Consortium's supervision, to perform the installation work as enabled by the jurisdictional labour agreement negotiated by OPG, which will leverage OPG's internal staff expertise and deliver execution efficiencies. Refer to Ex. D2-3-4, Section 2.2, for OPG's workforce planning approach to support Pickering Refurbishment and Ex. F4-3-1, Section 2.0, for discussion of the requisite labour agreements.

3.4.3 Static and Dynamic Commissioning

Static commissioning and dynamic commissioning support work is executed using a reimbursable cost model. During the commissioning phases, OPG is performing the work with Siemens technical support. Given the importance of timely technical support to resolve issues through commissioning, there is a schedule incentive available to the TG Consortium should commissioning of a given unit finish on time or early.

3.4.4 Warranty

The TG contract includes extended warranty periods to ensure the equipment performs as required, with different warranty periods for hardware, software and installation to reflect the reasonable timelines in which defects would become apparent. In addition, Siemens has agreed to a performance guarantee on the output of the TG. There are incentives and disincentives tied to performance of the TG during and after commissioning, with anything below the minimum output deemed "defective" with a requirement to correct at Siemens's cost.

3.4.5 Reimbursable Costs

For Siemens's reimbursable costs, OPG pays predetermined rates that are comparable to rates employed by similar OEM contractors. For Aecon's work, OPG pays for actual costs, with

the same burden, overhead and profit profile as the RFBR contract, to ensure that Aecon personnel can seamlessly move between projects.

3.5 Deep Water Intake

The implementation of a DWI project is a strategic initiative aimed at enhancing Pickering's operational efficiency, supporting increased electrical output, reducing environmental impacts, and improving its resilience to climate-related challenges. For further information on this project, see Ex. D2-3-5, Section 4.6.

3.5.1 Request-For-Market-Information

A request for market information was launched in early 2024 to assess the level of market interest for this DWI project and to obtain feedback on aspects of the project, including regarding viable contracting options to procure and deliver the work. OPG received a total of 15 requests for market information submissions indicating a high level of interest from the market. In addition, OPG considered three contracting options: 1) design-bid-build; 2) traditional EPC; and 3) EPC with more collaborative principles (collaborative EPC). Five screening factors were used to determine the basis for assessing the three contracting options: 1) cost certainty; 2) on-time delivery; 3) time to construction; 4) risk allocation; and 5) ability to achieve the best value for the project. The contracting options analysis assessment ultimately concluded that a collaborative EPC contracting option is the optimal approach. Lessons learned from OPG's Niagara Tunnel project were also considered, including how to account for geotechnical and subsurface conditions, as well as uncertainty associated with underground tunnelling.

3.5.2 Contracting Model

The DWI project was contracted via a two-stage procurement selection process. This entailed a Request-for-Prequalification ("RFPQ") stage and a Request-for-Proposal ("RFP") stage. The two-stage process allowed OPG to evaluate multiple interested bidders based on company experience and qualifications prior to shortlisting a discrete set of RFP proponents. Utilizing a two-stage process facilitated a focus on evaluating and shortlisting the most capable entities

on a consistent experience-based level prior to releasing detailed DWI requirements and terms and conditions to the bidders.

3.5.3 Request-For-Prequalification, Request-For-Proposals, and Contract Award

OPG concluded its stage 1 RFPQ in December 2024 and shortlisted a total of five proponents. Over a five-month period, OPG executed an RFP process that successfully achieved four competitive RFP submissions. OPG entered into a one-month RFP Evaluation Period and evaluated the four RFP submissions from a technical, commercial, and pricing standpoint. A preferred "Negotiations Proponent" was identified at the conclusion of the evaluation period. OPG entered into negotiations with the Negotiations Proponent and successfully concluded the process by awarding the contract on July 24, 2025, which marked the start to the Definition Phase. Final agreement with the DIG GP was executed on July 24, 2025. The DWI contract is currently in its Definition Phase with a target to complete the Definition Phase by no later than February 2027. Upon completion of the Definition Phase Works, OPG will issue the Final Execution Phase Work NTP and the concurrent execution of the Execution Phase Amendment.

3.5.4 Pricing Model

In alignment with the collaborative EPC delivery model, the contracting strategy for the DWI project is a "target" price model that incorporates target cost and target schedule incentives and disincentives for both the Definition Phase and Execution Phase. The target price incentive and disincentive mechanism is structured to achieve alignment between contractor interests and OPG's objective of limiting cost increases and schedule delays.

3.5.5 Incentive and Disincentives – Costs and Schedule

3.5.5.1 Definition Phase – Cost Incentives and Disincentives

The agreement establishes a neutral band for the Definition Phase target cost. If the actual amount of allowed costs incurred in respect of the Definition Phase work falls below the neutral band, OPG will pay the contractor a percentage of OPG's cost savings up to a maximum amount equal to a percentage of the Definition Phase Fixed Fee. If the actual amount of allowed costs incurred exceeds the neutral band, the contractor will pay OPG a percentage of

OPG's cost overruns up to a maximum amount equal to a percentage of the Definition Phase Fixed Fee. Cost incentives and disincentives will be payable on the earlier of (1) the effective date of the Execution Phase Amendment, and (2) the date on which the aggregate amount of cost disincentives exceeds the overall limit, subject to early termination.

3.5.5.2 Execution Phase – Cost Incentives and Disincentives

The Agreement establishes a tighter neutral band during the Execution Phase. If the actual amount of allowed costs incurred in respect of the Execution Phase work falls below the neutral band, OPG will pay the contractor a percentage of OPG's cost savings up to a maximum amount equal to a percentage of the Execution Phase Fixed Fee. If the actual amount of allowed costs incurred exceeds the neutral band, the contractor will pay OPG a percentage of OPG's cost overruns up to a maximum amount equal to a percentage of the Execution Phase Fixed Fee.

3.5.5.3 Execution Phase – Milestone Schedule Incentives and Disincentives

If the contractor achieves Substantial Completion more than 20 days earlier than the guaranteed Substantial Completion date, OPG will pay the contractor an incentive amount determined in accordance with the agreement (as a percentage of the Execution Phase Fixed Fee) up to a maximum amount equal to a percentage of the Execution Phase Fixed Fee. If the contractor achieves Substantial Completion by more than 20 days later than the guaranteed Substantial Completion date, the contractor will pay OPG an amount determined in accordance with the agreement (as a percentage of the Execution Phase Fixed Fee) up to a maximum amount equal to a percentage of the Execution Phase Fixed Fee.

A copy of the contract summary for the DWI project is provided in Attachment 3.

3.6 Balance of Plant

The Balance of Plant work bundle includes scope on both nuclear and conventional systems that could not be effectively grouped with other major work bundles. Balance of Plant work includes engineering modifications and many non-modification scopes of work (i.e., like-for-like replacements).

The ESMSA is the form of contract used for the majority of the Balance of Plant work bundle,[7] as well as for the Facilities & Infrastructure projects. The ESMSA is a form of contract that establishes a set of terms and conditions in advance with a contractor, enabling OPG to significantly shorten the procurement cycle for obtaining engineering, procurement, or construction services, or any combination of the three types of services, as required. Where possible, OPG will optimize resourcing by utilizing existing PWU-represented resources to support construction work, as appropriate.

As described in EB-2016-0152 and EB-2020-0290, in 2012, OPG established ESMSAs with ES Fox and Black & McDonald. In 2015, in order to increase competition and to mitigate capacity risks, OPG selected the Atkins/Aecon JV as a third ESMSA contractor. The initial contract term under each ESMSA was for five years. The term has since been extended to 2027 for each of ES Fox, Black & McDonald and the Atkins/Aecon JV. The current form of agreement in place for all three of these contractors has benefited from clarifications and adjustments based on OPG's experience with the work conducted to date under the ESMSAs, including through the DRP. An ESMSA worksheet template, which contains all of the key ESMSA contract requirements, is used and customized by OPG for each individual Balance of Plant project, to direct the ESMSA contractor on how the required service is to be completed as per the ESMSA contract.

Entering substantially similar agreements with the ESMSA contractors through a competitive process has allowed OPG to achieve a number of benefits with respect to pricing and terms and conditions, as well as flexibility and control by OPG. Some of the key contract features and benefits are highlighted below:

- *Core Team* – Contractor will own the work from start to finish under a "one-stop shop" approach. Each contractor is required to establish and maintain a core team capable of managing, controlling and administering the provision of all work pursuant to the ESMSA. Key personnel for an individual project may be designated in the purchase order for the

[7] The ESMSA vendors make up for 67% of the awarded work for the Balance of Plant bundle. Other significant vendors include MBJV (Makhos-Bird Joint Venture) for the site facilities scope, and Framatome for the transformer construction scope. Together, these vendors make up for 95% of the Balance of Plant work.

project with OPG's consent. Members of the core team and any designated key personnel cannot be replaced without OPG's prior written consent. This approach ensures committed and focused contractor leadership for OPG work and reduces the complexity and costs relating to OPG's ongoing interface with and management of the contractors.

- *Pricing and Profit at Risk Model* – Fixed labour rates for trades and non-trades as well as set fees for material management provide cost predictability under the ESMSA. At the same time, for each project awarded pursuant to the ESMSA, OPG may adopt the appropriate pricing model (i.e., fixed/firm price, time and materials, target price, or other types as appropriate). Under each ESMSA, the contractor is required to submit an application to OPG for payment for work completed. OPG withholds a percentage (specified in the contract) of each corresponding payment and contributes these amounts to a performance fee pool for each ESMSA contractor.[8] As a result, a percentage of the contractor's costs, including the contractor's profits and overhead, are at risk through the performance fee mechanism. Performance fees are paid out of the performance fee pool based on a performance scorecard included in each ESMSA and which is comprised of approved performance indicators, including in the areas of safety, human performance, cost and schedule. The performance scorecards and indicators are established on an annual basis and reviewed regularly by OPG. Altogether, the performance fee mechanism aligns each contractor's incentives with OPG's interests in terms of ongoing performance improvement and delivery of projects in a timely and cost-effective manner. To enhance the effectiveness of the performance mechanism, OPG is also in the process of developing project-specific performance scorecards for the Balance of Plant work packages awarded under the ESMSAs.
- *Work Request Processes and Change Management* – OPG retains the sole discretion to issue a work request to any of the ESMSA contractors and is not restricted in its ability to issue the work request to other contractors regardless of whether they have entered into a similar ESMSA with OPG. While the ESMSA contractor is required to respond to all work requests from OPG, OPG does not guarantee that any specific amount of work will be provided to the contractor, nor does OPG guarantee the exclusive right of the contractor to

[8] The percentage withheld does not apply to applications for payment related to fixed price work, payments of performance fee, or the fixed fees associated with a core team of personnel identified in each ESMSA.

submit a work request response in respect of any work. The ESMSA also sets out a process for addressing changes by way of project change authorizations.

- *Other Terms and Conditions* – Risks have been managed by transfer to the contractors, where appropriate, through a number of terms and conditions, including but not limited to performance security and indemnity, limits of liability and exclusions, requirements regarding delays, termination and events of default, and warranty and rework. A robust dispute resolution process has also been agreed to between OPG and each of the ESMSA contractors.

A summary of the ESMSAs, along with an ESMSA worksheet template, is provided in Attachment 4. An amendment to the ESMSAs are currently being negotiated and are expected to be finalized by the end of 2025. OPG is also evaluating the incoming volume of work across the fleet and the need to execute additional ESMSA contracts to mitigate capacity risks by building out a broader ESMSA vendor pool.

3.7 Facilities & Infrastructure

The Facilities & Infrastructures bundle includes scopes that surround the readiness of buildings and infrastructure to support the staff and equipment necessary for the refurbishment. This includes upgrading current infrastructure such as site facilities, roads, electrical work, or the development of new buildings, where appropriate. This work needs to be executed ahead of other bundle work to ensure there is sufficient capacity at the site to accommodate the resources for the other bundles.

3.7.1 Contract Strategy

The Facilities & Infrastructure bundle is broken down based on the requisite quality assurance program, which varies between commercial grade up until nuclear quality assurance. Similar to the BOP bundle, this bundle utilizes the ESMSA vendors for all projects that require nuclear quality assurance. Each scope is awarded based on the operating experience and ability of the contractor to perform the work.

For commercial grade projects, OPG has entered a competitive procurement process to ensure value for money. For example, projects located offsite do not require nuclear quality assurance, and the selection of vendors will be based from a prepared set of evaluation criteria including pricing, schedule, and technical expertise. Selected contractors will also be subject to benchmarking and reference reviews to ensure the validity of proposals prior to contract issuance.

Certain scope that includes new infrastructure such as the Common Services Building, Pickering Maintenance Facility, and Security Port Upgrades will be completed via a sole source justification to Makhos Bird Joint Venture ("MBJV"). Concurrently, OPG is in negotiations with the MBJV to form part of the ESMSA contractors. The buildings would be built commercially, with the nuclear tie-in portions being completed by the current ESMSA vendors. The commercial terms for these contracts are expected to follow a similar approach as the ESMSA vendors.

3.8 Operations and Maintenance

The Operations and Maintenance bundle includes project scope that will be executed by OPG maintenance personnel. This scope is comprised of project work on both nuclear and conventional systems. The main contracting functions will be based on design support, and material procurement to support work execution.

3.8.1 Design Contract Strategy

For items requiring design support to develop a material solution, Design Service Providers ("DSPs") are being engaged to provide support engineering services to develop solutions and augment OPG's design resources. The DSPs are selected based on OPG's pre-qualified Vendor of Record process ("VOR"). In the VOR process, an open invitation to any supplier is processed at a five-year interval to provide specific services to OPG. The benefits of this approach are that all vendors will have pre-negotiated rates, commercial terms, and vetted experience which reduces the procurement process length. The DSPs that fall under the Engineering Services VOR have a history supporting OPG across the enterprise and have

familiarity with OPG systems and processes, and in some cases may have been a part of the original team that helped develop the solution.

OPG completed a secondary compete process to bid the applicable scopes to these Engineering Services VOR vendors, with selection to be based on a combination of pricing, historical experience, and technical expertise with the provided scope. Vendors that have been awarded the work will be expected to follow the intended delivery schedule, adhering to the request quality program and oversight forums.

3.8.2 Material Contract Strategy

Material procurement sequencing follows the refurbishment program milestones, beginning with initial identification of long lead material, then procurement of long lead material, and followed by procurement based on work segments. Any items that are a risk to the project execution window, or have a history of being difficult to source, are also included in advanced scope to allow more time to procure the material.

Materials procurement also utilizes VORs, which are based on key commodities such as valves, transformers, pumps, and others. The aforementioned benefits of the VORs also apply to this approach. Having strategic agreements with these vendors also allows for additional ability to ensure timely deliveries once purchase orders have been issued for the procurement. There are also opportunities for value for money benefits based on volume discounts that can be secured through OPG's Tier 1 VOR listings.

Items which are not being procured under a VOR are typically either sourced directly from the OEM, which have the most expertise in delivering such material, or are placed through a competitive invitation procurement process. Vendors are selected for invitation based on their history of supplying similar scopes of work. The quotes received are reviewed for technical, schedule, and cost compliance.

For items that are more commoditized and are high turnover in nature, OPG has established Master Product Agreements ("MPAs"), whereby distributors provide products at a fixed price

for a period of time, with commercial terms, rebate structures, and delivery times secured. These MPAs can then be automatically processed by the system as inventory is depleted to allow for a more efficient procurement process. The MPAs are owned by OPG's Category Management team and updated at regular intervals to ensure accuracy of the pricing and delivery times.

LIST OF ATTACHMENTS

Attachment 1: Contract Summary for RFBR with Atkins/Aecon JV

Attachment 2: Contract Summary for Turbine Generators with the TG Consortium

Attachment 3: Contract Summary for DWI

Attachment 4: ESMSA Contract Summary and ESMSA Worksheet Template

Engineering, Procurement and Construction Agreement for the Pickering Refurbishment Retube, Feeder and Boiler Replacement Project (Units 5 to 8)

Pickering Nuclear Generating Station Refurbishment Program

Summary of Key Terms

Date of Agreement: January 1, 2025

The following is a summary of the key terms and conditions of the Engineering, Procurement and Construction Agreement for the Pickering Refurbishment Retube, Feeder and Boiler Replacement Project (Units 5-8) (Pickering Nuclear Generating Station Refurbishment Program) dated as of January 1, 2025 (the "**Agreement**") between Ontario Power Generation Inc. ("**OPG**"), as the owner, and a joint venture between SNC-Lavalin Nuclear Inc. and Aecon Nuclear, a division of Aecon Construction Group Inc. (the "**Contractor**"), as the contractor. Capitalized terms used but not defined in this summary have the meanings set out in the Agreement.[1]

The form of Agreement is an engineering, procurement and construction contract, and the form of Agreement reflects extensive feedback from the entire OPG project team, external legal counsel (Blake, Cassels & Graydon LLP) and the Contractor.

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[1] The objective of this summary is to summarize certain provisions of the Agreement and does not purport to give a complete and accurate summary of all provisions of the Agreement. This summary reflects the state of the Agreement as at the date noted above and does not address any changes following such date.

Phased Approach to Refurbishment Work

The Agreement divides the work on the Pickering Refurbishment Retube, Feeder and Boiler Replacement Project (Units 5-8) (the "**Project**") into three phases – the definition phase, the execution phase, and the commissioning phase.

- The definition phase commenced on December 5, 2023 pursuant to the Early Works Agreement and ends when OPG and the Contractor reach agreement on all components of the execution phase plan for Unit 5.
- The execution phase commences on the date of the issuance of a notice to proceed for the execution phase work and ends on the date on which final completion occurs. OPG may change the start date for the execution phase work on each Unit by issuing a project change directive. If OPG changes this start date, OPG must compensate the Contractor for any reimbursable costs, together with the profit and overhead component of the percentage(s) applicable to the relevant cost categories, including demobilization costs approved by OPG.
- The commissioning phase (for each Unit) commences on the date on which unit mechanical completion is achieved and ends when such unit is returned to service.

Schedules

The definition phase and execution phase are both governed by a milestone schedule, a target schedule, and a submittal schedule. For both phases, the milestone schedules set out high-level milestones for the work and fixes the dates for which the Contractor commits to complete defined aspects of the work. The target schedules establish a detailed project schedule for completion of the work with dates for starting and entirely completing each component of the work, including references to milestones and submittals. The submittal schedules set out the dates and/or time periods for delivery of required submittals. the definition phase schedules were agreed upon by the by parties and are appended to the Agreement. the execution phase schedules are developed collaboratively by the parties during the definition Phase and must be approved by OPG to be final. Once finalized, the milestone schedules, target schedules and submittal schedules may only be changed by an amendment.

Payment of the Contract Price

OPG will pay the Contractor, on a monthly basis and subject to an approved application for payment: (i) its reimbursable costs for all work performed and goods supplied; (ii) the monthly portion of the applicable fixed fee (i.e., 50% of the fixed fee divided by the number of months in the applicable phase); (iii) the portion of the applicable fixed fee payable for milestones achieved; and (iv) the applicable portion of any fixed price or firm price work. Reimbursable costs are the Contractor's actual costs incurred in the performance of its work and calculated in accordance with the cost allocation table. Reimbursable costs do not include disallowed costs (as per the cost allocation table), any costs of owner-specified materials (including boilers) or any cost that is compensated for through a fixed fee, the mark-up for goods, the mark-up for owner-specified materials or the mark-up for boilers. Certain target costs, fees and other pricing elements are subject to escalation.

To maintain a cash neutral position throughout the definition phase and execution phase, the Contractor may receive a monthly advance reflecting the forecast costs for the upcoming two months. Any outstanding advance will be deducted in full by OPG from payments to the Contractor or repaid by the Contractor on a monthly basis or upon early termination.

Rework

To account for typical rework on a project of this nature, each of the definition phase target cost and execution phase target cost, as described below, include an allowance equal to [redacted]. Any costs incurred by the Contractor for rework in excess of such allowance will be reimbursable by OPG, but target costs will not be adjusted.

Completion Milestones

The Agreement establishes a process for completion of three major milestones, provided that the Contractor has delivered the required notices and OPG has confirmed the conditions have been met: "Unit Mechanical Completion", "Final Mechanical Completion" and "Final Completion".

Unit Mechanical Completion - On a Unit-by-Unit basis, when (i) the Contractor has restored the primary heat transport system pressure boundary to a condition that satisfies the requirements; (ii) a Unit has been completely refurbished in compliance with the scope of work

and Agreement other than certain punch list items; (iii) the Contractor has completed all required testing of the Unit and the results meet the requirements of the scope of work; (iv) all outstanding deficiencies and defective items have been completed or repaired and no work remains incomplete (except for punch list items agreed to by OPG); (v) it has obtained and delivered to OPG all required approvals; and (vi) full access to the vault can be returned to OPG such that OPG may commence the commissioning phase work.

Final Mechanical Completion – Unit Mechanical Completion has been achieved on all four Units and available for service documentation for all four Units has been provided to OPG.

Final Completion – The Contractor has completed the execution phase work and OPG has received all amounts owing to it by Contractor (including any disincentive payments) and any amounts related to the delay of return to service (as described in the Agreement). The Agreement entitles OPG to hold back an additional $10,000,000 of the execution phase fixed fee and reimbursable costs for the execution phase until OPG determines all execution phase work has been completed.

Incentives and Disincentives – Costs and Schedule

The Agreement includes financial incentives and disincentives for the Contractor's ability to meet the target costs and schedules set forth in the Agreement during the definition phase and execution phase.

Definition Phase – Cost and Schedule Incentives and Disincentives

The Agreement establishes a neutral band [redacted]. If the actual amount of reimbursable costs falls outside the neutral band, OPG will pay the Contractor a specified cost incentive amount (for cost savings) or the Contractor will pay OPG a specified disincentive amount (for cost overruns), subject to certain thresholds.

If the Contractor completes all definition phase work more than 23 days ahead of the date set forth in the target schedule, OPG will pay the Contractor an incentive per calendar day up to a maximum schedule incentive amount. If the Contractor completes the work more than 45 days beyond the date set forth in the target schedule, the Contractor will pay to OPG a disincentive per calendar day delayed up to a maximum schedule disincentive amount.

Execution Phase – Cost and Schedule Incentives and Disincentives

The Agreement sets out how the parties will allocate cost and schedule incentives and disincentives relating to the execution phases for Units 5 to 8. Similar to the definition phase incentives and disincentives, the Agreement requires OPG to pay the Contractor a cost incentive if reimbursable costs fall below the neutral band, and the Contractor to pay OPG a cost disincentive if reimbursable costs rise above the neutral band, subject in each case to defined maximum incentive and disincentive amounts. For the execution phase, the Agreement establishes different bands outside of the neutral band, where each band establishes a cost incentive or disincentive amount that progressively increases, up to a predetermined maximum. The Agreement also sets out schedule incentive and disincentives in a similar way for each Unit.

Project Change Directives, Excusable Delays and Force Majeure

The Agreement permits OPG to issue a project change directive and direct the Contractor to make changes in the work (including suspending the performance of the work) and the milestone schedules for an enumerated list of circumstances, including excusable delays, changes in law force majeure delays and concealed conditions. The Contractor may request that OPG issue a project change directive for the same circumstances. In certain cases, OPG is not obliged to accept such request and will not issue a project change directive if certain cost and schedule thresholds are not met. If OPG issues a project change directive, the Contractor is entitled to cost and schedule relief, subject to certain exceptions. Once the changes resulting from a project change directive have been agreed to by the parties, OPG and the Contractor must execute an amendment evidencing any such changes to the work, target cost and/or schedules.

An “excusable delay” is a delay that is caused by an OPG breach or stop work order, emergency or hazardous condition for which OPG is responsible, and which extends the critical path of the definition phase milestone schedule or the execution phase milestone schedule by more than three days.

Neither party will be responsible for material delays caused by “force majeure” events for fire, flood, tidal wave, lightening, earthquake, cyclone, tornado, hurricane, explosion, severe ice storm, epidemic or pandemic disease, legal strike or lock-out (other than those caused by the Contractor, a subcontractor, or their employees, or work to rule activities), war, riot, sabotage or other acts of public enemies, including terrorists, or site-related blockades (other than labour-related events).

An “excusable delay” or a “force majeure” event entitles the applicable party to schedule and/or cost relief depending on the type of work (i.e. fixed, firm price or reimbursable work) impacted by the delay or the event.

In the event there is a single qualified supplier for boilers, pressure tubes, calandria tubes, feeders, end fittings and bellows and the Contractor faces a delay in procuring such special materials, the Contractor will be entitled to schedule relief and reimbursement of its actual costs, but not target cost relief. If there is a delay in the procurement of boilers, and delivery is delayed by more than 152 days, then the Contractor is entitled to schedule relief, target cost relief, and reimbursement of actual costs incurred after the 152 day threshold.

Tooling

Throughout the term of the Agreement, the Contractor will develop specialized tooling equipment for performance of the work. The Contractor will transfer to OPG ownership of the tooling at the time of fabrication or acquisition of the tooling The Contractor will at all times retain ownership of all tooling intellectual property and intellectual property rights, except for any intellectual property developed by OPG. At the end of the project, OPG can retain or remove and dispose of the tooling.

The Contactor agrees that the tooling will be new when delivered to the Pickering Nuclear Generating Station (the "**PNGS**"), will not be diverted for use in any other project, and will not be used except at the PNGS until the Unit Mechanical Completion is achieved for the last Unit.

Procurement of Owner-Specified Materials

The Agreement requires the Contractor to procure both all goods required for the Project and "Owner-Specified Materials". "Owner-Specified Materials" includes (i) boilers; (ii) all "nuclear material" as defined under the *Nuclear Liability and Compensation* Act (Canada) in respect of which the duties under the *Nuclear Liability and Compensation Act* (Canada) are imposed on OPG; certain other owner-specified materials set out in the Agreement; (iv) all nuclear waste containers, racks and flasks; and (v) such other goods that the parties agree from time to time are owner-specified materials.

Subcontractors

The Agreement allows for subcontractors, for whom the Contractor is solely responsible. The Contractor agrees to enter into a written contract with each subcontractor performing any of the work and flow down all applicable terms and conditions of the Agreement. The Contractor, its designated key subcontractors and any successor thereto or replacement thereof must obtain the prior written consent of OPG to enter into any agreement or arrangement in respect of the work with a subcontractor that is an affiliate, or in which any one of them or their affiliates has a direct or indirect beneficial interest of 10% or greater.

Scientific Research and Experimental Development ("SR&ED") Tax Credit

The Agreement provides that OPG is entitled to claim all SRED tax credits generated by work on the Pickering project.

Clean Technology Investment Tax Credits ("ITCs")

The Agreement provides that OPG is entitled to claim ITCs in respect of eligible equipment on the Project and makes provision for certain prevailing wage, apprenticeship and reporting requirements to be followed by the Contractor.

Performance Security

The Agreement obliges the Contractor to post a letter of credit to support its obligations under the Agreement, initially in the amount of $50,000,000 and, within 5 business days of the parties executing the amendment for the execution phase work, increasing the security to $100,000,000.This letter of credit decreases over time as work on the project is completed, up until the expiry of the warranty period for the last Unit to achieve Unit Mechanical Completion.

The Contractor also provided two parental guarantees (one for each Contractor entity) in support of all the Contractor's obligations under the Agreement. The Agreement contains ratings-based and/or tangible net worth based tests of ongoing creditworthiness of the parent guarantors.

Intellectual Property

The Agreement requires the Contractor to or cause its subcontractors to transfer to OPG all intellectual property ownership rights in the physical and electronic results of the work, including designs, software, data and other Contractor work product, subject to exceptions for tooling and other retained intellectual property for which OPG is granted a license to use for certain purposes. OPG will own all other intellectual property in the contractor work product and all associated intellectual property rights, effective immediately and without any payment or other documentation.

Warranty

The Agreement provides for a warranty of the Contractor's work and materials (excluding to the extent that any breach of such warranty is due to (i) maintenance, operation or storage by OPG contrary to the instructions provided by the Contractor; (ii) negligence of wilful misconduct by OPG; (iii) normal wear and tear; or (iv) boiler design defects). The Warranty Period ends on the earlier of the date that is three months after the actual end date of the first planned outage where inspections take place for such Unit, and the date that is five years from the date of Unit Mechanical Completion for such Unit.

If any of the work is determined to be defective, the Contractor will correct or replace such defective portion of the work within a period of time specified by OPG and the warranty period

will recommence on the date that such corrected or replaced part re-enters commercial operation, and end on the earlier of the date that is three months from the actual end date of the next planned outage for the applicable Unit and the date that is four years from the date that such corrected or replaced part re-enters commercial operation.

The Contractor is responsible to rectify or repair any boiler design defect which is either determined by dispute resolution to be, or agreed in writing by the boiler supplier to be, a boiler design defect. The Contractor's costs to correct boiler design defects are allowed costs (including profit and overhead) but do not impact the target costs. If such defect or repair continues for more than 40 calendar days on the critical path, the Contractor will be entitled to an extension of the execution phase milestone schedule. In the event of a dispute, OPG will pay the Contractor's reimbursable costs pending the dispute and the Contractor will provide and maintain certain letters of credit as security for costs.

Termination for Default

This Agreement includes standard events of default for both Owner and the Contractor, including the winding up of the Contractor and the commencement of liquidation or bankruptcy proceedings. If the Contractor defaults, OPG will be entitled to immediately terminate the Agreement upon notice and to exercise a number of remedies, including directing the Contractor to stop performing the work. In the event of default, the Contractor will be liable to OPG for the amount of all costs incurred by OPG to complete the work and to correct or replace defects, and all other losses suffered (subject to the terms of the Agreement). The Contractor's liability is limited to 20% of the sum of the applicable target cost and fixed fee, subject to certain exceptions for safety, environment, confidentiality and insurance, among others.

Termination for Convenience

The Agreement permits OPG to terminate for convenience from time to time. If OPG terminates the Contractor for convenience, OPG will pay the Contractor (i) amounts due and payable for work performed up to the date of termination; (ii) an equitable portion of the fixed fee that would otherwise have been paid to the Contractor; and (iii) reasonable extra direct damages suffered by the Contractor due to the termination. OPG will not be liable for any consequential damages

and severance costs related to the termination of the Contractor's personnel will only constitute direct damages if agreed to in writing by OPG.

Suspension of the Work

OPG may, upon notice to the Contractor, suspend the work at any time. Except in the event of default or negligence, certain types of reasonable direct damages will be payable by OPG to the Contractor upon suspension of the work. Indirect or consequential losses, including loss of profit, will not be recoverable. Severance costs respecting termination of the Contractor's personnel are only recoverable if OPG agrees in writing. Once OPG issues a notice of resumption, the Contractor must resume performance of work, subject to a reasonable ramp-up period.

Dispute Resolution

The Agreement provides for a tiered dispute resolution process. Disputes must first refer to the project representatives of each party, then to senior management representatives, and then to the steering committee. Any dispute not resolved by the steering committee will then be referred to binding arbitration conducted pursuant to the Arbitration Rules of the ADR Institute of Canada in Toronto, Ontario.

Assignment

The Agreement prohibits either party from assigning the Agreement, in whole or in part, without prior written consent of the other party, except that OPG may assign the Agreement to a successor operator and either party may assign the Agreement as security to its lenders, with the prior written consent of the other party.

Engineering, Procurement and Construction Agreement for the Turbine Generators Refurbishment Project (Units 5 to 8)
Pickering Nuclear Generating Station Refurbishment Program

Summary of Key Terms

Date of Agreement: February 14, 2025

The following is a summary of the key terms and conditions of the Engineering, Procurement and Construction Agreement for the Turbine Generators Refurbishment Project (Units 5 to 8) (Pickering Nuclear Generating Station Refurbishment Project (Units 5 to 8)) dated as of February 14, 2025 (the "**Agreement**") between Ontario Power Generation Inc., ("**OPG**"), as the owner, and Siemens Energy Canada Limited ("**SECL**") and Aecon Nuclear ("**Aecon**") (collectively, the "**Contractor**"), as the contractor. Capitalized terms used but not defined in this summary have the meanings set out in the Agreement.[1]

The form of agreement is an engineering, procurement and construction contract, and the form of agreement reflects extensive feedback from the entire OPG project team, external legal counsel (Blake, Cassels & Graydon LLP) and the Contractor.

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[1] The objective of this summary is to summarize certain provisions of the Agreement and does not purport to give a complete and accurate summary of all provisions of the Agreement. This summary reflects the state of the Agreement as at the date noted above and does not address any changes following such date.

Phased Approach to Refurbishment Work

The Agreement divides the Contractor's work on the Turbine Generators Refurbishment Project into the definition phase and the execution phase. The Agreement further divides the Contractor's work between work that each of SECL individually (engineering, manufacturing, transporting and providing technical field advice support for commissioning turbine generator hardware, performance testing of the hardware) and Aecon and SECL collectively (procuring, receiving, storing and installing turbine generator equipment, providing related field engineering services and providing support for the commissioning of such equipment) with the latter being on a joint and several basis.

- The definition phase commenced February 3, 2025 and will end when each of the Contractor's submittals have been received and approved by OPG and the Contractor has delivered the requisite notice to OPG. During the definition phase, the parties will collaboratively plan and prepare for the execution phase work.
- The execution phase begins when OPG issues the a notice to proceed for the execution phase and ends upon final completion. If the Contractor achieves definition phase completion prior to the date on which OPG issues the notice to proceed for the execution phase, then the parties may agree to performance by the Contractor of execution phase work in advance of the receipt of the notice to proceed upon OPG's approval of a "Standby Plan" submitted by the Contractor. OPG can also change the start date for the execution phase work on each unit upon notice to the Contractor, in which case the Contractor will be entitled to compensation for reimbursable standby and demobilization and remobilization costs upon approval by OPG.

Schedules

The definition phase and execution phase are both governed by a milestone schedule, a target schedule, and a submittal schedule. For both phases, the milestone schedules set out high-level milestones for the work and fix the dates for which the Contractor commits to complete defined aspects of the work. The target schedules establish a detailed project schedule for completion of the work, indicating the dates for starting and entirely completing each component of the work, including references to each milestone. The submittal schedules set out the dates and/or time periods for delivery of required submittals.

The definition phase schedules were agreed upon by the parties and are appended to the Agreement. The execution phase schedules are developed collaboratively by the parties during the definition phase and must be approved by OPG to be final. Once finalized, the milestone schedules, target schedules and submittal schedules may only be changed by an amendment.

Payment of the Contract Price

OPG will pay the Contractor, on a monthly basis and subject to an approved application for payment: (i) its reimbursable costs incurred in connection with the work, plus profit and overhead at set percentages for labour; (ii) its reimbursable costs, plus a mark-up for goods and non-hardware turbine components (e.g., moisture separator reheaters) purchased; (iii) a set mark-up percentage for unionized labour (OPG bears the cost otherwise); and (iv) actual and substantiated costs for transportation of the hardware with a set mark-up. Reimbursable costs are the Contractor's actual costs incurred in the performance of its work and calculated in accordance with the cost allocation table. Reimbursable costs do not include disallowed costs (as per the cost allocation table), any firm price or fixed price costs or any cost that is compensated for through a fixed fee or mark-up. The hardware firm price is excluded from the reimbursable costs and will be paid to the Contractor on a monthly basis for milestones achieved. OPG will also pay AECON on a monthly basis for payroll burden costs according to a pre-determined multiplier. Certain target costs, fees and other pricing elements are subject to escalation.

The Agreement further provides that OPG will pay the Contractor a fixed price or firm price, as applicable, for any work agreed to by the parties through an amendment, and OPG will pay the Contractor annually a fee to maintain its letters of credit. A 5% reimbursable holdback applies to each application for payment submitted by the Contractor. Upon the achievement of the applicable quarterly milestones as specified in the Agreement, the corresponding reimbursable holdback amounts withheld by OPG will be released.

The Contractor may receive a monthly advance reflecting the forecast costs for the upcoming two months. Any outstanding advance will be deducted in full by OPG from payments to the Contractor or repaid by the Contractor on a monthly basis or upon early termination.

Rework

To account for typical rework on a project of this nature, each of the definition phase target cost and execution phase target cost include an allowance equal to 3% of the labour portion of each target cost. Any costs incurred by the Contractor for rework in excess of such allowance will be reimbursable by OPG, but target costs will not be adjusted. Any cost related to rework for work performed on a fixed/firm price basis such as the provision of hardware and any cost related to rework performed by a Subcontractor under a reimbursable work fixed/firm price subcontract is not reimbursable by OPG.

Completion Milestones

The Agreement establishes a process for completion of four major milestones: “Definition Phase Completion”, “Unit Substantial Completion”, “Unit Completion” and “Final Completion”.

Definition Phase Completion – Definition Phase Completion occurs when each of the Contractor’s submittals has been submitted and has received a “Reviewed” or “Reviewed as Noted” comment from OPG and the Contractor has delivered a notice of Definition Phase Completion, following which OPG has delivered a certificate of Definition Phase Completion.

Unit Substantial Completion – Unit Substantial Completion occurs when, in respect of a Unit: (i) all relevant work has been completed; (ii) all required construction completion declaration documentation has been submitted to and accepted by OPG; (iii) the Contractor has provided a punch list approved by OPG; (iv) all submittals referenced in the scope of work have been delivered to, and accepted by, OPG; and (v) the Contractor has delivered a notice of Unit Substantial Completion, following which OPG has delivered a certificate of Unit Substantial Completion. Upon achievement of Unit Substantial Completion for a Unit, OPG will hold back payment equal to $500,000. Such holdback will be released when all Unit punch list items have been completed or corrected.

Unit Completion – Unit Completion occurs when, in respect of a Unit, (i) all work and unit punch list items have been completed; (ii) unit provisional completion has been achieved (i.e., all commissioning work has been completed and such unit is available for service); (iii) all

performance tests have been completed demonstrating successful completion of the performance guarantees; (iv) all performance liquidated damages have been received or set-off by OPG; (v) all vendor and manufacturer documentation has been delivered to, and accepted by, OPG; (vi) the applicable parts of the sites are free of all waste materials or rubbish caused by the Contractor; and (vii) the Contractor has delivered a notice of unit completion, following which OPG has delivered a certificate of Unit Completion.

Final Completion – Final Completion occurs when (i) Unit Completion has been achieved for all Units; (ii) all work has been completed; (iii) the Contractor has delivered to OPG all submittals; (iv) all other documentation has been delivered to, and accepted by, OPG; and (v) the Contractor has delivered a notice of Final Completion. Upon issuance of the certificate of Final Completion by OPG, the Contractor may make a final application for payment, subject to any adjustments or set-off, in accordance with the terms of the Agreement.

Incentives and Disincentives – Costs, Schedule and Performance

This Agreement includes financial incentives and disincentives for the Contractor's ability to meet the target costs and schedules set forth in the Agreement during the definition phase and the execution phase.

Definition Phase – Cost and Schedule Incentives and Disincentives

The Agreement establishes a neutral band [redacted] If the actual amount of reimbursable costs incurred in respect of the definition phase work falls below the neutral band, OPG will pay the Contractor a cost incentive amount calculated based on an incentive factor of [redacted] of the definition phase target cost.

If the actual amount of reimbursable costs incurred in respect of the definition phase work exceeds the definition phase target cost and exceeds the neutral band, the Contractor will pay OPG cost disincentives which are calculated based on two incentive factors. Band two applies after the actual costs exceed the definition phase target cost plus [redacted]. The definition phase cost disincentives are payable on a monthly basis for the invoiced costs of that month one the neutral band has been exceeded.

If the Contractor completes all definition phase work before the scheduled date for Definition Phase Completion, OPG will pay the Contractor an incentive amount per day up to a maximum aggregate incentive amount. If the Contractor completes all definition phase work more than 30 days late, the Contractor must pay OPG a disincentive amount per day late, up to a maximum aggregate disincentive amount.

Execution Phase – Cost and Schedule Incentives and Disincentives

The Agreement establishes a neutral band between the execution phase target cost (4-Unit aggregate) and the execution phase target cost plus [redacted]. If the actual amount of reimbursable costs incurred in respect of the execution phase work falls below the neutral band, OPG will pay the Contractor a cost incentive amount calculated based on an incentive factor of [redacted] up to a maximum cost incentive of [redacted] of the execution phase target cost.

If the actual amount of reimbursable costs incurred in respect of the execution phase work exceeds the neutral band, the Contractor owes OPG cost disincentives which are calculated based on four incentive factors. The execution phase cost disincentives are payable on a monthly basis for the invoiced costs of that month one the neutral band has been exceeded. Additionally, if the actual amount of reimbursable costs exceed [redacted] of the execution phase target cost, OPG has a right to terminate the Agreement.

The schedule incentive and disincentive regime differs for Unit 5, Units 6 and 7, and Unit 8. In each case, OPG will pay the Contractor schedule incentive amounts if the Contractor completes Unit Substantial Completion before the applicable guaranteed date, calculated up to a maximum amount based on a maximum of 50 days early. Unit 5 has a 60 day neutral band (later than the guaranteed date) and the remaining units have a 50 day neutral band. In all cases, if Unit Substantial Completion exceeds the neutral band, the Contractor will pay OPG the applicable schedule disincentive amounts up to a maximum amount of [redacted] (Units 5 and 8) or [redacted] (Units 6 and 7) of the execution phase target cost.

Static Commissioning Schedule Incentives

In order to ensure seamless and timely support through the OPG-led commissioning phase, if the parties collectively complete static commissioning on or before the guaranteed date, OPG will pay the Contractor a fixed incentive amount for a given Unit. If the parties collectively complete static commissioning for a given Unit late, OPG will pay the Contractor an amount equal to the fixed incentive amount less a fixed amount for each full calendar day late (such reductions not to exceed an amount equal to the fixed incentive amount). Additionally, there is no potential for relief (e.g. Excusable Delays) on the static commissioning schedule incentives.

Performance Tests

The Agreement provides a regime for performance testing and guaranteed turbine generator output for certain Units. If a tested Unit fails to achieve the guaranteed output, SECL will pay OPG liquidated damages per kW (net) for the electrical output deficiency, up to a specified maximum amount. If a tested Unit fails to achieve a specified minimum output either SECL will correct the Unit until the minimum output is achieved or OPG can accept payment of the maximum liquidated damages in lieu. If a tested Unit exceeds the guaranteed output, OPG will pay SECL an incentive per kW (net) for the excess electrical output, up to a specified maximum amount.

<u>Project Change Directives, Excusable Delays and Force Majeure</u>

The Agreement permits OPG to issue a project change directive and direct the Contractor to make changes to the scope of work and/or milestone schedules for an enumerated list of circumstances, including excusable delay, changes in law, force majeure delays and concealed conditions. The Contractor may request that OPG issue a project change directive for the same circumstances to change the target cost, the fixed or firm prices or the milestone schedules. In certain cases, OPG is not obliged to accept such request and will not issue a project change directive if certain cost and schedule thresholds are not met. If OPG issues a project change directive, the Contractor is entitled to cost and schedule relief, subject to certain exceptions. Once the changes resulting from a project change directive have been agreed to by the parties, OPG and the Contractor must execute and amendment evidencing any such changes to the work, target cost, any fixed or firm price, and/or milestone schedules.

An “excusable delay” is a delay that is caused by an OPG breach or stop work order, an emergency or hazardous condition for which OPG is responsible, and which extends the critical path of the definition phase milestone schedule or the execution phase milestone schedule by more than three days.

Neither party will be responsible for material delays caused by “force majeure” events for fire, flood, tidal wave, lightening, earthquake, cyclone, tornado, hurricane, explosion, severe ice storm, epidemic or pandemic disease, legal strike or lock-out (other than those caused by the Contractor, a subcontractor, or their employees, or work to rule activities), war, riot, sabotage or other acts of public enemies, including terrorists, or site-related blockades (other than labour-related events), or the inability of Contractor to obtain or delay in the obtaining of any approval required by the scope of work (unless caused by the Contractor). The Agreement also takes a standard approach to scope changes resulting from “concealed conditions” at the site and within the turbine generators. The Contactor is not able to examine all of these areas prior to commencement of the execution phase work.

An “excusable delay” or a “force majeure” event entitles the applicable party to schedule and/or cost relief depending on the type of work (i.e., fixed price, firm price or reimbursable work) impacted by the delay or the event.

Tariff Mitigation Plan

The Agreement sets out that no later than four months following execution, SECL must submit and implement a mitigation plan detailing SECL’s strategy to avoid and mitigate any potential or actual change in hardware customs duties after January 1, 2025. As part of the plan, the Contractor must develop a strategy and working group with OPG and/or the Canadian Nuclear Association to participate in any government consultation processes to advocate for any proposed change in hardware customs duties to have the least potential impact on the Project, and to apply for any available exemptions to any change in hardware customs duties. The Agreement holds that on a quarterly basis, SECL and OPG will meet to discuss tariff-related strategies. Following such meetings, the parties may mutually agree to changes to the specifications of the hardware and adjusting Project schedules and arranging for cost effective

alternatives in order to accommodate importation of hardware prior to any potential change in hardware customs duties.

In order for the Contractor to be eligible to receive cost relief pursuant to a project change directive for changes in hardware customs duties, the Contractor must substantiate it costs and comply with and implement the tariff mitigation plan and other above stated requirements. OPG will receive a dollar-for-dollar credit from SECL, up to a maximum credit amount, that OPG can apply towards ordering of spare parts or technical specification exclusions, for any increased customs duties OPG pays to SECL as a result of changes in hardware customs duties imposed on hardware imports by the USA.

Subcontractors

The Agreement permits the use of subcontractors, for whom the Contractor is solely responsible. The Contractor agrees to enter into a written contract with each subcontractor performing any of the work and to flow down all applicable terms and conditions of the Agreement. Except for Affiliates listed in Exhibit 2.15(d) to the Agreement or an Indigenous Joint Venture, none of the Contractor, its key subcontractors or any successor thereto will, without the prior written consent of OPG, enter into any agreement or arrangement in respect of the Work with a subcontractor that is an Affiliate of any one of them or in which any one of them or their Affiliates has a direct or indirect beneficial interest of 10% or greater.

Scientific Research and Experimental Development (“SR&ED”) Tax Credit

This Agreement provides that OPG is entitled to claim all SRED tax credits generated by Work on the project.

Clean Technology Investment Tax Credits (“ITCs”)

The Agreement provides that OPG is entitled to claim ITCs in respect of eligible equipment on the Project and makes provision for certain prevailing wage, apprenticeship and reporting requirements to be followed by the Contractor.

Performance Security

The Agreement requires SECL and AECON to post one or more letters of credit to support their respective obligations under the Agreement. SECL must provide one or more letter of credit, initially in the aggregate amount of $25,000,000 for its hardware obligations, which may be replaced upon the achievement of Unit Provisional Completion for the applicable Unit for a letter of credit in the amount of $12,500,000, which shall be maintained until the end of the Unit hardware warranty period for the applicable Unit, subject to any extension thereof. The Contractor must provide one or more letters of credit to OPG in an aggregate amount equal to $10,000,000 for all other obligations under the Agreement, which must be increased to $20,000,000 within 30 days of executing the execution phase amendment. Upon Unit Substantial Completion for each Unit, such amount will be reduced by $2,500,000 per Unit, and thereafter upon expiry of the Unit work warranty period, subject to any extension thereof, such amount will be further reduced by $2,500,000 per Unit, until the expiry of the Unit work warranty period for the last Unit to achieve Unit Substantial Completion.

SECL and AECON each provided a parental guarantee in support of all the Contractor's obligations under the Agreement. The Agreement contains ratings-based and/or tangible net worth based tests of ongoing creditworthiness of the parent guarantors.

Intellectual Property

The Agreement requires the Contractor to or cause its subcontractors to assign to OPG the intellectual property ("**IP**") that exists in connection with the scope of work, the submittals, and other deliverables under the Agreement, other than the intellectual property in the hardware and certain Contractor retained intellectual property for which the Contractor grants to OPG a broad license to use for listed permitted purposes.

Warranty

The Agreement provides for a work warranty and hardware warranty (including a software warranty), warranting that the work, goods and hardware will be free from defects and conform to the applicable standards (excluding to the extent that any breach of such warranty is due to (i) maintenance, operation or storage or lay-up by OPG contrary to prudent practices; (ii) conditions of operation outside of those specified by prudent practices; (iii) accidental damage by a force majeure event; (iv) reasonable wear and tear; (v) modifications contrary to prudent

practice; or (vi) the use of free-issued materials accepted on as “as is” and “without warranty” basis).

During the applicable warranty period, the Contractor must correct any defects subject to a warranty correction plan provided to OPG. The correction costs are borne by the Contractor for the work warranty and by SECL for the hardware warranty.

The warranty period for hardware warranties relating to a Unit expires on the earlier of (i) six years following Unit Hardware Delivery Completion for the applicable Unit; or (ii) three years following the applicable Unit Provisional Completion Date for such Unit, subject to extensions. The warranty period for work warranties relating to a Unit, exclusive of software and non-hardware turbine components (“**NHTC**s”) expires on the earlier of: (i) three months after the actual end date of the first planned outage (excluding a forced outage) where inspections take place for the applicable Unit, and (ii) three years from the date of Unit Substantial Completion Date for such Unit. With respect to NHTCs (and exclusive of software), the warranty period is the same as the warranty period for Hardware.

The warranty period for software warranties expires on the earlier of: (i) four and a half years following Unit Hardware Delivery Completion for the applicable Unit; or (ii) one and a half years from the Unit Provisional Completion Date for such Unit.

Where there has been a correction or replacement of any defect, the applicable warranty will continue for the longer of (i) the remainder of the original applicable Unit warranty period or (ii) 12 months following the date that such correction or replacement is completed, but no later than 12 months following the original expiry of the applicable warranty period.

<u>Termination for Default</u>

The Agreement includes standard events of default for OPG and the Contractor. If the Contractor defaults, OPG is entitled to immediately terminate the Agreement by delivering notice to the Contractor and to exercise a number of other remedies, including directing the Contractor to stop performing the work. In the event of a default, the Contractor will be liable to OPG for the amount of all costs incurred by OPG to complete the work and to correct or

replace defects, subject to the Contractor's limitation of liability, calculated as a percentage of the applicable target cost or firm price (subject to certain exceptions for insurance, willful misconduct by the Contractor, indemnity obligations and losses for failure to provide clear title to OPG).

Termination for Convenience

The Agreement permits OPG to immediately terminate for convenience from time to time upon notice to the Contractor. If OPG terminates the Agreement for convenience, OPG will pay the Contractor (i) amounts due and payable for work performed up to the date of termination and (ii) reasonable extra direct costs and expenses incurred by the Contractor due to the termination. OPG will not be liable for any consequential damages and severance costs related to the termination of the Contractor's personnel will only constitute direct damages if agreed to in writing by OPG.

Suspension of the Work

The Agreement permits OPG to suspend the performance of the scope of work at any time, provided that OPG gives no less than three business days' notice to the Contractor. Except in the event of default or negligence, certain types of reasonable direct damages will be payable by OPG to the Contractor upon suspension of the work. Indirect or consequential damages, including loss of profit, will not be recoverable. Severance costs respecting termination of the Contractor's personnel are only recoverable if OPG agrees in writing.

If the suspension continues for more than 30 days, the Contractor can remove its employees from the Project site. If the suspension continues for more than 60 days, the Contractor will postpone all hardware and NHTC production.

Once OPG issues a notice of resumption, the Contractor must resume performance of work, subject to a reasonable ramp-up period.

Dispute Resolution

The Agreement provides for both informal and formal resolution of disputes. The informal procedure, which must be attempted first, contemplates a staged escalation of disputes within

OPG's and the Contractor's management structure with a view to achieving a consensual resolution of the dispute. The formal mechanism is binding arbitration under commercial arbitration rules, which can be utilized should the informal procedure not resolve the dispute.

Assignment

The Agreement prohibits either party from assigning the Agreement, in whole or in part, without prior written consent of the other party, except that OPG may assign the Agreement to a successor operator and either party may assign the Agreement as security to its lenders, with the prior written consent of the other party.

Engineering, Procurement and Construction Agreement

Deep Water Intake Tunnel for Pickering Nuclear Generating Station Refurbishment

Summary of Key Terms

Date of Agreement: July 24, 2025

The following is a brief summary of the key terms and conditions of the Engineering, Procurement and Construction Agreement for the Deep Water Intake Tunnel Project (Pickering Nuclear Generating Station Refurbishment) dated as of July 24, 2025 (the "**Agreement**") between Ontario Power Generation Inc. ("**OPG**"), as the owner, and Deep-Water Intake Group General Partnership, a general partnership between Bessac Canada Ltd., Dodin Quebec Inc. and Janin Atlas Inc. ("**Contractor**"), as the contractor. Capitalized terms used but not defined in this summary have the meanings set out in the Agreement.[1]

The form of the Agreement is based on an engineering, procurement and construction contract, and the form of agreement reflects extensive feedback from the entire OPG project team,

[1] The objective of this summary is to summarize certain provisions of the Agreement and does not purport to give a complete and accurate summary of all provisions of the Agreement. This summary reflects the state of the Agreement as at the date noted above and does not address any changes following such date.

external legal counsel (Blake, Cassels & Graydon LLP), the Contractor and other proponents during a competitive procurement process.

Phased Approach to Contractor Work

The Agreement divides the work on the Deep Water Intake Tunnel Project (the "**Project**") into a definition phase and an execution phase.

- The definition phase commenced on July 24, 2025 and will end when OPG issues the final notice to proceed for the execution phase work and the execution phase amendment is executed. During the definition phase, the parties will collaboratively plan and prepare for the execution phase work, including development of the geotechnical baseline report ("**GBR**") and an environmental management plan.
- The execution phase will commence when the definition phase ends and ends upon final completion. OPG may issue one or more notices to proceed for the execution phase work for complete work packages before the beginning of the execution phase and change the start date of the execution phase work. If OPG accelerates or delays the start date, the Contractor is entitled to any incremental additional allowed costs with applicable profit and overhead. OPG must issue a change directive reflecting the required adjustments to the execution phase target cost and/or execution phase milestone schedule, if applicable. If OPG and the Contractor do not reach an agreement on all components of the execution phase plan by the specified date, OPG may extend the specified date by no more than 12 months or terminate the Agreement for convenience, or the Contractor may terminate the Agreement upon notice to OPG if no extension is provided.

Schedules

The definition phase and execution phase are both governed by a milestone schedule, a target schedule, and a submittal schedule. For both phases, the milestone schedules set out high-level milestones for the work and fix the dates for which the Contractor commits to complete defined aspects of the definition phase work and execution phase work. The target schedules establish a detailed project schedule for completion of the applicable work, including references to milestones and submittals. The submittal schedules set out the dates for the Contractor to submit and finalize each submittal required under the Agreement.

the definition phase schedules were submitted by the Contractor during the request for proposals ("**RFP**") in-market period for the Project and are appended to the Agreement. The preliminary execution phase schedules were also submitted during the RFP in-market period. The final execution phase schedules will be developed collaboratively by the parties during the definition phase and must be approved by OPG to be final. Once finalized, the milestone schedules, target schedules and submittal schedules may only be changed by an Amendment.

Payment of the Contract Price

OPG will pay the Contractor, on a monthly basis and subject to an approved application for payment: (i) its allowed costs and pass-through costs incurred in the previous month; (ii) the monthly portion of the applicable fixed fee (50% of the total fixed fee divided by the applicable number of months in the definition phase or execution phase); (iii) the milestone fixed fee amount associated with any milestones completed; and (iv) any change order fixed fees.

The Contractor may receive a monthly advance reflecting the forecast costs for the upcoming two months. Any outstanding advance will be deducted in full by OPG from payments to the Contractor or repaid by the Contractor.

OPG will hold back 10% of the total amount of each application for payment pursuant to *the Construction Act* (Ontario) and release holdbacks annually, provided the Contractor is not in default and there are no preserved or perfected liens, unless the Contractor elects to deliver to OPG a letter of credit equal to 10% of the Contractor's forecasted annual spend for the applicable contract year.

Substantial and Final Completion

The Agreement establishes a process for completion of two major milestones: "Substantial Completion" and "Final Completion".

Substantial Completion – Substantial Completion will be achieved when (i) "substantial performance" has occurred (as defined in the *Construction Act* (Ontario)); (ii) the Contractor has delivered to OPG the required approvals; (iii) the Project has been commissioned and

meets all specified tests; (iv) the Project is operating materially in accordance with the specifications for a period of at least 72 hours; (v) the Contractor has delivered all required submittals and copies of all reports of performance tests; and (vi) the Contractor has delivered a notice of Substantial Completion to OPG and OPG has delivered a certificate of Substantial Completion to the Contractor.

Final Completion – Final Completion will be achieved when (i) the Contractor has entirely finished or corrected all items on the final punch list and (ii) the Contractor has delivered a notice of Final Completion to OPG and OPG has delivered a certificate of Final Completion to the Contractor. OPG is entitled to hold back $500,000 from the final payments to the Contractor until OPG has determined all goods, work and submittals required under the Agreement have been submitted.

Incentives and Disincentives – Costs, Schedule and Performance

Definition Phase – Cost Incentives and Disincentives

The Agreement establishes a neutral band [redacted] a definition phase target cost. If the actual amount of allowed costs incurred in respect of the definition phase work falls below the neutral band, OPG will pay the Contractor [redacted] of its cost savings up to a maximum amount equal to [redacted] of the definition phase fixed fee. if the actual amount of allowed costs incurred exceeds the neutral band, the Contractor will pay OPG [redacted] of its cost overruns up to a maximum amount equal to [redacted] of the definition phase fixed fee. Cost incentives and disincentives will be payable on the earlier of (i) the effective date of the execution phase amendment and (ii) the date on which the aggregate amount of cost disincentives exceeds the overall limit, subject to early termination.

Execution Phase – Cost Incentives and Disincentives

The Agreement establishes a neutral band [redacted] an execution phase target cost. If the actual amount of allowed costs incurred in respect of the execution phase work falls below the neutral band, OPG will pay the Contractor a percentage of its cost savings up to a maximum amount equal to [redacted] of the execution phase fixed fee. If the actual amount of allowed costs incurred exceeds the neutral band, the Contractor will pay OPG a percentage of its cost overruns up to a maximum amount equal to [redacted] of the execution phase fixed fee. Cost

incentives and disincentives will be payable on the earlier of (i) the Final Completion date and (ii) the date on which the aggregate amount of cost disincentives exceeds the overall limit, subject to early termination.

Milestone Schedule Incentives and Disincentives

If the Contractor achieves Substantial Completion more than 20 days earlier than the guaranteed Substantial Completion date, OPG will pay the Contractor an amount determined in accordance with the Agreement (as a percentage of the execution phase fixed fee) up to a maximum amount equal to [redacted] of the execution phase fixed fee. If the Contractor achieves Substantial Completion by more than 20 days later than the guaranteed Substantial Completion date, the Contractor will pay OPG an amount determined in accordance with the Agreement (as a percentage of the execution phase fixed fee) up to a maximum amount equal to [redacted] of the execution phase fixed fee. Schedule incentives or disincentives are payable on the earlier of (i) Substantial Completion or (ii) the date on which the aggregate amount of disincentives exceeds the overall limit, subject to early termination.

Project Change Directives, Excusable Delays and Force Majeure

The Agreement permits OPG to issue change directives to direct the Contractor to make changes in the work, goods, project, milestone or target schedules, including the suspension of the work. The Agreement restricts the ability of the Contractor to initiate change directives except in specified circumstances and with the prior written consent of OPG, such as claims made upon the occurrence of an “excusable delay” or a “force majeure” event.

If OPG determines a change is required, or if the Contractor notifies OPG that a change order is required, OPG will issue a draft change order for review by the Contractor. After OPG receives the Contractor’s comments on the draft change order, the parties will negotiate a mutually acceptable change order to be executed by both parties.

An “excusable delay” is a delay that is caused by (i) OPG for a stop work order or similar notice, or as requested under the *Nuclear Safety and Control Act* (Canada), a state of emergency, a hazardous condition for which OPG is responsible; (ii) any error or omission in the reliance Information not waived by the Contractor; (iii) unforeseen subsurface conditions or other specified site conditions; (iv) any suspension, termination, interruption, denial, failure or any

delays to issue any necessary approval or permit by any governmental authority; (v) the failure of other OPG contractors or OPG personnel to comply with the agreed access protocol; (vi) suspension by the Contractor of all or any of the work; or (vii) OPG's failure to perform certain obligations under the Agreement.

Neither party will be responsible for material delays caused by "force majeure" events for fire, flood, tidal wave, lightening, earthquake, cyclone, tornado, hurricane, explosion, severe ice storm, epidemic or pandemic disease, legal strike or lock-out (other than those caused by the contractor, a subcontractor, or their employees, or work to rule activities), war, riot, sabotage or other acts of public enemies, including terrorists, or site-related blockades (other than labour-related events), an event beyond the reasonable control of the party claiming relief or that could not have been prevented or avoided by the affected party exercising due diligence and acting in accordance with good industry practice, and the event is not the result of a breach of its obligations under the Agreement.

The Contractor is entitled to receive cost and schedule relief for an "excusable delay" and schedule relief for a "force majeure" event, in proportion to the delay and provided the Contractor did not cause or contribute to the delay.

Customs Duties Mitigation Plan

The Agreement sets out that no later than two months following execution, the Contractor must submit and implement a mitigation plan detailing the Contractor's strategy to avoid and mitigate any potential or actual change in customs duties. The plan will include (i) assessing the reasonable forecast of known and potential tariff risks based on the supply chain proposed to source equipment and materials for the Project with the objective of mitigating cost impacts prior to selecting and contracting with suppliers, (ii) actively identifying alternate manufacturing and sourcing supply chain options for equipment and materials, while still ensuring compliance with the requirements of the Agreement, and (iii) considering adjustments to project schedules to accelerate or expedite the importation of any equipment or materials required for the work or the Project prior to the effective date of any such potential change in customs duties. The Contractor will provide quarterly progress reports. The Contractor will use commercially reasonable efforts (individually or together with OPG) to avoid and mitigate any potential or

actual impact of a change in customs duties on the Project, including, without limitation: (1) participating in any government consultation processes to advocate for any proposed change in customs duties to have the least potential impact on the Project and (2) applying for any available exemptions to or remissions from any change in customs duties.

In order for the Contractor to be eligible to receive cost relief pursuant to a change order for changes in customs duties for import into Canada, the Contractor must substantiate it costs and comply with and implement the customs duties mitigation plan and other above stated requirements.

Subcontractors

The Agreement permits subcontractors for whom the Contractor is solely responsible for. The Agreement lists major subcontractors providing or expected to provide any of the work pursuant to a subcontract. OPG is entitled to review and agree or reject to any such major subcontract and certain other subcontracts.

Scientific Research and Experimental Development ("SR&ED") Tax Credit

The Agreement entitles OPG to claim all SR&ED tax credits generated by the Work and the Contractor agrees to perform the Work relater to the SR&ED on behalf of OPG and agrees that OPG will be entitled to claim all "investment tax credits" arising from the activities of the Contractor under the Agreement.

Performance Security

The Agreement requires the Contractor to provide a letter of credit to support its obligations under the Agreement, initially in an amount equal to [redacted] of the definition phase target price. Following the execution of the execution phase amendment, the Contractor must deliver a replacement or amendment to the letter of credit evidencing an increased amount equal to [redacted] of the Contract Price. Upon the achievement of Substantial Completion, such amount can be reduced to [redacted] of the Contract Price plus an amount equal to the sum of (i) the amount estimated by OPG that would be required for correction or replacement of defective parts of the work, goods or project and (ii) the value of any outstanding claims, up to a maximum of 10% of the Contract Price. Such warranty letter of credit will remain in place following the

expiration of the warranty period (including any extension thereof) until all the Contractor's obligations to correct or replace defective parts has been completed in full and all outstanding claims have been resolved. In the event the Contract Price is adjusted by more than $50,000,000, the Contractor will increase or decrease the amount of the performance letter of credit.

The Contractor provided two parental guarantees in support of all the Contractor's obligations under the Agreement. The obligations of each guarantor under the Agreement are joint and several through its respective Contractor general partner that are each jointly and severally liable for the obligations of the Contractor under the Agreement.

Intellectual Property

The Agreement requires the Contractor to, or to cause its subcontractors to, assign all intellectual property rights created in connection with the work, goods, project, submittals and other deliverables required to be provided under the Agreement to OPG, including confidential information, patents, trademarks, copyrights, and any other intellectual property developed in the course of performing the work. The Contractor and each subcontractor retain ownership rights of any pre-existing intellectual property if they can establish that such intellectual property existed before the earlier of the date of the Agreement or the date that the Contractor commenced the work. In such cases, the Contractor must notify OPG in writing and grant OPG a license to use this retained intellectual property.

Warranty

The Contractor provides a warranty that all Work and Goods will be free from all defects and conform with all specifications and meet or exceed industry standard. The Contractor is required to correct any defective part of the work, goods or project at its own cost. The warranty period for the Agreement is the greater of: (i) two years following the date of Substantial Completion, subject to any extension; (ii) the warranty period specified in any warranty from a Subcontractor for any specific part of the work, goods and project; and (iii) the warranty period specified in the Agreement for any specific part of the work, goods and project (excluding to the extent that any breach of the warranty is due to (i) maintenance or operation by OPG contrary to instructions; (ii) conditions of operation materially more severe than those specified

for the Project; (iii) negligence of OPG or any person providing services to OPG; or (iv) reasonable wear and tear for normal usage).

If there is any correction or replacement of the defective part of the work, goods or Project, then the warranty period will: (1) be extended for an additional 2 years following the correction/replacement of the defective part; and (2) for any part of work that ceases to be used in commercial operations because of the defective part, be suspended at the date that the work is taken out of commercial operation and will be extended for an additional 2 years following the date the work re-enters commercial operation. The warranty period will not extend more than 4 years from the date of Substantial Completion.

Termination for Default

The Agreement includes standard events of default for OPG and the Contractor. If the Contractor defaults, OPG will be entitled to terminate the agreement and to exercise a number of other remedies, including ejecting persons from the site, directing the Contractor to stop performing the Work and correcting defective parts of the work, among others. In the event of a default, the Contractor will be liable to OPG for all costs incurred by OPG to finish the work and correct or replace defects and any other losses suffered by OPG as a result of the default, subject to the Contractor's limitation of liability.

Termination for Convenience

The Agreement permits OPG to immediately terminate the Agreement for convenience at any time, by providing notice to Contractor. Certain types of direct damages (and reasonable extra direct damages) will be payable by OPG to the Contractor in such circumstances.

If the Agreement is terminated before the execution phase, or upon termination during the execution phase, the contractor will transfer title and deliver all unfinished work to OPG and OPG will indemnify the Contractor from all losses suffered as a result of continued use of the definition phase work in the event of any changes to the work, use of unfinished work and use on a different project

Termination for Force Majeure

If a Force Majeure Event lasts longer than 180 days from the date that a party claiming relief due to such Force Majeure Event gives Notice, the party not seeking relief is entitled to terminate the Agreement upon ten Business Days prior Notice.

Suspension of the Work

The Agreement permits OPG to suspend Work at any time. Certain compensation will be payable by OPG to the Contractor in such circumstances.

Dispute Resolution

The Agreement provides for both informal and formal resolution of disputes. The informal procedure utilizes a dispute resolution board made up of impartial members who hear disputes from parties. The formal procedure is binding arbitration under commercial arbitration rules. Parties can choose to proceed by either the informal or formal mechanism, with the option to choose the formal procedure should the informal process not succeed.

Assignment

The Agreement restricts the Contractor from assigning the Agreement without the prior consent of OPG, which may be withheld in OPG's sole and absolute discretion. OPG may, without the consent of the Contractor, assign the Agreement.

Extended Services Master Services Agreements with

E.S. Fox Limited

Date of Agreement: February 12, 2012

Date of Amendment 1: June 28, 2013

Date of Amendment 2: July 1, 2015

Date of Amendment 3: August 1, 2016

Date of Amendment and Restatement: September 27, 2019

Date of Amendment and Restatement: July 31, 2025

Black & McDonald Limited

Date of Agreement: February 12, 2012

Date of Amendment 1: June 28, 2013

Date of Amendment 2: December 16, 2015

Date of Amendment 3: August 1, 2016

Date of Amendment and Restatement: September 27, 2019

Date of Amendment and Restatement: August 22, 2025

SLN-AECON JV

(AECON Construction Group Inc. & SNC-Lavalin Nuclear Inc.)

Date of Agreement: December 19, 2014

Date of Amendment 1: July 7, 2015

Date of Amendment 2: January 1, 2017

Date of Amendment and Restatement: December 23, 2019

Date of Termination: February 15, 2027

Replaced by

AECON Construction Group Inc.

Date of Agreement: August 21, 2025

Summary of Key Terms

Date of Summary: October 21, 2025

The following is a brief summary of the key terms and conditions of the Extended Services Master Services Agreements that were entered into between: (1) Black & McDonald Limited and OPG as of February 12, 2012, as amended by Amendment 1 dated as of June 28, 2013, Amendment 2 dated as of December 16, 2015, Amendment 3 dated as of August 1, 2016, as amended and restated by an Amended and Restated Extended Services Master Services Agreement dated as of September 27, 2019 and as amended and restated by an Amended and Restated Extended Services Master Services Agreement dated as of August 22, 2025; (2) E.S. Fox Limited and OPG as of February 12, 2012, as amended by Amendment 1 dated as of June 28, 2013, Amendment 2 dated as of July 1, 2015, Amendment 3 dated as of August 1, 2016, as amended and restated by an Amended and Restated Extended Services Master Services Agreement dated as of September 27, 2019 and as amended and restated by an Amended and Restated Extended Services Master Services Agreement dated as of July 31, 2025; and (3) AECON Construction Group Inc. ("AECON") and OPG dated as of August 21, 2025.

The form of agreement was developed as an engineering, procurement and construction contract and was intended to serve as a general framework applying to work in support of OPG's nuclear generating stations and related facilities. The agreements reflect extensive feedback from the entire OPG project team, external legal counsel (Torys LLP (as to the original agreements with E.S. Fox Limited and Black & McDonald Limited) and Blake, Cassels & Graydon LLP (as to the original agreement with SNC-Lavalin Nuclear Inc. and AECON acting jointly and severally doing business as a contractual joint venture (the "SNC/AECON JV"), on which the subsequent agreement with AECON was based)), and the contractors.

<u>Contracting Strategy for Extended Services Master Services Agreement</u>

In February of 2012, OPG entered into Extended Services Master Services Agreements ("ESMSAs") with two contractors, Black & McDonald Limited and E.S. Fox Limited, as a result of a competitive process. In order to increase competition between contractors and to mitigate capacity risks, OPG entered into an ESMSA with the SNC/AECON JV, which had also participated in the earlier RFP process for the ESMSAs. The SNC/AECON JV ESMSA was subsequently terminated and OPG entered into a new ESMSA with only AECON. The current

agreements with all three contractors benefited from clarifications and adjustments based on OPG's experience with the work conducted under the ESMSAs.

Performance of Work

The agreement is intended to apply to any work requested by OPG to be performed by the contractor during the term, which extends to August 22, 2030 for Black & McDonald Limited, July 31, 2030 for E.S. Fox Limited and August 22, 2030 for AECON (with an option in the Black & McDonald Limited and E.S. Fox Limited ESMSAs for OPG to renew the agreement for up to five additional years), unless earlier terminated in accordance with the agreement. The contractor is not guaranteed any specific amount of work under the agreement.

When OPG requires work to be performed in relation to its nuclear generating stations and other related facilities, it may issue a work request under the agreement. The work request will include a worksheet listing any relevant OPG specifications, the pricing model applicable to the work, an indication of which of the interface requirements contained in a schedule to the agreement may apply to the work and any other relevant information. OPG has the option, in its sole discretion, of issuing the work request to the contractor alone, or to any other contractors. The contractor must then respond to the work request with the information requested by OPG, including an estimated schedule and cost for performing the work. If OPG accepts the contractor's response, OPG will issue a purchase order for the work, and the contractor will be required to perform all of the work so awarded. Relief from the schedule and cost set forth in the contractor's work request response is strictly controlled under the agreement, as the contractor is expected to have taken into account the relevant aspects of OPG's ongoing nuclear operations in its preparation of the response.

Depending on the type of work requested in the purchase order, specific terms and conditions set out in the appendices to the agreement will apply. The work performed by the contractor under the agreement could consist of (1) engineering, procurement and construction work where OPG is both the owner and the constructor, (2) engineering, procurement and construction work where OPG is the owner and the contractor is the constructor, (3) any combination of engineering, procurement, and construction work or (4) any of these types of work individually. OPG also reserves the right to impose additional terms and conditions as

may be set out in a work request, and to request that any work be performed on a phased basis.

In the event OPG determines certain work to be an emergency, the contractor may be authorized by OPG to proceed with the work without a purchase order, pursuant to the protocols set out in the agreement for “rapid response work”. The contractor is responsible for keeping a list of emergency contacts up to date for the purpose of responding to rapid response work requests as soon as practicable.

Personnel

The agreement requires the contractor to provide an organizational chart identifying personnel who will be involved in the work in any material way by name, title and contact information. OPG may require the contractor to provide résumés for any personnel. Personnel that are named on a purchase order are “key personnel” whose replacement are subject to certain restrictions, such as prior written approval of OPG, and penalties.

The agreement requires that the contractor use its personnel in the most cost-effective and efficient manner to perform the work, taking into account the appropriate experience and qualifications required for each task.

Master Status Report and Schedules

The contractor is required to develop and maintain a master status report for all work performed under the agreement in a form approved by OPG, and to update the report at least once a month for the purposes of providing OPG with the information it requires. Among other things, the master status report should provide an integrated schedule, capacity metrics and forecasting for all purchase orders, show the workloading of all of the contractor’s personnel and track all corrective action.

Additionally, the contractor is required to complete and submit a draft project schedule in respect of the work under each purchase order, which must incorporate and be consistent with the milestones set out in the purchase order, if any. OPG will have the opportunity to review and provide comments on any proposed project schedule, and once approved, the schedule

will be final. The contractor will be entitled to schedule relief only in the event of a project change authorization (or may request schedule relief in the event of an “excusable delay”).

Incentives and Disincentives

The agreement includes financial incentives and disincentives for the contractor’s ability to meet the target costs and schedules.

For target price work, OPG will share cost savings and cost overruns with the contractor based on how the aggregate reimbursable costs compares to the target reimbursable cost. Outside a [redacted] neutral band, OPG will pay the contractor a specified cost incentive amount (as a percentage of cost savings) or the contractor will pay OPG a specified disincentive amount (as a percentage of cost overruns). The applicable percentages increase as the applicable cost savings or cost overruns, as the case may be, exceed specified thresholds.

OPG may include in purchase orders a schedule incentive or schedule disincentive that results in an additional payment from OPG to contractor for early milestone completion or requires contractor to pay OPG for late milestone completion, respectively, subject to limits as set out in the purchase order.

Other Components of the Contract Price

The contract price for projects to be performed under this agreement will be set out in the applicable purchase order, subject to amendments contained in any “project change authorization” (as described below). The work may be provided on a fixed price basis, where the total compensation payable to the contractor for the work under the applicable purchase order is reflected in a fixed price, or on a reimbursable cost basis. Reimbursable costs consist of: (i) labour incurred by the contractor, and (ii) non-labour costs incurred and actually paid by the contractor, and which are calculated in accordance with the applicable reimbursable cost table set out in a schedule to the agreement.

For rapid response work, OPG will pay to the contractor its reimbursable costs (including both labour and non-labour costs) and overhead and profit amounts calculated by multiplying the

estimated reimbursable labour costs by fixed percentages [redacted]

Goods will be supplied at the contractor's actual cost plus an agreed administration fee set out in the worksheet to the purchase order, [redacted]. Rented equipment with a book value of greater than $2,000-$4000, depending on the contractor, will be treated as reimbursable non-labour costs at the contractor's cost plus an agreed administration fee [redacted]

Subcontracts will be priced at the contractor's actual cost plus an agreed administration fee of [redacted] for "first tier contractors".

The contractor is entitled to be reimbursed (without a mark-up) for business expenses in accordance with the business expense reimbursement schedule attached to the agreement.

"Open Book" Approach and Audit Rights

All estimates, costs incurred, contingencies (where applicable) and other pricing, whether in respect of rapid response work, time and material work or target price work, will be developed by the contractor on a fully open book and transparent basis, allowing OPG full review of labour and other quantities, unit prices, rates, quotations, allowances, internal costs and charges and contingencies, as applicable. For fixed price work, OPG may request from the contractor a breakdown of their estimate to enable OPG to evaluate the basis of such estimate.

The agreement requires the contractor to provide OPG with full access to all financial and other records relating to the work performed under the agreement. The agreement also provides OPG with extensive audit rights for all financial and other records that relate to work that is performed on a reimbursable costs basis, with few restrictions on the lookback periods for audits and readjustment of contractor cost claims. OPG is not entitled to dispute or audit any profit, overhead or contingency amounts forming part of the contract price payable in respect of fixed price work.

Performance Security, Insurance and Indemnities

The agreement obliges the contractor to post a letter of credit in the amount of [redacted]. OPG may require that the amount of the letter of credit be increased or decreased at any time in the event OPG reasonably determines there is a material change in the current estimated quarterly spend. In addition, OPG may stipulate in a purchase order that a project-specific letter of credit is required in an amount not to exceed 10% of the contract price of the purchase order. If a project-specific letter of credit is required, the estimated quarterly spend under such purchase order will not be included for the purposes of calculating the amount of the general letter of credit. The contractor must maintain the letter of credit in force until 60 days after all of its obligations under the agreement and any outstanding purchase orders have been satisfied in full, including all warranty obligations.

The Black & McDonald Limited and E.S. Fox Limited ESMSAs contain standard holdback provisions, while the AECON ESMSA does not and instead requires the contractor to provide an additional letter of credit.

In the case of AECON, the contractor provides guarantees from the ultimate parent companies of the contractor in support of all of the contractor's obligations under the agreement. These guarantees contain ratings-based and/or covenant based tests of the ongoing creditworthiness of the parent guarantors.

The agreement contains insurance requirements set out in a schedule to the agreement. The agreement also contains contractor indemnity provisions and limits of liability consistent with general industry standards.

Project Change Authorizations and Excusable Delays

The agreement tightly restricts changes to "project change authorizations", being project change directives issued by OPG (including deemed project change directives for changes in applicable laws, codes and standards) and project change orders agreed by OPG.

The contractor may request a time extension for an "excusable delay" that affects the critical path of the relevant project schedule set out in the purchase order. An "excusable delay" is a

delay that is caused by a stop work order, a state of emergency requiring the contractor to leave the site, a corrective action plan regarding a “hazardous condition”, OPG’s failure to perform certain obligations and severe and unusual weather conditions at the site which could not have been anticipated by an experienced contractor and which exceed the 50 year severity for that weather condition in the applicable area of Ontario.

Under the AECON ESMSA and the Black & McDonald ESMSA, project change authorizations for target price work that result in adjustments to price and schedule shall result in corresponding changes to the target cost and schedule if the project change authorization is required as a result of: (1) a change in applicable laws (not related to taxes) or if there are new Canadian federal or provincial sales, use or excise taxes, duties or any changes in the rates or applicability of such taxes and duties; (2) a force majeure event or excusable delay (discussed below) for the AECON ESMSA or a force majeure event only for the Black & McDonald Limited ESMSA; (3) an amendment to OPG specifications; (4) a suspension of work; (5) a project change directive issued by OPG which has a mutually agreed upon cost and/or schedule impact; (6) an annual escalation when the project schedule is extended by OPG; (7) changes in OPG policies and procedures that directly impact the work; or (8) changes resulting from amendments to certain labour agreements.

Neither party will be responsible for delays caused by a “force majeure event”, which are restricted to fire, flood, tidal wave, lightning, earthquake, cyclone, tornado, hurricane, explosion, severe ice-storm, epidemic or pandemic disease, embargo, sanction, boycott, legal strike or lockout by persons working at the applicable site (excluding lockouts initiated solely by contractor or the subcontractor or its employees, or work to rule activities), war, riot or act of public enemies, including terrorists, or site related blockades (other than labour related events).

Subcontractors

The agreement permits the use of subcontractors, provided OPG does not object to any such subcontractor. Certain “first tier subcontractors” are identified on a schedule to the agreement, and OPG must be notified immediately if there are any changes to the identity of the first tier

subcontractors, or to the work to be performed by them. Any such changes to the first tier subcontractors must be approved by OPG.

Intellectual Property

The agreement requires the contractor to transfer to OPG, or to license to OPG, all intellectual property required for the performance of the work.

Warranty

The warranties in respect of the work are determined on a project by project basis and are set out in the terms and conditions applicable to the type of work set out in the relevant purchase order.

Scientific Research and Experimental Development ("SRED") Tax Credit

The agreement provides that OPG is entitled to claim all SRED tax credits generated by the work under the agreement.

Termination for Default

The agreement includes standard events of default. If the contactor defaults, OPG will be entitled to terminate the agreement and to exercise a number of self-help remedies.

If an event of default occurs under a specific purchase order that does not permit OPG to terminate the entire agreement for cause, OPG has several self-help remedies available to it in respect of the remaining work under the relevant purchase order.

Termination for default would permit OPG to make a claim against the contractor for full contractual damages (subject to a percentage cap formula that is linked to the total contract price and certain other amounts).

Termination for Convenience

The agreement permits OPG to terminate the agreement or any purchase order for convenience at any time. Certain types of direct damages (but not full contractual damages) will be payable by OPG to the contractor in such circumstances.

Suspension of Work

The agreement permits OPG to suspend the work under any purchase order, in whole or in part, at any time. Reasonable incremental direct costs (but not full contractual damages) will be payable by OPG to the contractor in such circumstances, provided that the contractor takes all commercially reasonable steps to mitigate such costs, including redeploying its personnel.

OPG may also order the contractor to suspend the work as a result of a situation that puts such work, any part of the work site or any people at risk (a “stand down order”), for example in the case of a human performance error, or a procedural or environmental issue. If the stand down order is not caused by the contractor, its subcontractors or its personnel, OPG will compensate the contractor for the direct costs and expenses resulting from the stand down order, unless the stand down order results from an “excusable delay”.

Dispute Resolution

The agreement provides for both informal and formal resolution of disputes. The informal procedure contemplates a staged escalation of disputes within OPG’s and the contractor’s management structure with a view to achieving a consensual resolution of the dispute. The formal mechanism is binding arbitration under commercial arbitration rules. The agreement limits the recourse of the contractor and OPG to the ordinary courts.

Project Title:			
OPG Organization:			
Worksheet Number:		**Revision:**	000
Purchase Order & Line #:	TBD	**Revision:**	000
Unit #:			
Contractor:	TBD		

APPROVALS:			
OPG Representative:	_____ Name & title	Date:	
Contractor Representative:	_____ *[Name & title]*	Date:	

The purpose of this Worksheet is to document the Project specific details for a specific Project awarded under the ES MSA. Once finalized the approved Worksheet will be included in the Purchase Order awarded to the Contractor.

As specified in the ES MSA, the Agreement between OPG and the Contractor in respect of the Project consists of the ES MSA, the applicable Appendix, schedules, exhibits and the terms and conditions set out in the Worksheet which is included in the Purchase Order. This Worksheet cannot amend terms in the ES MSA except as expressly provided in the ES MSA.

This Worksheet is not to be used for Rapid Response Work or Augmented Staff Purchase Orders. Contact the MSA Representative for the form of the Worksheet to be used for these types of Work.

Capitalized terms have the meanings given to those terms in the ES MSA and the applicable Appendix.

For certainty, in cases of conflict the requirements of section 1.9 of the ES MSA apply.

Information to aid the preparer in filling in the Worksheet is attached at the end of this document.

A copy of all communications regarding the Worksheet should be sent the following:

- For Refurbishment Project Worksheets send a copy to NR.ESMSA.COMMERCIAL@opg.com
- For Projects and Modifications Worksheets send a copy to ESMSA.REPRESENTATIVE@opg.com

#	Item	Applicable ES MSA Section	Details of Required Information
DESCRIPTION OF WORK:			
1.1	Type of Work	2.3	☐ Engineering, procurement, and construction – OPG owner and constructor (Appendix 1) ☐ Engineering, procurement, and construction – OPG as owner only (Appendix 2) ☐ Engineering (Appendix 3) ☐ Procurement (Appendix 4) ☐ Construction (Appendix 5) ☐ Engineering and procurement (Appendix 6) ☐ Engineering and construction (Appendix 7) ☐ Procurement and construction (Appendix 8) **Additional information**
1.2	OPG Specifications	1.1(zz) and 3.9(g)	OPG Specifications, including any scopes of work, are attached as **Attachment 1** of this Worksheet. **Additional information**
1.3	Interface Requirements	1.1(nn) 1.1(xxxx) and Schedule 6	The Interface Requirements ☐ DO ☐ DO NOT apply to the Work. The applicable Interface Requirements and project specific deviations for this Work are attached as OPG Specifications in **Attachment 1** to this Worksheet. **Additional information**
1.4	OPG's Quality Assurance Program	3.10(f)	The quality assurance program for the Work is ☐ CONTRACTOR ☐ OPG Project specific requirements for the quality program are documented in the OPG Specifications in **Attachment 1** to this Worksheet. **Additional Information**

#	Item	Applicable ES MSA Section	Details of Required Information
1.5	Maintenance Services	6.10 of Appendix 1 5.10 of Appendix 2 6.10 of Appendix 5 or 6.10 of Appendix 8	Maintenance services are ☐ REQUIRED ☐ NOT REQUIRED as part of the Work and are specified in the OPG Specifications in **Attachment 1** to this Worksheet. **Additional Information**
1.6	Inspections, Tests and Approvals	6.3 of Appendix 1 5.3 of Appendix 2 3.3 of Appendix 4 6.3 of Appendix 5 3.3 of Appendix 6 or 6.3 of Appendix 8	The Contractor is responsible for all inspections, tests and approvals required as part of the Work, including any additional inspections, tests, and approvals specified in the OPG Specifications in **Attachment 1** to this Worksheet. **Additional Information**
1.7	Other Project Meetings	3.3(g) and 2.2 of Appendix 1 2.2 of Appendix 2 2.2 of Appendix 3 2.2 of Appendix 4 2.2 of Appendix 5 2.2 of Appendix 6 or 2.2 of Appendix 8	Additional project meeting requirements for the Work are specified in the OPG Specifications in **Attachment 1** to this Worksheet. It is understood that the frequency of project meetings may change based on the phase of the Project. **Additional Information**
1.8	Cyber Security	3.7 Schedule 3.7	Cyber Assets included in the Work are: - Priority One Cyber Assets are: - Priority One Cyber Services are: - **Additional Information**
PRICING:			
2.1	Pricing	8.1	The pricing model for this Work is: ☐ Performance Fee Work (not applicable) ☐ Fixed Price Work

<table>
<tr><th>#</th><th>Item</th><th>Applicable ES MSA Section</th><th>Details of Required Information</th></tr>
<tr><td></td><td></td><td></td><td>☐ Non-Performance Fee Work

The agreed to Contract Price pricing for the Work is:
<table><tr><td>Performance Fee Work:</td><td>$ ****</td></tr><tr><td>Performance Fee Work Consent to Proceed (In accordance with 8.1(c)(2) of the ES MSA, OPG has provided consent to proceed Notice(s) for this amount permitting the Contractor to proceed with the Performance Fee Work.)</td><td>$ ****</td></tr><tr><td>Fixed Price Work:</td><td>$ ****</td></tr><tr><td>Non-Performance Fee Work:</td><td>$ ****</td></tr><tr><td>Total Contract Price:</td><td>$ ****</td></tr></table>The Work included in the non-Performance Fee Work is documented in section 2.6 of this Worksheet. Additional details of the Contract Price are outlined in Attachment 2 to this Worksheet.

*The non-Performance Fee Work of $XXX includes EPSCA ($XXX) and Training ($XXX).

Additional details of the funding release are provided in Attachment 2 to this Worksheet.

NOTE: This revision incorporates all previously agreed to changes to the Contract Price, including all signed PCAs, CTPs and release memos.</td></tr>
<tr><td>2.2</td><td>Goods</td><td>8.1(f)</td><td>The administration fee for all Goods is as per the ES MSA.

TBD %</td></tr>
<tr><td>2.3</td><td>Business Expenses</td><td>8.1(j)
<u>and</u>
Schedule 8</td><td>The Contractor

☒ WILL ☐ WILL NOT

be reimbursed for business expenses in accordance with the OPG Business Expense Reimbursement Schedule for the following project roles:

- ****

The Contractor will notify OPG in advance and in a timely manner of any upcoming business expenses.</td></tr>
</table>

#	Item	Applicable ES MSA Section	Details of Required Information
2.4	Specialty Work	8.1(p) and 8.1(q)	The Work ☐ DOES ☐ DOES NOT include specialty work. Any specialty work is defined in the OPG Specifications in **Attachment 1** to this Worksheet. The amount of specialty work is 0%. Adjustments to the Reimbursable Labour Costs Table for non-trades are: - none **Additional Information**
2.5	Reimbursable Non-Labour Costs	1.1 (ffff) and Schedule 5	Disallowed costs will be in accordance with Schedule 5 of the ES MSA with the following project specific deviations: - none **Additional Information**
2.6	Non-Performance Fee Work		Work that is included in the Contract as non-Performance Fee Work is: - Small Tools - Consumables - In-Processing and Training - Contractor Business Expenses / EPSCA **Additional Information**
SCHEDULE:			
3.1	Key Milestone Dates	3.8(b)	A list of Key Milestones are specified in **Attachment 3** of this Worksheet. **Additional Information**
3.2	Development of Project Schedule	3.8(b)	The Contractor must submit its draft Project Schedule **TEN** Business Days after the date of issue of the Purchase Order. The finalized Project Schedule must be approved by **OPG**. **Additional Information**
3.3	Requirements for Project Schedule	3.8(c)	The Project Schedule will meet the ES MSA requirements with the following exceptions: - none

#	Item	Applicable ES MSA Section	Details of Required Information
			Any additional requirements for the Project Schedule are specified in the OPG Specifications in **Attachment 1** to this Worksheet. **Additional Information**
3.4	Adherence to Project Schedule	3.8(d)	The Contractor will adhere to the OPG approved Project Schedule. **Additional Information**
3.5	Progress Updates	3.8(e)	The Contractor will provide a **WEEKLY** (e.g. Weekly) report indicating the status and progress of the Work that meets the requirements specified in the ES MSA. Project specific deviations are specified in the OPG Specifications in **Attachment 1** of this Worksheet. **Additional Information**
LOCATION:			
4.1	Site	1.1(kkkk)	All Work will be performed at **TBD Nuclear Generating Station** **Additional Information**
4.2	Designated Areas	3.4(a)	The Contractor will ensure that Work is restricted to the designated areas specified in the OPG Specifications in **Attachment 1** of this Worksheet. **Additional Information**
4.3	Access by Other OPG Contractors	3.4(h)	The provisions of Section 3.4 (h) ☒ DO ☐ DO NOT apply. The Contractor will comply with the Access Request Protocol, N-FORM-11584. **Additional Information**
PERSONNEL:			
5.1	OPG's Project Representative	1.1(ccc) and 4.2	OPG's Project Representative is: Name: Title: Contact Information: Phone:

#	Item	Applicable ES MSA Section	Details of Required Information
			Email: **OPG's Designated Delegates is:** **OPG's Designated Delegate's scope of authority includes decisions regarding scope, schedule, quality and commercial issues for the Work and changes to the Contract Price up to $250,000 in the aggregate. Changes greater than $250,000 require approval from OPG's Project Representative.** Designated Delegate's Contact Information: Name: Phone: Email:
5.2	Contractor's Project Representative	1.1(t) and 3.1(g)	The Contractor's Project Representative is: Name: **** Title: **** Contact Information: **** **Additional Information**
5.3	Contractor's Key Personnel	1.1(oo) and 3.2(e)	Key Personnel are: **** **Additional Information**
5.4	List of Subcontractors	3.12(a)	The Contractor ☐ WILL ☐ WILL NOT be using Subcontractors to perform the Work. A list of Subcontractors proposed for this Project are listed in **Attachment 4** to this Worksheet. All Subcontractors which will perform Work in OPG Nuclear shall have a standing of "C" or better in ISN. If an exception is required the Contractor must obtain OPG approval to use the Subcontractor prior to any Work being performed.

#	Item	Applicable ES MSA Section	Details of Required Information
			OPG reserves the right to reject and ask the Contractor to replace, any such Subcontractors which do not meet the criteria for working on Site. **Additional Information**
5.5	Management of Subcontractors	3.12(e)	As specified in the OPG Specifications in **Attachment 1** to this Worksheet, a Subcontractor Management Plan ☐ IS ☐ IS NOT required. If required, the Subcontractor Management Plan is included as **Attachment 5** to this Worksheet. **Additional Information**
SUBMITTALS:			
6.1	Submittals	1.1(rrrr) and 3.7(a)	Requirements for Submittals are listed in the OPG Specifications in **Attachment 1** to this Worksheet. **Additional Information**
6.2	Submittal Schedule	3.9(b)	Requirements as per the ES MSA with the following deviations: - none **Additional Information**
6.3	OPG Review Period	3.9(c)	The Project Schedule will allow for an OPG review period of **TEN** Business Days for all Submittals. **Additional Information**
6.4	Review of Submittals by Contractor	3.9(d)	Requirements as per ES MSA with the following deviations: - none **Additional Information**
6.5	Return of Submittals	3.9(e)	Requirements as per ES MSA with the following deviations: - none **Additional Information**
PROCUREMENT:			
7.1	Goods	2.7(a) of Appendix 1 2.7(a) of Appendix 2	Contractor is responsible for procurement of all Goods consistent with the ES MSA and as specified in the OPG

#	Item	Applicable ES MSA Section	Details of Required Information
		2.7(a) of Appendix 5 or 2.7(a) of Appendix 8	Specifications in **Attachment 1** to this Worksheet with the following deviations: All scaffolding materials will be supplied by: ☐ OPG ☐ CONTRACTOR Welding consumables, if required, will be managed in accordance with **Attachment 6** to this Worksheet. **Free Issue Materials listed in Attachment 7 will be provided by OPG as per item #7.3 of this Worksheet. All small tools and consumables will be provided by OPG as Free Issue Materials.**
7.2	Procurement Plan	2.7(c) of Appendix 1 2.7(c) of Appendix 2 2.6(b) of Appendix 4 2.7(c) of Appendix 5 2.8(b) of Appendix 6 or 2.7(c) of Appendix 8	A Procurement Plan is ☐ REQUIRED ☐ NOT REQUIRED **Additional Information**
7.3	Free Issue Materials	3.8(d) and Schedule 13	Free Issue Materials ☐ WILL ☐ WILL NOT be provided by OPG. A list of Free Issue Materials is provided in **Attachment 7** to this Worksheet. The Contractor will identify when Free Issue Materials are required from OPG in the Project Schedule. **Additional Information**
APPLICATION FOR PAYMENT:			
8.1	Applications for Payment	8.3(a)	The Contractor will submit an Application for Payment on a **WEEKLY** basis. Milestone payments and fixed fee payments, if required, will be paid to the Contractor in accordance with **Attachment 8** to this Worksheet. **The Contractor shall provide a weekly cost report in a digital format. The weekly cost report will be broken down per Oncore Activity with details including but are not limited to: Original Budget, Approved Change Requests, Current Contract Values, Released Funds, LTD Oncore invoices, LTD Cost Accrued, LTD Actual, % Spend on current contract price, % Complete, LTD Earned Value, and Forecast at Complete. No**

#	Item	Applicable ES MSA Section	Details of Required Information
			Invoice will be required to be paid if it is not submitted to OPG within 180 days of the performance of the work to which the invoice relates.
DELAYS:			
9.1	Notice of Delay	7.2(b)	The Contractor will provide Notice to OPG within **SEVEN** Business Days about the commencement of a Delay using the 'Notice of Delay' form, a copy of which is included as **Attachment 9** to this Worksheet. **Additional Information.**
PERFORMANCE INDICATORS:			
10.1	Project Specific Performance Indicators	5.1(h)	Contractor performance ☐ WILL ☐ WILL NOT be measured using Project-specific Performance Indicators on a stand-alone basis using the Project-specific score card in **Attachment 10** to this Worksheet. **Additional Information**
APPROVALS:			
11.1	Approvals	3.5(b) and 4.1(c)	Requirements as per the ES MSA with the following exceptions: - none **Additional Information**
SUBSTANTIAL AND FINAL COMPLETION:			
12.1	Substantial Completion	1.1(ssss) and 3.4(b) and 5.1 of Appendix 1 4.1 of Appendix 2 5.1 of Appendix 5 or 5.1 of Appendix 8	Requirements for Substantial Completion include all requirements specified in the ES MSA and the following additional requirements: - none **Additional Information**
12.2	Final Completion	1.1(dd) and 3.4(b) and	Requirements for Final Completion include all requirements specified in the ES MSA and the following additional requirements:

#	Item	Applicable ES MSA Section	Details of Required Information
		5.2 of Appendix 1 4.2 of Appendix 2 5.1 of Appendix 5 or 5.1 of Appendix 8	- Support post window lessons learned meeting held with representatives from each of the execution groups and lessons learned are documented. - HDOCs accepted as per N-GUID-00120-10128 for construction and N-GUID-00680-10000 for materials. **Additional Information**
INSURANCE:			
13.1	Insurance Requirements	6.3 Schedule 12	☐ Schedule 12, Part A applies. ☒ Schedule 12, Part B applies. Deviations from these requirements are not permitted.
WARRANTY:			
14.1	Warranty Provisions	6.1(a) of Appendix 1 5.1(a) of Appendix 2 3.1(a) of Appendix 3 3.1(a) of Appendix 4 6.1(a) of Appendix 5 3.1(a) or Appendix 6 or 6.1(a) of Appendix 8	The warranty provisions are as defined in the ES MSA including the following project specific additional warranties: - none **Additional Information**
14.2	Warranty Period	6.8(a) of Appendix 1 5.8(a) of Appendix 2 1.1(j) or Appendix 3 1.1(m) or Appendix 4 6.8(a) of Appendix 5 1.1(o) or Appendix 6 or 6.8(a) of Appendix 8	The Warranty Period is as defined in the ES MSA with the following project specific deviations: - none **Additional Information**
MANAGEMENT PLANS:			
15.1	Project Site Specific Safety Plan	2.3(h)(1) of Appendix 1 2.3(h)(1) of Appendix 2 2.3(h)(1) of Appendix 5	A project site specific safety plan is ☐ REQUIRED ☐ NOT REQUIRED **Additional Information**

#	Item	Applicable ES MSA Section	Details of Required Information
		or 2.3(h)(1) of Appendix 8	
15.2	Job Safety Analysis	2.3(h)(2) of Appendix 1 2.3(h)(2) of Appendix 2 2.3(h)(2) of Appendix 5 or 2.3(h)(2) of Appendix 8	A job safety analysis is ☐ REQUIRED ☐ NOT REQUIRED **Additional Information**
15.3	Safety Program	2.3(c)(2) of Appendix 1 2.3(c)(2) of Appendix 2 2.3(c)(2) of Appendix 5 or 2.3(c)(2) of Appendix 8	The Contractor's safety program is ☐ REQUIRED ☐ NOT REQUIRED and is attached as **Attachment 11** to this Worksheet. **Additional Information**
15.4	Environment Management and Protection Plan	2.4(a) of Appendix 1 2.4(a) of Appendix 2 2.4(a) of Appendix 5 or 2.4(a) of Appendix 8	Contractor's environmental management and protection program and plan is ☐ REQUIRED ☐ NOT REQUIRED and is attached as **Attachment 12** to this Worksheet. **Additional Information**
INFORMATION WAIVER:			
16.1	Information Waiver	3.1(j)	The Contractor must satisfy itself with respect to the accuracy and/or completeness of any information, assumptions or representations provided or made available by any member of the OPG Group except for: - none **Additional Information**
OTHER TERMS AND CONDITIONS:			
17.1	Contractor's Risk Register		The Contractor is

#	Item	Applicable ES MSA Section	Details of Required Information
			☒ REQUIRED ☐ NOT REQUIRED to submit a risk register as part of the Work Request Response as **Attachment 13** to this Worksheet. **Additional Information**

ATTACHMENT 1: OPG SPECIFICATIONS *[MANDATORY]*

Document #	Title	Revision	Embedded File
N-COI-00120-00001	Contractor / Owner Interface Requirements for Nuclear	R000	N-COI-00120-00001.pdf
		R000	
		R000	

Additional Information

ATTACHMENT 2: PRICING *[MANDATORY]*

PO Line	Description	Pricing Model	Holdback	Value
0001	Construction	Non-Performance Fee	No	
0001	Construction – EPSCA	Non-Performance Fee	No	
0001	Construction – Training	Non-Performance Fee	No	
			TOTAL CONTRACT PRICE	

PO Line 0001 - Construction

PO Line Summary	Released	PCA	CTP	EPSCA	Training	Total

PO Line Summary	Released	PCA	CTP	EPSCA	Training	Total
Contract Value						

ATTACHMENT 3: KEY MILESTONES *[MANDATORY]*

Milestone Title	Accountability	Date	Completion Criteria
Design Complete	OPG		
All Construction Work Packages Completed and Issued	Contractor		
Installation Phase 1 Completion	Contractor		
Partial Available for Service	OPG		
Substantial Completion	Contractor		
Installation Phase 2 Completion	Contractor		
Available for Service	OPG		
Final Completion	Contractor		

Additional Information

OPTIONAL ATTACHMENTS:

Attachment	Required (Y/N)	Document #, Title, & Revision	Embedded File
ATTACHMENT 4: List of Subcontractors	Yes		
ATTACHMENT 5: Subcontractor Management Plan	Yes		

Attachment	Required (Y/N)	Document #, Title, & Revision	Embedded File
ATTACHMENT 6: Welding Consumables	Yes		
ATTACHMENT 7: Free Issue Materials	Yes		
ATTACHMENT 8: Applications for Payment	No		
ATTACHMENT 9: Notice of Delay Template	Yes	Notice of Delay	Notice of Delay Template.docx
ATTACHMENT 10: Project Specific Score Card	No		
ATTACHMENT 11: Safety Program	Yes		
ATTACHMENT 12: Environmental Management and Protection Plan	Yes		
ATTACHMENT 13: Risk Register	Yes		
ATTACHMENT 14: Procurement Plan	Yes		
ATTACHMENT 15: Site Specific Safety Plan	Yes		

CHANGE HISTORY

Incorporated Changes	Change Date	Details

Additional Information

REVISION HISTORY:

Revision	Date	Changes Made
000	TBD	Initial release

INSTRUCTIONS FOR FILLING IN THE WORKSHEET

The following information is provided to aid in completing the Worksheet. This information is for reference only and does not need to be included in the Purchase Order.

The information in this table is organized in the same format at the main table in the Worksheet.

#	Item	Instructions
1.1	Type of Work	*OPG to specify the applicable appendix as part of the Work Request. Once specified, the terms and conditions in the applicable Appendix apply in addition to the provisions in the overall Agreement.*
1.2	OPG Specifications	*OPG to attach all OPG Specifications as part of the Work Request in Attachment 1. OPG Specifications may need to be updated prior to Purchase Order award to incorporate any assumptions and/or clarifications identified by the Contractor as part of their Work Request Response and/or negotiations.*
1.3	Interface Requirements	*OPG to specify if COIR applies to the Work. OPG to attach Project specific deviations, using N-FORM-11583, as part of the Work Request.*
1.4	OPG's Quality Assurance Program	*OPG to specify as part of the Work Request if OPG's QA program applies to any part of the Work. Specific details of the quality program needs to be spelt out in the scope of work.*
1.5	Maintenance Services	*OPG to specify in the scope of work attached to the Work Request any maintenance Services and related Goods required for the Project.*
1.6	Inspections, Tests and Approvals	*OPG to specify in the scope of work attached to the Work Request any additional inspections, tests, and/or approvals required for the Project.*
1.7	Other Project Meetings	*OPG to specify in the scope of work attached to the Work Request any meeting requirements (type and/or frequency) that exceed the requirements in the ES MSA (refer to the applicable appendix).*
1.8	Cyber Security	*NEW IN TEMPLATE REVISION 003* *OPG to specify if the Contractor is providing any Cyber Assets, Priority One Cyber Assets, or Priority One Cyber Services as defined in Schedule 3.7 of the ES MSA as part of the Work. OPG is also to specify if any computing hardware, software, firmware or other computing or information technology is not considered a Cyber Asset.*
2.1	Pricing	*OPG to specify as part of the Work Request all clauses of 8.1 which apply. Contractor to update as required as part of the Work Request Response. Agreed to Contract Price to be inserted prior to PO award.* *All Work where it has been determined that the Performance Fee will not be withheld is considered non-Performance Fee Work. Possible examples include Business Expenses, Goods, or training.* *NOTE: Rapid Response Work does not use a Worksheet and must be documented in accordance with the ES MSA. An alternate Worksheet template is available for Augmented Staff Work.*
2.2	Goods	*Administration fee to be finalized prior to PO award. Administration fee shall not exceed the amount agreed to in the ES MSA.*
2.3	Business Expenses	*OPG to specify as part of the Work Request if business expenses will be reimbursed. Contractor to add names as part of the Work Request Response.*
2.4	Specialty Work	*Specialty work needs to be agreed to by both Parties.*

#	Item	Instructions
2.5	Reimbursable Non-Labour Costs	*Schedule 5 requires OPG consent for the Contractor to charge costs related to the following categories of staff:* - *Directors above the level of project director;* - *Secretaries and clerks;* - *Personnel staff;* - *General management and departmental management;* - *Legal staff and/or legal advisors;* - *General accountancy staff;* - *Administrative staff; and* - *Procurement and purchasing staff.* *The name and role of every individual from the above categories needs to be included in order to be considered a Reimbursable Labour Cost.*
2.6	Non-Performance Fee Work	*All Work where it has been determined that the Performance Fee will not be withheld is considered non-Performance Fee Work. Possible examples include Business Expenses, Goods, or training.* *A list of all Work included in this pricing model to be included prior to finalizing the Contract.*
3.1	Key Milestone Dates	*OPG to provide a list of Key Milestones for the Project in the Attachment, including the requirements that need to be met to prove the milestone has been achieved.*
3.2	Development of Project Schedule	*OPG to document as part of the Work Request the date by which the Contractor must submit its draft Project Schedule. The requirement in the ES MSA is five days from the date of issue of the Purchase Order. OPG to add any requirements for finalization / approval of the Project Schedule. The approved Project Schedule is required for enforcement of 3.6(d)*
3.3	Requirements for Project Schedule	*OPG to specify if there are any exceptions to the requirements in 3.6(c) as part of the Work Request. Any additional requirements should be specified in the scope of work.*
3.4	Adherence to Project Schedule	*See notes under 'Development of Project Schedule.'*
3.5	Progress Updates	*OPG to specify if the requirement deviates from the weekly requirement specified in the ES MSA as part of the Work Request. Any specific details for the status report need to be included in the scope of work.*
4.1	Site	*OPG to specify as part of the Work Request the Site where the Work is to be performed.*
4.2	Designated Areas	*OPG to specify the designated areas and any site specific requirements for the designated areas in the scope of work that is attached as part of the Work Request.*
4.3	Access by Other OPG Contractors	*OPG to specify as part of the Work Request. NOTE: The ES MSA refers to N-FORM-11594 however the correct reference is N-FORM-11584.*
5.1	OPG's Project Representative	*OPG to insert the name, title, and contact information as part of the Work Request. OPG's Project Representative is the individual designated to act as OPG's representative in dealings with the Contractor in respect to the Project.*
5.2	Contractor's Project Representative	*Contractor to insert the name, title, and contact information as part of the Work Request Response. The Contractor's Project Representative is the individual designated by the Contractor to act as the Contractor's representative in dealings with OPG for this Project.*
5.3	Contractor's Key Personnel	*Contractor to insert the name(s), title, and contact information as part of the Work Request Response. The Contractor <u>will not</u> replace any Key Personnel without the prior written consent of OPG's Project Representative, except as allowed in 3.2(e)]*

#	Item	Instructions
5.4	List of Subcontractors	*Contractor to confirm if Subcontractors will be used and attach list as part of the Work Request Response including name, address and/or resume for all Subcontractors.*
5.5	Management of Subcontractors	*OPG to specify as part of the Work Request if a Subcontractor Management Plan is required. Contractor to attach the Subcontractor Management Plan as part of Work Request Response.*
6.1	Submittals	*OPG to include Submittal requirements in the scope of work, including submission method.*
6.2	Submittal Schedule	*OPG to specify as part of the Work Request if there are any deviations from the ES MSA requirement for the Contractor to provide a progressive, timely, and orderly flow of Submittals to OPG's Project Representative.*
6.3	OPG Review Period	*OPG to specify as part of the Work Request. The default ES MSA requirement is 10 Business Days however this can be modified as part of the Work Request.*
6.4	Review of Submittals by Contractor	*OPG to specify as part of the Work Request if there is any deviations from the ES MSA requirement that the Contractor review all Submittals prior to submission to OPG's Project Representative.*
6.5	Return of Submittals	*OPG to specify as part of the Work Request if there are any modifications to the ES MSA requirements that OPG's Project Representative will return Submittals to the Contractor indicating if any revisions are required and requirements regarding the extent of OPG's review of Submittals.*
7.1	Goods	*OPG to specify in the Work Request any deviations from requirements specified in the ES MSA and applicable Appendix. OPG to remove requirements for welding consumables, and the applicable attachment, if not required for the Work.*
7.2	Procurement Plan	*OPG to specify as part of the Work Request if a Procurement Plan is required. Requirements for the Procurement Plan are specified in the COIR.*
7.3	Free Issue Materials	*OPG to specify as part of the Work Request any Free Issue Materials that will be provided to perform the Work.*
8.1	Applications for Payment	*OPG to specify as part of the Work Request if the application for payment frequency is other than monthly and attach a payment schedule for milestones and/or the fixed fee.*
9.1	Notice of Delay	*OPG to specify as part of the Work Request if there is any deviation from the ES MSA requirement to provide Notice within seven Business Days.*
10.1	Project Specific Performance Indicators	*OPG to specify in the Work Request if Project-specific Performance Indicators and score card will be used. A Project-specific score card replaces Schedule 11 of the ES MSA and needs to be attached to this Worksheet.*
11.1	Approvals	*OPG to document as part of the Work Request if there are any exceptions to the Contractor's obligations to obtain and pay for all Approvals required in respect to the Work, except for any Approvals from the CNSC.*
12.1	Substantial Completion	*OPG to include as part of the Work Request any additional requirements that the Contractor must satisfy in order for Substantial Completion to have occurred. Substantial Completion is significant since it defines the start of the Warranty Period. It should be considered a Key Milestone and identified in Attachment 3 to this Worksheet. Substantial Completion must be documented in accordance with the applicable Appendix.*

#	Item	Instructions
12.2	Final Completion	*OPG to include as part of the Work Request any additional requirements that the Contractor must satisfy in order for Final Completion to have occurred. Final Completion should be considered a Key Milestone and identified in Attachment 3 to this Worksheet. Final Completion must be documented in accordance with the applicable Appendix.*
13.1	Insurance Requirements	*OPG to specify if Part A or B of Schedule 12 applies. Part B applies to all Work performed at the Darlington Site during Refurbishment. Modifications to the applicable insurance provisions are not permitted.*
14.1	Warranty Provisions	*OPG to specify as part of the Work Request any additional warranties that are required over and above the requirements specified in the ES MSA.*
14.2	Warranty Period	*OPG to specify as part of the Work Request any changes from the standard Warranty Period defined in the ES MSA (two years). The Warranty Period cannot be extended for more than eight years from Substantial Completion for a Darlington Refurbishment Project.*
15.1	Project Site Specific Safety Plan	*As part of the Work Request OPG to specify if a Project Site Specific Safety Plan is required as part of the Project. Plan to be provided to OPG at least 90 days prior to commencement of Work at the Site.*
15.2	Job Safety Analysis	*As part of the Work Request OPG to specify if a Job Safety Analysis is required as part of the Project. Plan to be provided to OPG at least 90 days prior provision of any work to which the Job Safety Analysis relates.*
15.3	Safety Program	*If required the Contractor is to attach as part of the Work Request Response.*
15.4	Environment Management and Protection Plan	*If required the Contractor is to attach as part of the Work Request Response.*
16.1	Information Waiver	*OPG to provide a list of exceptions as part of the Work Request and/or Contractor may add as part of the Work Request Response. List to be finalized prior to Purchase Order award. This list modifies the Contractor's obligations under section 2.1(a)(4) of the applicable Appendix.*
17.1	Contractor's Risk Register	*OPG to specify if a risk register is required as part of the Work Request. Contractor to include their risk register as part of the Work Request Response.*
ATTACHMENTS:		
ATTACHMENT 1: OPG Specifications		*Mandatory attachment required by Worksheet section 1.2, OPG Specifications.* *OPG to attach any applicable specifications, including but not limited to the scope of work and COIR list of deviations (N-FORM-11583).*
ATTACHMENT 2: Pricing		*Mandatory attachment required by Worksheet section 2.1, Pricing.* *Contractor to attach as part of the Work Request Response. Attachment to be finalized (price and format) prior to Purchase Order award.*
ATTACHMENT 3: Key Milestones		*Mandatory attachment required by Worksheet section 3.1, Key Milestone Dates.* *OPG to attach a list of Key Milestones, including acceptance criteria.* *NOTE: These are contractual milestones and may not directly align with milestones in the working schedule. Examples of Key Milestones include:* - *Purchase Order award date* - *OPG engineering complete*

#	Item	Instructions
		- *Long lead materials ordered* - *Installation planning complete* - *OPG delivery of Free Issue Materials* - *Readiness to execute* - *Procurement complete* - *Start of installation* - *Field work complete* - *Substantial Completion* - *Final Completion*
ATTACHMENT 4: List of Subcontractors		*Optional attachment required by Worksheet section 5.5, List of Subcontractors.* *Attachment to be added by Contractor if Subcontractors will be used as part of the Contract.*
ATTACHMENT 5: Subcontractor Management Plan		*Optional attachment required by Worksheet section 5.6, Management of Subcontractors.* *Contractor to attach if requested by OPG.*
ATTACHMENT 6: Welding Consumables		*Optional attachment required by Worksheet section 7.1, Goods.* *OPG may remove if welding consumables are not required for the Work.*
ATTACHMENT 7: Free Issue Materials		*Optional attachment required by Worksheet section 7.3, Free Issue Materials.* *OPG to attach a list if providing Free Issue Materials.*
ATTACHMENT 8: Applications for Payment		*Optional attachment required by Worksheet section 8.1, Applications for Payment.* *Payment schedule for milestones and/or the fixed fee, if applicable.*
ATTACHMENT 9: Notice of Delay		*Template to be used for providing Notice when a Delay occurs.*
ATTACHMENT 10: Project Specific Score Card		*Optional attachment required by Worksheet section 10.1, Project Specific Performance Indicators.* *Project specific score card if project specific Performance Indicators are being used.*
ATTACHMENT 11: Safety Program		*Optional attachment required by Worksheet section 15.3, Safety Program, depending on the type of work specified in Worksheet section 1.1, Type of Work.* *Contractor to attach.*
ATTACHMENT 12: Environmental Management and Protection Plan		*Optional attachment required by Worksheet section 15.4, Environmental Management and Protection Plan, depending on the type of work specified in Worksheet section 1.1, Type of Work.* *Contractor to attach.*
ATTACHMENT 13: Risk Register		*Optional attachment required by Worksheet section 17.1, Contractor's Risk Register.* *Contractor to attach.*

TEMPLATE REVISION HISTORY

Rev	Date	Comments
0	Mar. 5, 2019	Initial Release
1	Mar. 20, 2019	Fixed formatting issues.
2	Nov. 7, 2019	Updated first page header to include date CanAtom signed the ES MSA.

3	Feb. 10, 2020	Updated first page header to reference the new amended and restated version of the ES MSA. Added section 1.8, Cyber Security. Fixed formatting issues.
4	Oct. 14, 2020	Section 2.1, Pricing, updated to include a line for Performance Fee Work consent to proceed and clarifying note 1 added. Clarification of what is non-Performance Fee Work added to section 2.1. Page header updated to clarify 'Worksheet revision'.

PICKERING REFURBISHMENT PROGRAM

PROGRAM PLANNING

1.0 OVERVIEW

To ensure successful execution of the Pickering Refurbishment Program ("PRP"), OPG is investing in planning during the Definition Phase. This has enabled OPG to establish detailed scope and a high-confidence schedule and cost estimate aimed at minimizing the risk of scope creep, schedule delays and resulting cost increases. This exhibit describes OPG's extensive planning effort to enable the PRP to be completed safely, on time, on budget, and with the required quality.

2.0 PLANNING

2.1 Investment in Planning

In comparison to the Darlington Refurbishment Program ("DRP"), PRP is conducting its planning over approximately five years as opposed to ten years. This comparatively shorter timeframe is enabled by OPG's ability to leverage the successful planning and execution of the DRP, including the processes already in place, supply chain infrastructure that was built for DRP, DRP's commercial structure as applicable to PRP, as well as significant operational experience and lessons learned (see Chart 1 below). This has created efficiencies for PRP, allowing it to complete the necessary diligence, detailed planning and cost and schedule estimation in the shorter timeframe. In doing so, PRP has also thoroughly considered scope differences between the two refurbishment programs, the main elements of which are compared in Ex. D2-3-5.

OPG has organized the PRP into four phases: (1) Feasibility Phase, (2) Initiation, (3) Definition Phase, and (4) Execution Phase. Each phase is discussed below. The PRP is currently in the Definition Phase. In the next year, OPG will be finalizing planning, design and long-lead procurements prior to the planned beginning of the Execution Phase in January 2027.

2.1.1 Feasibility Phase

In 2022, following the Province of Ontario's request for OPG to update its feasibility assessment for refurbishing Pickering Units 5-8, OPG began the Feasibility Phase. The Feasibility Phase was the initial step in assessing whether refurbishment of the Pickering Nuclear Generating Station ("Pickering") is technically, economically, and operationally viable. During this phase, a comprehensive Feasibility Study was conducted, evaluating a range of options and identifying the most promising path forward.[1] The project team undertook high-level technical assessments, examined the condition of key station components, and developed preliminary strategies for refurbishment.

Key outputs from the Feasibility Phase included a preliminary project scope, an order-of-magnitude cost estimate, and a high-level schedule. OPG conducted early engagement with stakeholders, including regulators, government, and Indigenous communities, to understand expectations and concerns. A preliminary risk assessment was also completed, identifying major technical and delivery risks, along with potential mitigation strategies.

The primary outputs of the Feasibility Phase were:

1. Feasibility Study Report
2. Preliminary Project Scope
3. Preliminary Cost Estimate
4. Preliminary Project Schedule
5. Risk Assessment
6. Regulatory Strategy
7. Preliminary Project Execution Strategy

At the conclusion of the Feasibility Phase, a formal recommendation was made on whether to proceed to the next stage based on the results of the feasibility assessment, the preliminary cost and schedule estimates, and the overall risk profile.

[1] The Feasibility Study was funded by Nuclear Operations Base OM&A. Refer to Ex. F2-1-1, Section 5.4 for details.

In August 2023, the OPG Board of Directors approved the feasibility assessment. In January 2024, the Province of Ontario announced its support for OPG to proceed to the Initiation Phase.

2.1.2 Initiation Phase

During this phase, PRP's core objectives were defined, including the need to extend the operational life of Pickering, enhance safety systems, and meet regulatory requirements.

The PRP's preliminary scope, high-level schedule, and initial resource requirements were further outlined, while major risks were identified and mitigation strategies were considered. This phase culminated in the development of a Class 4 estimate and the establishment of a governance structure, which together provided the basis for seeking executive and regulatory approvals to advance the project.

Key outputs of the Initiation Phase were:

- Initial determination of refurbishment scope through completion of:
  - Technical assessments of all major components
  - Condition assessments of balance of plant components
  - Initiation of regulatory processes
- Class 4 cost and schedule estimates
- Economic feasibility assessment
- Project management approach and governance
- Overall contracting strategy
- Recommendation to proceed to Definition Phase

In November 2024, with the OPG Board of Directors' approval, this phase was completed and the PRP transitioned into the Definition Phase, with the Province of Ontario announcing its support in January 2025.

2.1.3 Definition Phase

Building upon the foundation established during the Feasibility and Initiation Phases, the Definition Phase is dedicated to advancing the project to a level of detail that enables a confident investment decision and lays the groundwork for successful execution. In this phase, the project scope is refined and systematically decomposed into detailed work packages, supported by comprehensive engineering studies and site investigations. A resource-loaded project schedule is developed, clearly identifying critical path activities and key milestones.

The primary outputs of the Definition Phase are:

1. Detailed project scope and work breakdown structure
2. Project governance and organization structure
3. Class 3 RQE Estimate
4. Integrated project schedule
5. Execution plan
6. Contracting and procurement strategy
7. Detailed engineering design
8. Risk management plan
9. Regulatory and licensing submissions
10. Stakeholder engagement and communication plan
11. Quality assurance and safety plans

To date, PRP has completed major deliverables which supported the development of the Class 3 RQE. Details are provided in: Ex. D2-3-5 (scope), Ex. D2-3-6 (schedule), Ex. D2-3-7 (contingency), and Ex. D2-3-8 (cost). Key Highlights include:

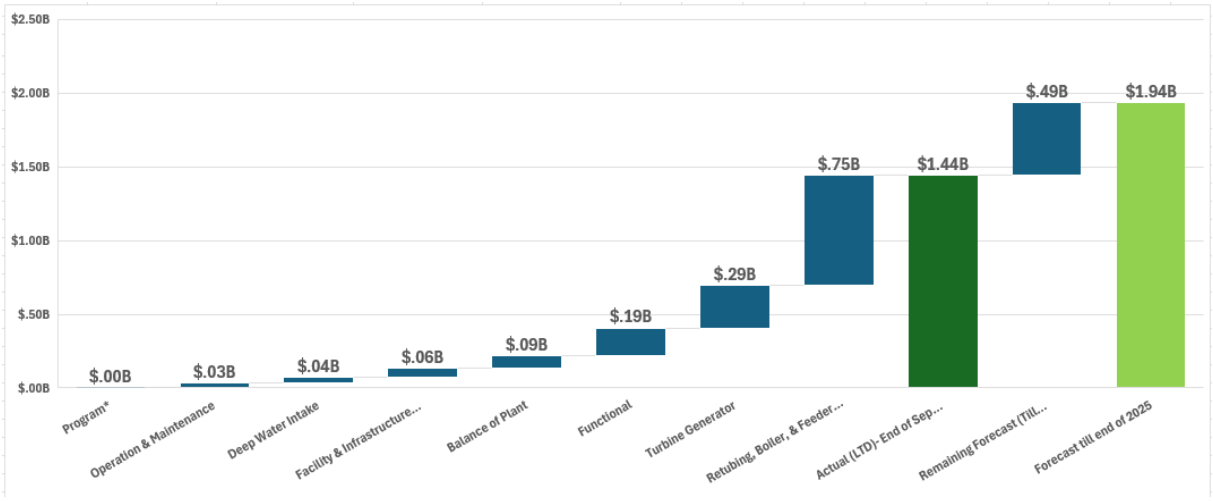
- Front-end engineering has been completed, and the detailed design phase is in progress.
- Final detailed design for Segment 0 was finalized in November 2025. Overall, approximately 36% of engineering for all major scopes have been completed to date.
- Final scope reviews have been completed, including assessing complexity and managing first-of-a-kind project risks for the first unit under refurbishment, Unit 5.
- All major contracts have been awarded (see Ex. D2-4-3).

- All long lead items for the four units have been ordered, including fuel channels, feeders, boilers and turbine generator components. Supplier cost estimates and delivery commitments are incorporated into the estimate.
- Pickering licence renewal application was submitted to the Canadian Nuclear Safety Commission ("CNSC") on June 27, 2025. Regulatory discussions with CNSC have been successful, confirming activities that will be completed under the current licence.
- A road servicing agreement to optimize site access was successfully completed with a cross functional working group including OPG, the Ministry of Transportation, and the City of Pickering.
- The Level 1 and 2 detailed schedules for execution of the four-unit program have been developed, depicting key components, major scope, and integration logic. This is underpinned by a detailed resource loaded Level 3 working schedule for major scopes which will be used to monitor and control construction and commissioning.
- Established and implemented a workforce strategy based on resourcing requirements for the overall PRP, leveraging OPG's existing workforce where optimal and appropriate (see Section 2.2 below).
- Execution of the Facility and Infrastructure work program is in progress, and all pre-requisite projects are on plan to be completed prior to the start of the Execution Phase.
- On the Deep Water Intake program, OPG and contractor parties continue to prioritize engagement with Indigenous parties and document considerations in program planning, perimetry requirements and any ground disturbing activities.

In summary, the Definition Phase to date has advanced scope and design maturity. The completion of detailed engineering deliverables as well as risk analysis and contractor input have provided increased certainty on technical requirements and material quantities, all of which were used to finalize contracting and procurement strategies and secure and award all of the major PRP contracts. As a result of this detailed planning, the RQE was approved by OPG's Board of Directors in November 2025. On November 26, 2025, the Province of Ontario announced that it had approved OPG's plan to refurbish Pickering Units 5-8.

Program expenditures inclusive of interest and escalation as of September 2025 were $1.44B, which reflects the extensive planning work carried out during the Feasibility Phase and the Definition Phase to date. A high-level summary of the expenditures to date is provided in Figure 1 below.

Figure 1 – Summary of Life to Date Actual Expenditures as of September 30, 2025 ($B)



*$417,000 spent Life to Date on 'Program', which includes Functional costs and fees.

In the remainder of the Definition Phase, OPG will be completing procurements of long-lead materials and continuing to advance Definition Phase deliverables including completion of detailed design, which will inform the Execution Phase contracts (see Ex. D2-3-3 for more information). In addition, OPG will be completing pre-requisite work to support execution readiness, progression on the Deep Water Intake, and substantial completion of new infrastructure buildings and campus upgrades within the Facilities and Infrastructure major work bundle.

2.1.4 Execution Phase

Moving into the Execution Phase, the focus shifts to implementing the plans developed during the Definition Phase, including mobilizing resources and initiating construction and refurbishment activities. Major components of the refurbishment include reactor core component replacement, steam generator and heat exchanger upgrades, turbine and generator overhauls, balance-of-plant improvements, and comprehensive safety and control system enhancements.

The primary outputs of the Execution Phase are:

- Fully refurbished reactor units ready for recommissioning and operation.
- As-built drawings and updated technical documentation reflecting all modifications.
- Comprehensive quality assurance and safety compliance reports.
- Completion certificates for major project milestones and deliverables.
- Updated maintenance manuals and operational procedures.
- Detailed commissioning plan for returning units to service.
- Records of inspections, tests, and regulatory approvals.
- Lessons learned documentation and improvement recommendations.
- Stakeholder and regulatory communication reports summarizing progress and outcomes.

The forecasted spend at the end of the Execution Phase of Unit 5 is $11.65B (including interest and contingency), as detailed in Ex. D2-3-8.

2.2 Workforce Strategy

A key difference between the PRP and DRP is that PRP will begin with the full station being offline and all four units being refurbished in parallel, creating larger resourcing demands and greater complexity in execution. At the same time, subject to labour agreements and union jurisdiction, all units being offline provides an opportunity to redeploy existing operational staff with critical expertise and knowledge of the station to meet the increased resourcing demands and execute certain work more efficiently.

As part of the planning for the PRP, OPG evaluated the appropriate blend of labour that would combine OPG's existing workforce with contractor staff. In developing this strategy, OPG sought to balance the benefits of external contractors, including scalability and construction expertise, with OPG employee experience in site operations and maintenance such as with radiation protection, maintenance and fuel handling.

To enable the full extent of this workforce strategy, OPG successfully negotiated the necessary redeployment agreements with the PWU and Society and optimized jurisdictional terms for the PWU, with the Building Trades Unions. Over 1,000 PWU represented employees and about 150 Society represented employees are expected to be redeployed from Pickering operations to PRP by the end of 2026.

This workforce strategy ensures timely access to sufficient and proficient labour to meet project schedules, leverages skilled employees familiar with the station for safe and efficient execution and mitigates the risk of labour shortages in a competitive market. The cost and schedule benefits of this blended workforce strategy has been incorporated into the PRP Release Quality Estimate. Furthermore, the strategy avoids certain severance, hiring and training costs that would otherwise be incurred should OPG not have negotiated the necessary labour agreements. Further details on these labour arrangements are discussed in Ex. F4-3-1, Sections 2 and 5.

2.3 Lessons Learned

The lessons learned process for the PRP is a structured and continuous approach designed to capture, analyze, and apply knowledge gained throughout the project lifecycle. At the outset of each project phase, the team not only reviews lessons learned from previous Pickering initiatives, the DRP and other OPG projects but also conducts comprehensive benchmarking with leading nuclear and non-nuclear projects worldwide.

As part of the PRP's commitment to continuous improvement, the lessons learned process has been strategically structured to align both a "Unit-over-Unit" execution plan for critical path activities and "Major Work Bundle" approach incorporating a combination of in-series and in-

parallel activities (refer to Ex. D2-3-6 regarding schedule). The Unit-over-Unit strategy enables the project teams to capture and implement lessons learned after each unit, driving continuous improvement, reducing risks, and enhancing efficiency and safety across subsequent units. The Major Work Bundle approach provides a structured and holistic framework for planning and executing complex project scopes. By segmenting work into distinct bundles and systematically applying industry best practices and operational experience, the team can optimize resource allocation, improve collaboration, and strengthen quality assurance.

To ensure timely and effective knowledge transfer, requirements have been established for lessons learned sessions to be conducted promptly after the completion of each work window – ideally within three weeks, and no later than six weeks post-window. For work windows that overlap across multiple units, the lessons learned strategy identifies specific activities – particularly those that are complex, first-of-a-kind, or have historically presented challenges – for which dedicated lessons learned meetings are held prior to executing the same work on subsequent units. These critical activities are intentionally scheduled at the beginning of the work window to maximize the opportunity for capturing and applying lessons learned before similar tasks commence on the next unit.

In particular, the major work bundle approach for the PRP has enabled the systematic application of lessons learned and operational experience (“OPEX”) from other major refurbishment scopes, including DRP and Bruce Power, as well as other CANDU 6 stations across several critical project scopes.

Furthermore, critical path windows – such as lead-in, removal series, installation series, and lead-out – are scheduled in series across the four units. This sequencing enables the project team to systematically capture, review, and incorporate lessons learned from each phase, thereby improving planning, execution, and outcomes for subsequent units. By embedding these practices into the project schedule and workflow, the PRP ensures that insights and improvements are rapidly integrated, reducing risk, enhancing efficiency, and supporting the successful delivery of each unit refurbishment.

In addition to the application of lessons learned based on execution of work within the PRP, OPG's planning efforts included reviews of operating experience and lessons learned from the DRP, other major projects and industry experts, including past CANDU and other nuclear refurbishments as set out in Chart 1 below.

Chart 1 – Lessons Learned and OPEX Incorporated into Each Major Work Bundle

Bundle	Lesson Learned
Retube, Feeder and Boiler Replacement	• Operating experience from the DRP, Bruce Power, and Point Lepreau projects identified that a mock-up facility can help mitigate delays and cost impacts associated with a lack of worker training and task familiarity at the reactor work face. • Operating experience from the DRP, Bruce Power and Point Lepreau projects identified the need for tools to be tested to avoid significant delays and cost impacts associated with tooling incompatibility. • Engaged "The Steam Generator Team", a group with industry-recognized experience in major plant modifications, to provide industry lessons learned with respect to the RFBR work. Lessons learned from The Steam Generator Team included the need to mitigate weather/wind delays with planning major lifts at night and the need for welding training. • Also collected OPEX from Watts Bar, Bruce Power, and Darlington Steam Generator Primary Moisture Separator Replacement Project.
Turbine Generator	• Engaged "Turbine Generator Advisors", a network of turbine and generator experts with extensive OEM, utility and engineering consulting experience, to provide industry perspective on the Turbine Generator bundle of work. Lessons learned from the Turbine Generator Advisors included: for the steam turbine design, recommendations to conduct a blade vibration monitoring test; need for a torsional frequency separation requirement; and for generator rewinds, to include a minimum set of witness hold points to reduce risks. • Lessons learned implemented from DRP, Bruce Power and Point Lepreau projects include:

Bundle	Lesson Learned
	○ Simplified requirements for Turbine Generator removals improve planning and execution timelines. ○ Strategic and staggered initiation of commissioning as discreet construction work is completed allows for system energization and testing. ○ Inclusion of Turbine Controls remote Input/Output panels and fiber optic cabling simplifies construction strategy (i.e. minimize cable runs), supporting a more efficient installation schedule. ○ Maximize benefit of modular construction and offsite pre-commissioning activities.
Deep Water Intake	• Implemented ISO 9001 quality program, where possible, in order to apply a fit for purpose approach. • Performed weather delay study for marine work in a similar project within Lake Ontario to ensure schedule is reasonable. • Utilized lessons learned from industry on starter shaft to reduce schedule duration by removing execution activities from the critical path. • Adapted innovative marine structure and approach to reduce the marine schedule based on industry OPEX.
Balance of Plant	• Integrated lessons learned from DRP, Bruce, and other comparable sites to optimize estimates and project planning. • Comprehensive OPEX reviews from Darlington and Bruce informed the development of in-house front-end engineering design, which enabled the early identification and procurement of long-lead materials and enhanced scope definition for EPC contracts. • Bulk ordering was leveraged for all units, resulting in procurement cost savings on major long lead material items. • Early construction engagement and advanced field surveys, including 3D scanning, were also initiated to drive improvements in design quality and execution readiness.

Bundle	Lesson Learned
	• Adoption of execution readiness challenge meetings and checklists, as utilized during DRP, to provide high confidence in readiness for construction execution.
Facilities & Infrastructure	• Incorporated OPEX from Darlington Storage Structure #3 and the Pickering firehall project located within the protected area. • Lessons learned from commissioning the Security Monitoring System project in Pickering will be incorporated into the Security Expansion project. This will include a dedicated, qualified OPG commissioning team. • Incorporated lessons learned from Darlington's installed security equipment project. • OPEX from similar Civil projects incorporated quality assurance, contracting, and construction strategies on Common Services Building project.
Operations and Maintenance	• Facilitated knowledge transfer between Pickering and Darlington staff to leverage operational experience from previous refurbishment projects. • Teams engaged with non-OPG utilities to glean knowledge and OPEX, incorporating lessons into the plans and estimates. • Incorporated key lessons learned from Pickering U1/U4 defuel and NB Power to improve hardware reliability and reduce execution timelines. • Enhanced equipment reliability and readiness by integrating DRP OPEXs. • Engaged stakeholders in action planning sessions to strengthen project execution and resource utilization. • Adopted a proactive design and procurement approach to minimize re-work, material shortages, and overall procurement cost and schedule impact.

In summary, the integration of both the Unit-over-Unit and Major Work Bundle approaches, as well as lessons learned and operational experience from DRP and other projects both within and outside of OPG, are instrumental to the success of the PRP.

2.4 Engineering Completion

The AACE recommended practices indicate that 30% to 40% of engineering deliverables are to be completed to achieve the Class 3 estimate. OPG achieved 36% of engineering for all major scopes in alignment to the recommended practice prior to the establishment of the PRP Release Quality Estimate. This level of engineering is sufficient for developing a Class 3 estimate for a refurbishment project as the components are known commodities. As further discussed in Ex. D2-3-5, relating to their respective contracts, OPG established a Q4 2026 milestone for completion of detailed engineering for all Unit 5 modification-based scope prior to the start of the Execution Phase.

2.5 Reactor Mock-Up, Tool Fabrication and Testing

During the Definition Phase, OPG and Atkins/Aecon JV will complete construction and fit up of the Pickering Training & Mock-up Facility ("TMF"), which includes a partial reactor mock-up. The TMF is part of the RFBR work bundle and is scheduled to be ready to start receiving mockup components and tooling in March 2026. Training at the TMF for Unit 5 execution is planned to begin in Q3 2026. The TMF allows training to be conducted by OPG and its contractors prior to execution, so that those who will be doing work on the reactors during the refurbishment outages do not consume valuable time to overcome the significant learning curve associated with work procedures and equipment. This is particularly important with respect to critical path work. The TMF responds to operating experience from the Bruce Power, DRP and Pt. Lepreau projects, which demonstrate that a mock-up facility can help mitigate delays and cost impacts associated with a lack of worker training and task familiarity at the reactor work face. The training program and building/mock-up layout is structured such that it can support a multi-unit overlap by incorporating numerous series-specific mock-up areas to allow for parallel work.

Also significant is that the PRP requires several customized engineered tools to be developed and tested for use during the PRP Execution Phase. As part of the comprehensive planning process for the RFBR work bundle, engineered tooling development will also be completed, thereby allowing the tools to be tested and workers trained at the TMF. This responds to operating experience from the DRP, Bruce Power and Point Lepreau projects where significant

delays and cost impacts were incurred as a result of tooling incompatibility. The result of this tool testing will be an important input to the accuracy of current critical path plans as it enables management to determine with a high degree of accuracy the duration required to complete various activities. This data will be considered in sequencing tasks and in refining and optimizing project schedules. This will help confirm OPG's high confidence schedule estimate for the RFBR work bundle. Additionally, based on lessons learned from the DRP, high mock-up pedigree (i.e., with real-life dimensions, interferences, etc.) will be used to ensure the quality of the training mimics actual field conditions.

PICKERING REFURBISHMENT PROGRAM SCOPE

1.0 OVERVIEW

OPG has undertaken a comprehensive planning process for the Pickering Refurbishment Program ("PRP"), built upon a thorough, methodical, and disciplined approach to identifying and defining the scope of work. This section outlines:

- the steps OPG took during the Definition Phase to determine the PRP's scope, with a particular focus on the work planned for Unit 5;
- the completion of Detailed Design and engineering efforts; and
- the finalized scope of work for each major work bundle.

The PRP has integrated lessons learned from the Darlington Refurbishment Program ("DRP"), ensuring that efficiencies in both preparation and execution are included in the release quality estimate. At the same time, the PRP scope differs from the DRP in several key areas:

- The overall project duration is comparatively shorter for the PRP than for the DRP.
- A significant portion of the PRP will take place in a nuclear facility with all units simultaneously offline, creating opportunities to perform tasks that are usually difficult or impractical when some of the units are operational (e.g., work pertaining to the vacuum building, Deep Water Intake ("DWI"), etc.).
- The scope of work is more complex, featuring a greater amount of First-of-a-Kind and First-in-A-While activities, such as Digital Control Computer ("DCC") upgrades, boiler (steam generator) replacements, DWI installation, and more.
- There is a larger Balance of Plant project portfolio aimed at improving and addressing equipment reliability issues.

A list of the key scope differences between the PRP and the DRP is set out in Attachment 1. These scope changes have a material impact on the cost, schedule, and complexity of the PRP.

2.0 IMPORTANCE OF SCOPING

Having a detailed understanding of scope enables the development of a schedule that is inclusive of all work. For the PRP, OPG has established a clear and well-defined Program scope, forming a solid foundation for developing high-confidence budget and schedule estimates. To manage the risk of scope creep, OPG will continue to leverage its established scope control process that is continuously refined through lessons learned from both OPG's own projects and other major projects.

A detailed understanding of scope is essential for creating a comprehensive schedule that accounts for all required work. Given the interdependencies within the project, any scope changes during execution could trigger cascading effects, leading to cost and schedule consequences. By investing in scope definition prior to execution, and maintaining rigorous scope control, OPG mitigates these risks. Additionally, a well-defined scope allows OPG and its contractors to sufficiently progress all necessary engineering work before unit execution and to secure the required materials, parts, tools, labour, and craft resources to support the project schedule.

3.0 APPROACH TO WORK SCOPE DEFINITION

To support the scoping process for the PRP, 54 System Condition Assessment ("SCA") reports, covering all station systems, were developed as part of the PRP feasibility study with cross-functional input from various internal stakeholders including Engineering, Operations, Maintenance and others as required. Those reports identified individual Scope IDs which detailed potential improvements, engineering modifications (see Section 3.1 below) and other works required for life extension of Pickering Units 5-8 for an additional 30+ years.

During scope definition phase, the Scope IDs were categorized and prioritized by importance, required unit condition, and operational risk. Each scope request included a description of the work being proposed, the units to which the work would apply, whether and how the work responds to regulatory requirements, as well as various means of classifying the work based on its objectives and relationship to other work. Higher ranking items were presented to the Program Scope Review Board ("PSRB") for approval into the PRP via scope requests. The

PSRB included representation from Operations & Maintenance, Refurbishment, Station Engineering, and Finance functions. The following factors were considered in defining refurbishment scope:

- Must-do (no alternate solution, cannot defer outside of refurbishment).
- Regulatory or safety (safety improvement opportunities, requirements for return to service, code compliance, etc.) (see Section 3.2 below).
- Reliability or infrequent evolution (known contributor to forced loss rate, end of life considerations, requires outage windows that are infrequent (moderator drain, vacuum building outage, electrical bus outage, service water outage, etc.)).

As part of its oversight, the Refurbishment Review Board further reviewed the volume of project scope, taking into consideration schedule, complexity, preliminary design timelines and sourcing newly design equipment. Where risks were identified, Performance Engineering led a cross-functional review of the Scope IDs to determine mitigations. The resulting recommendations were presented to an Executive Scope Review Board ("ESRB") for consideration. The ESRB is composed of OPG's Chief Projects Officer, Chief Nuclear Officer, and Chief Nuclear Engineer.

Through the above process, the major scope definition milestone was met in May 2024, establishing the major scope categories that included but were not limited to the following:

- Core scope (regulatory, life limiting components that require a dewater/defuel unit condition, etc.).
- Significant scope requiring modifications.
- Significant lifecycle replacements.
- Scope requiring long lead material.
- Scope impacting critical (or near critical) path.

Following completion of the major scope definition milestone, scope control was transferred to the Refurbishment Change Control Board ("RCCB"), which will continue for the duration of the PRP. The objective of the RCCB is to provide a standing structured forum for control of

changes to the scope and organization of the PRP. The RCCB included representation from Pickering Station, Project Controls and Finance functions and is responsible for the review and approval of:

- New scope additions to the PRP after major scope freeze – new Scope IDs.
- Changes to approved scope with existing Scope IDs. Such changes may impact schedule, cost, and/or scope.

Since the major scope definition milestone, the ESRB and the RCCB have continued to review and approve scope changes, as necessary. As planning progressed, this included refining the Unit 5 scope to manage the complexity of the first unit's refurbishment taking into account operational experience and lessons learned from the DRP. As of release quality estimate, Unit 5 scope differs from Units 6-8 in the following material scopes: modifications to the DCC and plant computer, modifications to the neutron overpower protection system and ultrasonic flowmeters, and modification of stationary blading on high pressure turbines.[1] Further details on these scopes of work are set out in Section 4.3 below. In addition, replacement of Unit 5 Adjuster Rods was also removed from scope.[2]

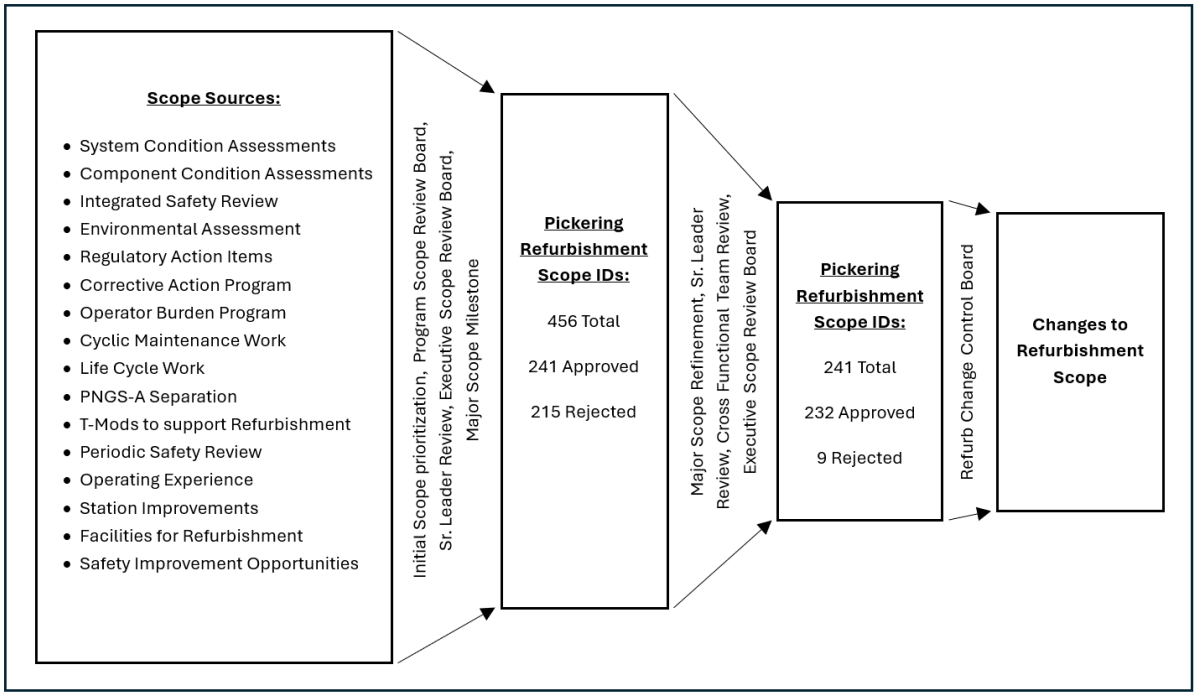
In September 2025, 558 Component Condition Assessments ("CCA") were issued for all systems, structures, and components. The purpose of the CCA was to assess and document present conditions of the systems, structures and components and confirm appropriate measures to address any significant existing or anticipated aging degradation. These assessments were required to support the Periodic Safety Review ("PSR") submission for the Pickering license extension beyond 2026 and to identify any new scope related to high-critical safety components since the System Condition Assessments were completed. This process helps ensure newly identified components issues were assessed for scope definition.

[1] As discussed in Section 4.3, this scope is also excluded from Unit 7. Furthermore, since Unit 5 & 7 high pressure turbines were replaced in 2019, this scope was deemed not required for refurbishment.

[2] Unit 5 is the only unit that requires replacement of the adjuster rods as the Units 6-8 adjuster rods were already replaced previously within regular planned outages. Following further assessment prior to the release quality estimate process, it was determined that that this work could similarly be undertaken in a future planned outage. This Pickering Unit Reactor Regulating System Adjuster Rod Replacement is an unallocated project listed in the OPG Nuclear Facilities projects portfolio (Ex. D2-1-3, Table 5b, line 58).

Recommended actions from CCAs were presented to the RCCB for decision on scope, which resulted in the approval of a minor addition to scope of worth approximately $5M.

Figure 1 – Scope Definition and Refinement Process



In addition to establishing the PRP scope, this scoping process also helped inform the identification of potential sustaining works needed in support of Pickering “second life” operations. Such works are considered through OPG’s asset management and portfolio management processes (see Ex. D2-1-1 and Ex. D2-1-2).

3.1 Engineering Modifications

As discussed above, SCA reports included consideration of whether engineering modifications are required. Engineering modifications involve revisions to final design documents that impact a system, structure, component, software, or engineered tool. These Scope Requests for the PRP were evaluated during feasibility and definition phase to identify if either temporary or permanent modifications are needed. These modifications will be implemented throughout

various stages of the project and may evolve as the scope is further refined. These Scope Requests also cover modifications that alter the design, functionality, or execution of specific operations, including the removal, abandonment, or retirement of currently installed equipment. Permanent changes are intended to improve operating margin for the site in order to expand the station's lifespan by 38 years. There may be a need to provide temporary alterations to support refurbishment execution, after which the alteration would be reverted prior to return to service of the unit.

3.2 Regulatory Scope

As discussed above, regulatory or safety scope is one of the key components to defining refurbishment scope.

As part of each Pickering life extension, OPG was required to complete a Canadian Nuclear Safety Commission ("CNSC") Power Reactor Operating License amendment. To do so, OPG is required to complete a PSR. The most recently completed PSR was to extend Pickering operations to 2026, which resulted in OPG's issuance of the Global Assessment Report ("GAR")[3] and corresponding CNSC-approved Integrated Implementation Plan ("IIP")[4] in mid-2023.

To support PRP and Pickering operations for an additional 38 years of operating life, OPG has initiated another PSR. As part of the PSR, OPG is required to provide safety factor reviews, which assess Pickering's current design and condition against applicable laws, regulations, codes, and standards. This was completed with the issuance of 15 safety factor reports to the CNSC in May 2025. OPG is in the process of preparing the PRP's GAR and IIP for CNSC review, currently planned for submission in August 2026 and August 2027, respectively.

[3] The Global Assessment Report is a requirement under CNSC REGDOC 2.3.3 Periodic Safety Reviews. The report documents the overall conclusions, corrective actions and safety improvements to be considered, as part of the Periodic Safety Review process.

[4] The Integrated Implementation Plan is a requirement under CNSC REGDOC 2.3.3 Periodic Safety Reviews. The plan addresses the results of the global assessment report, as part of the Periodic Safety Review process.

The gaps dispositioned in prior PSRs have informed the PRP scope, and the planned safety improvements have been proactively communicated to the CNSC with no additional scope being requested by the regulator. Based on the thorough safety factor reviews, and OPG's recent CNSC-approved IIP to support operation through 2026, OPG has sufficient confidence that it has appropriately identified the regulatory scope for the PRP.

The CNSC's acceptance of the GAR and IIP will confirm the final regulatory scope for the PRP.

3.3 Work Bundles

For each Scope Request that was approved as part of the PRP scope, the corresponding work was then assigned to one of the six major work bundles that are described in Ex. D2-3-3 or to the functional support groups described in Ex. D2-3-2, Section 3.2.

After the Scope Requests were assigned to specific work bundles, the corresponding project teams, through studies or preliminary engineering, further defined the particular scopes of work to be performed in connection with each Scope Request. As a result, scope may differ between units based on need.

4.0 SCOPE FOR MAJOR WORK BUNDLES

For each major work bundle, OPG has appropriately and to a high level of specificity defined the relevant work, as well as effectively planned and integrated the work into the overall PRP and unit schedules. The scope of work associated with each of the major work bundles in the PRP is as follows.

4.1 Retube, Feeder and Boiler Replacement

The Retube, Feeder and Boiler Replacement ("RFBR") major work bundle is critical for extending the operational lifespan of Pickering Units 5-8. The refurbishment includes major component replacements, infrastructure upgrades, and rigorous testing to ensure compliance with modern standards. As work progresses, collaboration between OPG and contractors will be essential to achieving project objectives and maintaining operational integrity. This major

work bundle focuses on two main areas: (1) RFBR, and (2) support scopes (interference removal/replacement and infrastructure). The following are the associated main tasks:

Boiler and Reactor System Replacement

- Establishment of preconditions for work, including vacuum drying of the heat transport and moderator systems, and implementing a dry air purge.
- Removal and replacement of all 48 boilers by creating two access points in the roof of each Reactor Unit containment dome.
- Replacement of 380 fuel channel assemblies and calandria tubes with modern components to meet operational lifespan targets.
- Replacement of feeder system components, including feeder pipe, grayloc hubs, header nozzles, spring can hangers, and auxiliary components.

Reactor Inspection

- Inspections of non-replaced plant components that can only be conducted in a refurbishment state, including calandria vessel internals.[5]

Infrastructure and Equipment Utilization

- Identification and use of existing OPG infrastructure, such as cranes, overhead doors, and hoist wells. OPG will assess and maintain infrastructure before turnover to the contractor.
- Replacement of fueling machine ball screws and interfacing components.

Containment and System Testing

- Support for containment pressure tests to ensure there are no leaks from penetrations affected by refurbishment work.
- Performance of hydrostatic testing on the primary heat transport system, with verification by contractors as required.

[5] Any findings will be subject to further engineering assessment and consideration on any resulting work required, either as meeting the criteria for refurbishment scope (Section 3.0 above) or future sustaining project portfolio.

- Implementation of a temporary "Disconnect and Cap" strategy based on lessons learned from the DRP. This strategy allows for systems and components to be safely isolated from system energy sources, allowing the contractor to implement its work protection within the boundaries of the disconnected and capped system.

Quality Assurance and Operational Readiness

- Completion of code-driven baseline inspections on pressure tubes, feeders, and boilers.
- Collaborative development of test methods with RFBR contractors to confirm boiler performance post-refurbishment.
- New fuel load execution, including shield plug and Pickering station design closure plug installations.
- Establishment of a Quality Assurance Program to oversee component transfers and ensure compliance.

4.2 Turbine Generators

The Turbine Generators major work bundle is comprised of a series of modification and maintenance scopes. It is comprised of five broad areas of scope: (1) high-pressure and low-pressure turbine centreline mechanical work, (2) generator and auxiliaries, (3) turbine controls and generator excitation work, and (4) turbine main steam and auxiliaries maintenance work.

The Unit 5 and Unit 7 scopes exclude upgrades to the high-pressure turbines and guide blade carriers, which are in scope for Units 6 and 8. This is because high pressure turbine upgrades were performed on the Unit 5 and Unit 7 in 2019. As a result, during scope review, the PSRB determined that upgrades to the guide blade carriers for Unit 5 and 7 could be more cost effectively performed in a regular planned outage, as the Unit 5 and 7 guide blade carriers approach end of service life.[6]

[6] Pickering Unit 5 and 7 Modify High Pressure Turbine Diagonal Stage is an unallocated project listed in the OPG Nuclear Facilities projects portfolio and will be treated as eligible for the Capacity Refurbishment Variance Account (Ex. D2-1-3, Table 5c, line 76).

The five main areas comprising the scope of the Turbine Generators major work bundle are further described below:

High-Pressure and Low-Pressure Turbine Centerline Mechanical Work

The scope for the turbine mechanical work includes: (1) disassembly and disposal of old turbine spindles and inner casings, (2) inspections of retained components and contingent modifications of outer casings and expansion joints, (3) reassembly of new turbines with new inner casings and spindles, including any needed alignments, (4) bearing and gland seal segment replacements, and (5) main lube oil pump dummy shaft modifications.

Generator Centerline Work

- Rewind of generator rotors.
- Replacement of the generator stator windings with new design.
- New terminal bushings, current transformers, and resistance columns.

Generator Auxiliaries Modifications Work

- Stator Cooling Water system – complete replacement of skid, instrumentation, copper piping, etc.
- Seal Oil Upgrades – including a new radial seal design, complete replacement of skid, instrumentation, lube oil tank modifications, etc.
- Hydrogen Cooling Upgrades – including upgraded hydrogen coolers, hydrogen panel and cooling components, and hydrogen temperature control.
- Brush gear Upgrades.

Generator Electrical Auxiliaries Work

- Removal of the rotating excitation system, and supply and installation of a static excitation system.
- Neutral Grounding Transformers and Resistor Banks replacement.

- GenAdvisor monitoring system installation (shaft torsional vibration monitoring, shaft voltage and current monitoring, rotor short circuit monitoring, end winding vibration monitoring)
- New Excitation Power Transformers.

Turbine Controls Work

- Installation of new Siemens Energy T3000 Turbine Control system sized to suit turbine controls functional requirements, and interfacing and integration with other station systems. This includes all cabinets, local human machine interfaces, network switches hardware, servers, software, and more.
- Installation of new turbine supervisory system cabinet(s) for machine monitoring including vibration, temperature and other parameter monitoring modules. This includes all hardware, processors, controllers, input/output modules, and human machine interfaces required for monitoring, recording and integration with the turbine control system.
- Installation of a new hydraulic turbine tripping system to replace mechanical trip plungers existing trip block functions, and trip system parameter functions and testing.

Turbine Maintenance Work

The scope for this works includes various maintenance activities (preventative maintenance, and some proactive and backlog work), such as:

- Moisture Separator & Reheater live steam reheat work.
- Turbine main steam valve inspections and overhauls.
- Turbine valve control system overhaul and inspection of valve control units and hydraulic relays.
- Turbine auxiliaries maintenance.

4.3 Balance of Plant

The Balance of Plant major work bundle is comprised of two broad areas of scope: (1) Conventional, Electrical, and Nuclear System Modifications, and (2) Specialized Projects. Each of these scope areas are relatively distinct and described in more detail below.

4.3.1 Conventional, Electrical & Nuclear System Modifications

The scope of the conventional, electrical and nuclear system modifications encompasses comprehensive inspections of the condition of systems and components associated with the emergency coolant injection and emergency water supply systems. This includes inspection and repair, if required, of Class IV cable, the replacement of the continuous boiler blowdown system, as well as the inspection and, where necessary, repair of the service water concrete duct and structural and containment steel component and concrete structures.

Additionally, the scope includes upgrades to the Pickering training simulator, as required by the CNSC to ensure the training simulator is identical to the station's main control room, as well as engineered upgrades to the fire protection systems and fire water makeup to the heat transport and moderator systems, station transformers, and Class I and II switchgears and rectifiers, which convert AC power to DC power, providing uninterrupted DC supply for critical safety and control functions. Civil modifications include installation of remote vacuum building inspection tooling, Unit 8 Main Output Transformer foundation repairs, Unit 7 control equipment room exterior wall reinforcement and, the installation of helium storage tank dykes. The project also provides for like-for-like replacement of components such as reactor building coolers, vacuum building roof and joint seals, the vacuum building dousing system, and emergency low-pressure service water strainers.

These system upgrades are intended to enhance both component and overall system reliability and to support the extended operational life of the station.

Furthermore, the scope includes upgrades and modifications to the breathing air system, enhancing system reliability while ensuring sufficient capacity during boiler room and vault work activities.

4.3.2 Specialized Projects

This scope involves seven main areas of specialized work, relating to:

- Digital Control Computer.

- Regional overpower protection (“ROP”), neutron overpower protection computer, data extraction system (“DES”) and plant thermal performance (“PTP”) monitoring computer.
- Vault coolers.
- Containment filtered venting system (“CFVS”).
- Containment vessel over-pressure protection system.
- Reactor building (“RB”) ventilation and vapour recovery.
- Modification of common station services, including transfer and/or separation of services to common systems from the Pickering Units 1-4 side to the Pickering Units 5-8 side.

The **DCC system** comprises two Varian Model V72 computers, designated as DCC-X and DCC-Y, as well as the unit contact scanner. This system is responsible for monitoring and controlling the main plant process systems of the unit, which includes, but is not limited to, the regulation of overall reactor power, reactor zone thermal power, boiler pressure, moderator temperature, and the operation of steam relief valves as required. Additionally, DCC-Y is utilized for the sequential process control of the fuel handling system. Both DCC-X and DCC-Y are classified as nuclear safety-related real-time process computer systems, which exercise control over the unit’s nuclear reactors and principal plant process systems.

The existing legacy DCC systems are scheduled for replacement to facilitate an extended operational life of the facility following refurbishment. The scope of work for Unit 5 is limited to the replacement of the unit contact scanner hardware and the V72 DCC software. For Units 6, 7, and 8, the scope encompasses the complete replacement of the DCC-X, DCC-Y, and unit contact scanner, in addition to the installation of new software, peripherals, cabinets, and all associated devices and internal cabling. The replacement of the DCC-X and DCC-Y systems was de-scoped from Unit 5 refurbishment to manage the complexity associated with the first unit’s refurbishment. This work will be undertaken during a future planned outage.[7]

[7] Pickering Unit 5 Digital Control Computers Replacement is an unallocated project listed in the OPG Nuclear Facilities projects portfolio and will be treated as eligible for the Capacity Refurbishment Variance Account (Ex. D2-1-3, Table 5c, line 74).

The **replacement of the neutron overpower protection computer, DES, and PTP computers** is planned to ensure continued compliance with applicable codes and standards, enhance cyber security protections, and support an extended operational life of the facility following refurbishment. In order to manage the complexity of the first unit's refurbishment, for Unit 5, the scope of work is limited to the design and replacement of common plant computer components, with the replacement of the DES and PTP computers to be executed during a future planned outage.[8] For Units 6, 7, and 8, the scope includes the complete replacement of ROP, DES, and PTP computer components, as well as all associated network components.

The **vault coolers** scope of work includes the like-for-like replacement of vault cooler coils and fan motors in each unit to address and mitigate component reliability concerns. Additionally, the installation of a cooling coil within the feeder cabinet walkway supply duct is planned. This measure is expected to result in improved feeder cabinet walkway temperature regulation, particularly during the summer months.

The **installation of a CFVS** is intended to address a safety improvement opportunity by providing an emergency venting capability for containment, thereby preventing over-pressurization and ensuring the integrity of containment during the unlikely occurrence of a beyond design basis event resulting in an extended loss of onsite power. The CFVS is designed as a dry-type, passive filtered system, which serves to minimize radiological dose impacts to both the public and workers in the event of a post-accident scenario.

The **installation of a containment vessel over-pressure protection system** is intended to address an identified safety improvement opportunity by providing substantial relief capacity for the end shield and calandria vault in the event of a loss of end shield cooling or inventory flow following a beyond design basis event. This measure is designed to prevent shield tank failure under such circumstances. The relief device will be configured to discharge into containment.

[8] Pickering Unit 5 Plant Computers is an unallocated project listed in the OPG Nuclear Facilities projects portfolio (Ex. D2-1-3, Table 5b, line 44).

The **capacity of the existing RB ventilation and vapour recovery systems** must be expanded during unit refurbishments to accommodate an increased number of workers utilizing breathing air suits within the RB for retube, feeder, and boiler refurbishment activities. This scope of work necessitates that air locks be “pinned” open and that a substantial opening be created in the RB dome to facilitate boiler replacement operations.

Modifications to station common services, which include services within the vacuum building are required to facilitate the transfer of electrical and mechanical services currently supplied from the Pickering Units 1-4 side to the Pickering Units 5-8 side. This undertaking will necessitate the installation of new power and control cable runs, as well as new service and instrument air and service water piping, to enable the integration of services from the Pickering systems. The scope of work further includes the transfer of Class IV power to common services supplied from Pickering Units 5-8. This will involve the installation of a new 4.16kV/600V transformer substation, which will be equipped with 4.16kV circuit breakers, 600V switchgears, and two 600V Motor Control Centers.

4.4 Operations & Maintenance

The Operations & Maintenance major work bundle is compromised of the following broad areas of scope: (1) shutdown/layup, (2) plant systems, (3) valves, and (4) defuel, fuel handling reliability, and new fuel loading. Each of these scope areas is relatively distinct and described in more detail below.

4.4.1 Shutdown/Layup

This scope includes work that is needed to establish specific conditions for the shutdown of each unit and layup of the unit’s systems to maintain a protected environment until the systems are returned to service following completion of refurbishment activities. In order to preserve the station equipment, modifications will be required to drain and air dry systems as part of the layup process. Dryer skids will feed dry air into various areas of pipework to minimize effects of corrosion and ensure asset preservation during the extended layup period. In addition, the heat transport system will undergo a chemical decontamination process to reduce the radiation fields to the workers during the refurbishment execution window.

4.4.2 Plant Systems

This area encompasses a comprehensive scope of work across both nuclear and conventional station systems. This includes critical engineering modifications while implementing a significant volume of like-for-like replacements to address station life cycle management. The PRP will strategically utilize station staff expertise and resources to ensure proficient execution of this work to help extend the operational life of the station while maintaining the highest safety and reliability standards.

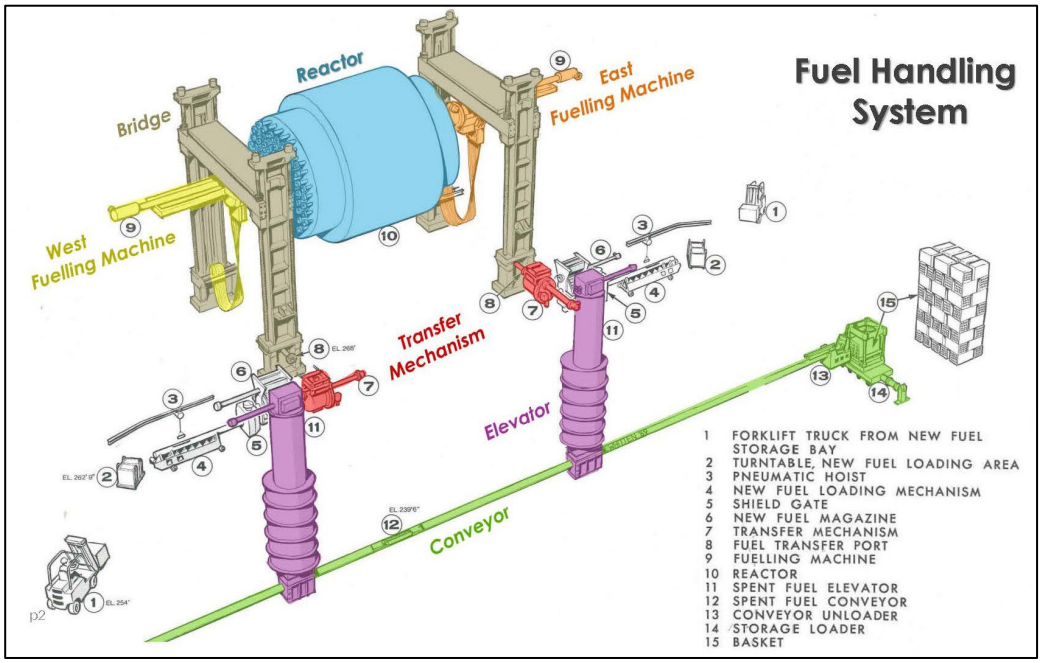
4.4.3 Valves

Valve work will address proactive replacements and overhauls of critical components on the nuclear and conventional side, including safety-related systems based on engineering assessments.

4.4.4 Fuel Handling and Defueling

The Fuel Handling ("FH") work is comprised of five broad areas of scope: (1) defuel the reactors, (2) new fuel load, (3) removal and re-installation of Fueling Machine ("FM") and carriage, (4) overhaul of FH components, and (5) service room and FM bridge movement.

Figure 2 – Fuel Handling System



4.4.4.1 Defuel the Reactors

The first major step once the refurbishment outage commences is to remove the irradiated fuel ("IF") from the reactor core. There are 380 reactor channels per unit (12 bundles/channel, 4560 bundles) that will be defueled after bringing the unit to the guaranteed shutdown state. This work will be executed as part of the initial segment on critical path and is required to allow downstream activities including RFBR work to take place on the reactor face.

Figure 3 – Reactor Face

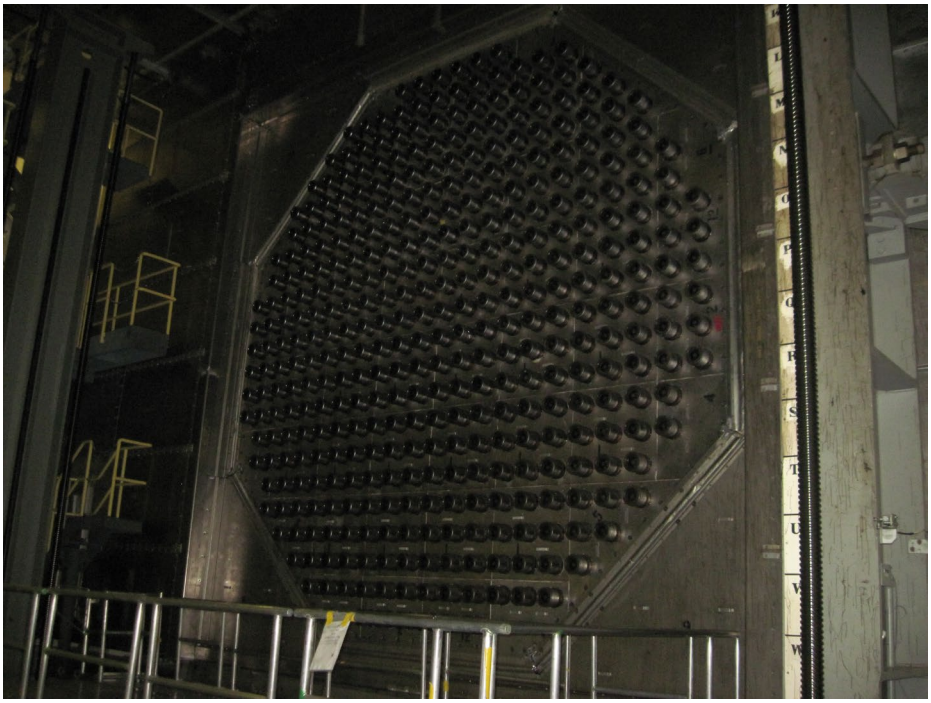


Figure 4 – End Fitting

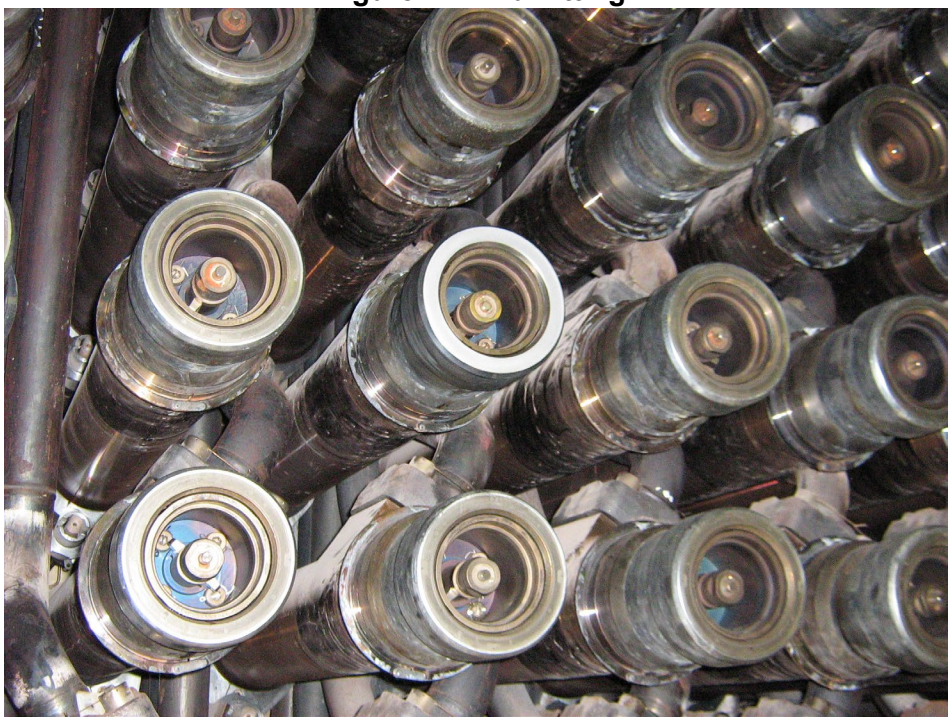
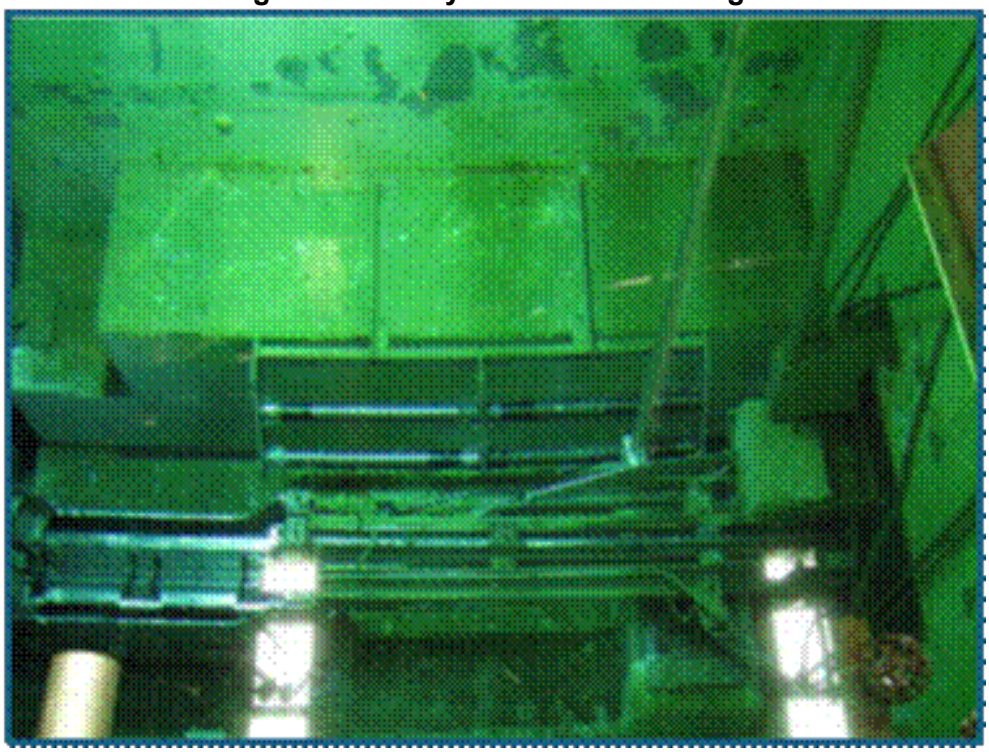


Figure 5 – IF Bay- Channels Discharge



Defueling a reactor requires in house expertise for engineering work (i.e., software modifications, equipment re-configuration design engineering changes, etc.) procurement of tools, extensions, spare parts, etc. and FH licensed station staff to execute the work accordingly.

4.4.4.2 New Fuel Load

New fuel load scope encompasses loading 4560 fuel bundles manually back into 380 channels. This execution is crucial for vault restoration and therefore is scheduled on critical path.

Figure 6 – New Fuel

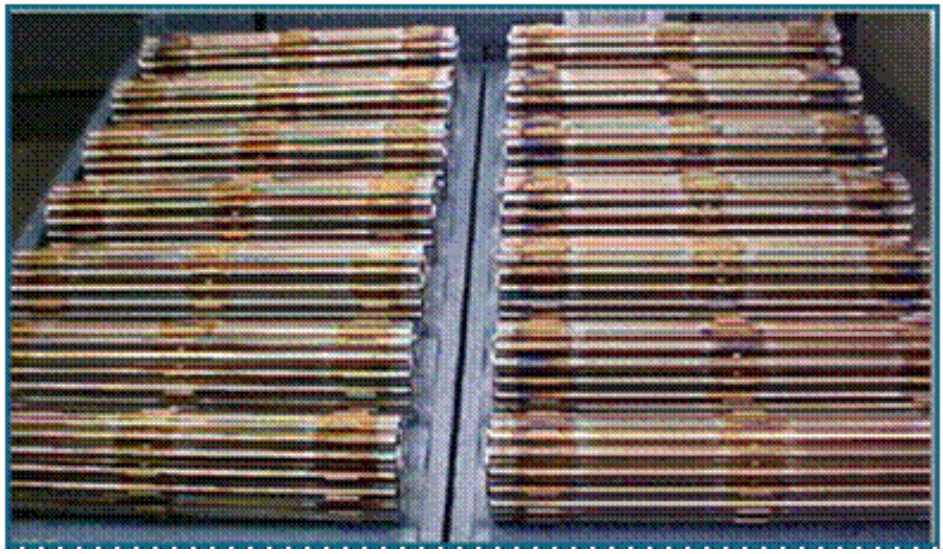
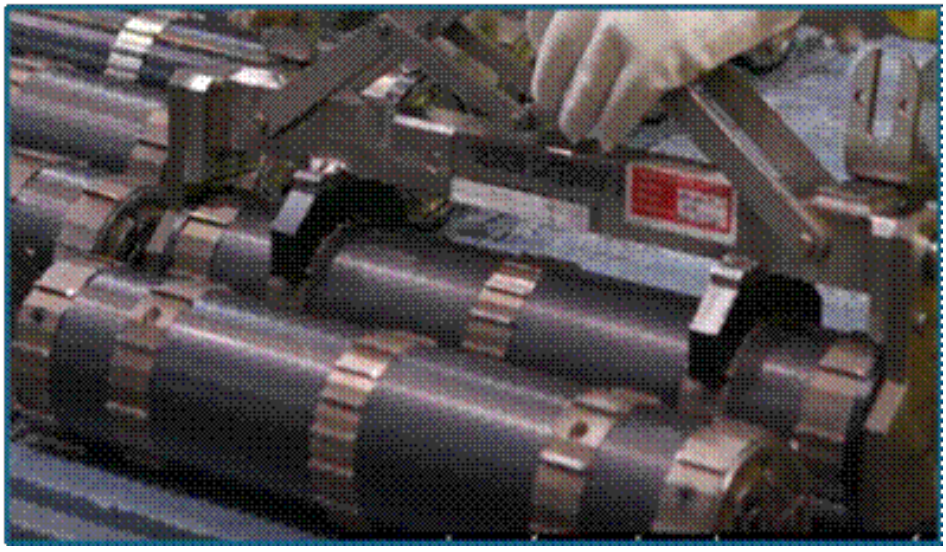


Figure 7 – Manual Load of New Fuel



This work requires a joint effort between OPG and contractors as part of the planning process to procure materials (i.e., new fuel, tools, etc.), develop work plans, establish safe work areas for new fuel storage, and provide training to all required work groups in order to maintain the highest safety, proficiency and quality in support of the refurbishment program.

4.4.4.3 Removal & Re-installation of Fueling Machine & Carriage

Removal of FM from service room and carriage assembly from the RB is part of the PRP scope of work. It is planned to be executed post defuel of the reactor, off-critical path and prior to vault turnover to OPG's contractor for RFBR work.

Figure 8 – Fuel Machine in Service Room

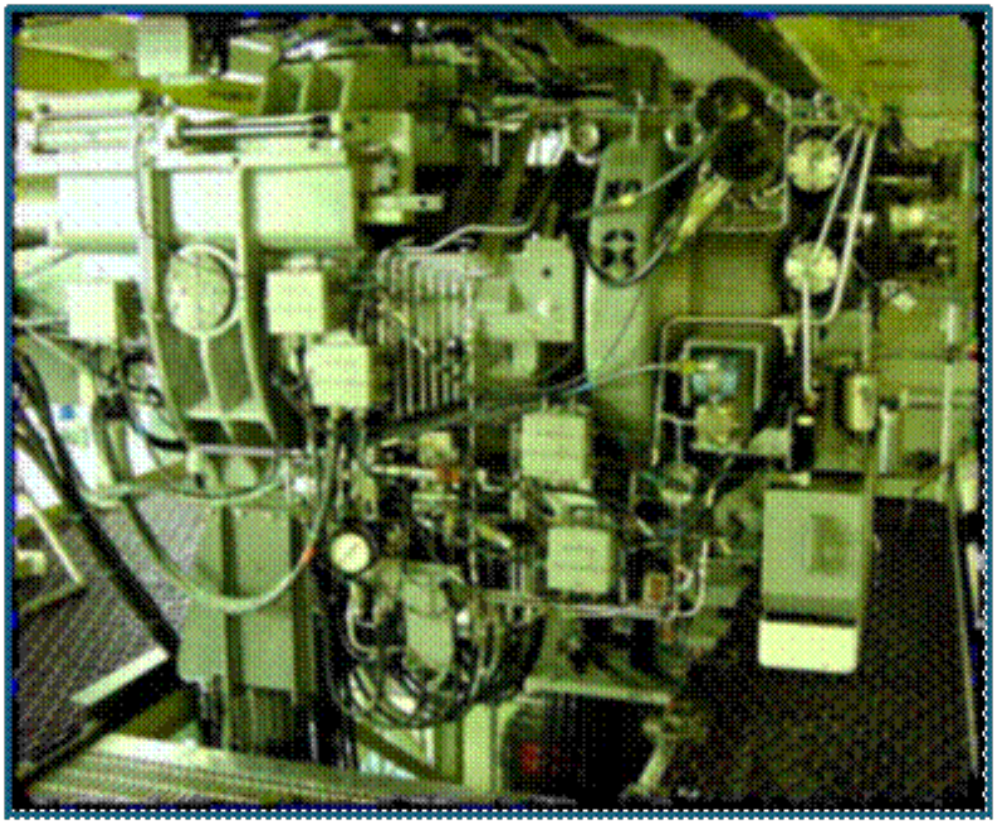
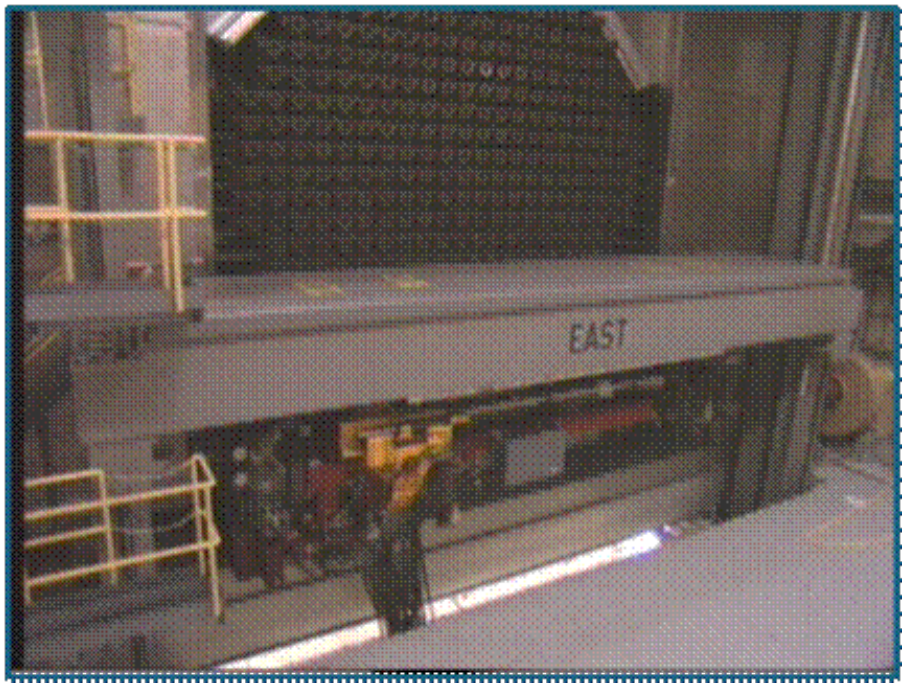


Figure 9 – Carriage Assembly



Once these assemblies are removed, pre-determined key components (i.e., FM head, round way bearings, etc.) within these assemblies will be refurbished by OPG station staff. These assemblies will be stored until they are ready for re-installation on critical path for each unit.

This entire refurbishment cycle of FM and carriage assembly will primarily be led and managed by OPG, encompassing project management, engineering, materials, tooling and execution staff to perform the work along with collaborative support from contractors to remove/re-install any interferences.

4.4.4.4 Overhaul of Fuel Handling Components

This bundle also includes the inspection and replacement (as required) of fuel transfer conveyer and elevator components that have been in constant use and submerged in fuel bay water for the station's life. This work requires collaborative support from the Balance of Plant team to isolate and drain Units 5-8 receiving bays from the main portion of IF Bay "B".

In addition, the PRP scope includes pipework downstream of FM heavy water pressurizing pumps that have been subject and incurred degradation and wear over the course of operation. Those segments will be inspected and repaired accordingly.

As part of the FM and carriage assembly removal, there will be a series of smaller modifications performed to reduce maintenance execution time post-refurbishment, which includes grayloc leak repairs on at least five FM heads across Units 5-8.

Figure 10 – Elevator Mechanism

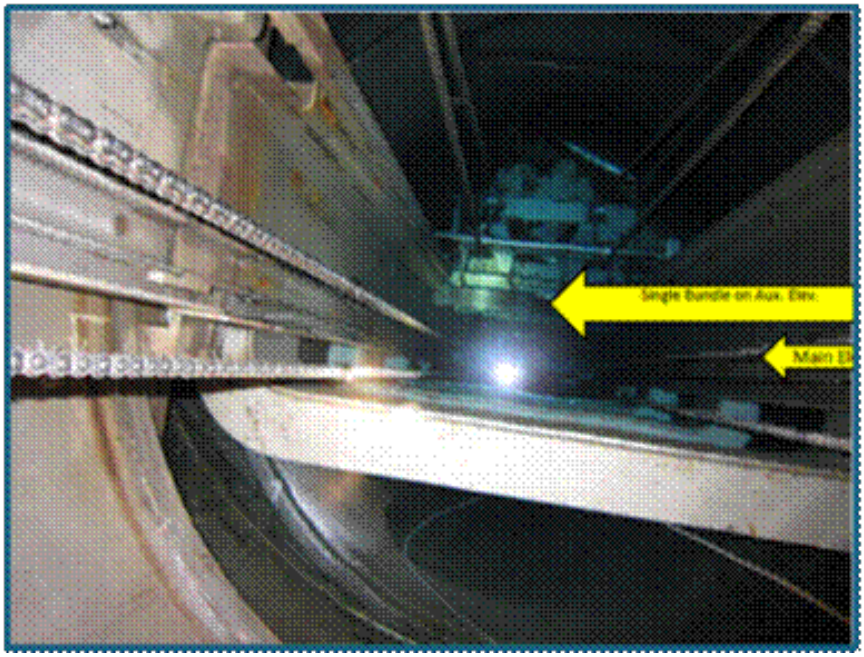
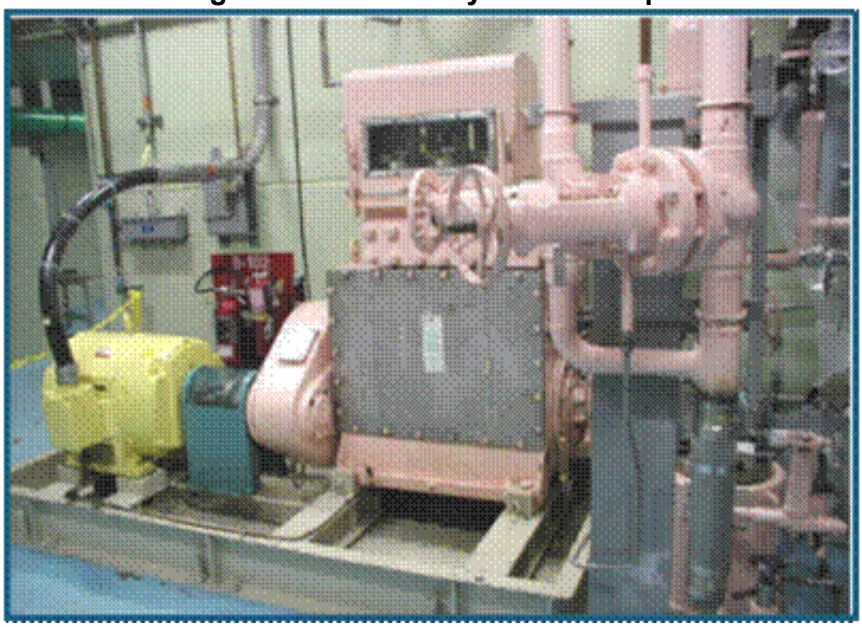


Figure 11 – FM Heavy Water Pumps



4.4.4.5 Service Room Changes & FM Bridge Movement

To facilitate refurbishment activities, it is necessary to remove any interferences in the service rooms. The Operations & Maintenance bundle will plan and execute the removal and restoration of these interferences. Over the course of the PRP, the FH team will facilitate the FM Bridge movements to support RFBR work on reactor face. There are two bridge assemblies (one per reactor face). Each bridge enables the FM head to move both horizontally and vertically at the reactor face.

4.5 Facilities and Infrastructure

To ensure the necessary facilities and infrastructure are in place to support project bundles, this bundle of work includes executing various preparatory activities prior to unit shutdowns. This includes conducting conceptual assessments, completing early works, and carrying out facilities and infrastructure construction activities in advance. Examples of some key deliverables are:

- Traffic Study (Municipal, Onsite)
- Site Preparation and Service Upgrades
- Renovations and Upgrades to Existing Buildings

- Construction or Leasing of New Buildings

4.5.1 Traffic Study and Capacity Management

With the anticipated increase in personnel and vehicular traffic at the Pickering site, a comprehensive traffic volume evaluation has been conducted. This assessment has helped define the logistical requirements needed to manage the higher traffic flow efficiently while ensuring safe and effective transportation routes for workers, deliveries, and equipment.

To further support these efforts, a Traffic Working Committee has been formed. This committee is working with external stakeholders, such as local municipalities and rights holders, to assess the access routes to the site. Planned improvements include resurfacing Sandy Beach Road and Montgomery Park Road with additional traffic control measures and other potential projects to reduce congestion and enhance overall accessibility.

In addition to external roadways, onsite infrastructure is being upgraded. Parking facilities are being expanded to accommodate the growing workforce, ensuring adequate space for both personal and fleet vehicles. Roadways within the site are being assessed and upgraded to improve traffic movement, reduce congestion points, and support the safe and efficient transport of personnel and materials.

4.5.2 Site Preparation and Service Upgrades

Prior to refurbishment commencing, it is essential to secure sufficient space for storing materials, staging equipment, and construction of new buildings. With this objective, the site grounds have been sectioned into areas where nonessential equipment and construction materials will be removed. Inside the powerhouse, storage areas are being created by ensuring equipment and materials not required to support refurbishment are repurposed, relocated, or disposed of through appropriate waste management processes.

Additionally, a comprehensive assessment was undertaken of the underground infrastructure will be undertaken to thoroughly evaluate the condition and integrity of critical piping and support systems. The assessment which was completed in the second quarter of 2025 revealed that there are no immediate needs for replacement of majority of aforementioned services and only a portion of utilities required to be rerouted to accommodate the constriction of common services building and retube feeder replacement islanding storage annex building.

4.5.3 Renovations and Upgrades to Existing Buildings

These projects are designed to modernize essential systems, enhance operational capabilities, and ensure compliance with evolving regulatory standards. By upgrading key facilities and infrastructure components, this scope aims to support the successful execution of refurbishment activities and minimize operational disruptions

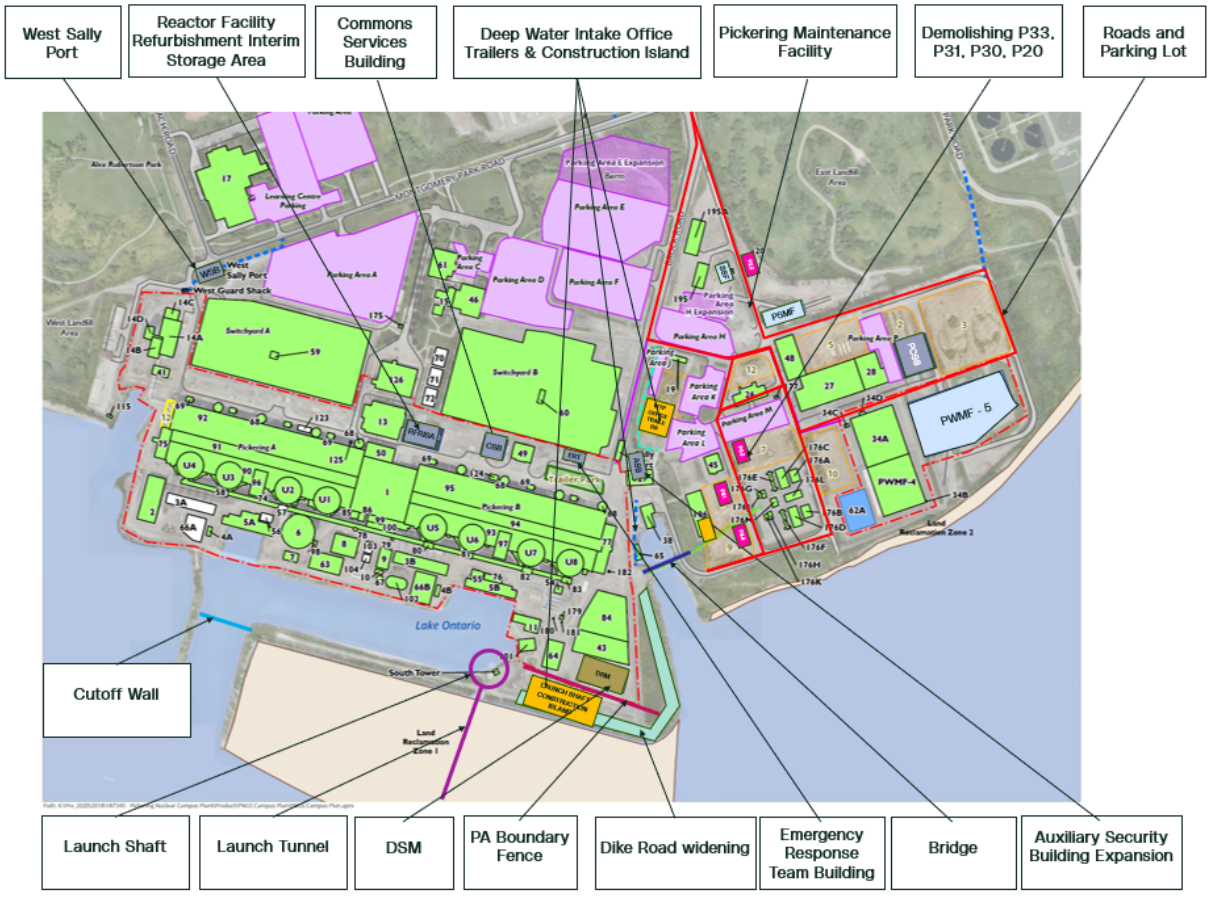
- To ensure efficient movement of personnel and materials across different levels within the powerhouse, an assessment of passenger and freight elevators has been completed. This evaluation has identified key components requiring upgrades necessary to maintain elevator reliability throughout the refurbishment activities.
- To address space limitations for processing launderable radiological personal protective equipment, a project was undertaken to remove four obsolete washing machines and four outdated dryers. This created additional floor space to support the preparation of spent radiological personal protective equipment for transport to an offsite laundering facility.
- Given the increased workforce onsite, hygiene facilities must remain accessible and fully operational. Existing facilities have been maintained to ensure functionality, and personal storage lockers will be installed in the current change rooms. Additional hygiene facilities and lockers will also be available in the new common services building.
- To address the increasing demand for project support staff who provide essential field assistance, it was determined that additional office space closer proximity to the worksite is required. To achieve this, the Engineering Services Building 1 and 2 will be reorganized to maximize the use of existing space. This will involve optimizing office layouts, converting areas for more effective use, and ensuring that the necessary infrastructure is in place to create a productive work environment. Upgrades will include the installation and enhancement of LAN, IT, and Wi-Fi networks, providing reliable connectivity that enables

real-time communication, efficient data access, and smooth coordination among field teams.

4.5.4 Construction or Leasing of New Buildings

Several new buildings are required to support the PRP. These projects will accommodate a growing workforce, improve material logistics, and enhance overall efficiency. Together, they will streamline material flow, strengthen project coordination, and provide essential workspace for key partners.

Figure 12 – Campus Plan



4.5.4.1 New Warehouse Lease (Church Street)

OPG has entered a new ten-year warehouse lease to support the staging and preparation of materials prior to their delivery to the project site for execution, as well as mock-up training. Given the sole use of this warehouse location is to support PRP activities, it was determined that leasing was more appropriate than constructing a new building. This facility is intended to streamline the flow of materials, ensuring that all necessary components are organized, inspected, and ready for use when needed at the site. In addition to its warehousing functions, the facility will also feature a dedicated training area. This space will be used to conduct hands-on training sessions and simulations, helping workers become familiar with project-specific tasks and safety protocols. By integrating material management and workforce training in one location, facility is expected to improve overall project readiness and efficiency.

4.5.4.2 Common Services Building and Retube Feeder Replacement Island Storage Annex

Within the protected area, a new, two storey modular common services building (see Figure 12 above) will be constructed to accommodate craft personnel working on the PRP. It will include a shared lunch area for approximately 700 workers along with changerooms. Post refurbishment, this facility will continue to accommodate personnel for ongoing projects and outages.

A three-story retube feeder replacement islanding storage annex (see Figure 12 above) will also be built within the protected area to support the organization. The first two floors will provide office space for the RFBR contractor along with space for OPG project support, while the third floor will accommodate the Retube and Feeder Control Centres. The Control Centres will be in direct contact with the RB workers while they execute the work on the unit. Communication and video feed will be part of these Control Centres to ensure that the execution and coordination of work is carried out safely and in a controlled and monitored manner.

Together, these facilities will streamline material flow, enhance project logistics, and provide essential workspace for key project partners, supporting efficient and coordinated refurbishment activities.

4.5.4.3 Main Security and Auxiliary Security Building

To support increased traffic to the protected area, the Main Security Building and the Auxiliary Security Building are expanding ingress and egress lanes. Additionally, a new West Sally Port structure will be constructed, reducing congestion and delays at the East Sally Port (see "West Sally Port" in Figure 12 above). The West Sally Port will also support larger equipment deliveries.

4.5.4.4 Pickering Maintenance Facility

The new Pickering Maintenance Facility will be constructed to meet the growing demands of ongoing station operations, refurbishment activities, and the long-term support required for reliable plant performance. The existing maintenance infrastructure is at end of life and is no longer adequate to efficiently accommodate the increased volume and complexity of maintenance tasks. The new Pickering Maintenance Facility is necessary to provide safe, efficient, and properly equipped workspaces for maintenance staff, as well as secure storage for tools, parts, and specialized equipment. By investing in a purpose-built maintenance facility, the station will be better positioned to ensure operational reliability, minimize downtime, and extend the overall service life of critical assets. The current facility will be demolished to create a laydown area for material and equipment storage, supporting various project bundles.

4.6 Deep Water Intake

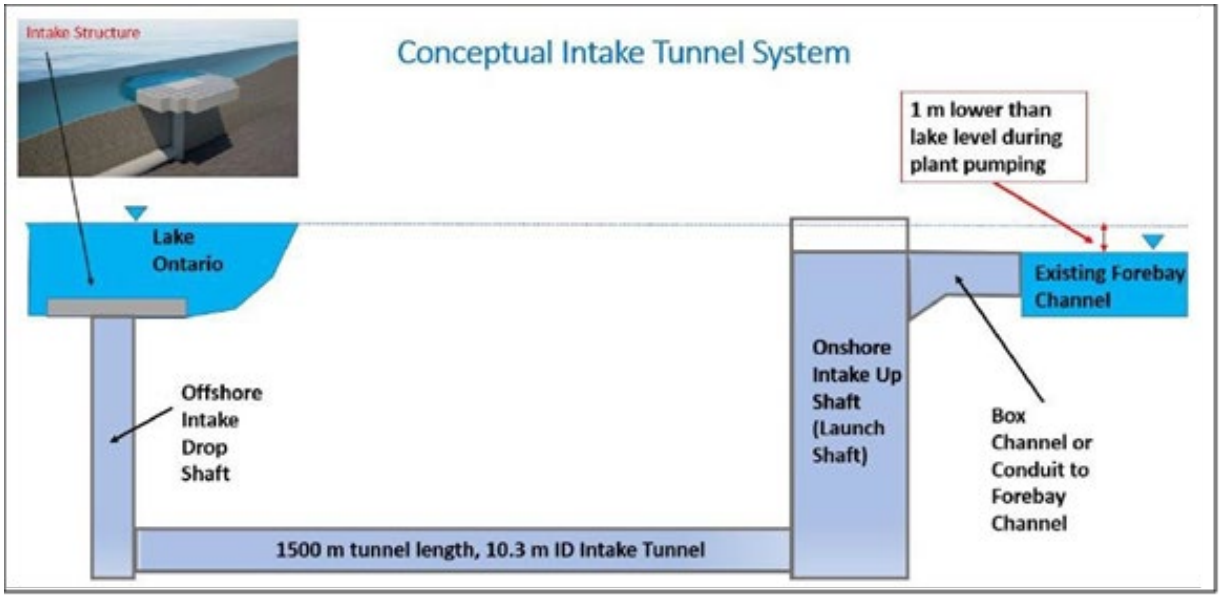
A deep-water intake system is an engineered structure that draws water from deep below the surface of the lake to ensure a stable supply of clean, cold water to forebay.

The installation of the DWI system is expected to yield several benefits, including:

- Improved thermal efficiency and support for increased electrical power output: By drawing cooler lake water, the DWI system will enable Pickering Units 5-8 to operate at optimal temperatures, resulting in improved thermal efficiency and reduced energy losses.
- Reduced biofouling events: The DWI system will minimize the risk of biofouling events, which will lead to reduced water flow rates, decreased maintenance costs, and increased plant availability.

- Decrease fish impingement and entrainment: By drawing water from a deeper depth, the DWI system will reduce the risk of fish impingement and entrainment, which have resulted in generation losses and operating challenges for the station.
- Enhanced resilience to climate change: The implementation of the DWI system will enable Pickering Units 5-8 to adapt to the changing climate and reduce its exposure to extreme weather events, such as heatwaves and higher lake temperatures, over approximately the next 45 years.

Figure 13 – Conceptual Intake Tunnel System



This project is categorized into four major work areas:

Tunnel and Shaft Construction

- Includes excavation, tunneling, and installation of intake structures. Excavation and construction of an underwater intake tunnel will be performed utilizing a tunnel boring machine.
- Development of an offshore intake drop shaft and launch shaft to facilitate water flow.
- Implementation of erosion and durability protection for tunnel lining and shaft structures.

- Hydraulic and structural analysis to ensure optimal water flow and pressure management.

Forebay and Intake System Modifications

Water intake to the forebay will be changed by implementing a surface water intake cutoff wall and a DWI that conveys water from the lake through an intake cap, down shaft, tunnel, an upshaft, forebay box conduit and ultimately into the existing forebay:

- Design and installation of a modular intake cap with erosion-resistant features.
- Connection of the intake tunnel to the existing forebay structure while ensuring minimal impact on plant operations.
- Modifications to the forebay box conduit for seamless integration with the intake system.

Power and Infrastructure Development

- Installation of a construction power distribution system with high voltage equipment.
- Construction of a bridge structure to support heavy equipment transportation.
- Upgrades to Dike Road to enhance site accessibility and logistics.

Cut-Off Wall

The DWI system utilizes the natural force of gravity to transport water through the tunnel to the forebay, to ensure the forebay is effectively isolated from the lake and to create the necessary differential head for water flow. The cutoff wall will be constructed with features to maintaining operational integrity and safety standards.

LIST OF ATTACHMENTS

Attachment 1: Scope Differences Between Darlington Refurbishment and Pickering Refurbishment

Attachment 1 -

Summary of Scope Differences of Pickering vs. Darlington Refurbishment

Major Work Bundle	Pickering Refurbishment	Darlington Refurbishment	Notes
Re-tube and Feeder Replacement	380 Fuel Channels 760 Feeders	480 Fuel Channels 960 Feeders	Bigger Vault size in PRP that can facilitate waste processing directly in the vault. Retube storage building vs. Retube waste processing building (different building requirements).
Boilers	12 x 4 Units - Boiler Replacement	4 x 4 Units - Boiler inspections & cleanings	Full replacement of Boilers (PRP) vs. Refurbishment/water lancing of Boilers (DRP)
Turbine Generators	LP Turbine rotor replacements (12 rotors, 3/unit) including new inner casing and guide blade carriers HP Rotor replacement (x2) including new guide blade carriers Turbine bearing replacement Generator Stator (x4) and Rotor rewinds (x4) Generator Stator Core Replacement (x4) Moisture Separator & Reheater Retrofit Hydrogen seal design change (axial to radial)	No LP/HP Turbine rotor or guide blade carrier replacements Generator Stator rewinds (x2) No Generator Core Replacement Moisture Separator & Reheater Inspections only Condenser strut replacements	Increased PRP scope due to age of components

	Hydrogen cooler replacement (x12, 4/unit) New Lube Oil Purifier Brushgear replacement Steam extraction expansion joint replacement		
Deep Water Intake	Construction and commissioning of a Deep Water Intake System	No modification required	Deep Water Intake System required at PRP to support second-life operability and reliability
Balance of Plant	DCC Replacements (Units 6, 7 & 8)	DCC minimum upgrades	More systems and components as compared to DRP.

1

PICKERING REFURBISHMENT PROGRAM
PROGRAM SCHEDULE

1.0 OVERVIEW

The ability to validate, integrate, oversee, and maintain control over the program schedule has been a key driver of OPG's strategy for the Pickering Refurbishment Program ("PRP"). OPG has developed a fully integrated program schedule that consolidates the project schedules for each major work bundle, breaking them down into individual work packages or components. By retaining control over the program schedule, OPG can effectively manage costs and drive program success.

This evidence describes:

- the development process for OPG's integrated program schedule;
- OPG's multi-level scheduling approach;
- the Unit 5 critical path; and
- the difference between PRP's working schedule and the high confidence schedule.

This exhibit focuses on schedule formation, while Ex. D2-3-9 addresses schedule management in execution.

2.0 SCHEDULE DEVELOPMENT

Developing an accurate and realistic schedule is a critical planning tool for any complex project like the PRP.

The Unit 5 schedule reflects the total of the estimated duration of the individual tasks included within the developed scope. This schedule is needed to properly strategize, plan and prepare for upcoming project work, to determine resource requirements, to understand how the work is progressing, and to apply corrective actions if required.

OPG and the contractors have collaboratively developed the Unit 5 and full program schedule with input from appropriate project stakeholders. The development process is characterized by multiple layers of review and rigorous challenge, including cross-functional, cross-bundle and contractors challenge sessions where each project team actively defended and refined their own segment of the schedule and associated resource estimates and costs. In addition, OPG has conducted independent challenges, drawing on prior experience, lessons learned from other major construction projects, and knowledge of project constraints, milestones, resource requirements and critical path considerations.

These reviews include vertical slice analyses, where the schedule is reviewed in relation to other project work being executed in the same time period. This approach ensures that schedule assumptions are robust and balanced, and that there is transparency in how resource estimates and durations are established.

Further, once the schedule is drafted, all scope and its associated cost, schedule, and risk analysis undergoes formal approval through the PRP Gate Review Board prior to being released for execution. The Gate Review Board is an OPG governance requirement within Phase Gate Management and has membership from OPG project leadership as well as OPG oversight functions such as Finance and the Enterprise Project Management Office. Only after these independent checks and formal reviews is the schedule activated. This process is designed to drive a high standard of schedule quality and integrity.

OPG and its contractors have developed schedules based on input from relevant project stakeholders. The scheduling process includes:

- Defining the scope of work to be completed;
- Identifying key activities, including their start and finish dates, duration, and required resources;
- Establishing the sequence and logical relationships between activities and milestones;
- Identifying and optimizing the critical path;
- Continuously monitoring and updating schedules to track performance, forecast outcomes, and mitigate schedule risks; and

- Conducting forward-looking planning to assess priorities, opportunities, and potential risks.

OPG project teams have developed a deliverable-oriented work breakdown structure that accounts for 100% of the project scope, detailing individual work components within each bundle (also known as “work packages”). This breakdown aligns with the PRP’s contracting strategies, ensuring clear allocation of work scope, budgets, and responsibilities.

Project schedules undergo regular quality reviews to ensure they comply with process requirements. These reviews are conducted periodically as part of routine schedule updates. Additionally, schedules have been refined through an iterative review process and approved by project teams and key stakeholders. These reviews consider project and program constraints, milestones, resource needs, and the critical path to validate the schedule’s feasibility.

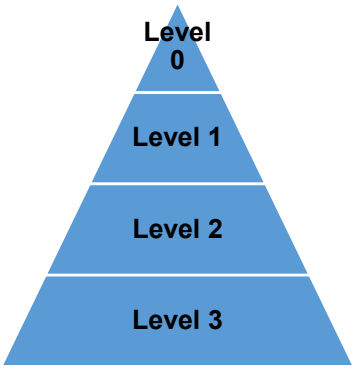
3.0 MULTI-LEVEL SCHEDULING APPROACH

Based on its past practices and project governance, OPG has established the PRP Schedule using a multi-level scheduling approach.

As shown in Figure 1 below, project schedules are prepared with varying levels of detail, from Level “0”, which contains the milestones managed by OPG that identify the major deliverables and timelines for PRP, to Level “3”, which contains the greatest level of detail showing individual work components at the task level.

For example, the parties to the project will perform their project management activities with the Level 0 to Level 2 Working Schedules. The Level 3 Working Schedule will be used to monitor and control most work for the completion of Unit 5, including engineering, procurement, construction, installation, testing, commissioning, completion and facility turnover.

Figure 1 - Multi-level Scheduling Framework[1]



Level 0: Nuclear Program Milestone Schedule, controlled by OPG Senior Management.
Level 1: Nuclear Program Integrated Master Schedule, controlled by OPG Senior Management. Program Level 1 contains all Control Accounts from all Projects as well as for Program Management work.
Level 2: Nuclear Program Coordination & Control Schedules, controlled by OPG Nuclear Program/Project teams. Program Level 2 contains all Work Packages in the Program and they are interrelated.
Level 3: Nuclear Project Detailed Production Schedules, controlled at the project level, by contractors or OPG (for OPG executed projects).

Level 0, the Nuclear Program/Project Milestone Schedule, serves as the foundation for OPG senior management to establish the master schedule. It includes key milestones such as program release dates, regulatory deadlines, outage preparation, and outage execution timelines.

Level 1, the Nuclear Program/Project Integrated Master Schedule, outlines specific work scopes, timeframes, and responsible organizations. Providing a high-level summary of the program or project, it encompasses all units, phases, and work bundles and is used by project managers, contractors, and scheduling teams.

Level 2, the Nuclear Program/Project Coordination & Control Schedule, is the primary tool OPG uses to monitor the overall program status. This schedule, maintained and updated by OPG, is derived from the contractors' detailed Level 3 schedules.

Level 3, the Nuclear Program/Project Detailed Production Schedule, breaks work down into the most granular level of activities. These schedules are developed by the executing teams

[1] A Level 1 schedule is comprised of Control Accounts, which represent high level execution windows in each outage segment. A Level 2 schedule is comprised of Work Packages, which are used to integrate costs and schedule as well as provide grouping for related Level 3 activities. Earned Value Management (a project management technique that integrates project scope, cost, and schedule to provide an objective measure of project performance and progress) is performed at this level.

— typically contractors, though in some cases, OPG prepares them when self-performing work.

Once approved, schedules are “baselined” by project owners to serve as a benchmark for tracking implementation performance. These approved schedules are archived and will not be modified, except by means of a re-baselining process involving cost and schedule analysis and only through authorized change control. This process is further detailed in Ex. D2-3-9.

4.0 CRITICAL PATH AND SCHEDULE OVERVIEW

The critical path refers to the longest sequence of dependent activities in a project plan which must be completed on time for the timely delivery of the overall project. Activities on the critical path cannot be started until one or more predecessor activities are complete. If the critical path is delayed for one day, the entire project will be delayed for one day, unless the critical path activities following the delay are completed one day earlier than planned or future critical path activities are forecast to be completed earlier than the original plan.

Figure 2 presents a simplified PRP outage schedule and illustrates the major phases for the execution of Unit 5. The phases are:

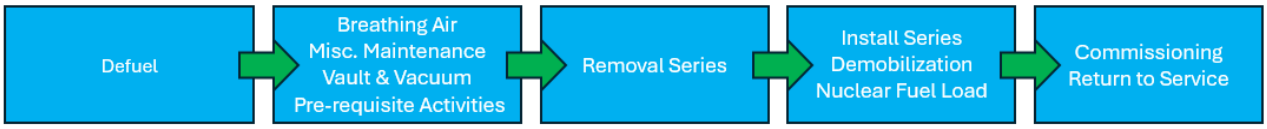
- Reactor shutdown
- Defuel reactor
- Vault Preparation, Pre-requisites Vacuum Dry and other Pre-requisite activities
- Removal series
- Install Series Lead-Out & Nuclear Fuel Load
- Commission and Return to Service

As a project progresses, the critical path may shift due to factors such as emerging risks, resource reallocations, or schedule optimizations. Any alterations to the critical path are managed through the change management process which includes evaluating the effects of the modifications, securing the necessary approvals and revising the schedule to reflect

updated objectives and constraints. Additional detail on the change management process can be found in Ex. D2-3-9.

A more detailed schedule for Unit 5 is provided in Attachment 1.

Figure 2 – Simplified Unit 5 Refurbishment Critical Path



5.0 WORKING SCHEDULE VERSUS HIGH CONFIDENCE SCHEDULE

The Working Schedule represents the PRP's most current and detailed timeline, incorporating input from engineering, procurement, construction, and commissioning teams. This schedule is continually updated to reflect the latest progress, risks, and lessons learned from ongoing activities. It includes all major milestones, critical path activities, and dependencies between work packages. As part of the schedule development process, OPG has integrated all schedules, determined the critical path and created the schedule provided in Attachment 1. This schedule is the Working Schedule. It is used to manage day-to-day project performance and will be used to determine contractor incentives and disincentives, where applicable. It is also the basis for measuring the use of project-controlled schedule contingency.

OPG has also evaluated the risks and uncertainties for each element of the schedule based on robust risk analysis, historical performance data, and expert judgment to determine the amount of schedule contingency required to deliver the PRP. This resulted in a schedule that includes contingency for certain schedule risks that may be encountered during construction execution and commissioning. Through probabilistic analysis, OPG expects to execute PRP within this schedule. This High Confidence Schedule is the basis for the RQE, which serves as the control budget. This High Confidence Schedule is also the schedule from which project success will be assessed.

Based on these definitions, OPG is targeting to return Unit 5 to service per the High Confidence Schedule on May 15, 2031. Internally, OPG is managing the day-to-day performance of Unit 5 against the Working Schedule.

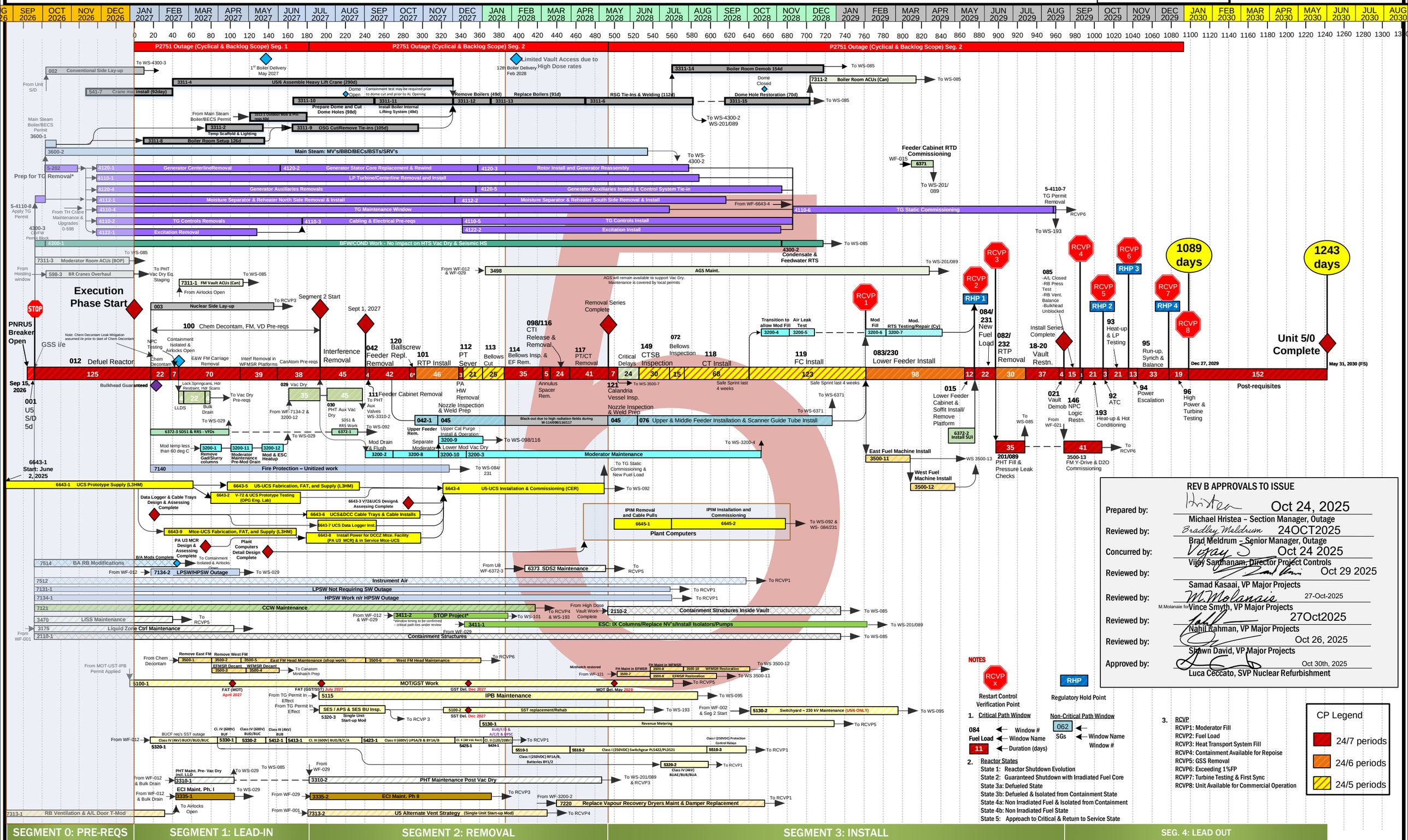
LIST OF ATTACHMENTS

Attachment 1: Pickering Refurbishment Outage Schedule – Level 1 Overview

Unit 5 Refurb – Revision B Level 1 Overview

Filed: 2025-12-12
EB-2025-0297, Exhibit D2-3-6
Attachment 1, Page 1 of 2

Revision B
Oct 2025



REV B APPROVALS TO ISSUE

Prepared by:	Michael Hristea – Section Manager, Outage	Oct 24, 2025
Reviewed by:	Brad Meldrum – Senior Manager, Outage	24OCT2025
Concurred by:	Vijay Sanmanam, Director Project Controls	Oct 24 2025
Reviewed by:	Samad Kasaai, VP Major Projects	Oct 29 2025
Reviewed by:	M.Molanaie for Vince Smyth, VP Major Projects	27-Oct-2025
Reviewed by:	Nahil Rahman, VP Major Projects	27Oct2025
Reviewed by:	Shawn David, VP Major Projects	Oct 26, 2025
Approved by:	Luca Ceccato, SVP Nuclear Refurbishment	Oct 30th, 2025

NOTES

RCVP X — Restart Control Verification Point

RHP — Regulatory Hold Point

1. Critical Path Window
   - 084 — Window #
   - Fuel Load — Window Name
   - 11 — Duration (days)

   Non-Critical Path Window
   - 062 — Window #
   - SGs — Window Name

2. Reactor States
   - State 1: Reactor Shutdown Evolution
   - State 2: Guaranteed Shutdown with Irradiated Fuel Core
   - State 3a: Defueled State
   - State 3b: Defueled & Isolated from Containment State
   - State 4a: Non Irradiated Fuel & Isolated from Containment
   - State 4b: Non Irradiated Fuel State
   - State 5: Approach to Critical & Return to Service State

3. RCVP
   - RCVP1: Moderator Fill
   - RCVP2: Fuel Load
   - RCVP3: Heat Transport System Fill
   - RCVP4: Containment Available for Repoise
   - RCVP5: GSS Removal
   - RCVP6: Exceeding 1%FP
   - RCVP7: Turbine Testing & First Sync
   - RCVP8: Unit Available for Commercial Operation

CP Legend
- 24/7 periods
- 24/6 periods
- 24/5 periods

Unit 0 Refurb – Revision A Level 1 Overview

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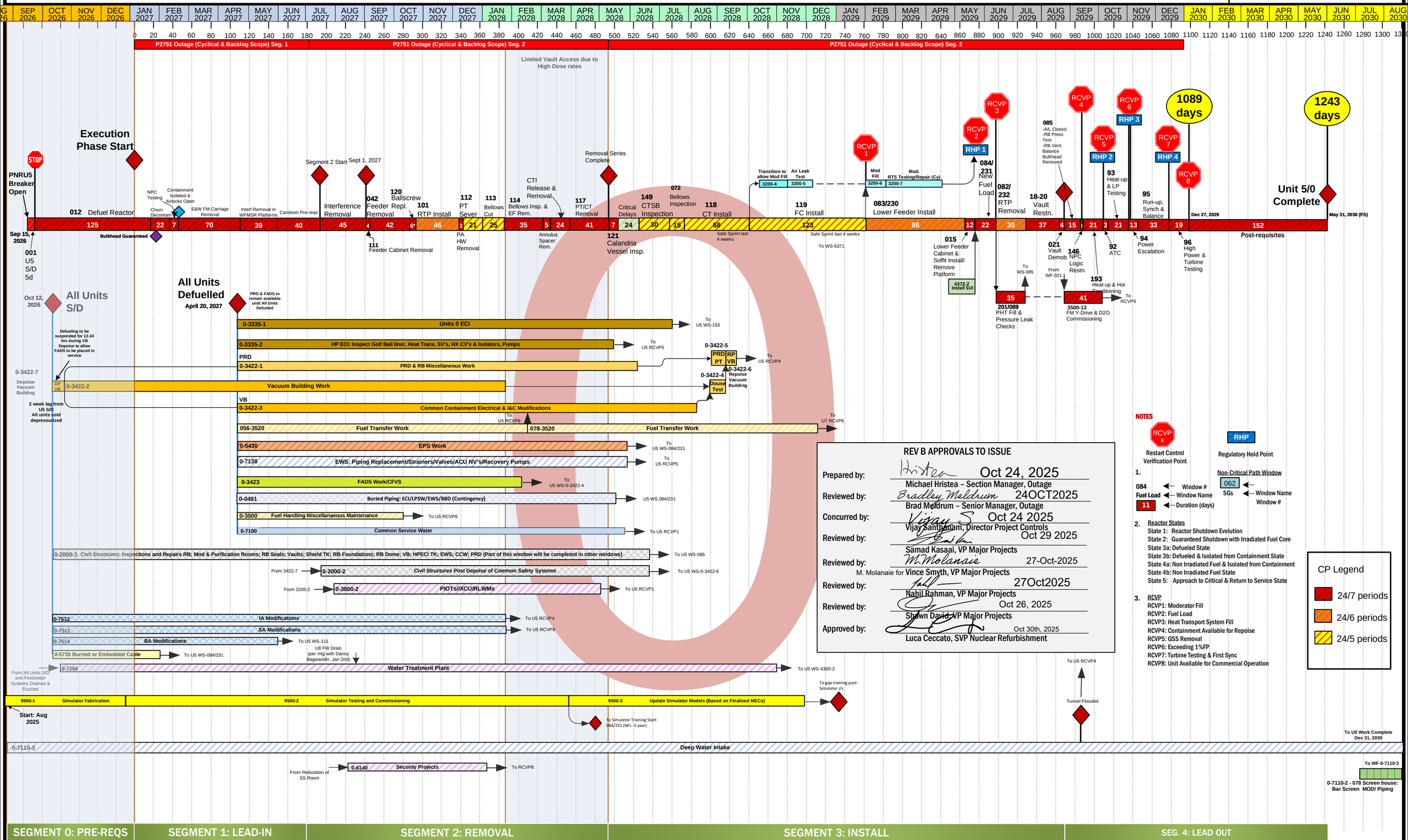
Attachment 1, Page 2 of 2

Revision B
Oct 2025



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RCVP X – Restart Control Verification Point

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1. Non-Critical Path Window: 062 SGs ← Window Name; Window # ← 084 Fuel Load ← Window Name; 11 ← Duration (days)

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RCVP6: Exceeding 1%FP
RCVP7: Turbine Testing & First Sync
RCVP8: Unit Available for Commercial Operation

CP Legend
- 24/7 periods
- 24/6 periods
- 24/5 periods

PICKERING REFURBISHMENT PROGRAM CONTINGENCY

1.0 OVERVIEW

Risk management is a systematic approach for proactively identifying, analyzing, managing and responding to project risks.

OPG has implemented a comprehensive and robust risk management system for the Pickering Refurbishment Program ("PRP"). A key product of this system is the contingency that is included in the Release Quality Estimate ("RQE"). Contingency is an important tool for managing uncertainty and risk throughout the life of a project.

The process that OPG has used to develop the PRP contingency is set out in this exhibit and is largely the same process that was used on the Darlington Refurbishment Program. The process that OPG will use to manage the contingency during the Execution Phase is described in Ex. D2-3-9.

2.0 CONTINGENCY

Determining the amount of contingency for a particular project or program is integral to the estimating, scheduling and risk management processes. Importantly, contingency refers to amounts that are expected to be expended because there are risks and uncertainties that will occur and that cannot be entirely mitigated or avoided.

Contingency is included as a component of a project cost estimate just like any other component. It is not an extra amount that will not be spent if the project goes as planned, nor is it a tool to compensate for an underdeveloped project plan. It is a necessary, legitimate and thoughtfully developed part of the estimated project cost based on residual (post-mitigated) risk and uncertainty.

The Association for the Advancement of Cost Engineering International ("AACE"), a leading authority in the area of cost engineering, management and estimation, defines "contingency" as an amount that is added to an estimate to allow for items, conditions or events, for which the state, occurrence or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. In addition, the AACE definition states that "contingency is generally included in most estimates, and is expected to be expended."[1] Contingency is typically estimated using statistical analysis informed by judgment based on experience. It considers only residual (post-mitigated) risk exposures. Similarly, the Project Management Institute, a leading professional membership association for the project, program and portfolio management profession, explains that contingency allowances are part of the funding requirements for a project, necessary to account for cost uncertainty.[2]

OPG developed the PRP estimate in accordance with AACE's recommended practices for estimate classification. As part of this approach, OPG identified and classified risks, and performed Monte Carlo simulation analysis based on industry best practices (including AACE guidelines). OPG used this risk quantification to inform the contingency component of the RQE.

3.0 CONTINGENCY DEVELOPMENT

OPG has established a risk management team within the PRP organizational structure and equipped them with the necessary tools to identify, develop, manage and monitor risks associated with the PRP.

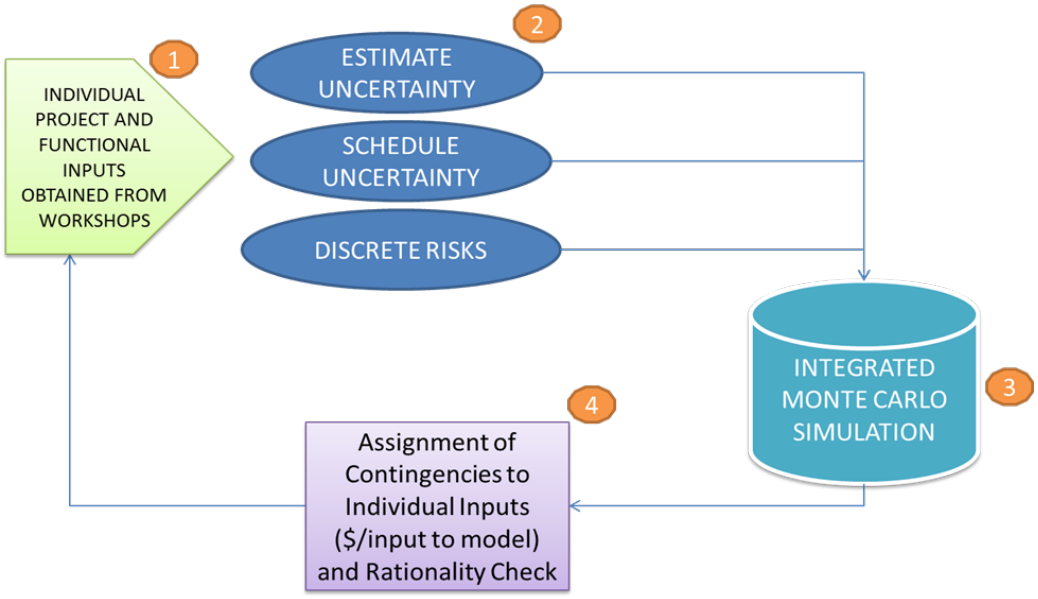
The contingency estimate was developed through a detailed evaluation of: (1) the uncertainties in estimating cost and schedule, (2) discrete risks relating to cost and schedule, and (3) contingent work across each project and the entire PRP. This process relied upon the use of both qualitative and quantitative methods, including performance of an integrated cost and schedule Monte Carlo simulation.

[1] "Cost Engineering Terminology", Recommended Practice 10S-90, AACE International, WV, rev. 2007.
[2] Project Management Institute, *Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 4th ed., 2008, Section 7.1.2.6 at p. 173.

- *Cost estimating uncertainty* is the possibility that the costs of the projects are more or less than the applicable estimates, taking into consideration the estimate classification of the base project cost (excluding discrete risk events).
- *Schedule estimating uncertainty* is the possibility that the actual schedule durations for the projects are more or less than the estimated durations (excluding discrete risk events).
- *Discrete risks* are the incremental cost and schedule impacts to the project baselines if risk events were to occur. These include risks that are specific and applied to individual bundles scope, such as delays to procurement of a specific component for a specific project, as well as global PRP risks that could impact the PRP in an overarching manner, such as with respect to the availability of sufficient skilled trades resources to execute the refurbishment work program.

An illustration of the iterative process to gather, process, and refine the contingency inputs is shown in Figure 1 below.

Figure 1 – Iterative Process for Gathering, Processing, and Refining Contingency Inputs



A comprehensive risk register including AACE estimate classifications for each project and detailed schedule logic was used to develop the contingency estimate. The risk register was initially developed by each project team with the support of OPG's internal Risk Management Team. It was then vetted through a series of challenge sessions to ensure reasonability and that the risks input to the process are legitimate and being effectively managed.

The "cost uncertainty" and "schedule uncertainty" components of contingency were reviewed by the project management teams in collaboration with the Project Controls function (Risk Management Team) in workshops and with reference to the AACE estimate classification and schedule durations. This practice of identifying and modeling the integrated effects of risk and uncertainty on schedule is an approach which is considered best practice and was successfully applied to the Darlington Refurbishment Program.

The contingency amount for the PRP was established through a rigorous and systematic risk management process, drawing on industry best practices and lessons learned from previous nuclear refurbishment projects. OPG used @Risk, a leading risk analysis software tool from Palisade Corporation, an internationally recognized leader in this field.

A comprehensive risk identification exercise was undertaken, involving multidisciplinary teams to capture potential technical, regulatory, schedule, and supply chain risks unique to the Pickering facility. Each identified risk was then assessed for its likelihood and potential impact on both cost and schedule, with findings documented in a detailed risk register. Next, an integrated Monte Carlo simulation representing execution of the entire PRP on a four-unit basis was conducted. A Monte Carlo simulation is a computerized mathematical technique that replicates execution of the project thousands of times, accounting for potential realization of risk events and uncertainties. It provides decision makers with a range of possible outcomes and the probabilities that those outcomes will occur to certain confidence levels.

A Monte Carlo simulation builds models of possible results by substituting a range of values for any factor that has inherent uncertainty. The model is then used to calculate the results in an iterative manner, involving thousands of iterations, each using a different set of random values from the probability functions.[3] The intent is to simulate the outcome of PRP risk and uncertainty variables thousands of times and integrate these results to determine the contingency estimate confidence level. As a result, the RQE contingency estimate is a high confidence estimate based on the risk and uncertainty profile.

After initial contingency development workshops were completed and a preliminary contingency estimate was prepared, management reviews were held to validate the overall adequacy of the contingency estimate. This further ensured that the level of detail and the input of risks and uncertainties were reasonable.

4.0 CONTINGENCY AMOUNTS

4.1 PRP Contingency Amounts

The detailed evaluation of cost and schedule uncertainties and discrete risks, as well as contingent work across each project and the entire PRP, enabled OPG to determine the appropriate amount of contingency to include in the RQE. The outcome of this analysis yielded that, at a high confidence level, the RQE should include $3.76B (2025$) of contingency, which is comprised of project contingency and program contingency amounts.

Project contingency is derived from the individual discrete risks and cost uncertainties managed by project directors and have a localized project impact if they occur. The *Program contingency* is derived from overarching PRP risks managed at the executive level that could influence the overall PRP's objectives, may require program-wide response and may have a global impact on the PRP.

[3] Palisade Corporation, *Monte Carlo Simulation* <http://www.palisade.com/risk/monte_carlo_simulation.asp>.

For a project of the size and duration of the PRP, there are several low probability high consequence events that could impact the PRP and that are outside of the contingency determined in the RQE. Due to the low probability, these items would not contribute sufficiently to a probabilistic assessment used in establishing contingency. Examples of events may include force majeure, a significant labour disruption, changes in the political environment, or incident, and unforeseen changes to financial and other economic factors beyond those assumed in the PRP. As an a more direct example, in light of the volatility characterizing the current economic trade environment, the inclusion of tariffs in RQE calculations could result in either excessive or insufficient contingency. As such, tariffs were excluded on the basis of the high uncertainty for both their probability and impact. If such an event were to occur, Management would evaluate the cost and schedule consequences of the event and provide a recommendation to the Board of Directors for approval on the appropriate response.

A breakdown of the PRP contingency amounts is set out below in Chart 1 excluding interest and escalation.

Chart 1 – Major Work Bundle and Program Contingency

#	Bundles / Category	Estimate Class[4]	Contingency ($M)
1.	Retube, Feeder, & Boiler Replace	Class 3	998
2.	Turbine Generator	Class 3	386
3.	Facilities and Infrastructure	Class 3	70
4.	Operations & Maintenance	Class 3	397
5.	Balance of Plant	Class 4	360
6.	Deep Water Intake	Class 4	287
7.	**Sub Total Major Work Bundles**		**2,497**
8.	Functions	N/A	224
9.	Sub Total – Major Work Bundles and Functions	N/A	**2,722**
10.	Program Contingency	N/A	1,043
11.	**Total Contingency ($M)[1]**	**-**	**$3,764**

[1] Totals may not match due to rounding

[4] See Ex. D2-3-8, Section 2.0 for further information on estimate classification.

Authorization of the use of contingency funds is strictly controlled through the Change Control Board, which requires an explanation of the risk or uncertainty element that has been realized and requires escalation for use of any contingency funds. Additional information regarding the Change Control Board is found under Ex. D2-3-9.

4.2 Unit 5 Contingency Amounts

Allocation of the total contingency across the four units was based on "risk exposure windows", which refers to the anticipated timing for when the risks or uncertainties would be realized and associated contingency costs would be incurred. In allocating contingency to Unit 5, OPG assumed, based on industry experience, that the first unit will realize more risks than subsequent units and that lessons learned will be incorporated for subsequent units to avoid recurrence. On this basis, 41% of the total contingency has been allocated to Unit 5 as outlined in Chart 2 and detailed by major work bundle in Chart 3.

Chart 2 – Unit by Unit Contingency ($M)

#	Unit	Project Contingency ($M)	Program Contingency ($M)	Total ($M)
1.	Unit 5	1,347	209	1,555
2.	Unit 6	461	325	786
3.	Unit 7	429	353	782
4.	Unit 8	485	156	641
5.	**Total[1]**	**$2,722**	**$1,043**	**$3,764**

[1] Totals may not match due to rounding

Chart 3 – Breakdown of Unit 5 Contingency Amounts – Major Work Bundle ($M)

#	Bundles / Category	Contingency ($M)
1.	Retube, Feeder, & Boiler Replace	382
2.	Turbine Generator	154
3.	Facilities and Infrastructure	70
4.	Operations & Maintenance	151
5.	Balance of Plant	258
6.	Deep Water Intake	287
7.	**Sub Total Major Work Bundles**	**$1302**
8.	Functions	44
9.	**Sub Total – Major Work Bundles and Functions**	**1,347**
10.	Program Contingency	209
11.	**Total Contingency ($M)[1]**	**$1,555**

[1] Totals may not match due to rounding

OPG's proposed revenue requirements reflect the forecast Unit 5 in-service additions based on the cost and schedule in the RQE. As set out in Ex. H1-1-1, Section 5.6, the difference between the revenue requirement impacts of the actual costs and firm financial commitments made for the PRP and those forecast costs and firm financial commitments reflected in the 2027-2031 annual nuclear revenue requirement approved by the OEB in this proceeding be recorded in the Capacity Refurbishment Variance Account for later disposition subject to the OEB's review, in accordance with Ontario Regulation 53/05. The nuclear revenue requirement includes PRP in-service additions. As such, in the event of any unallocated contingency at the point of in-service, the favourable revenue requirement variance will be recorded in the account and returned to ratepayers in a future period.

PICKERING REFURBISHMENT PROGRAM COSTS AND IN-SERVICE AMOUNTS

1.0 OVERVIEW

The Release Quality Estimate ("RQE") provides a high confidence estimate of the cost of the Pickering Refurbishment Program ("PRP") based on the costs spent to date and estimated costs to completion, as derived from detailed planning that has been undertaken. This schedule describes the costs of the PRP, including the specific cost of Units 5-8 refurbishment and the costs of the Major Work Bundles, as determined in the RQE.

On November 14, 2025, OPG's Board of Directors approved the PRP RQE, a copy of the memo is provided as Attachment 1. The RQE to refurbish all four Units 5-8 at Pickering is $26.8B including interest, escalation and contingency. In approving the RQE, the OPG Board of Directors approved the full release of the PRP to complete definition deliverables prior to moving into execution for all units. Risk identification and contingency modelling has confirmed adequate contingency for the overall program.

This schedule presents the process used for determining the RQE, along with the result of an independent review of the governance and processes used to develop the RQE. It also provides a breakdown of the RQE costing and resulting capital in-service amounts forecasted to enter rate base over the IR term and discusses the relationship of these amounts to the provisions of Ontario Regulation 53/05 ("O. Reg. 53/05") that provide for recovery of interest amounts in respect of the PRP prior to the assets being placed in service.

2.0 RELEASE QUALITY ESTIMATE

The purpose of the RQE is to produce a comprehensive description of the PRP scope, and a high confidence estimate of the cost and schedule to complete that scope. Importantly, the quality of an estimate is directly related to how well the project scope has been defined. For purposes of classifying its cost estimates, OPG relies upon the estimate accuracy

classification standards established by the Association for the Advancement of Cost Engineering International ("AACE").

Specifically, OPG developed and classified the RQE in accordance with AACE's Recommended Practice No. 18R-97,[1] which defines classes of cost estimates based on the level of engineering and scope definition completed. As seen in Chart 1 below, the estimate classes range from Class 5 (most conceptual with the widest range of potential variability) to Class 1 (most mature with the narrowest range of potential variability).

[1] AACE Recommend Practice 18R-97: "Cost Estimate Classification System – As Applied in Engineering, Procurement and Construction for the Process Industries" was originally published in 1997. It is the basis for OPG's estimating governance and has been used to classify OPG projects and major programs such as the Darlington Refurbishment Program. In 2022, AACE published a new Recommended Practice 115R-21: "Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Nuclear Power Industries", includes more stringent requirements for project definition maturity, which is a primary characteristic for estimate development, and wider accuracy ranges for estimates for nuclear industries (class 3 expected accuracy range of -10% to -20% on the low side to +20% to +60% on the high side). The +/- value represents typical percentage variation after the application of appropriate contingency for a given scope, essentially recognizing that nuclear projects inherently have greater accuracy variability.

As part of the development of RQE, OPG assessed its estimate under both AACE Recommended Practice 18R-97 and AACE Recommended Practice 115R-21, including meeting the more stringent estimate maturity requirements under AACE Recommended Practice 115R-21. Based on OPG's estimate maturity and scope definition at the time of RQE, OPG considered the RQE falling within the accuracy ranges presented in AACE Recommended Practice 18R-97. OPG will continue to refer to both recommended practices going forward as applicable.

Chart 1 – Generic Cost Estimate Matrix - AACE Recommended Practice No. 18R-97

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

The PRP RQE is a Class 3 estimate, and it is being used as the control budget for the delivery of the PRP. Approximately 80% of the estimated costs in the RQE meet or exceed the level of estimate accuracy corresponding to a Class 3, with remaining approximately 20% at Class 4. These estimate classifications, and the associated maturity of scope definition are considered during the risk analysis and contingency development. Generally, scope elements with a lower estimate class and greater uncertainty would generate a greater risk profile and need for contingency.

The largest component of the work bundle estimate, the Retube, Feeder and Boiler Replacement ("RFBR") estimate, is a Class 3 estimate. Chart 2 provides the estimate class for each of the Major Work Bundles.

Chart 2 – Class of Estimate for the Major Work Bundles

Project	Estimate Class
RFBR	Class 3
Turbine Generator	Class 3
Operations and Maintenance	Class 3
Facilities and Infrastructure	Class 3
Balance of Plant	Class 4
Deep Water Intake	Class 4

The expected accuracy range of a Class 3 estimate under the above AACE guideline is -10% to -20% on the low side to +10% to +30% on the high side.

OPG engaged KPMG to provide an independent review of the governance and processes used to develop the RQE. KPMG's review consisted of (1) estimate process & governance, and (2) Detailed Estimate Reviews. KPMG's final report arising from this review is provided in Attachment 2.

Overall, KPMG assessed OPG's estimating AACE guidelines for estimate development, classification, review, validation, document management and risk management. KPMG found that that the estimating processes and governance employed by OPG are well-defined and in alignment with the recommended practices of the AACE and leading industry standards. KPMG also found that that the estimate leverages relevant experience and lessons-learned from previous major projects, notably the Darlington Refurbishment Program ("DRP"), and is based on a consistent work breakdown structure and robust planning methodologies.[2]

More specifically, KPMG reviewed OPG's estimating governance and management processes for developing the PRP RQE against the recommended industry practices published by AACE. The applicable recommended practices that form the basis of this review included the following, 1) development of estimate plan process, 2) development of

[2] KPMG, "Pickering Refurbishment Release Quality Estimate Independent Review" (November 13, 2025), p. 1.

estimate plan content, 3) basis of estimate, 4) estimate classification system, and 5) estimate review, validation and documentation. KPMG assessed the estimating processes and governance against the AACE guidelines using a four-tiered rating scale. Out of 17 items of the estimate process and governance assessment analyzed, KPMG's report identified six areas as Rating 4 (optimized and in line with leading practices), 11 as Rating 3 (well defined with some opportunities for improvement), and no items that it classified as Rating 1 (unreliable/informal) or Rating 2 (standardized) gaps.[3]

With respect to the Class 3 estimate classification assessment, KPMG determined that the RQE was assessed to substantially meet the requirements of a Class 3 estimate, with 78% of the review sample aligned to the respective AACE criteria and RQE management plan. Additionally, KPMG found that good estimating processes and a detailed bottom-up approach have been used in the preparation of estimates.[4]

KPMG concluded that the project team demonstrated strong expertise in the planning and delivery of large nuclear refurbishment programs, and the use of detailed bottom-up approaches for key cost components further supports the reliability of the estimate. KPMG also found that the RQE is in alignment with standard industry practices and has been developed by an experienced team that brings unique knowledge and expertise in the planning and delivery of large nuclear refurbishment programs.[5]

2.1 Cost Estimating Structure

In preparation for the RQE and following the definition of a mature project scope, OPG conducted a rigorous and highly detailed estimating process for each major work bundle. This process was supported by engineering deliverables and a comprehensive understanding of the work to be executed. The associated contingency, interest and

[3] *Ibid.*, pp. 3-4.
[4] *Ibid.*, pp. 9-10.
[5] *Ibid.*, p. 4.

escalation[6] were then determined for each category. These factors collectively enabled the development of a robust estimate that accurately reflected the most current design information, contractor quotations, and specific project requirements.

The overall Class 3 estimate was based on a bottom-up estimating methodology. This approach involved constructing the estimate from detailed work packages, each of which delineated key parameters such as crew composition, skill sets, shift patterns, and task durations. The team leveraged historical data from previous refurbishment projects to validate underlying assumptions and enhance the overall precision of the estimate. In addition, lessons learned and process improvements – such as the integration of advanced tooling strategies and the optimization of work sequences – were systematically incorporated.

Risk management was an essential component of the estimating process. As the project scope and schedule became increasingly defined, OPG employed a systematic approach to identify and assess project risks and opportunities. Based on this comprehensive risk analysis, appropriate contingency allowances were established to ensure that the estimate adequately addressed potential uncertainties and provided a sound basis for decision-making.

This process provides OPG with confidence in the estimated durations and cost estimate for the PRP.

3.0 PRP COST BREAKDOWN

Chart 3 below provides a detailed cost breakdown of the RQE components across the PRP. The RQE comprises $26,413.3M in capital costs and $426.7M in OM&A costs.

[6] Escalation for 2025 onwards was calculated based on existing commercial agreements, supplier estimates, applicable collective agreements, or otherwise as reflected in OPG's business planning escalation assumptions (Ex. A2-2-1).

Chart 3 – PRP RQE Breakdown ($M)

#	Bundle / Category	Total Cost	%
1	Retube, Feeder, and Boiler Replacement	7,853	29
2	Turbine Generators	3,272	12
3	Balance of Plant	1,747	7
4	Operations & Maintenance	2,256	8
5	Facilities & Infrastructure	411	2
6	Deep Water Intake	926	3
7	**Sub-Total of Major Work Bundles**	**16,464**	**61**
8	Function and Program Support	2,564	10
9	Contingency[1]	3,764	14
10	RQE Capitalized Interest	4,048	15
11	**Total Release Quality Estimate[23]**	**26,840**	**100**

[1] Escalation is included in each of the Major Work Bundle and Functional and Program Support cost amounts and Contingency, and accounts for $1,938M of the RQE cost.
[2] OM&A costs (L&ILW variable expenses and Removal costs) are included. See Ex. F2-8-1.
[3] Totals may not match due to rounding

Chart 4 below further shows the PRP RQE broken down by unit.

Chart 4 - RQE Unit Cost Breakdown ($B)

#	Unit / Category	Total Cost	%
1	Unit 5	**8.4**	31
2	Unit 6	**3.6**	14
3	Unit 7	**3.4**	13
4	Unit 8	**3.6**	13
5	**Sub-Total Unit Costs[1]**	**19.0**	**71**
6	Contingency[1]	**3.8**	14
7	RQE Capitalized Interest[2]	**4.0**	15
8	**Total Release Quality Estimate[2]**	**26.8**	**100**

[1] Escalation is included in each Unit cost amount and Contingency, and accounts for $1.9B of the RQE cost.
[2] OM&A costs (L&ILW variable expenses and Removal costs) are included. See Ex. F2-8-1.

4.0 UNIT 5 COST AND IN-SERVICE AMOUNT BREAKDOWN

Based on the RQE, the Application is requesting capital in-service additions of $9,867.9M for the PRP over the 2026-2031 period, associated with the return to service of a refurbished Unit 5 inclusive of any common costs, as further detailed in Section 6.0. Unit 5 is the only unit

being returned to service during the IR term. A detailed breakdown of the components of this estimate is provided in Chart 5 below. The Application is also requesting recovery of $378.5M in OM&A costs for the PRP over the 2027-2031 period, as separately detailed in Ex. F2-8-1.

Chart 5 – Breakdown of the 2026-2031 PRP In-Service Additions ($M)

#	Bundles / Category	RQE Total Cost	%
1	Retube, Feeder, and Boiler Replacement	3,215	33
2	Turbine Generators	915	9
3	Balance of Plant	1,026	10
4	Operations & Maintenance	820	8
5	Facilities & Infrastructure	343	4
6	Deep Water Intake	926	9
7	**Sub-Total Major Work Bundles[12]**	**7,245**	**73**
8	Function and Program Support	1,038	11
9	Contingency	1,555	16
10	RQE Capitalized Interest prior to January 1, 2026	30	0
11	**Total 2026-2031 PRP In-Service Additions[3]**	**9,868**	**100**

[1] Escalation has been included in Major Work Bundle and Functional & Program Support cost and Contingency, and accounts for $530M of $1,938M total escalation cost.
[2] OM&A costs (L&ILW variable expenses and Removal costs) are excluded. See Ex. F2-8-1.
[3] Totals may not match due to rounding

The total cost associated with refurbishing and returning all four units to service will not be a simple multiple of the Unit 5 refurbishment cost. As the first unit to be refurbished, Unit 5 includes additional costs that will not be incurred to refurbish the subsequent units. In particular, the Unit 5 refurbishment cost includes all Definition Phase costs and common costs[7] (unless such costs are only attributable to units other than Unit 5). In addition, the Execution Phase for the Unit 5 refurbishment includes a broader scope than the refurbishment execution phases for each of the remaining units. Specifically, the Unit 5 refurbishment cost covers all Definition Phase expenses and certain unit engineering costs that will not need to be repeated for subsequent units. It also includes the cost of tooling required for Unit 5, which will not need to be repurchased in later units.

[7] Common costs (also called Unit 0) are costs of completing 'common' work that is required for two or more units.

Common costs, included with Unit 5, include projects under the Facilities & Infrastructure ("F&I") work bundle, projects under the Deep-Water Intake ("DWI") and a portion of projects under the Balance of Plant and Turbine Generator ("TG") work bundles. These projects fall under two categories: (1) not directly associated to a Unit refurbishment (e.g., Common Services Building), or (2) support operations of multiple units through a shared function (e.g., Vacuum Building), or (3) is pre-requisite work to be executed prior to Unit shutdown.

4.1 Concurrent Cost Recovery

Chart 5 displays the cost of $9.868B represents the RQE cost excluding interest amounts after January 1, 2026, as interest amounts will be recovered separately pursuant to O. Reg. 53/05. The RQE was developed and approved prior to the O. Reg. 53/05 amendments that established these requirements. As discussed in Ex. I1-1-3, O. Reg. 53/05 has established a framework for recovery of interest amounts on capital expenditures for the PRP prior to the assets being placed in service, effective January 1, 2026. The Application refers to this framework as concurrent cost recovery ("CCR"). Pursuant to this framework, the Application is requesting recovery of forecast interest amounts totaling $2,923.3M over the IR term in respect of the PRP. The requested Unit 5 in-service addition therefore does not include capitalization of interest effective January 1, 2026. Detailed calculations of the forecast CCR interest amounts are provided in Ex. I1-1-1, Table 7. Any differences between the actual CCR interest amounts and such forecast amounts will be recorded in the Pickering B Refurbishment Project Variance Account in accordance with O. Reg. 53/05.

Program cost performance will continue to be measured inclusive of CCR interest amounts against the RQE for tracking and comparability.

4.2 In-Service Envelope and Capacity Refurbishment Variance Account

While actual costs may ultimately be different than forecast for individual line items shown in Chart 5, OPG is committed to completing the Unit 5 refurbishment, Early In-Service Projects and DWI and returning Unit 5 to service within the total in-service envelope budgeted for this purpose, being approximately $9.868B. To the extent there are deviations, OPG will record

the associated revenue requirement impacts within the Capacity Refurbishment Variance Account in accordance with O. Reg. 53/05, using the same process as for the DRP.

As this is a four-unit program being executed concurrently under an established four-unit RQE, to the extent of any deviations on Unit 5, OPG's success with respect to cost performance should continue to be measured relative to the four-unit RQE of $26.8B. As such, and as consistent with the DRP, OPG expects that any variances recorded in the Capacity Refurbishment Variance Account would be appropriately assessed at the completion of the PRP.

5.0 UNIT 5 MAJOR WORK BUNDLE COSTS BREAKDOWN

The total capital cost of the Major Work Bundles is $7,244.7M, including escalation and excluding contingency and interest. As illustrated in Chart 5 above, the Major Work Bundles account for 62% of the total Unit 5 refurbishment capital cost estimate (including common costs). The cost estimate and the estimate development process for each of the Major Work Bundles are detailed in the sections below, excluding contingency and interest.

The cost estimates for all Major Work Bundles are based on the detailed scheduling, scoping and contingency development as discussed in Ex. D2-3-5, Ex. D2-3-6, and Ex. D2-3-7. Cost estimation processes are described in Section 2.1 of this exhibit and were employed for each of the work bundles. The scope of each Major Work Bundle is executed by Project Management Teams and Functional Teams, as discussed in Ex. D2-3-2.

5.1 Retube, Feeder and Boiler Replacement

The RFBR major work bundle represents $3,292M of the total forecast Unit 5 in-service amount. A breakdown of the RFBR major work bundle cost estimate is set out in Chart 6 below.

Chart 6 – RFBR Cost Breakdown ($M)

#	Category	Cost	%
1	Project Management[1]	809	25
2	Inspections	0	0
3	Engineering	334	9
4	Procurement	1,272	39
5	Construction	719	22
6	Commissioning & Close-out	3	0
7	**Sub-Total**	**3,137**	**95**
8	Escalation	155	5
9	**Total[2,3]**	**3,292**	**100**

[1] Project Management includes OPG Project Management Team ("PMT"), Vendor PMT, Overhead, Expenses (Travel, Training, Other)
[2] Removal costs are included in the total
[3] Totals may not match due to rounding

As part of the cost estimating process discussed above in Section 2.1, OPG conducted a number of benchmarking exercises to challenge and validate the estimate for the RFBR major work bundle, including:

- All Direct Field Labour have been benchmarked against DRP; other CANDU reactors at Wolsong, Embalse were also referenced.
- Goods have been estimated based on DRP actual cost seen on each DRP unit. These actual costs have then been escalated based on the main groups of goods selected to be representative for PRP.
- The Site Access Training hours have been benchmarked to DRP's Re-tube and Feeder Replacement bundle actual hours.
- Estimating team interacted with Bruce Power's Unit 6 Boiler Replacement team.
- A direct correlation between the DRP project team roles and the projected Pickering project team roles was made.

5.2 Turbine Generators

The TG major work bundle represents $931M of the total forecast Unit 5 in-service amount. A breakdown of the TG major work bundle cost estimate is set out in Chart 7 below.

Chart 7 – Turbine Generators Cost Breakdown ($M)

#	Category	Cost	%
1	Project Management[1]	204	22
2	Inspections	0.3	0
3	Engineering	71	8
4	Procurement	392	42
5	Construction	174	19
6	Commissioning and Close-out	22	2
7	**Sub-Total**	**865**	**93**
8	Escalation	66	7
9	**Total[2,3]**	**931**	**100**

[1] Project Management includes OPG PMT, Vendor PMT, Overhead, Expenses (Travel, Training, Other)
[2] Removal costs are included in the total
[3] Totals may not match due to rounding

As part of the cost estimating process discussed above in Section 2.1, OPG conducted a number of benchmarking exercises to challenge and validate the estimate for the TG major work bundle, including:

- Cost comparison to DRP Units 3, 1, and 4 Turbine Generator Upgrades (Controls, Generator Auxiliaries, Centerline).
- Cost comparison to Darlington Turbine Generator Rotor Replacements (Low-Pressure and High-Pressure replacement).
- Construction cost estimate validation with competitive vendors.
- Waterford (Entergy) Consortium benchmark trip – Low-Pressure replacements
- Commanche Peak benchmark trip – Turbine Controls & Main Control Room
- Point Lepreau benchmark trip – Generator rewind
- Bruce Power collaboration (Turbine Generator related equipment projects) and benchmark trip – Turbine Controls
- Benchmark discussions on vendor/equipment OPEX and applicable project strategies: TVA (Watts Bar), Diablo Canyon, SaskPower, Point Lepreau, Bruce Power, Palisades, EDF Dungeness.

5.3 Balance of Plant

The Balance of Plant ("BOP") major work bundle represents $1,027M of the total forecast Unit 5 in-service amount. A breakdown of the BOP work bundle cost estimate is set out in Chart 8 below.

Chart 8 – Balance of Plant Cost Breakdown ($M)

#	Category	Cost[1]	%
1	Project Management [1]	318	31
2	Inspections	15	1
3	Engineering	156	15
4	Procurement	202	20
5	Construction	235	23
6	Commissioning and Close-out	23	2
7	**Sub-Total**	**949**	**92**
8	Escalation	77	8
9	**Total[2,3]**	**1,027**	**100**

[1] Project Management includes OPG PMT, Vendor PMT, Overhead, Expenses (Travel, Training, Other)
[2] Removal costs are included in the total
[3] Totals may not match due to rounding

As part of the cost estimating process discussed above in Section 2.1, OPG conducted a number of benchmarking exercises to challenge and validate the estimate for the BOP major work bundle, including:

- Cost comparison to Darlington Digital Control Computer Replacement.
- Operational experience sharing and benchmarking with Bruce Power Digital Control Computers replacement project team.
- Subject matter expert input on cost for Vacuum Building, Pressure Relief Duct and Reactor Building civil work (replacements, repairs). Input based on extensive operational experience collected from nine Vacuum Building Outages.
- Benchmarked actual costs from DRP individual projects to similar PRP projects. An example is the Reactor Building Ventilation project compared to the similar Vault Vapour Recovery System project at DRP. DRP lessons learned and subsequent units actual efficiencies were also considered.

5.4 Operations and Maintenance

The Operations & Maintenance ("O&M") major work bundle represents $841M of the total forecast Unit 5 in-service amount. A breakdown of the O&M work bundle cost estimate is set out in Chart 9 below.

Chart 9 – Operations and Maintenance Cost Breakdown ($M)

#	Category	Cost	%
1	Project Management [1]	69	8
2	Functional Labour	529	63
2	Inspections	0.1	0
3	Engineering	22	3
4	Procurement	58	7
5	Construction	83	10
6	Commissioning and Close-out	15	2
7	**Sub-Total**	**775**	**92**
8	Escalation	65	8
9	**Total[2,3]**	**841**	**100**

[1] Project Management includes OPG PMT, Vendor PMT, Overhead, Expenses (Travel, Training, Other)
[2] L&ILW variable expenses are included in the total
[3] Totals may not match due to rounding

As part of the cost estimating process discussed above in Section 2.1, OPG conducted a number of benchmarking exercises to challenge and validate the estimate for the F&I major work bundle, including:

- Fuel handling project team benchmarked the Point Lepreau defueling program. The team gathered strategies for execution and equipment reliability.
- Control Room Terminal Block Replacement Project – operational experience sharing and benchmarking with the Bruce Power Major Components Replacement Program on degradation and scoping.
- Planning and Execution Coordination Benchmarking from Bruce Power Major Components Replacement and DRP streamlined and enabled effective organization structure, scope control processes, work readiness processes, and execution run stream.

- Valve project benchmarked Bruce Power and Darlington and identified opportunities in welding practices and procurement of critical tools.
- Benchmarking of supply chain procurement strategies and licensing requirements for the material procured from the USA or outside Canada.

5.5 Facilities & Infrastructure

The F&I major work bundle represents $343M of the total Unit 5 forecast in-service amount. A breakdown of the F&I work bundle cost estimate is set out in Chart 10 below.

Chart 10 – F&I Costs Breakdown ($M)

#	Category	Cost	%
1	Project Management [1]	78	23
2	Inspections	6	2
3	Engineering	37	11
4	Procurement	53	15
5	Construction	139	40
6	Commissioning and Close-out	16	5
7	**Sub-Total**	**329**	**96**
8	Escalation	15	4
9	**Total[2]**	**343**	**100**

[1] Project Management includes OPG PMT, Vendor PMT, Overhead, Expenses (Travel, Training, Other)
[2] Totals may not match due to rounding

As part of the cost estimating process discussed above in Section 2.1, OPG conducted a number of benchmarking exercises to challenge and validate the estimate for the F&I major work bundle, including:

- Applied benchmarking insights from Bruce Power and operational experience from DRP and the Darlington facilities projects.
- Conducted lifecycle cost validation for new infrastructure buildings using an independent third-party estimator.
- Benchmarking specific to modular construction with similar project at Bruce Power.

5.6 Deep Water Intake

The DWI major work bundle represents $926M of the total forecast Unit 5 in-service amount. A breakdown of the DWI work bundle excluding contingency and interest is set out in Chart 11 below.

Chart 11 – Deep Water Intake Cost Breakdown ($M)

#	Category	Cost	%
1	Project Management [1]	230	25
2	Inspections	12	1
3	Engineering	77	8
4	Procurement	335	36
5	Construction	173	19
6	Commissioning and Close-out	6	1
7	**Sub-Total**	**832**	**90**
8	Escalation	93	10
9	**Total[2]**	**926**	**100**

[1] Project Management includes OPG PMT, Vendor PMT, Overhead, Expenses (Travel, Training, Other)
[2] Totals may not match due to rounding

As part of the cost estimating process discussed above in Section 2.1, OPG conducted a number of benchmarking exercises to challenge and validate the estimate for the DWI major work bundle, including:

- Benchmarked Darlington New Nuclear Program's condenser cooling water system work (see Ex. D2-4-5, Section 5.6.2).
- Lifecycle cost estimates obtained from two independent sources.
- Competitive RFP process resulted in four qualified proponent bids for comparison.
- Early offsetting options were benchmarked against similar offsetting projects across industries.
- Ex. Seaton Trail Dam Offsetting Concept – 2019 benchmark costing to bypass Pratts Dam was utilized as well as costing completed by Hatch in 2025 on a Nature like Fishway over a 9m high dam in New Brunswick.

6.0 IR TERM CAPITAL EXPENDITURES AND IN-SERVICE AMOUNTS

Capital expenditures for the PRP for the historical years (actual) and for the 2025-2031 period (forecast) are provided in Ex. D2-3-8, Table 1, based on the RQE. The associated capital in-service amounts are provided in Ex. D2-3-8, Tables 2-4. The figures in these tables do not include capitalization of interest effective January 1, 2026 as a result of the CCR framework under O. Reg. 53/05 providing for recovery of interest amounts prior to the assets being placed in service, as discussed in Section 3.0.

The in-service amounts are presented in three categories: (1) Unit Refurbishment, which comprises Unit 5, (2) DWI, which is planned to be in service with Unit 5, and (3) Early In-service F&I projects that are planned to be in service prior to Unit 5. The in-service amounts total $9,867.9M by 2031 and are summarized in Chart 12 below for the 2026-2031 period. There are no actual or forecasted in-service amounts for the PRP prior to 2026. The rationale for the early in-service of the F&I projects is discussed in Section 6.1 below. Given the size and nature of the DWI, OPG is treating it as an individual major work bundle to allow for greater oversight. Further details about this project are included in Ex. D2-2-3 and Ex. D2-3-5.

Chart 12 – In-service 2026-2031 ($M)

#	Unit/Category	2026	2027	2028	2029	2030	2031	Total
1	Unit Refurbishment	-	-	-	-	-	8,474.1	8,474.1
2	Deep Water Intake	-	-	-	-	-	1,213.9	1,213.9
3	Early In Service F&IP Projects	159.3	20.6	-	-	-	-	179.9
4	**Total**	**159.3**	**20.6**	**-**	**-**	**-**	**9,688.0**	**9,867.9**

As this Application represents the first time that the capital budget for the PRP will be before the OEB, there are no prior OEB-approved amounts.

6.1 Early In-Service Facilities and Infrastructure Projects

The total in-service amounts for the F&I projects are $159.3M in the bridge year, 2026, and $20.6M in 2027 during the IR term. Each F&I project with a total cost of at least $10M is discussed below.[8]

6.1.1 Common Services Building ("CSB")[9]

The CSB project, with a total project cost of $57.4M, is forecast to be placed in service in 2026. This building is necessary to address challenges with capacity and flow of trades at the site and is key to maintaining optimal productivity. The new facility will include essential services such as zonal boundary area, lockers, change rooms, showers and washrooms, and coverall dispensing areas on the ground floor, and cafeteria, kitchenette, and lunchroom facilities on the second floor. The building will be equipped with HVAC, fire protection, domestic water, sewage, and a building management system, as well as robust communications (LAN, Wi-Fi, fiber, and PA systems). The project cost reflects the scale and complexity of the building, and the modular construction approach to minimize on-site disruption. While the primary driver for the CSB is to support PRP, the facility is designed for long-term use and is expected to be used for ongoing operations when additional workforces are at the site, such as to support outages. The flexible design allows for adaptation to future operational needs, ensuring the asset continues to support station needs.

6.1.2 Pickering Maintenance Facility ("PMF")

The PMF project, with a total project cost of $30.7M will be placed in service in 2026. This project will replace the Transport Work Equipment garage, Calibration Shop, Carpentry Shop, and Radiography Building, which have reached end of life and no longer meet operational needs. The new PMF will consolidate maintenance operations into a modern, centralized facility, enhancing safety and operational efficiency. The PMF will support ongoing and future maintenance activities at the Pickering site.

[8] There are two F&I projects that are less than $10M in cost. The two projects have an average cost of $6.3M and a total cost of $12.7M to be placed in service in 2026 year. They are UF - F&IP - WHSE Church St (South) and UF - F&IP - Annex (E/W).

[9] OPG is also assessing the extended utility of the Retube Feeder Replacement Islanding Storage Annex beyond the refurbishment period and will make an in-service determination closer to the completion of construction.

6.1.3 Engineering Service Building 1 & Engineering Service Building 2 Workplace Optimization

The Engineering Service Building ("ESB") 1 and ESB 2 Workplace Optimization project, with a total project cost of $21.8M, will be placed in service in 2026. This project will refurbish approximately 120,000 square feet of existing office space across two buildings, located outside the protected area, to support resource needs for the PRP and enhance workplace efficiency.

The ESB1 and ESB2 buildings currently serve as essential office space for site operations and engineering staff. However, the existing facilities are deteriorated and no longer meet the functional, technological, or ergonomic needs of a modern workplace, particularly given the increased staffing and coordination required for the PRP. The project scope includes the full removal and replacement of all furniture, upgrades to electrical and LAN infrastructure to support new layouts, and provision of IT and AV solutions in order to better utilize the office space and maximize the number of work stations in the buildings. The upgrades will be completed while maintaining business operations, minimizing disruption to ongoing work. While the upgrades are timed to support PRP, the improvements are designed to provide long-term value to the organization and will continue to be used in support of ongoing site needs and station operations.

6.1.4 PN Campus Electrical Upgrades

The East Complex Infrastructure Upgrade project, with a total project cost of $19.5M, will be placed in service in 2026. The project will replace most electrical infrastructure, domestic water and firewater piping, all of which is reaching end-of-life. The project cost reflects the scope and complexity of replacing high-voltage electrical equipment, critical piping, and integrating EV charging infrastructure. The new electrical and piping infrastructure will support ongoing operations for multiple decades. These upgrades will enhance system reliability, extend asset life, and reduce the risk of equipment failure. In addition, the electrical power upgrade will accommodate the increasing electricity demand resulting from the construction of new buildings outside of the protected area.

6.1.5 PN Campus Parking Lots/Roads

The Parking and Roadway Expansion project, with a total project cost of $17.1M, will be placed in service in 2026. This project will expand and upgrade parking areas and on-site roadways to accommodate increased personnel and vehicle traffic during the refurbishment project. New parking areas will be constructed, and existing lots will be reoriented and repaved, including a new lot on Montgomery Park Road. East Complex roads will be expanded, realigned, and improved to enhance site access and connectivity, including support for the new DWI bridge. Road and parking lot lighting will be upgraded in coordination with electrical infrastructure replacements to ensure safety and compliance. These upgrades are essential for safe, efficient operations and will provide immediate and ongoing benefits in capacity, safety, and traffic management for all site personnel and visitors.

6.1.6 Montgomery Park and Sandy Beach Road Upgrades

The Montgomery Park and Sandy Beach Road Upgrade project, with a total project cost of $20.6M, will be placed in service in 2027. This project will upgrade Montgomery Park Road and Sandy Beach Road to accommodate increased vehicle traffic and load demands for PRP. Current road conditions are insufficient for the expected volume and weight of traffic during refurbishment activities. Upgrades will enhance road capacity, durability, and safety and emergency site access, ensuring reliable access for staff, contractors, and deliveries. These improvements will support the continuous flow of people and materials essential for project success and will provide ongoing benefits to the site and its presence in the surrounding community.

6.1.7 Early In-Service Projects <$10M

There are two other F&IP projects that are less than $10M. The two projects have an average cost of $6.3M and a total cost of $12.7M to be placed in service in the 2026 bridge year.

LIST OF ATTACHMENTS

Attachment 1: Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release Board Memo

Attachment 2: KPMG Report on RQE

Note: Attachment 1 is marked “OPG Confidential Exclusive”, however, OPG has determined it to be non-confidential in its entirety.

ONTARIO POWER GENERATION

OPG Confidential Exclusive

FOR APPROVAL by the Board of Directors

November 13, 2025

Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program
Release Quality Estimate and Full Funding Release

DECISION REQUIRED

The purpose of this memo is to provide a summary of the business case for the Pickering Refurbishment Project (PRP) and request Board approval for the following:

- Approval of the Class 3 Release Quality Estimate (RQE) to execute the Pickering Refurbishment (Units 5-8) program totalling **$26,840 Million**.

- Approval to transition from the definition phase to the execution phase for the project, including a release of **$20,640 Million** to complete the full scope of the four-unit program. If approved, this would bring the overall release to **$26,840 Million**.

The Class 3 Estimate to refurbish the four units is $26,840 Million, with a projected levelized cost of electricity (LCOE) of $169/MWh (2024$) and a schedule that places all four units in service by 2034. This will provide critical supply with a capacity upgrade to 551 MW per unit to meet Ontario's growing electricity demand for an additional 30 years.

ISSUE

In November 2024, as part of the approval to proceed with the definition phase of the PRP, the Board approved a cumulative funding release of **$6,200 Million** to proceed with planning, engineering, procurement and execution of pre-requisite projects for refurbishing Units 5, 6, 7, and 8.

Since that time, OPG has progressed definition phase planning and engineering, refined scope, procured all long lead items for the four units, established contracts with vendors for all critical scopes of work, commenced execution of pre-requisite common facilities and infrastructure scope, and has submitted a licence renewal application to the Canadian Nuclear Safety Commission (CNSC) requesting a 10-year licence duration that will span the refurbishment period. As part of the planning process, the Project has also updated the cost estimate, progressed schedule development, and performed an updated risk and contingency analysis with the following conclusions:

- There continues to be technical high confidence in the Refurbishment of Pickering Units 5-8.

- The Class 3 estimate to complete refurbishment scope is **$26,840 Million**, consistent with the Class 4 estimate, and incorporates improved scope definition, updated vendor estimates and contingency.

- The overall refurbishment schedule has all four units shut down in Q3 2026, and all four units returned to service by mid-2034. The high-confidence return to service date for the first unit, Unit 5, is May 2031, providing critical supply to meet Ontario's electricity demand.

- The Independent Electricity System Operator (IESO) confirms that the refurbishment of Pickering Units 5-8 is the most practical and lowest risk solution to meet Ontario's future electricity demands. The Levelized Cost of Energy (LCOE) is $169/MWh (2024$).

- The refurbishment will be financed using a combination of the corporate debt platform, operating cash flow and other expected sources, with project costs recovered as part of regulated assets.

- Refurbishment of Pickering Units 5-8 will provide significant long term economic and social benefits and help meet Ontario and Canada's net zero carbon emission goals.

The project is adequately prepared, and is now requesting Board approval to proceed with the program execution phase activities including:

- Shutdown and defuel Pickering Units 5, 6, 7, and 8.
- Completion of the refurbishment execution for all four units, enabling work on each unit to proceed in parallel, optimizing resources and the schedule.
- Construction and commissioning of a Deep-Water Intake.
- Execution of maintenance and Balance of Plant scopes during the layup period.
- Staggered commissioning and return-to-service of the units.
- Application of lessons learned to subsequent unit refurbishments.
- Project close-out.

This funding release will cover the full refurbishment period through to July 2034. OPG will prepare a Check Estimate prior to commencing the retube and feeder replacement removal series.

ANALYSIS

Throughout the definition phase, the Project has completed several major deliverables which supported development of the program Class 3 estimate, including:

- Front-end engineering has been completed, and the detailed design phase is in progress. The detailed design for Segment 0 is scheduled to be finalised by November 2025. Overall, approximately 36% of engineering for all major scopes have been completed to date.
- All major contracts have been awarded, including: the Retube, Feeder & Boiler Replacement (RFBR) contract awarded in January 2025. This contract will enable progression of detailed design, tooling development, infrastructure and procurement of long lead materials; the Turbine Generator contract awarded in February 2025; and the Deep-Water Intake tunnel contract awarded in July 2025
- Recommendations to optimise scope and lower first-of-a-kind project risks for Unit 5 have been approved and included in the estimate.
- All long lead items for the four units have been ordered, including fuel channels, feeders, boilers and turbine generator components. Supplier cost estimates and delivery commitments are incorporated into the estimate.
- Pickering licence renewal application was submitted to the CNSC on June 27, 2025. Regulatory discussions with CNSC have been successful, confirming activities that will be completed under the current licence. These include relocation of the Dry Storage Modules and a Pickering Component Storage Structure (PCSS).
- A road servicing agreement to optimize site access was successfully completed with a cross functional working group including OPG, the Ministry of Transportation and the City of Pickering.
- Execution of the Facility and Infrastructure work program is in progress, and all pre-requisite projects are on plan to be completed prior to the start of the execution phase, forecast for January 2027.
- The Level 1 and 2 detailed schedules for execution of the four-unit program have been developed, depicting key components, major scope, and integration logic. This is underpinned by a detailed resource loaded Level 3 working schedule for major scopes which will be used to monitor and control construction and commissioning.

- The refurbishment maintenance scope assigned to the Power Workers' Union (PWU) represented resources have been further refined and assessed at the crew level and resource balanced for the overall refurbishment program.

- The Pickering Refurbishment team continues to prioritize Indigenous Relations engagement in support of the licencing process, engagement with vendor partners, documented consideration in program planning, perimetry requirements associated with the Deep-Water Intake program and any ground disturbing activities.

In summary, the definition phase has advanced scope, design maturity and vendor pricing on key contracts and materials through progression of detailed engineering deliverables, providing increased certainty on technical requirements and material quantities, and informing development of the program cost estimate and schedule.

1. The Release Quality Estimate (RQE) to execute the refurbishment of Pickering Units 5, 6, 7 and 8 is $26,840 Million including interest, escalation and contingency.

The Class 3 estimate to complete the refurbishment of the four Pickering Units is **$26,840 Million** including **$5,984 Million** of interest and escalation and **$3,765 Million** of contingency. Since the definition phase Class 4 estimate provided to the Board in November 2024, the estimate has been updated to reflect improved scope definition, revised schedule durations, improved risk definition and quantification, and updated vendor estimates. The project cost estimate reflects interest costs based on OPG's current credit ratings. Details on the four-unit program cost by scope, is provided in **Appendix 4**.

The estimate was developed in accordance with OPG and industry practices and meets the Association for the Advancement of Cost Engineering (AACE) Class 3 definition with over 80% of the scope meeting or exceeding Class 3 estimate requirements. The estimate reflects a refinement in program scope, negotiation of fixed price procurements for major equipment in the Retube, Feeder and Boiler Replacements (RFBR) and Turbine Generator (TG) bundles, establishment of the detailed Level 3 execution schedule for Unit 5, and progression of detailed engineering.

Contingency is derived through a detailed evaluation of the estimate uncertainties (cost and schedule) discrete risks (cost and schedule) and contingent work across the program. These inputs were loaded into a fully integrated Monte Carlo simulation to assist in estimating contingency requirements in consideration of the risk and uncertainty profile presented. As a result, the program estimate includes $3,765 Million of contingency which is approximately 30% of the overall direct cost exposure at risk. The recommended AACE cost estimate range and accuracy for a Class 3 estimate is +30% to -20% (see **Appendix 2: Estimate Classification**) which substantiates that the program contingency requested is adequate given the estimate class. A comparison of the project cost exposure vs. contingency is provided in **Appendix 3**.

2. An overall high-confidence schedule to complete the four-unit refurbishment has been established with Unit 5 returned to service by May 2031, and all units in operation by 2034.

As part of the definition phase, OPG has integrated all vendor schedules that were developed for each scope component, determined the critical path for the projects, evaluated risks for each critical path element, and determined the amount of contingency required to deliver the project – producing a medium confidence (P50) working schedule and a high confidence (P90) schedule. Operating Experience (OPEX) from Darlington Refurbishment and other CANDU-6s were incorporated as lessons learned.

OPG will manage day-to-day project performance using the detailed, Level 3 resource loaded working schedule. This schedule will form the basis of project-controlled schedule contingency.

A high confidence schedule includes contingency for certain schedule risks that may be encountered during execution or commissioning. This schedule will be the basis for external communication and measurement. The high confidence return to service dates for each unit are provided in Table 1. Refer to **Appendix 1, 2, 3, and 4** for more information.

The overall estimated four-unit refurbishment schedule is approximately 11 years to plan and execute the work, from 2024-2034, with the field execution duration spanning 8 years. Breaker-open for Pickering Units 5-8 is planned for September 2026. The planning and release strategy is aligned to a simultaneous four-unit station outage, rather than a series of unit shutdowns. The critical path sequencing of each unit considers the transfer of resources and tools from the previous unit, balancing of critical resources across the units and long lead material procurement delivery constraints. The unit shutdown strategy results in a longer multi-unit lay-up and maintenance work program requiring longer Return to Service durations compared to Darlington Refurbishment. The units are planned to be returned to service in 2031, 2032, 2033 and 2034, respectively. Refer to **Appendix 5** for more details.

Table 1: Four-unit Schedule Summary

Unit	Start	High Confidence Finish
Unit 5	Sep-26	May-31
Unit 6		Jul-32
Unit 7		Apr-33
Unit 8		Jul-34
Four-Unit*	Sep-26	Jul-2034

Each unit's schedule will be confirmed prior to commencing the unit specific retube and feeder removal series, ensuring that lessons from the previous unit(s) execution are incorporated and risk profiles are current.

3. Refurbishment of Pickering Units 5-8 continues to provide a competitive and critical supply to meet Ontario's growing electricity demand, providing economic benefits to Ontario.

Pickering Refurbishment is expected to be the most practical and lowest risk solution to meet Ontario's future electricity demands. The Levelized Cost of Energy (LCOE) is $169/MWh ($2024) as previously reported.

The refurbishment and subsequent operation of Pickering Units 5-8 is also expected to have significant economic and fiscal benefits for Ontario and Canada. The Conference Board of Canada (CBoC) estimates that refurbishment is expected to boost Ontario's GDP by $38.2 Billion (2024$) over the program period and would create over 235,000 person-year jobs in the province. The refurbishment and subsequent operations and maintenance of the facility until the early 2070s is estimated to support an average of 7,500 jobs per year in Canada, with 89% of these jobs being in Ontario. This would raise the Canadian GDP by over $41 Billion. It is estimated that the operation of Pickering Units 5 to 8 will reduce carbon emissions by 120 mega tonnes over the station's life. The direct impact on the Canadian supply chain of the program is estimated at over $10 Billion, with at least four major components and engineering services being supplied from within Canada.

4. Release Strategy is planned for a four-unit station outage.

As breaker open for Pickering Units 5-8 is planned for September 2026, the release strategy is planned for a four-unit station outage, rather than a series of unit outages similar to that of the Darlington Refurbishment Project.

The release strategy depicted below aims to address the need to procure materials early for all four units to mitigate supply chain risks, secure major scope contracts as soon as the project scope is finalized and leverage a four-unit execution approach, optimizing the commencement of non-vault scope during planned layup periods. This method enables efficient resource allocation and optimized transitions of work and associated trades between units, aimed at driving enhanced productivity and minimizing downtime across the execution cycle. As a result, this release requests the remaining funds for the full four unit-refurbishment program.

The release plan for the Program is identified in Table 2 below for a cumulative project release of $26,840 Million.

Table 2: Release summary

Release #	Major Deliverables	Timing	Released Value	Cumulative Total Request
1A – 1	• Procurement of major long lead materials for U5/U6 • Completion of scope refinement • Advancement of preliminary engineering	Feb 2024*	$2,100M	$2,100M (8%)
1A – 2	• Procurement of major long lead materials for U7/U8 • Completion of detailed design engineering • Execution of Facilities & Infrastructure • Tooling and RFR infrastructure • Site modifications for deep water intake	Nov 2024	$4,100M	$6,200M (23%)
1B Release Quality Estimate	• Completion of installation/work planning • Execution of defueling, Unit layup, and common work • Full execution and close out of Units 5, 6, 7, and 8	Nov 2025	$20,640M	$26,840M (100%)

* Reflects Cabinet approval date. OPG Board approval was received in Aug 2023.

To maintain effective oversight of the project, processes to validate the overall estimate, schedule and risks will be implemented and tied to specific checkpoints or milestones throughout the execution of the program. These checkpoints will be used to confirm that the program cost and schedule estimates remain within the bounding cost and schedule durations requested during the RQE or identify significant changes that may require additional actions to be taken.

5. Financing and Regulatory Structure

Pickering Refurbishment expenditures will form part of the rate regulated Pickering station, for which electricity prices are set by the Ontario Energy Board (OEB). Under this structure, OPG will recover prudently incurred costs of the program, together with a return on this investment, over the life of the Units. OPG's next rate application, for 2027-2031, will include a request for the OEB's approval of the forecasted in-service amounts related to Unit 5 Return to Service and associated revenue requirement.

It is anticipated that a majority of the program costs will be financed using a combination of OPG's corporate debt platform and reinvestment of operating cash flows, with additional funding provided by the Clean Electricity Investment Tax Credit estimated at $2.5 Billion (subject to finalization of federal legislation) and other potential sources. In May 2025, the Province published a proposed amendment to O. Reg. 53/05 that would establish a new regulatory mechanism for concurrent cost recovery of debt financing costs during the construction of the Pickering Refurbishment. OPG continues to pursue a range of financing solutions as part of its overall corporate funding strategy.

6. Indigenous Relations

OPG recognizes that it must conduct its business in a manner that is both socially and environmentally responsible. OPG's demonstration of this commitment is found within the company's Reconciliation Action Plan that provides a framework for engaging (and consulting where appropriate) with the Indigenous communities and supporting programs, committees and community initiatives that reflect its tenets and puts the philosophy into practice.

A comprehensive Indigenous Engagement Plan for the Pickering site was finalized in Q2 2024 based on feedback from Indigenous Nations and communities. The Pickering Refurbishment team continues to prioritize Indigenous Relations with engagement in support of the licencing process, engagement with vendor partners, documented consideration in program planning, perimetry requirements associated with the Deep Water Intake program and any ground disturbing activities along with finalizing long-term Capacity Funding Agreements with the Michi Saagiig Communities.

7. Program Risks

The following key program risks are used in the current analysis:

Risk Title	Risk Description	Mitigation
Facilities & Infrastructure	City of Pickering, Durham Region and Ministry of Transportation road and infrastructure improvements currently scheduled over the next 10 years will impact access/egress from site with significant potential to challenge the Program Schedule.	Road Servicing Agreement in place with City of Pickering with work advanced into 2025 to minimize impacts.
Commissioning and Return to Service	Complex integration of Digital Control Computer and plant commissioning including containment structure testing, turbine control and other operational overlapping commissioning activities may increase timelines. For Units 7 and 8, the period from breaker open to completion of execution is longer, resulting in added complexities and technical challenges due to the units being in an extended lay-up state.	Continue refining the execution schedule by mid-2026 through further integrated planning, logic review, and resource balancing. Work Management will collaborate across project bundles to optimize Return to Service activities and ensure efficient, fully integrated scheduling.
Balance of Plant	The volume of scope is more complex than Darlington Refurbishment. Unit 5 scope has been optimized as part of the RQE.	Effective scope controls processes in place to control scope growth.
Site Capacity Constraints	Programmed peak shift employee head count at 4,200 vehicular traffic and upwards of 600 trucks daily poses infrastructure challenges (parking, security, lunchrooms).	Site infrastructure improvements implemented to help mitigate the volume impact. Additional mitigating actions include scheduling and tracking on-time movement of people, materials including warehouse management, and material pre-security clearances. Pickering loading bay utilization will be managed through the constrained roadways and site.
Procurement	Procurement and delivery of extensive volume of non-long lead material poses a risk to the Project as delays to manufacturing and material delivery may impact execution.	Where reasonable, the team is actively advancing engineering, planning and procurement of materials and manufacturing slots to deliver necessary materials in advance of need dates.

RECOMMENDATION / RESOLUTION

That the Board of Directors approve:

1. The Pickering Refurbishment Class 3 Release Quality Cost Estimate and Schedule as set out in this memorandum.

2. Transition of the program from definition phase to execution phase, including a release of **$20,640 Million** to complete the planning and execution of the four-unit Pickering Refurbishment program, bringing total life-to-date funding release to **$26,840 Million**.

3. Delegation of approval authority to the OPG President and CEO for approval and/or amendments of the various commercial agreements needed to support the program.

Recommended by:

Subo Sinnathamby
Chief Programs Officer

Approved for submission to the Board of Directors by:

Nicolle Butcher
President and Chief Executive Officer

This Board memo was reviewed and approved for submission to the Board of Directors by the Major Projects Committee at their meeting of November 12, 2025.

APPENDICES

The following appendices provide additional details:

1. Four Unit Program Cost by Bundle
2. Estimate Classification
3. Cost Exposure vs Contingency
4. PNR Overall Program Cost by Unit
5. Four Unit Program Schedule
6. Unit 5 Schedule and Key Milestones
7. Levelized Cost of Electricity and Sensitivities
8. Four Unit Program Release Strategy
9. Business Case Assumptions
10. Program Milestones

Appendix 1: Four Unit Program Cost by Bundle

Bundles/Functions	Class 3 Estimate (2025$)
Retube/Feeder and Boilers Replacement	5.0
	2.3
Turbine Generators	2.9
Balance of Plant	1.6
OPS & Maintenance	2.0
Facilities & Infrastructure	0.4
Deep Water Intake	0.8
Functional Support Costs	2.1
Total Base (2025 $)	**17.1**
Total Contingency (2025 $)	**3.8**
Project Sub-Total before Escalation and Interest (2025 $)	**20.8**
Escalation 2025$ to Nominal$	1.9
Interest	4.0
Sub-Total Escalation and Interest	**6.0**
Grand Total	**26.8**

Appendix 2: Estimate Classification

- OPG's Estimate Classification is based on recommended practice by **Association for the Advancement of Cost Engineering (AACE) International**.

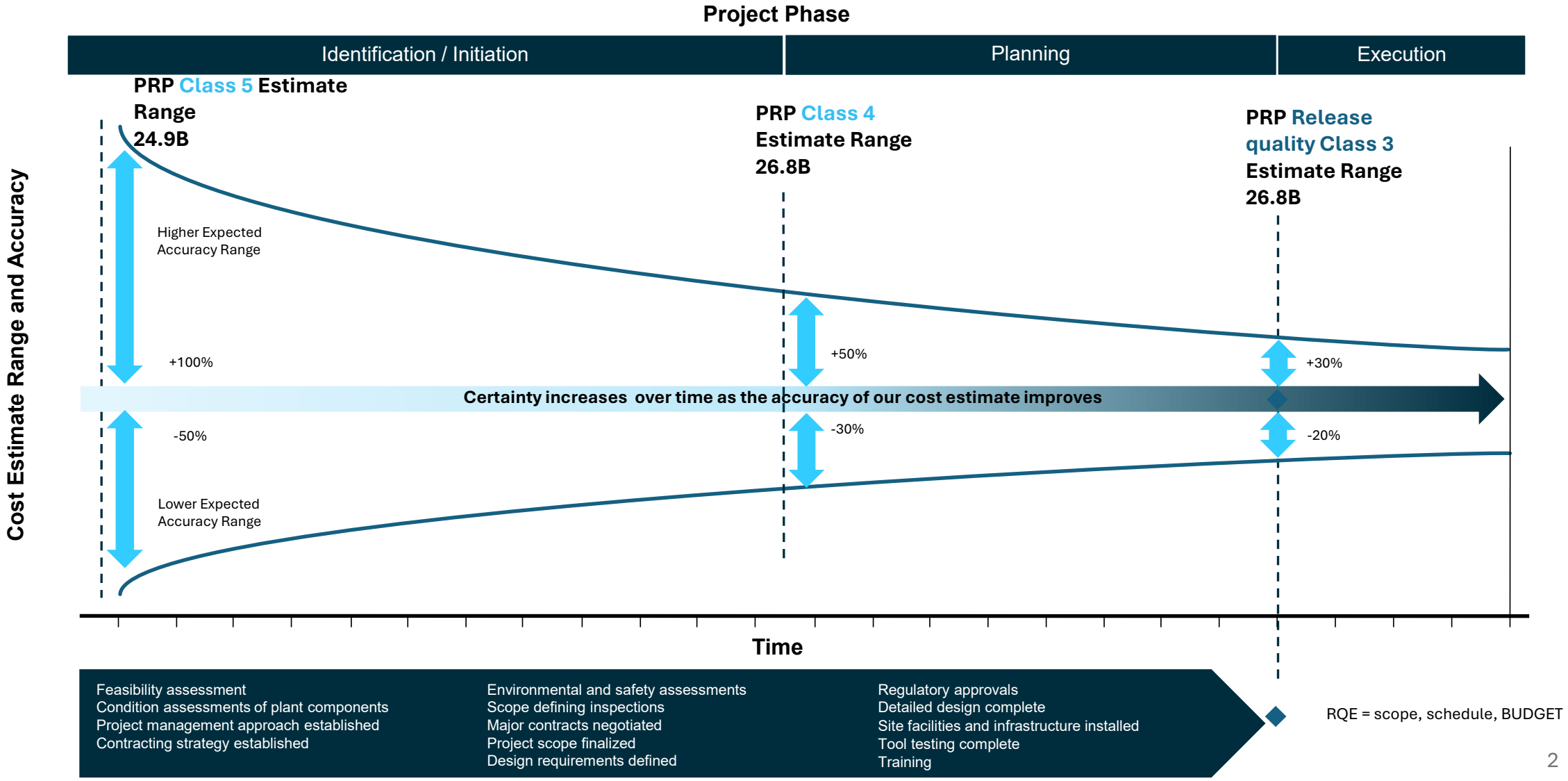


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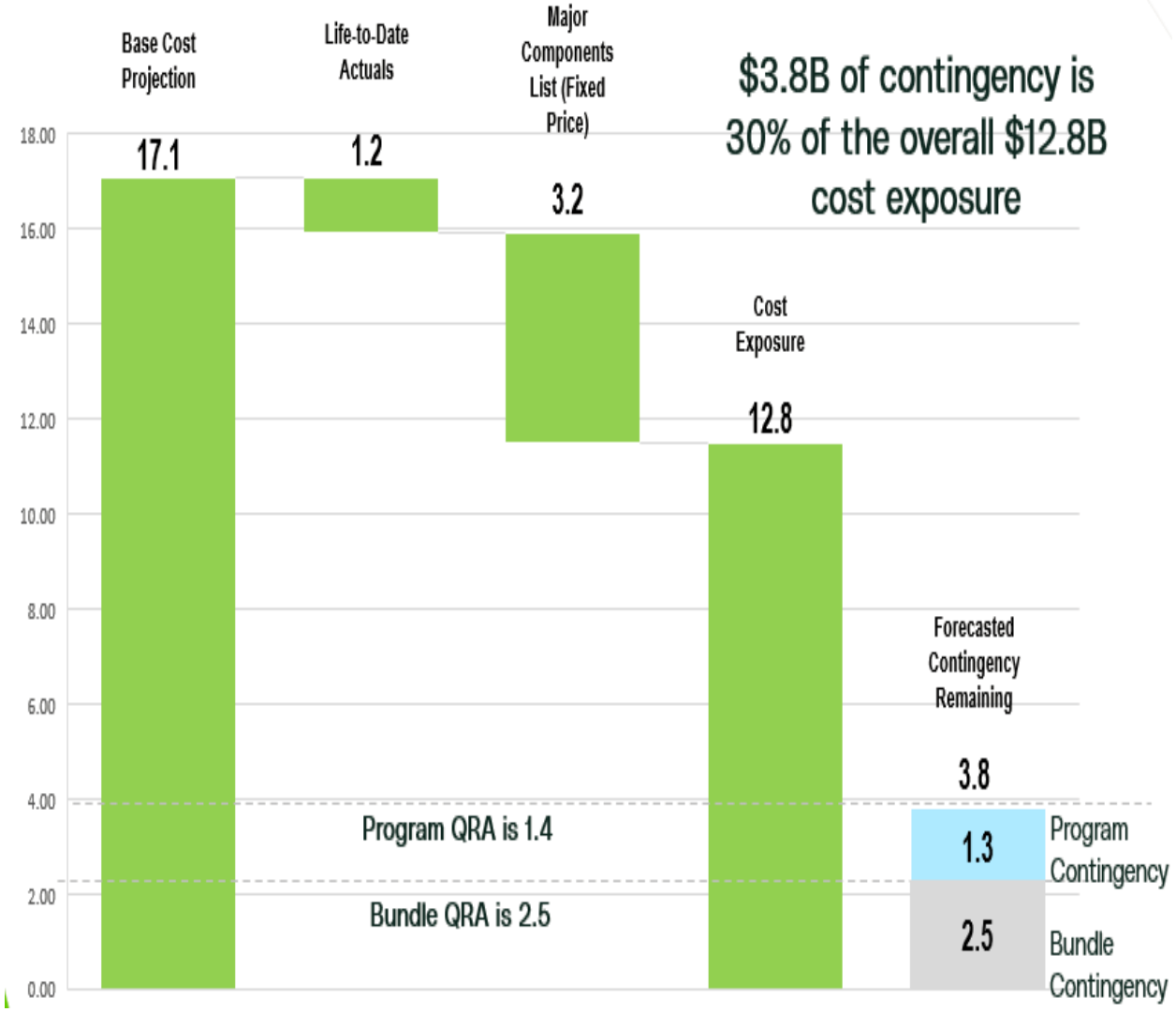
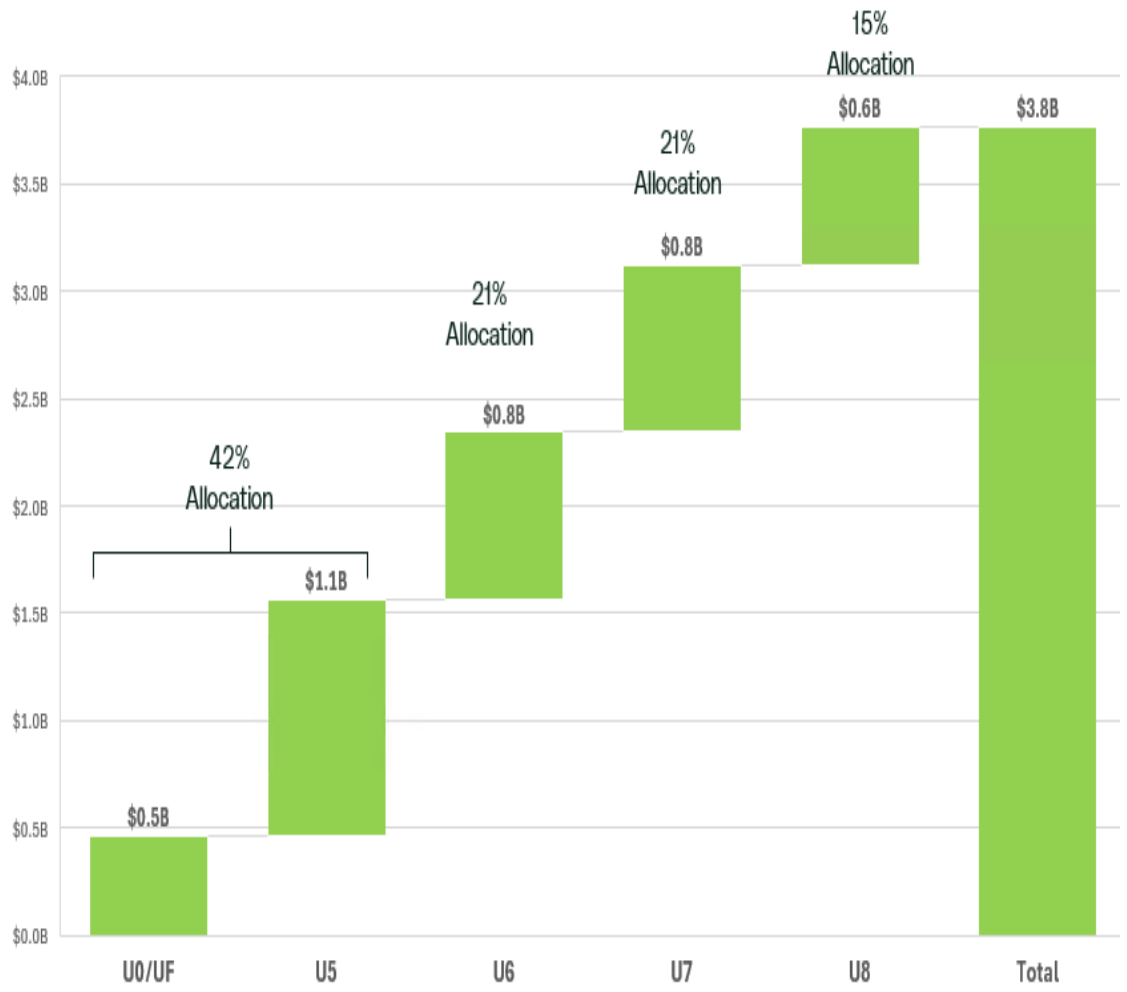
Exhibit D2-3-8
Attachment 1, Page 10 of 17

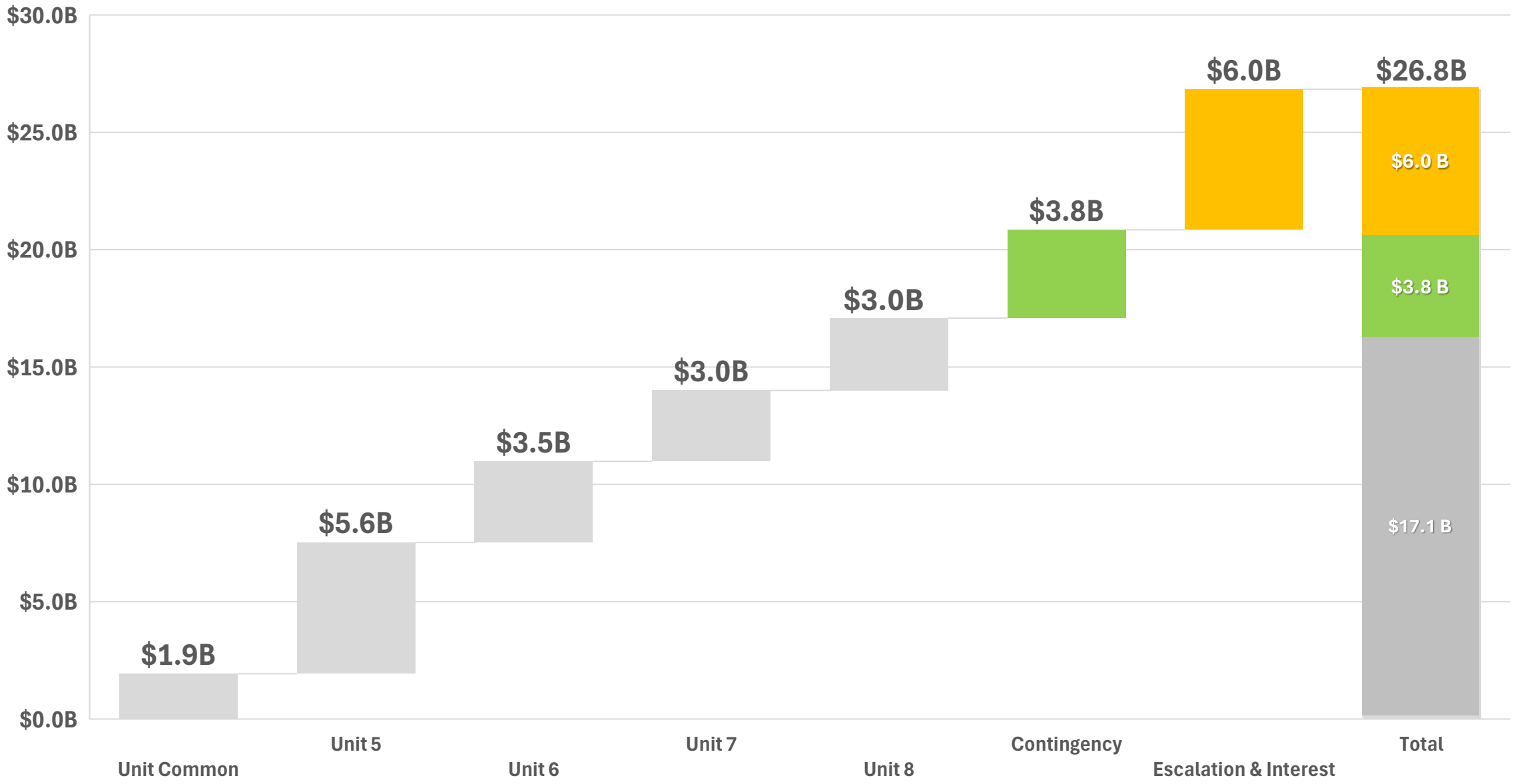
Contingency Breakdown & Exposure ($B)



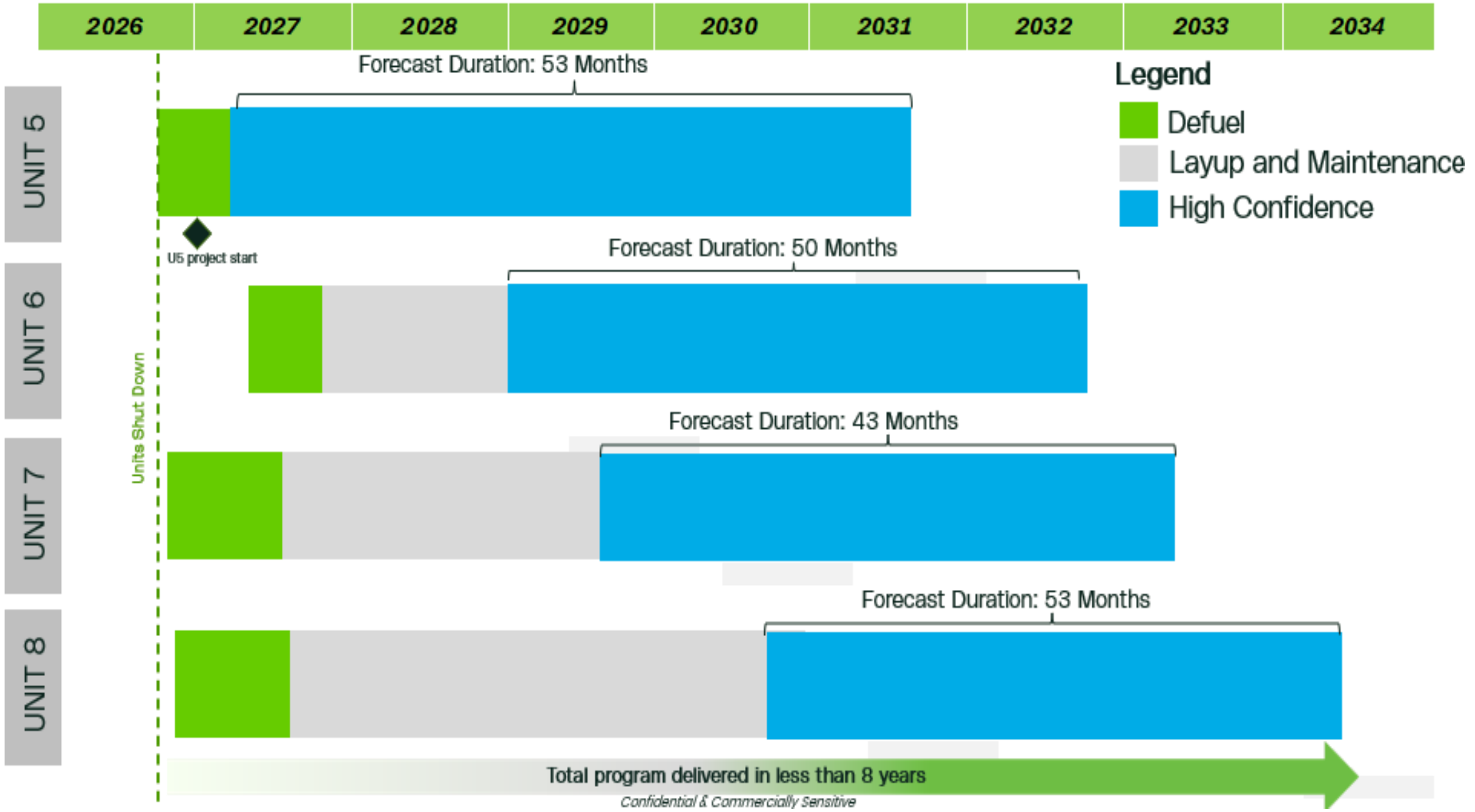
PNR Contingency (Unit over Unit Cost)



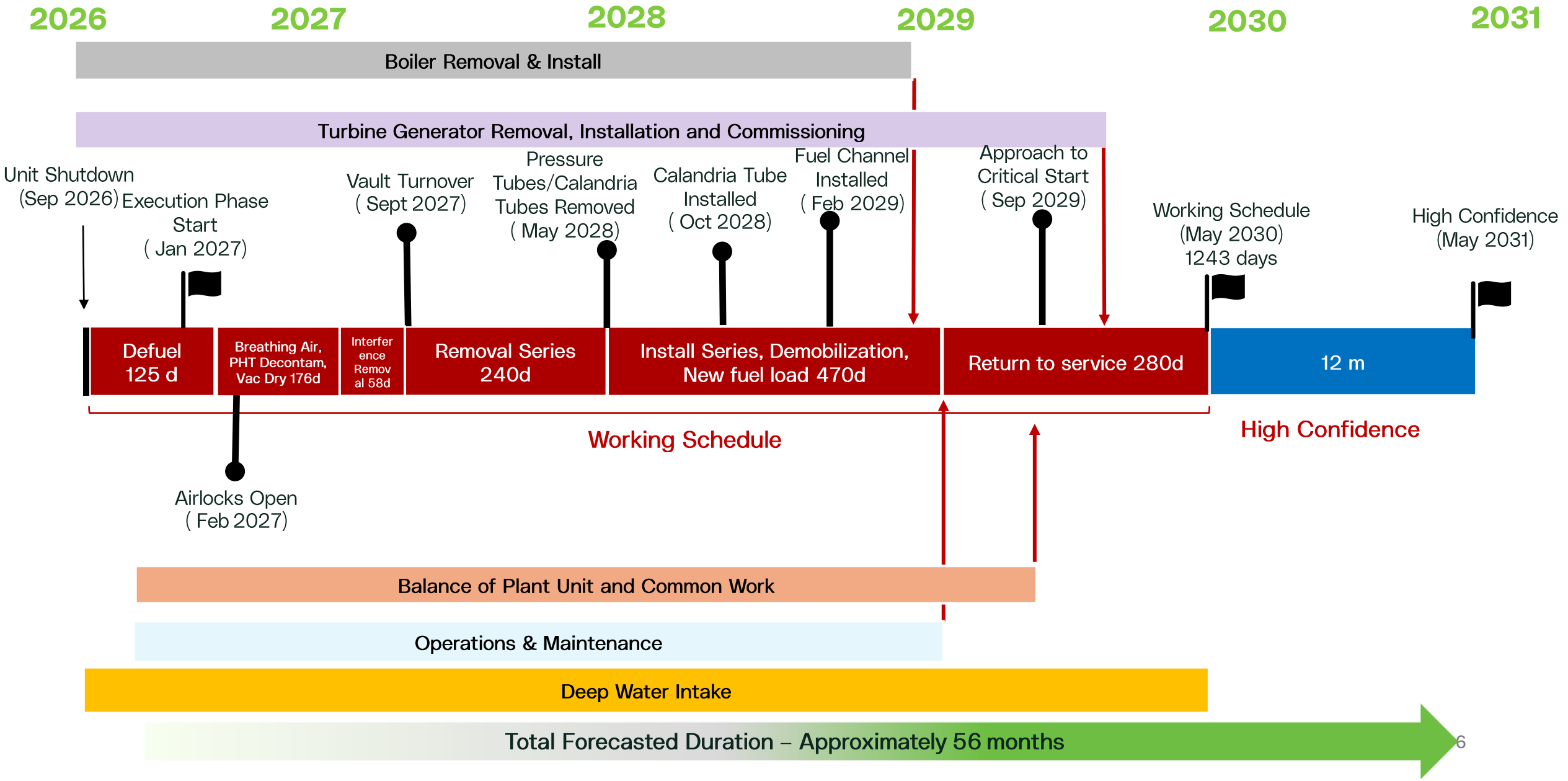
Appendix 4: PNR Overall Program Cost by Unit



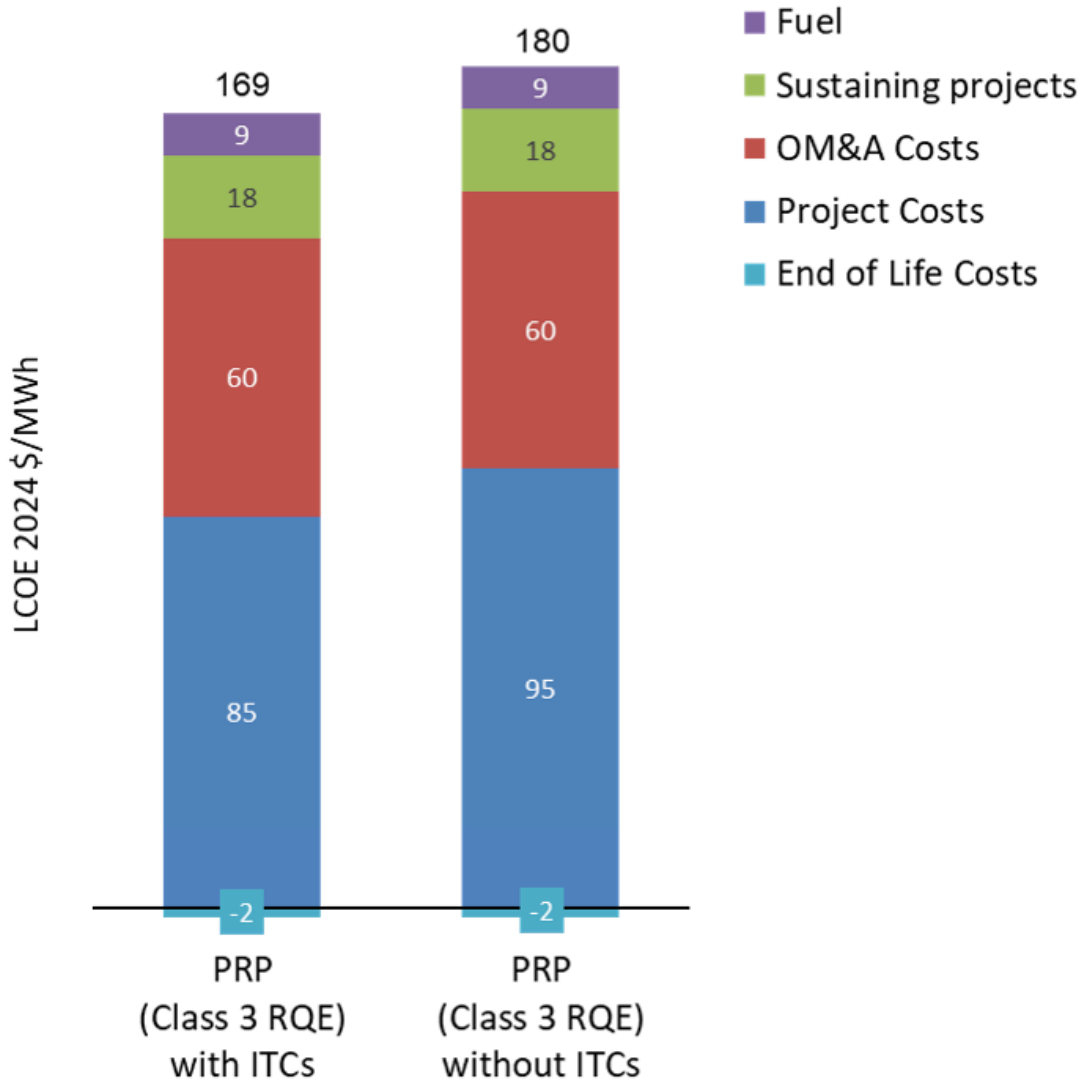
Appendix 5: Four Unit Program Schedule

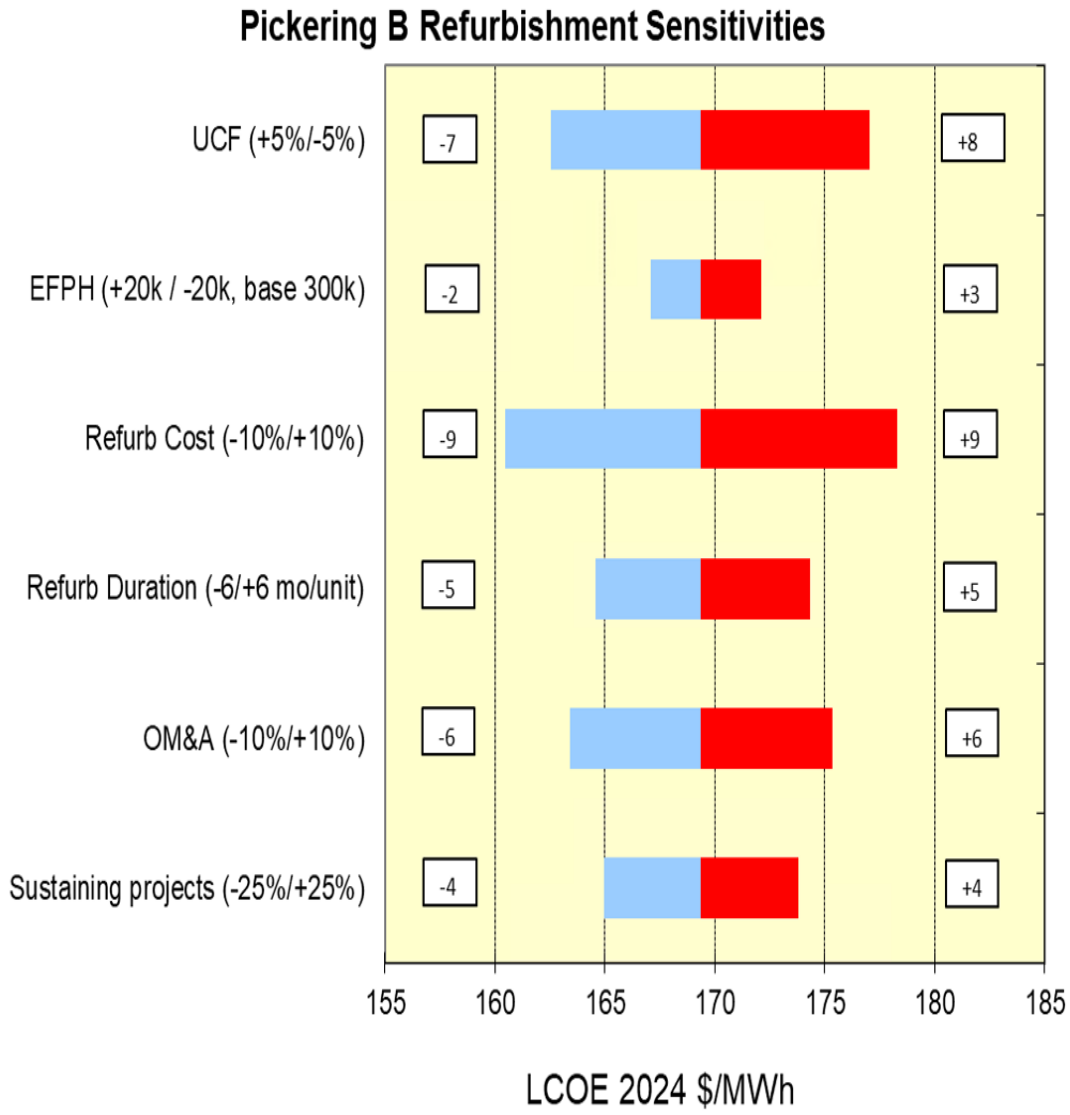


Appendix 6: Unit 5 Schedule and Key Milestones



Appendix 7: Levelized Cost of Electricity and Sensitivities





Appendix 8: Four Unit Program Release Strategy

Release #	Major Deliverables	Timing	Procurement	Planning and Execution	Total Requested	Cumulative Total Requested	Cumulative % Requested	Cumulative Spent
Release #1A-1 (Complete)	• Procurement of Major Long Lead Materials for U5/U6 • Completion of Definition Scope Refinement • Advancement of Preliminary Engineering	Feb-24	$1,437M	$663M	$2,100M	$2,100M	8%	N/A
Release #1A-2 Class IV (Complete)	• Procurement of Long Lead materials for U7/8 • Progress Engineering • Buildings & Infrastructure • Tooling Design & Procurement	Nov-24	$1,866M	$2,234M	$4,100M	$6,200M	23%	$1.800M
Release #1B – RQE/Final Release	• Completion of Installation/Work Planning • Segment 0 Execution • Procurement of Non-Long lead • Full execution of all units	Nov-25	-	$20,640M	$20,640M	$26,840M	100%	-
Program Check Estimate	• Check estimate to Board (No further approvals)	Aug-26	-					

Appendix 9: Business Case Assumptions

Category	Assumptions		
Procurement Escalation	**Materials & Equipment (uncommitted):** 4.5% trending down to 4.2% by 2032 **General Inflation:** 2.5%		
Labour Escalation	**Vendor Trades (EPSCA):** •5.3% trending down to 2.8% by 2030	**Vendor Non-trades:** •2.5%	**OPG Labour:** •2.75%
Interest (Capitalization rate)	•5%		
15% Clean Electricity Investment Tax Credit Eligibility	•~75% of qualifying project costs (excluding capitalized interest) eligible for Investment Tax Credit		
Station Operational Target Life and Unit Capability Factor (UCF)	•300,000 Effective Full Power Hours, ~88% Unit capability factor •Capacity upgrade to 551MW per units (~+27-33MW increase per unit) •30-month outage cycle •Ramp down to 2% Forced Loss Rate over 4 years post refurbishment		
Base/Support Costs during Operating Period ($2025)	•~$700M/yr		
Outage OM&A ($2025)	•~$65M/outage excl Vacuum building outage		
Station Sustaining Projects ($2025)	•~$1.6B/unit (life cycle)		
Uranium Fuel ($2025)	•~$6.00/MWh Uranium		
LCOE Discount Rate	•7%		

Appendix 10: Program Milestones

	Milestone Name	Baseline	Forecast	Status
1	All Major Components Orders Placed	Sept 30, 2024	Sept 30, 2024	Complete
2	Release 1A-2 / Class IV Estimate	Nov 12, 2024	Nov 12, 2024	Complete
3	Major Vendor Work Awarded	Dec 31, 2024	Feb 28, 2025	Complete
4	Front End Engineering Complete	Mar 31, 2025	Mar 31, 2025	Complete (with approved exceptions)
5	Balance of Plant and Operations & Maintenance Contracts Awarded	Jun 30, 2025	Jun 30, 2025	Complete
6	EPC Long Lead Materials PO's Issued	July 31, 2025	July 28, 2025	Complete
7	Release 1B-RQE / Class III Estimate	Nov 30, 2025	Nov 30, 2025	On Track
8	Segment 0 Design Complete	Nov 30, 2025	Nov 30, 2025	On Track
9	Execution check estimate	Aug 12 , 2026	Aug 12, 2026	On Track
10	Final Execution (Rev 0) Schedule Issued	Sep 03, 2026	Sep 03, 2026	On Track
11	Defuel for Unit 5	Sep 17, 2026	Sep 17, 2026	On Track
12	Unit 5 Construction Start	Jan 4, 2027	Jan 4, 2027	On Track

KPMG

Pickering Refurbishment Project Release Quality Estimate Independent Review

Ontario Power Generation

November 13, 2025

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Disclaimer

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The procedures carried out by KPMG in performing the work that forms the basis of this report were not such as to constitute an audit as per the standards established by the Auditing and Assurance Standards Board (“AASB”) in Canada. We express no opinion or any other form of assurance on the information presented in our report and make no representations concerning its accuracy or completeness.

Within this report, the sources of the information provided have been indicated. Our review was limited to the information obtained through interviews and the documents provided by OPG. KPMG has not sought to independently verify those sources unless otherwise noted within the report.

1. Executive Summary

KPMG LLP (“KPMG”) was engaged by OPG to conduct an independent review of the governance, processes, and classification of the Release Quality Estimate (“RQE”) for the Pickering Refurbishment Project (“PRP” or the “Program”). Our assessment found that the estimating processes and governance employed by OPG are well-defined and in alignment with the recommended practices of the American Association for Cost Engineering (“AACE”) and leading industry standards. It was noted that the estimate leverages relevant experience and lessons-learned from previous major projects, notably the Darlington Nuclear Refurbishment Project (“DNRP”), and is based on a consistent work breakdown structure (“WBS”) and robust planning methodologies. Throughout our review the project team demonstrated strong expertise in the planning and delivery of large nuclear refurbishment programs, and the use of detailed bottom-up approaches for key cost components further supports the reliability of the estimate.

While the overall approach is sound, our review identified several opportunities for improvement that should be addressed to further enhance the reliability and accuracy of the estimate. These include finalizing and integrating program-level Basis of Estimate (“BOE”) and Basis of Schedule (“BOS”) documents, clearly documenting the application and adaptation of benchmarking data, and reviewing escalation methodologies to ensure they reflect current construction market conditions. Additionally, we recommend continuing efforts to monitor the consistency in the assessment of design maturity across the PRP. As presented herein, OPG has already taken significant steps to address these opportunities and is continuing to refine the estimate and supporting documents.

2. Introduction

2.1. Scope of Review

KPMG was engaged by OPG to provide an independent review of the governance and processes used to develop the RQE for the PRP, assess the overarching classification of the estimate, and review the quality and traceability of the estimate inputs.

KPMG’s independent review of the PRP RQE processes and estimates comprised two workstreams:

- Estimate Process & Governance (“Workstream 1”); and,
- Detailed Estimate Reviews (“Workstream 2”).

Note that KPMG’s scope of work did not include the validation or assessment of the quantities, figures, or calculations performed by OPG and its partners to arrive at the final RQE cost.

2.1.1. Workstream 1 – Estimate Process & Governance Review

The objective of Workstream 1 was to assess OPG’s estimating governance and management processes for developing the PRP RQE against the recommended industry practices published by AACE. AACE recommended practices are globally recognized as leading industry practice and were similarly referenced by OPG in the RQE process for DNRP. The applicable recommended practices that form the basis of this review include the following:

- Development of Estimate Plan Process (AACE No. 36R-08);
- Development of Estimate Plan Content (AACE No. 36R-08);
- Basis of Estimate (AACE No. 34R-05);

- Estimate Classification System (AACE No. 18R-97); and
- Estimate Review, Validation, and Documentation (AACE No. 31R-03).

The AACE guidelines were used to support KPMG's evaluation of the RQE plan and estimate, including:

- **Adherence to RQE Management Plan:** Evaluation of compliance with the RQE Management Plan, involving document review and team interviews, with focus on identifying gaps and recommending improvements.
- **Assumption and Methodology Assessment:** Assessing the accuracy and consistency of design inputs, assumptions, and methodologies, while highlighting areas for clarification.
- **BOE and BOS Documentation:** Review of documentation supporting the estimates to ensure transparency and a clear audit trail of assumptions, while noting unsupported inputs.
- **Class 3 Estimate Assessment:** Verifying compliance with AACE Class 3 standards, with emphasis on assessing contingency and risk allowances.

2.1.2. Workstream 2 – Detailed Estimate Reviews

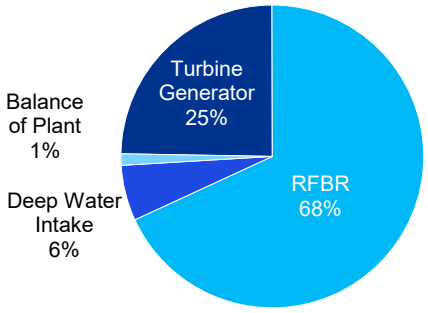
The objective of Workstream 2 was to perform more detailed review of key project packages, with a focus on vendor estimate packages. The Detailed Estimate Reviews included an evaluation of the following:

- **Analysis of Vendor Estimate Structure and Components:** Examining vendor estimates for alignment with industry standards and the PRP WBS, ensuring all cost components are properly defined.
- **Data Validation and Accuracy Assessment:** Validating data accuracy and traceability through sampling and cross-checking design documents, confirming unit rates and resource inputs, and ensuring estimate models accurately reflect the project scope and schedule.
- **Detailed Estimate Review Risks and Opportunities:** Identifying and prioritizing risks and opportunities related to estimate inputs and proposing mitigation strategies.

2.2. Project Sample Composition

The scope of review included major PRP packages, with a focus on vendor-developed estimates, representing approximately $10.6B of the total PRP costs. These packages represent the material components of the PRP, including the Retube, Feeder, and Boiler Replacement ("RFBR"), Turbine Generator, Deep Water Intake, and a selection of Balance of Plant ("BOP") packages (the "Review Sample"). Figure 1 illustrates the composition of the Review Sample based on the cost of each package. It is understood that OPG identified the Review Sample based on the significance of the respective packages to the overall refurbishment effort and their readiness for review.

Figure 1: RQE Estimate Review Sample Composition



2.3. Limitations

At the time of report preparation, the RQE Package intended for submission to the OPG Board was still in development. During the review period (June to September 2025), OPG's estimating team continued to advance towards the RQE Package Finalization milestone target of September 26, 2025.

KPMG has not reviewed a formal document intended for submission to OPG's Board, as this document will be a final product after all internal challenge reviews are complete, as laid out in the RQE roadmap. It is recommended that the findings from this review are addressed and included in the final package as appropriate.

It is understood that refinement of the estimate and supporting documentation is ongoing, and as such, many of the documents reviewed were annotated as 'draft', with expected completion in the fall of 2025. KPMG has relied on information contained in these documents as part of the assessment.

3. Estimate Process & Governance Assessment

3.1. Assessment Criteria and Results

OPG's estimating processes and governance have been assessed against AACE guidelines and leading industry practices using the rating criteria shown in Table 1. A summary of the assessment results for the major process and governance topics is shown in Table 2.

Table 1: Assessment Criteria

Rating	Summary	Description
4	**Optimized**	Process and governance structures are in line with leading practices with well-defined documentation.
3	**Monitored**	Processes and governance structures are well-defined and documented; however, there are areas for improvement to align with leading practices.
2	**Standardized**	Processes have been formalized and are adequately documented but are not aligned with leading practices and/or omit key elements.
1	**Unreliable / Informal**	Process and/or documentation is not designed or in place and/or are substantively not aligned with leading practices.

Table 2: Estimate Process & Governance Assessment Results

#	Requirements	Rating	Section
Development of Estimate Plan Content (AACE No.36R-08)			
1	**Purpose of the Estimate**	4	
2	**Program-Level Execution Plan (PEP)**	4	
3	**Construction, Fabrication, and Operating Parameters**	3	
4	**Project Execution Schedule Basis**	3	3.3.1.1
5	**Estimating Methodology**	4	
6	**Estimating Software**	3	
7	**WBS Filing Structure**	4	
8	**Labour Planning Considerations**	3	3.3.1.1 and 3.3.1.3

9	**Material & Equipment Considerations**	**3**	3.3.1.1 and 3.3.1.3
10	**Benchmarking**	**3**	3.3.1.2 and 3.3.1.3
11	**Cash Flow/Cost Flow**	**3**	
12	**Estimate Responsibility Matrix**	**3**	
Cost Estimate Classification System (AACE No.18R-97)			
13	**Cost Estimate Classification Matrix**	**4**	
14	**Determination of Cost Estimate Class**	**3**	
Reviewing, Validating and Documenting the Estimate (AACE No.31R-03)			
15	**Plan for the Estimate Reviews**	**3**	
16	**Technical (Engineering/Design) Reviews**	**3**	3.3.1.4
17	**Scope Management Reviews**	**4**	

3.2. Observations

The PRP RQE is in alignment with standard industry practices and has been developed by an experienced team that brings unique knowledge and expertise in the planning and delivery of large nuclear refurbishment programs. As highlighted below, the RQE is leverages relevant experience and lessons-learned from DNRP and a detailed assessment of the effort and time required to carry out the planning, design, and execution of the work.

3.2.1. Leveraging Experience

Throughout our review of the RQE documents and conversations with the team, it was evident that the estimate leverages the highly applicable experience from the DNRP, and the lessons learned in the successful delivery of that project. In particular, it was highlighted that many of the same alliance team members from the execution of the DNRP were involved in the development of the estimate, bringing hands-on understanding of the costs, schedule, and risks of the various elements of the estimate.

3.2.2. Detailed Work Planning

The costs associated with Direct Field Labour (“DFL”), Project Management Team (“PMT”), and Engineering for the RFBR were developed using a detailed bottom-up approach. In particular, DFL estimates were developed at a highly granular level, using a Construction Work Packaging (CWP) structures and leveraging experience from DNRP alliance members to break down and cost the various construction activities. Similarly, PMT and Engineering costs were calculated according to the specific resource requirements aligned with the project's detailed schedule. This level of granularity enables more thorough planning and assessment of the labour and time requirements, as well as interfaces with other packages, which ultimately drive cost.

3.2.3. Estimate Structure

OPG’s estimating practices employ a consistent WBS across the Project, using the InEight (Hard Dollar) system as the central repository for the estimate data at each level of the WBS. Having a well-defined WBS that is reflected in a dedicated estimating tool provides a consistent structure to the estimate, reduces the risk of scope gaps, and enables more detailed analysis of the estimate and comparison of pricing between packages and WBS levels.

3.3. Opportunities for Improvement

3.3.1. Estimate Reliability & Accuracy

While overall OPG's estimating approach is well defined and generally in adherence with the RQE Management Plan and AACE recommended practices, the following observations and corresponding recommendations were identified as part of the review. These findings represent areas of estimating process and governance that may impact the accuracy and reliability of the cost estimate for PRP.

3.3.1.1. Program-level BOE and BOS

The Program-level BOE and BOS are critical documents that provide the framework, background, inputs, and assumptions used in the development of project-level estimates. At the outset of the review, it was noted that there was no Program-level BOE or BOS to guide the development of project-level estimates. While the RQE Management Plan does include an Estimate Basis section (Section 4.1), this section only provides high-level guidance on considerations such as currency, units of measure, escalation, taxes, and contingency.

During the review of supporting project documentation, it was noted that the scope of work documents provided to the vendors for the respective packages included guidance on the structure and assumptions for the development of cost estimates. The scope of work documents outlined considerations such as high-level benchmarking and lessons learned from the DNRP, construction labour terms and costs, freight and logistics, and waste management, as recommended by AACE 36R-08 and 34R-05. In addition, the Level 1 program schedule provides high-level information on timelines and interfaces from a schedule perspective. It was also noted that each of the major project packages reviewed has a BOE document that laid out the project-specific considerations for the estimate.

During the period of the assessment, OPG was in the process of developing the Program-level BOE and BOS documents and subsequently provided the draft documents for review. While the documents are still in draft form, our review found that they generally align with AACE and industry practices. In particular, these documents provide guidance on common Program-level material and labour inputs and assumptions and clarify that project-specific considerations are addressed in the project-level estimating plans and scopes of work.

- ***Recommendation:*** *The draft BOE and BOS documents should be finalized and integrated into the final RQE Estimate Package.*

3.3.1.2. Benchmarking Approach

Due to significant commonalities between PRP and DNRP, cost and quantity data from DNRP has been used as a baseline to estimate several cost categories. However, there are differences in scope, quantities, and complexity between the two projects, and as a result, some DNRP benchmarking data requires adaptation for use in PRP cost estimates.

While our review noted significant discussion of benchmarks and comparator projects, the approach and level of detail that benchmarks were applied at was not consistent. For example, the RFBR DFL estimate employed detailed benchmarking for the respective CWPs based on the DNRP; however, the benchmarking of Goods and Subcontract costs was done at a higher level and did not appear to make adjustments for the specific considerations of the PRP. Similarly, for TG, only a general benchmarking comparison is available. Initial comparisons and lessons learned from DNRP were discussed in the *Pickering Refurbishment Feasibility Assessment (NK30-REP-09710-00001 and 00002)* and form a baseline for the PRP estimate. However, a formal benchmark study or document that outlines detailed estimation of project costs, such as productivity, time-in-motion, or staff/craft ratios was not available at the time of review.

It was noted that the draft Program-level BOE includes a section on benchmarking, which discusses the application of benchmarks to the respective bundles. For example, the BOE discusses the application of DFL benchmarks from DNRP Unit 1 CWPs for the RFBR bundle, which are reflected in a sample of DFL and CWP worksheets provided by OPG

- ***Recommendation:*** *In alignment with AACE guidance and industry leading practices, it is recommended that OPG clearly document how benchmarking cost data (particularly relating to the DNRP) has been applied. Accordingly, in addition to the high-level summary provided in the draft Program-level BOE, it is recommended that CWP and other estimate working papers more clearly cite how benchmarking data and inputs from other project have been integrated and adapted to the specific considerations of the PRP and specific bundle.*

3.3.1.3. Escalation of Benchmarking Data

Escalation factors used to account for increases in market pricing between the time of the benchmark data and current day (where traceable) appear to have been based on the Consumer Price Index (CPI) rather than indices more reflective of the construction industry (e.g., StatCan's Building Construction Price Index). Construction costs have risen considerably in the past 6 years (i.e., ranging from 30% to 50%) which exceeds CPI increases (typically 2% to 3% annually). During the review and based on subsequent consultation with OPG, it was noted that escalation factors had been applied to approximately 6% of the Review Sample where benchmarking cost data was utilized.

- ***Recommendation:*** *It is recommended that OPG consider the use of more construction industry-specific indices that better reflect the higher rates of escalation in construction labour, equipment, and materials compared to CPI. The use of more applicable indices will help improve the accuracy of estimates that leverage cost data from DNRP and other comparator projects.*

3.3.1.4. Design Maturity Measurement

While design progress and definition are often assessed in terms of percentage complete, in practice it can be challenging to accurately and consistently quantify the design process, particularly when comparing projects with different scope and complexity. To address this issue, OPG has created document *NK30-INS-09701-10002 White Paper: Design Quality Review Process for Pickering Refurbishment* (the "Design Quality Review Process"), which includes checklists for the respective levels of design definition. However, it was initially noted that the Design Quality Review Process was not consistently applied across all projects and design packages, with some project bundles using different metrics (e.g., schedule-based) and assumptions to assess design completion.

OPG has recently conducted a review of its design maturity assessment metrics and implemented new processes and tools to promote alignment and consistency in the measurement of design maturity. This includes a new dashboard to track progress and quality of the design for each project bundle and the contributing vendors. As of October 17, 2025, the dashboard shows overall PRP design completion of 36%, which is in line with the AACE Class 3 target design maturity of 10%-40%.

- ***Recommendation:*** *Given the complexity of the PRP and the differences in the nature of the various bundles, it is recommended that OPG continue to closely monitor the assessment of design completion and conduct regular reviews to ensure the reported metrics are an accurate reflection of completion and remaining effort.*

3.3.2. Estimate Quality

In addition to the estimate reliability and accuracy observations discussed above, KPMG has identified the below opportunities for improvement of the estimate quality. While these observations do not necessarily affect the accuracy or reliability of the RQE, they present opportunities to refine processes and governance to enhance the quality of OPG's cost estimates and supporting documentation.

3.3.2.1. Consistency in Estimating Approach

It is understood that each package in the review sample has unique attributes and requires a tailored estimating approach; however, inconsistencies were observed in how the estimating analysis was structured across the respective packages. For example, several of the detailed estimate analyses did not follow a consistent cost structure, provide a clear explanation of the methodology applied, or indicate the source of inputs and hard-coded data. As such, there is an opportunity to implement a more standardized template and improved structure across all estimate documents. OPG has indicated that estimates are intended to be developed in alignment with the Project WBS and the PIEPCCC (Project Management, Inspection, Engineering, Procurement, Construction, commissioning, Closeout) framework, which helps to provide a consistent structure to costs.

- ***Recommendation:*** *Implementing a more standardized approach would help to improve alignment between the various project bundles and enable more detailed review and comparison of inputs and assumption, thus improving estimate quality. OPG noted that standard forms and instructions on the estimating approach were provided as part of the Vendor Agreements and SOWs provided to vendors. This included the N-FORM template reviewed by KPMG, which are required by OPG for smaller project estimates (e.g., the Balance of Plant bundles).*

  While it is recognized that the estimating structure and approach for larger and more complex packages may evolve over the course of the project, it is recommended that OPG review the permissibility of deviations from the requested estimate format in order to improve consistency across the estimates for the respective bundles.

3.3.2.2. Availability of Supporting Documentation

At the time of review, some estimate packages were still under development, and as a result, OPG did not have full access to vendor-generated information (e.g., backup documentation for estimates had to be requested from vendor systems). While this issue is anticipated to be resolved upon submission of the formal RQE Package (note Exhibit 3.5 from the TG and RFBR Vendor Agreements require the estimates to be developed on an “open book basis”), leading practices for alliance delivery model and target price contracts (which constitute a significant portion of the PRP) requires that estimates be prepared with full transparency and that the owner retains intellectual property rights related to the estimate. It is important that OPG has full access to vendor estimate packages, particularly during future target price negotiations where a comprehensive understanding of vendor pricing will enable OPG to effectively scrutinize and challenge costs.

- ***Recommendation:*** *As OPG approaches the completion of the RQE Package, it is recommended that OPG carry out an audit of the vendor estimate packages for Target Price contracts to ensure all associated documents, including any data and analysis supporting inputs and assumptions have been provided to OPG in accordance with the respective Vendor Agreements in order to confirm that OPG has the required documentation to effectively challenge the vendor’s proposed target price.*

4. Class 3 Estimate Classification Assessment

4.1. AACE Estimate Classification Guidance

AACE is a leading industry group that provides guidance and recommended practices for the construction industry, with a focus on project controls and estimating processes. The AACE estimate classification system is an industry standard framework to guide the development, discussion, and use of cost estimates. The classification system spans from a Class 5 estimate at the concept design level (low design maturity) to a Class 1 estimate at the post-tender or as-built level of definition (highest design maturity).

While AACE publishes several different recommended practices for cost estimate classification in different industries, the *AACE 18R-97 - Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries* (i.e., a commonly referred to guidance for large construction projects) and *AACE 115R-21 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Nuclear Power Industries* (i.e., the most directly applicable guidance for nuclear projects such as the PRP) have been used as the framework to assess the classification of the PRP RQE.

It is common for large and complex projects like the PRP to have different elements of the estimate at different classification levels. Accordingly, KPMG has conducted a review of the classification of the estimate packages and underlying cost items to assess the composition of the RQE as either Class 5, Class 4, or Class 3 or better. As described below, the AACE recommended practices assess the classification of the estimate primarily on the basis of the level of design maturity and the estimating methodology utilized.

4.1.1. Design Maturity

Design maturity is based on the level of completion of specific design deliverables. AACE Recommended Practices 18R-97 and 115R-17 specify that projects require a design maturity of between 10% and 40% to achieve a Class 3 estimate. OPG's RQE Management Plan notes a target of 40% design definition for the RQE Package.

The RFBR and TG projects were found to have design definitions of approximately 30% to 40%, with the exception of the SGR packages within RFBR, which was found to have a design definition in the range of 20% to 30%. It should also be noted that significant fixed-price contracts have been awarded for the design and construction of major equipment, including the turbine generators and steam generators, which provides a higher degree of cost certainty in the estimate (i.e., Class 3 or better).

The RFBR and TG packages have been assessed to have sufficient design maturity to meet the requirements of a Class 3 estimate (i.e., 10% to 40% design definition). Similarly, the Definition Phase of the Deep Water Intake and the ESB 1 & 2 and a portion of the Service Air BOP packages are self-classified as Class 3. The Execution Phase of the Deep Water Intake and seven of the nine Balance of Plant projects reviewed do not yet meet the design maturity requirements for a Class 3 estimate and have been self-classified by the respective vendors as Class 4.

4.1.2. Estimating Methodology

The estimation methodology for the various project packages, including the RFBR, TG, DWI, and Balance of Plant, varies in level of detail and approach. However, the estimates were typically found to use a bottom-up approach, incorporating detailed resource requirements across Project Management Team (PMT), engineering, and Direct Field Labour (DFL) hours as well as materials and equipment, which generally aligns with the expectations for a Class 3 estimate. Overall inputs for the estimate have been primarily sourced from historical data, vendor quotations, and benchmarking against Darlington and similar projects.

4.2. Estimate Classification Rationale

In order to classify the various cost elements of the Review Sample, KPMG reviewed the respective project estimates to assess design maturity and the methodology utilized in the development of the estimate for each cost item. Specific cost elements and packages were classified utilizing the following rationale:

- **PMT and Engineering Costs:** PMT costs are typically estimated based on level of effort and project duration and are generally not tied to the level of design definition. Design engineering is typically estimated based on the estimated total installed cost of the facility and the complexity of the deliverables. As such, the estimate class of PMT and engineering costs was assessed on the methodology and level of detail provided only. Where a bottom-up approach with itemized individuals/roles and unit rates were observed, the estimate was assessed as Class 3 or better.
- **Committed Fixed Price Contracts:** Where OPG has awarded a fixed price contract, the cost risk is generally transferred and thus is unlikely to change significantly unless scope changes are required. As such committed fixed price contracts were assessed as Class 3 or better.
- **TG Costs:** The TG estimate predominantly used a bottom-up approach with detailed load boards for labour planning. However, some costs lacked supporting documentation and were therefore assessed as Class 4. The vendor's estimate summary for the Implementation Phase includes line-by-line estimate classifications ranging from Class 5 to Class 3.
- **RFBR Procurement Costs:** The RFBR estimate was developed collaboratively with the vendor using a bottom-up approach for DFL, PMT, and engineering hours, supported by detailed construction packages and historical data, as well as benchmarking against actual costs from DNRP. However, Goods and Subcontractors, and Reimbursable Non-Mark-up ("RNM") costs were often developed using a top-down approach benchmarked against other projects. As such, approximately 40% of Goods, 60% of Subcontractors, and 60% of RNM costs were assessed as Class 4.
- **DWI Costs:** The DWI vendor estimate applied an itemized bottom-up methodology. However, the DWI Definition and Execution Phase estimates are classified in the respective BOEs as Class 3 and Class 4 respectively, with a Class 3 Target Price for the Execution Phase expected to be in place by February 2027.
- **Balance of Plant**: Vendor estimates showed inconsistency in estimating approaches, with most estimates self-classified by respective vendors as Class 4.

4.3. Class 3 Estimate Classification Assessment

It was assessed that the design maturity of packages in the Review Sample generally meets the requirements for a Class 3 estimate, and that good estimating processes and a detailed bottom-up approach have been used in the preparation of estimates.

When dealing with a large program composed of multiple projects with varying estimate classifications, AACE guidance does not prescribe a single method for program-level classification. However, leading industry practices often defer to the dominant project classification, based on the largest or most critical project's classification. Similarly, OPG has advised of a target of 80% of the respective project bundle costs reaching Class 3 in order to classify the overarching program estimate as Class 3. In the case of the PRP, the RFBR project comprises 68% of the Review Sample estimated cost and 90% of costs are classified as Class 3 or better. Furthermore, the next largest project, the TG, comprising 25% of the Review Sample, is 66% Class 3 or better and includes a $1B fixed price contract for the provision of the turbines.

Accordingly, the Review Sample was assessed to substantially meet the requirements of a Class 3 estimate, with 78% of the Review Sample aligned to the respective AACE criteria and RQE Management Plan. Table 1 provides a summary of the Class 3 estimate assessment.

Table 1: Summary of the Class 3 Estimate Assessment

		Breakdown of Project Bundle			Breakdown of Review Sample		
	Percent of Sample	Class 5	Class 4	Class 3	Class 5	Class 4	Class 3
Turbine Generator	25%	4%	30%	66%	1%	8%	16%
RFBR	68%		10%	90%		7%	61%
Deep Water Intake	6%		85%	15%		5%	1%
Balance of Plant Projects	1%		78%	22%		1%	>1%
Total Sample	**100%**				**1%**	**21%**	**78%**

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Numbers may not add due to rounding.

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

Line No.	Description	2023 Actual	2024 Actual	2025 Budget	2026 Budget	2027 Plan	2028 Plan	2029 Plan	2030 Plan	2031 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	**Pickering Refurbishment Program - Unit Refurbishment[1]**	15.1	354.6	1,363.7	2,778.4	3,117.7	3,289.9	3,396.8	2,563.0	1,860.5
2	**Facilities and Infrastructure Projects**	0.0	1.0	79.0	97.1	2.7	0.0	0.0	0.0	0.0
3	**Deep Water Intake**	0.3	16.0	57.3	170.1	352.7	317.6	181.5	118.5	0.0
4	**Total Pickering Refurbishment Program[2]**	15.4	371.6	1,500.0	3,045.6	3,473.2	3,607.6	3,578.3	2,681.4	1,860.5

Notes:

1 The Pickering Unit Refurbishment includes Unit 5, Unit 6, Unit 7, and Unit 8.

2 OM&A costs (L&ILW variable expenses and Removal costs) are excluded from Total Pickering Refurbishment Program

Numbers may not add due to rounding.

Table 2
Capital Project Listing - Pickering Refurbishment Program
Projects ≥ $30M Total Project Cost [1]

Line No.	Facility	Project Name	Project Number	Category	Start Date	Final In-Service Date	Total Project Cost ($M)	Total In-Service ($M)	In-Service IR Term ($M)	In-Service 2026 ($M)	In-Service 2027 ($M)	In-Service 2028 ($M)	In-Service 2029 ($M)	In-Service 2030 ($M)	In-Service 2031 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
		ONGOING PROJECTS FROM EB-2020-0290													
1		No projects in this category													
2		**Subtotal**													
		COMPLETED PROJECTS FROM EB-2020-0290													
3		No projects in this category													
4		**Subtotal**													
		PROJECTS NOT IN EB-2020-0290													
5	PN	Common Services Building (CSB)	88537	F&IP	Apr-25	Sep-26	57.4	57.4	57.4	57.4	0.0	0.0	0.0	0.0	0.0
6	PN	Pickering Maintenance Facility (PMF)	88531	F&IP	Oct-25	Sep-26	30.7	30.7	30.7	30.7	0.0	0.0	0.0	0.0	0.0
7	PN	Deep Water Intake (DWI)	Various	DWI	Nov-23	May-31	1,213.9	1,213.9	1,213.9	0.0	0.0	0.0	0.0	0.0	1,213.9
8	PN	Pickering Refurbishment - Unit Refurbishment - Unit 5[1]	Various	Unit Refurb -Unit 5	Oct-23	May-31	8,474.1	8,474.1	8,474.1	0.0	0.0	0.0	0.0	0.0	8,474.1
9	PN	Pickering Refurbishment - Unit Refurbishment - Unit 6[1]	Various	Unit Refurb -Unit 6	Sep-24	Jul-32	4,315.7	4,315.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	PN	Pickering Refurbishment - Unit Refurbishment - Unit 7[1]	Various	Unit Refurb -Unit 7	Sep-24	Apr-33	4,107.9	4,107.9	0.0	0.0		0.0	0.0	0.0	0.0
11	PN	Pickering Refurbishment - Unit Refurbishment - Unit 8[1]	Various	Unit Refurb -Unit 8	Sep-24	Aug-34	4,112.5	4,112.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12		**Subtotal**					22,312.2	22,312.2	9,776.1	88.1	0.0	0.0	0.0	0.0	9,688.0
13		**Total - Projects ≥ $30M Total Project Cost**					22,312.2	22,312.2	9,776.1	88.1	0.0	0.0	0.0	0.0	9,688.0

Notes:
1 OM&A costs (L&ILW variable expenses and Removal costs) are excluded from Total Project Cost

Numbers may not add due to rounding.

Table 3
Capital Project Listing - Pickering Refurbishment Program
Projects $10M - $30M Total Project Cost [1]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project Cost ($M)	In-Service IR Term ($M)	In-Service 2026 ($M)	In-Service 2027 ($M)	In-Service 2028 ($M)	In-Service 2029 ($M)	In-Service 2030 ($M)	In-Service 2031 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
		ONGOING PROJECTS FROM EB-2020-0290													
1		No projects in this category													
2		**Subtotal**							0.0	0.0	0.0	0.0	0.0	0.0	0.0
		COMPLETED PROJECTS FROM EB-2020-0290													
3		No projects in this category													
4		**Subtotal**							0.0		0.0	0.0	0.0	0.0	0.0
		PROJECTS NOT IN EB-2020-0290													
5	PN	F&IP - ESB1 & ESB2 WPO	88532	F&IP	Renovate the existing facilities that have deteriorated and no longer meet the functional, technological, or ergonomic needs of a modern workplace, while accommodating increased staffing and coordination required for the PRP.	Apr-25	Sep-26	21.8	21.8	21.8	0.0	0.0	0.0	0.0	0.0
6	PN	F&IP - PN Campus Electrical Upgrades	88536	F&IP	Aging electrical and piping systems will be replaced to enhance reliability, safety, and efficiency, while also supporting future needs with new EV chargers.	Aug-25	Sep-26	19.5	19.5	19.5					
7	PN	F&IP - PN Campus Parking Lots/Roads (outside PA)	88535	F&IP	Parking areas and roadways will be expanded and upgraded to support increased personnel and vehicle traffic, with new lots, improved access, and enhanced lighting.	Sep-25	Dec-26	17.1	17.1	17.1					
8	PN	F&IP - Montgomery Park and Sandy Beach Roads Upgrades	88548	F&IP	Montgomery Park Road and Sandy Beach Road will be upgraded to handle increased traffic and load demands, improving capacity, durability, and safety.	Mar-26	Jun-27	20.6	20.6		20.6				
9		**Subtotal**						79.1	79.1	58.5	20.6	0.0	0.0	0.0	0.0
10		**Total - Projects $10M - $30M Total Project Cost**						79.1	79.1	58.5	20.6	0.0	0.0	0.0	0.0

Numbers may not add due to rounding.

Table 4
Capital Project Listing - Pickering Refurbishment Program
Projects <$10M Total Project Cost

Line No.	Project Name	Number of Projects	Total Project Cost ($M)	Average Cost Of All Projects ($M)	In-Service IR Term ($M)	In-Service 2026 ($M)	In-Service 2027 ($M)	In-Service 2028 ($M)	In-Service 2029 ($M)	In-Service 2028 ($M)	In-Service 2030 ($M)	In-Service 2031 ($M)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1	**Unit Refurbishment**											
2	**Facilities & Infrastructure Projects**	2	12.7	6.3	12.7	12.7	0.0	0.0	0.0	0.0	0.0	0.0
3	**Total - Projects <$10M Total Project Cost**	2	12.7	6.3	12.7	12.7	0.0	0.0	0.0	0.0	0.0	0.0

Numbers may not add due to rounding.

Filed: 2025-12-12
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Tab 3
Schedule 8
Table 5

Table 5
Comparison of In-Service Capital Additions - Pickering Refurbishment Program ($M) 2026-2031

Line No.	Business Unit	2026 Budget	(c)-(a) Change	2027 Plan	(e)-(c) Change	2028 Plan	(g)-(e) Change	2029 Plan	(i)-(g) Change	2030 Plan	(k)-(i) Change	2031 Plan	2026 Budget	(n)-(l) Change	2027-2031 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
1	**Unit Refurbishment - Unit 5**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8,474.1	8,474.1	0.0	8,474.1	8,474.1
2	**Subtotal**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8,474.1	8,474.1	0.0	8,474.1	8,474.1
3	**Deep Water Intake (DWI)**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,213.9	1,213.9	0.0	1,213.9	1,213.9
4	**F&IP - Common Services Building (CSB)**	57.4	(57.4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.4	(57.4)	0.0
5	**F&IP - Pickering Maintenance Facility (PMF)**	30.7	(30.7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.7	(30.7)	0.0
6	**F&IP - ESB1 & ESB2 WPO**	21.8	(21.8)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8	(21.8)	0.0
7	**F&IP - PN Campus Electrical Upgrades**	19.5	(19.5)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.5	(19.5)	0.0
8	**F&IP - PN Campus Parking Lots/Roads (outside PA)**	17.1	(17.1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	(17.1)	0.0
9	**F&IP - Montgomery Park and Sandy Beach Roads Upgrades**	0.0	20.6	20.6	(20.6)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.6	20.6
10	**F&IP - under $10M projects**	12.7	(12.7)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.7	(12.7)	0.0
11	**Total In-Service Capital Additions**	159.3	(138.7)	20.6	(20.6)	0.0	0.0	0.0	0.0	0.0	9,688.0	9,688.0	159.3	9,549.3	9,708.6

PICKERING REFURBISHMENT PROGRAM

PROGRAM EXECUTION

1.0 OVERVIEW

This exhibit focuses on execution management, outlining the methods OPG, as the Owner, will use to ensure all scope is delivered safely, on time, within budget, and to the required quality. As stated in Ex. D2-3-2, certain OPG functional support groups play a key role in execution management and support. This schedule details the activities these functions will perform in the Pickering Refurbishment Program ("PRP"), along with essential control measures to be implemented during the Execution Phase.

The following components of the Program Management Functional support for execution management are discussed:

- Project Execution Support Function
- Work Management
- Functional Operations and Maintenance
- Planning and Controls

In addition, the following key controlling activities are described:

- Cost and Schedule Performance Monitoring
- Risk Management
- Change Management
- Reporting
- Oversight

These components will allow OPG to efficiently coordinate with engineering, procurement, and construction contractors; maintain control over work and track changes through integrated scheduling and cost monitoring tools; uphold worker protection, conventional and nuclear safety, environmental safety, and plant safety; ensure compliance with all quality

requirements; effectively manage risks; and establish robust reporting mechanisms with strong internal and external oversight.

2.0 PROJECT EXECUTION SUPPORT FUNCTION

The Project Execution Support Function provides assistance across major work bundles in four key areas during the Execution Phase. The structure is based on the learnings from the Darlington Refurbishment Program ("DRP") to enable timely and efficient support.

The key activities of the Project Execution Support Function are described below:

- **Construction Execution and Field Support**: This team supports OPG's contractors in executing their work safely and efficiently while maintaining the overall schedule. They address field issues that may hinder progress, such as missing equipment, worksite interferences, or constructability challenges. Additionally, they actively monitor evolving risks during field execution. Effective construction and field support is a widely recognized best practice in managing large-scale projects. Based on industry standards and operational experience, OPG's continuous, structured support and monitoring of contractor activities will enhance overall project performance.
- **Quality Management**: This team conducts quality surveillance through execution planning and in-field construction, addressing critical and emerging issues. They oversee work completion and verify compliance with regulatory requirements through periodic documentation checks. This ensures traceability of field activities in accordance with Pickering's operating license issued by the Canadian Nuclear Safety Commission ("CNSC") and compliance with CSA N286-12.
- **Nuclear Refurbishment Project Parts Integration**: This team ensures consistency and integrity in the processes and systems used by project directors to manage contractors responsible for parts procurement and delivery. They track contractor and subcontractor purchasing activities and ensure uniformity in contractor information.
- **Program Execution Support**: This team enhances oversight of Execution Phase activities by establishing a ready-to-execute plan, implementing a division of responsibilities framework, developing a project manager training program to ensure

qualified personnel for future unit refurbishments, and coordinating insurance reviews and other oversight measures.

3.0 WORK MANAGEMENT FUNCTION

This function is responsible for integrating, publishing, and managing individual unit outage and execution schedules, ensuring that all deliverables are identified, communicated, and completed in line with planning and execution expectations. The Work Management Function ensures proper planning before execution, manages and controls unit scope, coordinates day-to-day work control and interface activities, resolves issues, initiates and oversee changes, and monitors and reports on risks, schedule status, and performance metrics.

In addition, it oversees the preparation and execution of each unit outage, ensuring overall readiness. While each project team is responsible for meeting quality and timeline expectations, this function validates these schedules and integrates them into the overall schedule.

During the Execution Phase, the Work Management Function will undertake the following activities:

- Ensure work activities are effectively planned, prepared, coordinated, and monitored through data systems, including availability of necessary parts and tools.
- Planning, coordinating, and executing logistics required during refurbishment outages, such as space, services, resources, permits, and radiation protection.
- Managing unit shutdown and restart activities, including layup, islanding, and defueling, while ensuring compliance with CNSC commitments.
- Monitoring work processes, identifying opportunities, and collaborating with Functional Operations and Maintenance to implement improvements.
- Scheduling inspection and maintenance work performed by external contractors, covering areas such as fuel channels, steam generators, feeders, turbine generators, islanding, shutdown/layup, and balance of plant.
- Producing detailed work execution schedules at the required frequency to support effective project execution.

- Conducting critical reviews of upcoming work to ensure project alignment and adherence to the execution window.
- Optimizing the critical path while considering cost impacts on individual projects.
- Providing timely and credible variance explanations and producing execution status metrics.
- Conducting problem-solving and analysis when performance deviations occur, ensuring corrective actions are implemented and monitored to resolution.
- Operating a Project Control Centre to manage work priorities and issue resolution, leveraging experience from prior refurbishments.

4.0 FUNCTIONAL OPERATIONS AND MAINTENANCE

The Functional Operations and Maintenance group supports major work bundles related to the unit undergoing refurbishment. This Function serves as the “controlling authority” for units within the construction island during refurbishment, holding responsibility for plant safety, worker protection, and environmental safeguards. It ensures compliance with CNSC licence requirements have been integrated into the PRP to maintain and refurbish relevant structures, systems, and components to nuclear standards. This ensures that units are returned to service in optimal condition, meeting high standards for safety, reliability, and production. Additionally, upon units returning to service, the Functional Operations and Maintenance group acts as the “custodian” of the plant’s operating units, ensuring that refurbishment activities do not negatively impact their operations.

Key responsibilities of the Operations and Maintenance Function during unit refurbishment include:

- Overseeing the shutdown and layup of the unit for refurbishment, as well as monitoring and maintaining laid-up equipment.
- Providing oversight for chemistry, environmental protection, and radiation protection activities.
- Controlling work protection and authorization processes.

- Coordinating the start-up of the refurbished unit, including executing modification commissioning plans, system restart plans, readiness demonstrations, and returning the unit to normal operations.
- Managing non-radiological waste and overseeing proper waste disposal.
- Managing unit turnover and transition to minimize disruption to refurbishment, as well as plant operations upon units returning to service.

5.0 PLANNING AND CONTROLS

This Function supports the PRP by establishing and applying project controls, such as cost management, reporting, and risk management, at both the PRP and project levels. The Function applies industry best practices and recommendations to set standards. Specifically, its responsibilities include

- front-end planning
- program-level scope controls
- project controls (including implementing a gated approval process for major work bundles), cost management, earned value management, forecasting, reporting, change control, and risk management.

The Function also allocates funding for the information technology tools necessary for executing the refurbishment. As the PRP transitions from the Definition Phase to the Execution Phase, the focus will shift from establishing governance, tools, and processes to monitoring program performance through project controls, metrics, and reporting.

6.0 COST AND SCHEDULE PERFORMANCE MONITORING

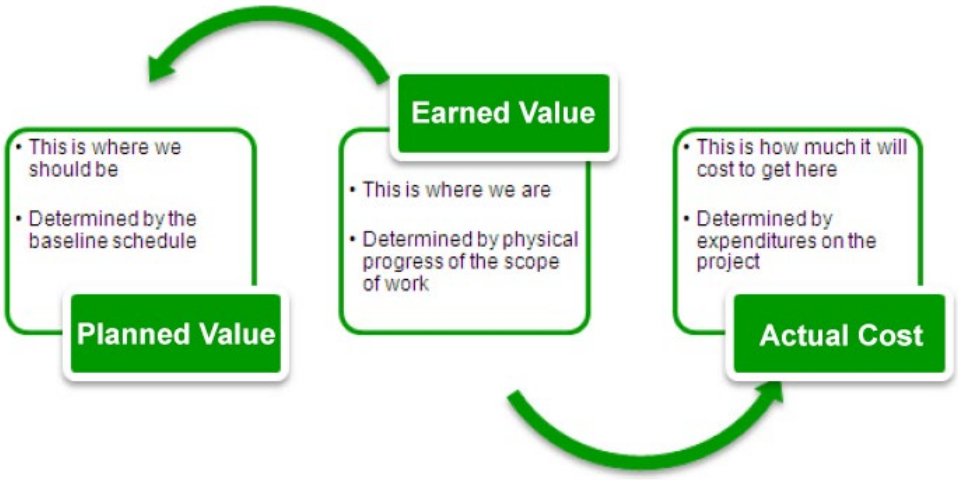
The Earned Value Management methodology is used by OPG as the primary tool for PRP cost and schedule management and monitoring. The Earned Value Management is a standard project management technique for quantifying and measuring project progress and performance. It provides a single objective system for tracking project progress, comparing planned work to actual work completed, and forecasting future performance in terms of both

budget and timeline. In other words, the project "earns" progress as work is completed, thus allowing management to implement corrective strategies if the project deviates from the plan. Earned Value Management analysis requires three key components:

1. Planned Value – The value of work scheduled to be completed at a given point in time.
2. Earned Value – The budgeted value of completed work, calculated as the percentage of physical progress achieved against the planned budget.
3. Actual Cost – The real expenditures incurred, sourced from finance/accounting records, contractor invoices, and accruals.

The Earned Value Process is illustrated in Figure 1 and further described below.

Figure 1 – Earned Value Process Summary Diagram



Cost performance is assessed by using standard industry metrics at the program, project, and functional levels. These earned value metrics provide insight into project efficiency and progress.

The following scenario illustrates how these metrics are calculated and interpreted:

Assume that four valves were scheduled for installation by the current date, each with a budgeted or planned value of $1,000, totaling $4,000. As of today, three valves have been installed, with a total expenditure of $2,500. Based on the experience of installing the first three valves, the cost to install the fourth valve is forecasted to be $800. The earned-value metrics are calculated as follows:

- **Schedule Performance Index ("SPI")** measures progress relative to the planned schedule (SPI = Earned Value / Planned Value). An SPI of 1.0 indicates that work is proceeding as planned, while a value below 1.0 signifies a schedule delay. A value above 1.0 means work has been completed ahead of schedule. In this scenario, SPI = $3,000 / $4,000 = 0.75, indicating that the project is behind schedule.
- **Cost Performance Index ("CPI")** evaluates cost efficiency by comparing the value of completed work to actual costs incurred (CPI = Earned Value / Actual Cost). A CPI of 1.0 means work has been completed at the planned cost, while a CPI below 1.0 indicates higher-than-expected costs. A CPI above 1.0 suggests cost savings. Here, CPI = $3,000 / $2,500 = 1.2, meaning the project is being executed more cost-effectively than planned.
- **Cost Variance ("CV")** represents the difference between the budgeted value of work performed and the actual cost incurred (CV = Earned Value - Actual Cost). In this case, CV = $3,000 - $2,500 = +$500, a favorable variance.
- **Schedule Variance ("SV")** measures the difference between the budgeted value of planned work and the earned value of completed work (SV = Earned Value – Planned Value). Here, SV = $3,000 - $4,000 = -$1,000, indicating an unfavorable schedule variance.

While SPI, CPI, and variance metrics provide insights into past performance, OPG also uses forecasting to assess future project success and enable proactive corrective actions at both the program and project levels. A key forecasting metric is the **Estimate at Completion ("EAC")**, which projects total expected costs (EAC = Actual Cost + Estimate to Complete). Using the scenario, EAC = $2,500 + $800 = $3,300.

Another important metric is the **Variance at Completion. ("VAC")**, which calculates the difference between the original budget and the forecasted final cost (VAC = Budget at

Completion - Estimate at Completion). In this case, VAC = $4,000 - $3,300 = +$700, indicating expected cost savings.

Estimate at Completion can be determined using different methodologies, such as applying the original planned values or adjusting forecasts based on actual unit costs. These forecasting tools allow OPG to maintain control over project costs and take corrective actions as needed.

7.0 RISK MANAGEMENT

The PRP has adopted a systematic approach to ensure risks and opportunities are identified, assessed, analyzed, mitigated with adequate risk response, and monitored to a robust and consistent standard to ensure that project objectives are achieved. This work is managed by the PMO Function, with additional oversight from OPG's Enterprise Project Management Office Risk Team.

Risk management provides projects with forward-looking actions and metrics to reduce the likelihood and minimize the impact of undesirable events (threats) during the project life cycle and increase the likelihood of positive events (opportunities) that can result in a cost and/or schedule saving.

Risk identification will continue throughout the lifecycle of the project utilizing various techniques as listed below:

- Risks identified during operating experience reviews and meetings with subject matter experts;
- Stakeholder interviews and reports; and
- Risk management meetings.

Specialists will qualitatively assess the probability and consequence of each identified risk and capture the information in the appropriate Risk Register to prioritize the risks.

All PRP Project teams are required to continuously review and monitor their individual Risk Registers throughout the project and adjust their assessments and mitigating actions

accordingly. Top program and major work bundle risks are reviewed during monthly status meetings. On a quarterly basis, a risk oversight meeting is held where top program and major work bundle risks are presented to and reviewed by the Risk Oversight Committee. In addition, specific projects risks and status are also presented during the project Gate Review process when seeking project funding approval from the Gate Review Board.

8.0 CHANGE MANAGEMENT

Change is inevitable in a project. A robust change management process provides guidance on how changes are assessed, implemented, and reported.

The PRP change management process ensures that all changes to project scope, cost, and schedule are controlled and documented; that contingency fund allocation is managed; and that the nature and cause of changes are documented, analyzed, approved, and implemented to minimize the impact to cost, schedule and scope.

The key principles that OPG applies with respect to change management include:

- the executing organization will first attempt to mitigate the impacts of the change so that change is managed at the lowest authorized level of the organization;
- a change that has a significant potential impact on scope, cost and schedule is reviewed in detail and the recommended direction is approved at the appropriate level;
- only after a change is approved by the appropriate authority level is the work assigned for action by the executing organization; and
- changes are not made solely for the purpose of correcting performance issues that are within the control of the work program owner.

The change control process is applied from project inception through completion. The constraints of cost, schedule, and scope are continuously and rigorously managed by rejecting or approving changes and subsequently incorporating approved changes into the revised program and performance measurement baseline where applicable.

Details of OPG's Integrated Change Management Process are set out in Attachment 1.

9.0 REPORTING

An integral part of successful project management is reliable and accurate performance information. Reporting provides this performance information through the collection, collation, and presentation of data and information. The key objectives of reporting are:

- ensure information is being communicated to the right stakeholders such that the appropriate decisions can be made, actions taken, or awareness generated;
- communicate the status of the Program including any trends, variance from plan, and how the potential variance is being addressed or corrected; and
- ensure information is reliable, accurate, and transparent.

A comprehensive reporting and data infrastructure framework has been established for reporting on the PRP. The purpose of the framework is to provide consistent, accurate, and timely information on project status to enable effective decisions and improve project performance.

Similar to the DRP, annual status reports are planned to be issued to the public and filed with the OEB for the duration of the PRP, beginning in the IR term. This reporting will include a range of measures, including construction completion, cost performance, schedule performance, and safety performance. The metrics proposed for PRP reporting are similar to those that were reported annually for the DRP, with refinements based on OPG's experience on reporting to date. Chart 1 illustrates the information that is planned to be provided through this public reporting for the duration of the PRP.

Chart 1 – Public Reporting on the PRP

Category	**Measure**
Introduction and Table Contents	N/A
Executive Summary	N/A
Overall Program Status	• High level overview of PRP
Progress	• Key Achievements • % Complete
Safety	• Serious Injury Incident Rate

Category	Measure
	• Summary of any material safety events
Significant Quality Events	• # of Significant Quality Events
Cost	• Cost Performance Index • Life-to-date cost • Forecast to Complete • Estimate at Complete
Schedule	• Current schedule performance (relative to OEB-approved) • Schedule Performance Index • Status of Key Milestones • Critical Path Progress • Forecasted Completion Dates
Engineering	• Summary of engineering status and key issues
Procurement	• Summary of procurement status and key issues
Construction	• Summary of construction progress and analysis of any material variances from plan • Summary of any material labour or staffing issues • Summary of any material environmental issues
Testing, Start-Up and Commissioning	• Summary of systems tested, commissioned, started, and any material key results and issues
Program Risks and Risk Management	• Key risks and mitigation • Key issues and corrective actions
Staffing	• Actual staffing levels against OEB-approved plan • Summary of any material staffing issues

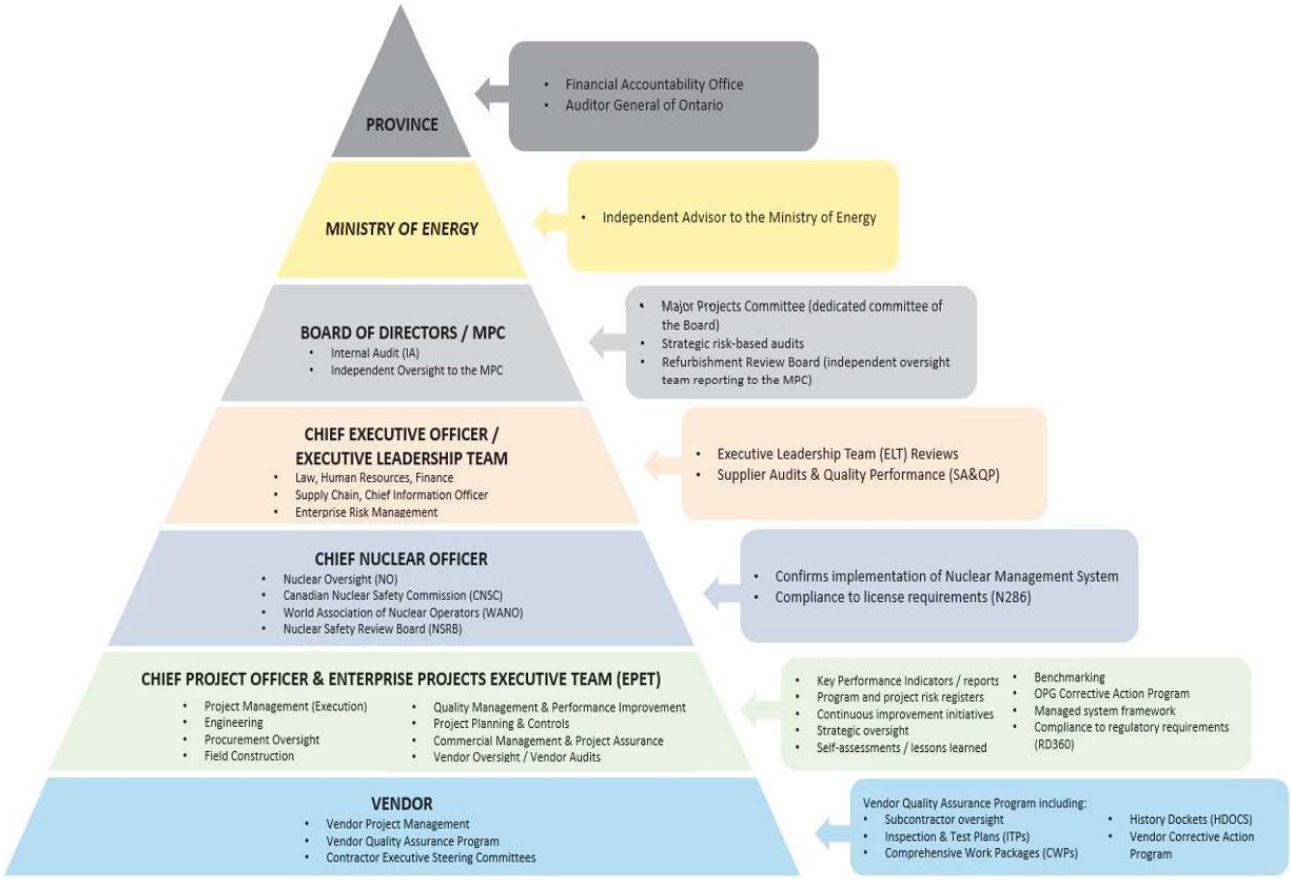
10.0 OVERSIGHT

OPG has established a comprehensive assurance plan that incorporates multiple layers of oversight, including PRP staff, external contractors, PRP leadership, enterprise leadership, and external advisors. This plan ensures robust oversight throughout the execution readiness and Execution Phase of the PRP, with a strong focus on key risk areas. Specifically, oversight will help to ensure that: (1) the PRP meets safety, quality, cost and

schedule expectations; (2) issues are identified and resolved expeditiously; and (3) transparent and accurate information is provided to OPG's Board of Directors to support effective oversight and decision-making.

The oversight and assurance processes are supported by transparent, timely and accurate information flows to support decision-making at appropriate levels within the organization. The flow of information and the organizational hierarchy of PRP oversight and assurance providers is provided in Figure 2 below. This figure provides context for various levels of oversight and examples of activities during the project.

Figure 2 – Pickering Refurbishment Program Oversight Assurance Framework



As per Institute of Nuclear Power Operations 17-004, Principles for Excellence in Corporate Performance, oversight is defined as "...the verification that the standards, expectations, and goals established through governance of the organization are met. Verification performed by managers and executives, up to and including the CEO and board of directors directly accountable for ensuring functional outcomes are met, is considered line oversight. Verification performed by personnel and groups; either internal or external to the organization and outside of the particular functional area, is considered independent oversight."[1]

The PRP Assurance is comprised of two main separate elements: External Assurance and Internal Assurance. Each element plays an important role in providing assurance to the stakeholders that the Program is being executed safely, to the required quality, on time and on budget.

The key provisions of this oversight and assurance model are provided below.

10.0 External Assurance

External Assurance is defined as oversight from outside the project including the Province of Ontario, industry and regulatory. The key provisions of External Assurance applied to the PRP include:

- *Independent Oversight* provided by an independent advisor of the Ministry of Energy who has been retained to monitor and report on the progress and performance of the PRP on a confidential basis directly to the Ministry of Energy. The Ministry of Environment, Conservation and Parks, and the Ministry of Labour, Immigration, Training and Skills Development may also provide oversight during the PRP as required.
- *Major Projects Committee of the OPG Board of Directors* supports program-level oversight by OPG's Board of Directors. As part of this oversight, the Major Projects Committee has retained the Refurbishment Review Board ("RRB") to provide independent assessments of the PRP. The RRB provides independent assessments of

[1] Institute of Nuclear Power Operations, "17-004, Principles for Excellence in Corporate Performance" (October 2017), p. 1-2.

PRP progress, estimates, and schedules to enable early intervention, help mitigate the project risks and improve overall project performance. It is typically comprised of five external experts in nuclear operations, mega-projects, and regulatory requirements (along with two internal OPG members). The RRB performs reviews of PRP three to four times per year, or at a frequency as directed by the Major Project Committee, and reports directly to the Major Projects Committee.

- *OPG's Nuclear Oversight* is an independent function within OPG that is separate from line management. Nuclear Oversight conducts the Independent Assessment Program to ensure that the PRP project meets the requirements of the Nuclear Management System as necessary. The findings are reported to OPG's Chief Nuclear Officer and are shared with the Major Projects Committee of OPG's Board of Directors.
- *OPG's Internal Audit,* which provides oversight in a broad range of areas such as scheduling, cost estimates, contractor procurement, quality assurance, cost management, contractor time keeping and contracts. OPG's Internal Audit group has functional independence from management. It publishes the results of audits in a report and requires management actions be assigned and tracked to completion. The results of all audits are presented to OPG's Chief Executive Officer and OPG's Board of Directors.
- *Industry Regulatory and Other Oversight Bodies* including the CNSC and the World Association of Nuclear Operators may perform routine audits, assessments, and inspections of PRP performance. As the PRP progresses, these reviews will include insights into the Program's compliance with applicable licences and regulations, and World Association of Nuclear Operators best practices.

10.1 Internal Assurance

Internal Assurance is defined as oversight provided by functional organizations within OPG and the PRP organization to support the project. The key provisions of Internal Assurance applied to PRP include:

- *Project-Specific Oversight* – Each Project Management Team, along with the Project Execution Support Function, conducts oversight based on risk management principles, operational experience, contract requirements, scope of work, and contractor performance evaluations (see Section 3.2.1 of Ex. D2-3-2).

- *Executing Organization Oversight* – PRP leadership and PRP functions oversee execution, including through the *Project Execution Support*, *Work Management, Functional Operations and Maintenance* and *Planning and Controls* Functions described above.
- *Oversight and assurance provided by OPG's Chief Nuclear Officer, Chief Projects Officer and Chief Nuclear Engineer,* who confirm compliance to the Nuclear Management System and licensing requirements throughout all project phases from design through to turnover to operations. This is achieved through functions including:
  - *Nuclear Regulatory Affairs,* which interfaces with external regulators such as the CNSC, Ministry of Energy and Ministry of Labour, Immigration, Training, and Skills Development, who perform assessments of compliance. OPG seeks to anticipate and address any issues in a way that maintains and builds regulatory confidence; and
  - *Construction Centre of Excellence,* which identifies, plans, executes and reports on construction oversight activities and trends throughout the project lifecycle.
- *Vendor Oversight* – Vendor oversight management involves actively monitoring and evaluating vendor performance to ensure compliance with contractual obligations, quality standards, and regulatory requirements. This process includes enforcing standardized processes for evaluation and performance monitoring to ensure vendors meet project requirements and safety standards. It also facilitates on-going communication and engagement with the vendors of contractual obligations, documentation of vendor activities, performance reviews requirements and frequency, and issue resolution. This oversight process minimizes risks, ensures service reliability, and protects OPG's interests by holding vendors accountable for their deliverables.

This multi-tiered oversight framework is integral to ensuring the success of the PRP, reinforcing accountability, and maintaining high standards for safety, cost efficiency, and schedule adherence.

LIST OF ATTACHMENTS

Attachment 1: Pickering Refurbishment Project Controls Program Management Plan – NK30-PLAN-00120-00003

ONTARIO POWER GENERATION

Program Management Plan

Internal Use Only

Document Number:
NK30-PLAN-00120-00003

Revision:
R001

Title:
PICKERING REFURBISHMENT PROJECT CONTROLS PROGRAM MANAGEMENT PLAN

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The Program Management Plans outline the specific requirements and procedures related to each function of a project, with the aim of communicating how the staff will carry out their tasks while aligning with the objectives of the current OPG Project Management Standard.

General Program Information

Program Name:	Pickering Refurbishment	**Facility/Site:**	NK30/ Pickering B
Program Manager:	Luca Ceccato, SVP Pickering Refurbishment Execution	**Executing Org:**	Refurbishment Project Controls
		Sponsor:	Subo Sinnathamby

Program Management Plan Approval

Prepared by: Joanne Mercieca 05Sep25 **Joanne Mercieca, Project Specialist / Date**	Reviewed by: Kevin Tse 11Sep25 **Kevin Tse, Sr Manager Project Controls /Date**
Approved by: Vijay S 22/Sep/2025 **Vijay Santhanam, Director Refurbishment Project Controls /Date**	

Title:
PICKERING REFURBISHMENT PROJECT CONTROLS PROGRAM MANAGEMENT PLAN

Revision Summary

Revision Number	Date	Comments
R0	2025-01-29	Initial Issue
R1	2025-04-10	Section 2.2.2 added to include Gate 3 Estimate review requirements
R2	2025-09-05	Document references updated, Program Management Plan structure (Appendix A) updated

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1.0 PURPOSE

The intent of this plan is to define the implementing project controls processes for successful execution of the Pickering Refurbishment Program (PRP). The program requirements below are the minimum criteria applicable to all the components within the Project Controls program.

Program-specific Management Plans are to be consulted for direction on program governance and compliance requirements.

2.0 PROGRAM REQUIREMENTS

The Enterprise Project Management Office (EPMO) has established an organizational model and associated procedures consistent with industry best standards including recommended practices from the Project Management Institute, the Construction Industry Institute (CII), and the Association for the Advancement of Cost Engineering. The EPMO, where appropriate, has also adopted operating experience from many large scale Nuclear and non-Nuclear projects.

It is the intent that the Pickering Refurbishment Program will adhere to the established EPMO Project Controls processes.

All projects within the PRP are classified as Scalability level ‘A’ due to the substantial integration and oversight requirements associated with managing the program. Individual project level classifications based on the project’s specific complexity and anticipated cost at completion is not required.

A program level Refurbishment Charter NK30-CHAR-09701-00001 [R01] is in place to establish and communicate the expectations of the Senior Vice President (SVP), Enterprise Chief Project Officer regarding the management of the PRP. It also provides the process support document framework to be implemented within the PRP to manage all activities related to the refurbishment of the Pickering units. Individual project charters are not required.

Specific Program and Project Management Plans will document how the PRP meets the requirements of the OPG Nuclear Management System. Project Management Plans (PMP) are prepared strategically at the bundle level.

The program requirements being implemented by Pickering Refurbishment are outlined in the following sections.

2.1 Funding Release Strategy

Board of Director (BoD) approval will be required for funding releases to the Pickering Refurbishment Program. The funding approval process will include separate releases for the planning, prerequisite, execution and close out phases for each unit.

The funding release for Pickering Refurbishment will utilize the following strategy:

- Phased BoD Program releases based on progression of work will be implemented to allow programmatic objectives to be progressed along with specific project deliverables.

- Project and Functional support releases will be implemented as draw downs on the Program release through phase-gate and/or change management. The processes to be followed are documented in OPG-MAN-00120-0019 Project Phase Gate Management [R02] and OPG-MAN-00120-0016 Project Integrated Change Control [R03].

- Project-specific business case summaries (BCS) for projects executed within the PRP charter are not required.

2.2 Phase Gate Management

A modified gating process will be used to control funding approval through the project phases.

Program Release	Applicable Gates	Scope	TCD
Release #1A-1 RP-0200	Bundle Gate 1	• Procurement of Major Long Lead Materials for U5/U6 • Completion of Scope Refinement • Advancement of Preliminary Engineering	Jan-24 COMPLETE
Release #1A-2 RP-0210	Bundle Gate 2	• Procurement of materials for U5/U6 • Procurement of all materials for U7/U8 • Completion of Detailed Design	Nov-24 COMPLETE
Release #1B RQE RP-0211	Bundle Gate 2/ Gate 3	• Completion of Installation/Work Planning • Execution of Facilities, Defueling, U5/U6 Layup, and selected common work	Nov-25
Release #2 RP-0220	Gate 3 U5, 6, 7 & 8	All Bundles Gate 3 approved • Full execution and close out of U5, 6, 7 & 8 (TG, BOP, RFBR, SGs)	Nov-26

Releases to execute individual project scopes will follow the principles of the phase-gating process guidelines documented in OPG-MAN-00120-0019, Project Phase-Gate Management [R02].

Projects within scope of the Refurbishment program that will be funded individually are included in the bundles below:

- Retube & Feeder Replacement
- Boiler Replacement
- Turbine Generator Refurbishment
- Deep Water Intake
- Balance of Plant Scope
- Operations & Maintenance
- Facility & Infrastructure Upgrades
- Functional Support

Gate package preparation should reflect the programmatic release strategy, project contracting strategies and planned funding requests.

Gate packages are to be prepared using the standardized Program Gate Progression Form in ePMX. The template provides additional details on the scope schedule and financial summaries within the projects in lieu of individual project Business Case Summaries.

Gate packages will be reviewed, evaluated and approved by the Pickering Refurbishment – Gate Review Board (GRB). The GRB Terms of Reference describes the function and role of the GRB in more detail.

A more detailed gate strategy and release plan for each bundle is documented in the Bundle-specific Project Management Plan.

2.2.1 Electronic Approval of Gate Packages

The following Gating requirements and expectations have been established for Pickering Refurbishment. Reference Pickering Refurbishment Program Gate Review Board Terms of Reference NK30-TOR-09701-00003 [R32]

Approvals for Gate 1 & Gate 2 including all sub-gates are permitted to be routed electronically instead of a Gate Review Board Quorum meeting. To use this exception ALL of the following conditions must be met:

- Release requested for the scope of work is in line with the Program Class IV estimate for that same scope of work, broken down to WBS level 1,
- Estimate classification for the release requested meets gate requirement.
- Schedule requirements for gate release are met, and

- Top risks for release have post-mitigation score of score ≤10.

Expectations for electronic approval:

1) Follow gating requirements. Governance still applies.

2) Prepare Gate Package including Gate Progression Form (GPF) and Gate Presentation and obtain reviews from Execution line up to VP and P&C Manager.

Prior to requesting approval, stakeholder endorsement reviews are to be held with

- Project Controls Sr Manager
- Project Controls Director
- SVP, Governing Body Chair

A .pdf of the Gate Progression Form is to be submitted to the above approvers and the results formally documented on the GPF Decision tab in ePMX.

All Gate 3 release requests require GRB quorum meeting per Terms of Reference NK30-TOR-09701-00003 [R33]. By exception only, email approval by Director, Project Controls is required for a Project or Function to seek an electronic gate approval instead of GRB quorum meeting for Gate 3 release.

2.2.2 Estimate Reviews

For all PNR Gate 3 packages, a formal estimate review by the PMO Estimating Team is required. The review is to be documented using GATE-FORM-004 and attached in the Estimate section of the Gate Progression Form in EBX. GATE-FORM-004 Estimate Checklist is available on the Project Management Governance Map under Phase Gate Management.

If an exception to this requirement has been granted by the Director P&C, email or memo documentation must be attached in the GPF in lieu of the review checklist.

2.3 Integration Management

Project Integration Management is the main process through which the project manager ensures that all elements of the project are adequately developed, coordinated, managed and aligned.

For the Pickering Refurbishment program, Project Controls will leverage the guiding principles identified in OPG-MAN-00120-0010, Project Integration Management [R04] for alignment between all projects executed within the program scope.

This includes the use of established Project Management Information Systems (PMIS) tools and software for managing related project work including EcoSys, ePMX, AS9 and P6 scheduling software.

A Pickering Refurbishment Program and Project Work Breakdown Structure has been developed and is to be used by all Bundles/projects. Use of a standardized Work Breakdown Structure (WBS) will facilitate successful coordination and alignment of project teams, processes, systems, and interfaces.

For the PRP, the Work Package level is the Cost and Schedule Integration point of scope, budget, actual cost and schedule and where the measurement of performance will occur. e.g.: Procurement Packages, Engineering/Design Packages, Construction Packages, etc.

2.4 Project Scope Management

The Refurbishment program Scope Management principles and requirements are documented in OPG-MAN-00120-0011, Project Scope Management [R05].

The objective of Scope Management is to ensure that the individual projects included in the Refurbishment program include all the work required, and only the work required, to complete the refurbishment successfully. Managing project scope is primarily concerned with defining and controlling what is and is not included in a specific project.

The Refurbishment Change Control Board (RCCB) has been established to provide a structured forum for control of changes to the scope and structure of the Pickering Refurbishment Program (PRP).

This Board is a transition from the Pickering Scope Review Board (PSRB) and takes authority as of May 2024, post Major Scope Freeze. Reference NK30-TOR-09701-00002 Pickering Refurbishment Program Refurbishment Change Control Board Terms of Reference [R06].

The RCCB will manage new scope requests and approved scope changes for the individual projects, ensuring requirements are fit-for-purpose, properly defined, validated, controlled, and align with the overall program objectives.

In addition to the Refurbishment Program, a Sustaining Capital/OM&A program will be implemented during the refurbishment time frame. The Sustaining program will be the responsibility of the Pickering Station.

For approval of scope that is funded from the Sustaining program, refer to Project Management OPG-STD-0148 and associated processes.

2.5 Manage Decisions

Throughout the PRP life cycle, concepts may be initiated/proposed for analysis and decision, which may involve significant changes and impacts to the program.

For the PRP, the Decision Record and Analysis Summary (DRAS) form will be used to initiate the process to analyze and approve or reject new concepts. Decisions are to be documented and administered through the DRAS - Decisions Module within Enterprise Project Management Extensions (ePMX).

Decisions affecting scope, schedule and/or budget will need to be approved by the Refurbishment Change Control Board.

OPG-MAN-00120-0010 Project Integration Management [R04] provides direction on management of decisions.

2.6 Schedule Management

Schedule Management will follow the principles and direction outlined in OPG-MAN-00120-0014, Project Schedule Management [R07]. The primary PMIS scheduling software is Primavera P6.

The schedule is the main planning tool used to understand and communicate the status, interrelationships and dependencies among project activities and deliverables.

Individual project schedules will be maintained throughout the life cycle of the projects, in addition, a program master schedule will be implemented and maintained to facilitate effective planning of the project components and to provide all key stakeholders with a visual representation of how the program is being delivered throughout the life cycle.

Maintaining a logic-based program network diagram and monitoring the critical paths for each project with interdependencies between other project work is essential for effective management of the program master schedule.

PRP Standard P6 milestones are to be identified and coded in each Bundle/Project schedule to enable consistent program reporting. The milestones and codes are documented in NK30-MAN-09701-10005-MLST [R08].

The Multi-Layer scheduling concept will be incorporated in which each project has a single schedule file containing activities of different levels, and high-level activities are summaries of their lower level activities. This concept includes vendor and OPG activities in the same schedule environment.

Management of the schedule performance measurement baseline will be in accordance with the Project Integrated Change Control process and will be supported by the PRP PMO Business Unit subject matter expert and Primavera system administrator assigned to the Refurbishment program.

Changes to schedule baselines will be coordinated and controlled across program components.

Each PMP should include a Schedule Management Plan defining the criteria and activities for developing, monitoring, and controlling the schedule. OPG-GUID-00120-0001 Project Scheduling Guide [R09] provides detailed guidance to assist OPG and vendor schedulers on understanding the requirements for project schedule development, updating and control within Primavera P6.

There will be one P6 scheduling database controlled and managed by OPG. All work groups (OPG and vendor work groups) will work in the same P6 instance.

- An OPG Assigned Master Scheduler is responsible to control and manage the unified P6 schedule.

- A Project Controls member will be assigned to each bundle and will follow schedule process direction from the OPG Master Scheduler.

  - The Lead Scheduler has authority to update and revise his schedule within the protocols specified by the Master Scheduler

2.7 Work Management

The Work Management section under the Project Controls Director is responsible for an Integrated Level 3 Execution Master Schedule providing collaboration between all the refurbishment projects for current and subsequent unit execution work.

The focus of the group will be on facilitating the planning, preparation and execution of the scope of work with individual Project Managers and Vendor Partners through schedule oversight.

There are three key fundamental areas of accountability:

1. Scope Management: The Work Management section manages the Major and Minor Scoping Milestones and post milestone scope control, reference:
   - N-GUID-09300-10000, Outage Scope Control Process [R26] – W/O Creation, Major Scope & Initial Planning.
   - N-GUID-09300-10010, WCTL Desktop Guide for Nuclear Planned Outages [R27] – Planned Outage Scoping, Preparation, Execution and Post Outage Expectations for Work Control Team Lead (WCTL).

2. Schedule Management: The Work Management section owns the individual unit outage execution schedules and provides key input to the overall program schedule, reference:
   - OPG-MAN-00120-0014, Project Schedule Management [R07].

   While each project and contractor are responsible to produce a logical and executable schedule, Work Management validates the schedule and integrates it into the overall program schedule, identifying modifications as required. The direction and oversight requirements of any individual project are the accountability of the project.

3. Planning Preparation Milestones: Work Management provides the oversite of and manages the Refurbishment Unit Planning Milestones program, reference:
   - NK30-MAN-09701-10005 Pickering Refurbishment Work Management [R28].
   - NK30-MAN-09701-10005 MLST Pickering Refurbishment Program Unit Planning Milestones [R29].
   - NK30-MAN-09701-10005 WIN Pickering Refurbishment Program Unit Planning Window Milestones [R30].

The responsibilities of Work Management with Integration and collaboration includes:

- Planning, organizing, coordinating and maintaining status on all preparatory and ongoing requirements of the schedule.
- Monitoring the work being performed to completion as scheduled and managing and directing the resolution of all intergroup or inter-department coordination issues.

- Implementation of a Unit Coordination and Lookahead Team - This Look Ahead Team ensures all work needed before the start of refurbishment execution is scoped, planned, and scheduled in a manner that will achieve the overall program strategies and goals.
- Ensure integration of contractors and refurbishment activities.
- Ensure logistics required during unit refurbishment including space, services, resources, permits, and radiation protection are planned, coordinated, and executed.
- Ensure the work execution is monitored & tracked to Window baseline durations & execution schedule timelines.
- Ensure work activities are properly planned, prepared, coordinated, and monitored during the actual execution phase through the planning controls systems including making sure parts and tools are readily available.
- Ensure Canadian Nuclear Safety Commission (CNSC) commitments related to assigned outage are coordinated and executed.
- Implementation of a Project Control Centre (PCC) - Responsible to communicate progress on a daily or weekly published schedule to a large number of coordinators and stakeholders, as well as ensure the schedule is followed, work is prioritized, and progression is tracked. All issues that require resolution during the Refurbishment execution are coordinated through the PCC Manager.

2.8 Cost Management/ Estimating

2.8.1 Cost Management

Cost Management is the process of estimating, budgeting, monitoring and controlling program/project costs.

The Refurbishment program will follow the principles outlined in OPG-MAN-00120-0013, Project Cost Management [R11].

To facilitate Cost Management the budgets of the individual program components need to be established to develop the overall budget for the program, and to integrate and control costs during program life cycle.

The following factors play a part in cost management:

- Funding, Budget (estimate), Forecasting
- Schedules
- Contract payment schedules
- Cost reporting and Metrics
- Change management.

Implementing the PRP standard Work Breakdown Structure (WBS) is critical for reporting as it facilitates alignment of cost and schedule within and between projects. The WBS used by individual projects should include 100% of the scope and all elements of cost for the project (e.g. direct effort, interest costs, staff expenses).

Program contingency will be managed at the Program level within the Functional Bundle.

Interest charges will be managed at the project level and are to be included in project estimates under the appropriate Cost Management WBS element.

Bundle contingency based on project risks will be available for allocation though the Integrated Change Control process. New scope or significant changes to draw contingency from the Program will need Change Control Board approval. Any changes to project budgets and drawdown/return of contingency should be managed in accordance with the Project Integrated Change Control manual. [R03]

EcoSys will be the repository of Program/Project budgets, forecasts and life-to-date actuals.

2.8.2 Estimating

The estimating process is performed during each phase of the program/project life cycle as project scope is further defined, modified, and refined. The refurbishment program will take guidance from OPG-MAN-00120-0012, Project Estimating Manual [R12] to develop or validate estimates.

Estimates are to be reviewed by the PMO Estimating Team. Ensure adequate time is allocated for estimate review and validation activities, and any resulting corrective actions.

2.8.3 Forecasting

Forecasting is the process of making projections of conditions and events in a projects' future, predicting the final outcome of the cost, time and resources required to complete a scope of work.

As described in the Cost Management Manual OPG-MAN-00120-0013 the project manager is to ensure that the project forecast is updated in EcoSys at a minimum, on a monthly basis.

For assistance in developing forecasts, Project Managers can refer to COST-DTG-001 FORECASTING [R13] available on the Governance Roadmap located on the EPMO Website

2.9 Integrated Change Control

Integrated Change Control: is a Project Management process that justifies or rejects a change request to scope, budget and/or schedule.

Implementing formal change control ensures that all changes to the Refurbishment program, and associated projects, performance baselines are controlled and documented to:

- Minimize the impact to program cost, schedule and scope by documenting, analyzing, and approving the nature and cause of project changes.
- Manage updates to project scope, schedule and/or cost "project performance baselines.
- Manage program contingency fund allocation.

The guiding principles identified in OPG-MAN-00120-0016, Project Integrated Change Control [R03] will be used to develop any PRP program/project specific change requirements.

Changes should be identified in a timely manner to allow for appropriate reviews and approvals prior to implementing resulting actions. This includes contractor and OPG request for change.

All change control is to be documented in the ePMX Change Control module. Baseline cost and schedules are updated within the OPG PMIS source systems. Example ePMX, EcoSys and P6, if applicable.

All changes to project scope, schedule and/or cost baselines should be performed through the ePMX Change Control Form (CCF) in a timely manner. Changes to baselines will be coordinated and controlled across program components.

As discussed in Section 2.4 Scope Management, any new scope requests and/or scope changes for individual projects must be approved by the RCCB before proceeding with CCF approval. Reference NK30-TOR-09701-00002 PRP RCCB Terms of Reference [R06].

2.10 Risk Management

2.10.1 Risk

The fundamental project risk management processes are:

- Plan Risk Management
- Identify Risks and Issues
- Perform Qualitative Risk Analysis
- Perform Quantitative Risk Analysis
- Plan and Implement Risk Responses
- Monitor Risks and Issues

NK30-PLAN-00120-10014 Pickering Refurbishment Risk Program Management Plan [R34] provides guidance on Risk management processes and approach required for the PRP. Project and program risks, issues and opportunities are to be maintained in the ePMX Risk and Actions Module. The Risk and Actions Module is a live tool that allows the project to provide details on risks, response type and mitigating actions to monitor and control risks, and actively execute effective, proactive risk management.

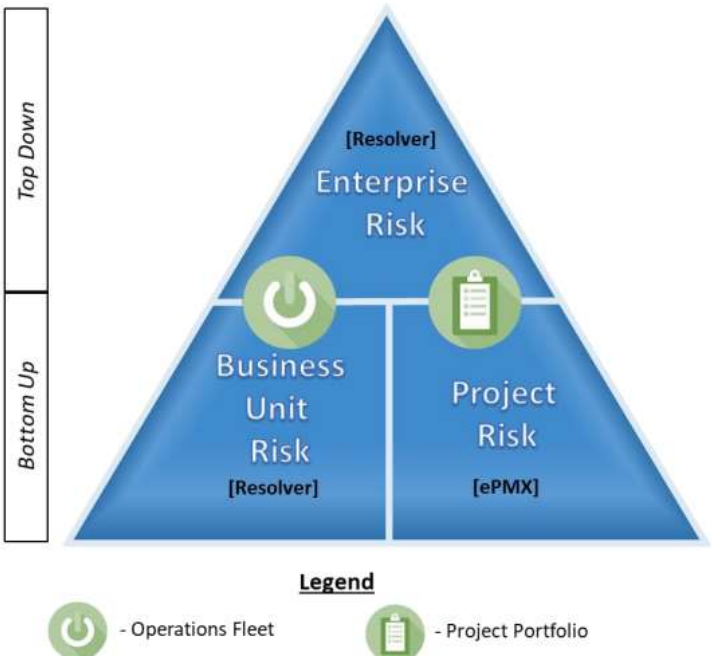
Risks specific to project scope or scope related items are to be captured in the individual project PMPs. OPG-MAN-00120-0015, Project Risk Management [R18] documents the process to identify and evaluate project risks and opportunities with an adequate risk response plan. Note for implementation of the requirements in the manual, all Bundles/projects within the Refurbishment program are Scalability A.

Key Program risks will be reported to Enterprise Risk Management (ERM) in accordance with reporting requirements defined in OPG-PROG-0004, Enterprise Risk Management.

Risk at the fleet and program level will be considered from a broader strategic perspective. For PRP risks that are included in the Enterprise and Business Unit risks, co-ordination will be managed by Enterprise Risk Management Team.

The Enterprise Project Risk Committee (EPRC) will be responsible for providing risk oversight of the Enterprise Projects portfolio via the Enterprise Project Management Oversight Committee (EPMOC) meeting.

The following diagram illustrates the risk management framework at OPG:



2.10.2 Lessons Learned

Lessons learned knowledge gained during initial Refurbishment work planning and execution will be used for the planning and execution of subsequent Refurbishment units, or Station Maintenance.

OPG-GUID-00120-10054 Lessons Learned Guide [R20] describes the Pickering Refurbishment Internal Lessons Learned Program.

All Refurbishment employees and vendor partners have a responsibility to identify and document lessons learned. Lessons are to be identified on an ongoing basis during the planning and execution of work, or as soon as possible after key work completion to ensure the information is accurate and complete.

The ePMX Lessons Learned module will serve as the single repository for documentation of all Refurbishment Lessons Learned.

2.11 Communication and Stakeholder Management

Communication provides the critical link between stakeholders and program information that is necessary for decision-making and support engagement. Effective communication and stakeholder management is part of effective project change management.

While projects share the need to communicate project information, the information needs, methods of distribution, and the amount of information may vary widely. Refer to OPG-MAN-00120-0017, Project Communication and Stakeholder Management [R21] principles for determining the information and communication needs of the stakeholders based on the program stakeholder register. A communication management plan should be included within the individual Project Management Plans (PMP). Consideration is to be give to Legal, regulatory, and commercial sensitivity requirements.

For specific requirements refer to the Communications & Stakeholder Relations PgMP NK30-PLAN-00120-00013 [R22].

2.12 Indigenous Engagement Plan

OPG is committed to working with Indigenous Nations and communities to foster positive and mutually beneficial relationships that will create social and economic benefits through partnership and collaboration. Projects are to develop effective Indigenous Engagement Plans (IEP) to support meaningful engagement and consultation with Indigenous Nations and communities with respect to OPG's current and future operations and projects.

IEPs are to be included in Project Management Plans and will be part of the PRP Gate progression checklist to ensure indigenous engagement has been integrated into the project team deliverables.

The Indigenous Relations Department is available to support development an IEP. Early engagement with Indigenous Nations and communities prior to finalizing an IEP is important in order to understand their interests and/or concerns related to the proposed project and to receive feedback on how they would like to be engaged.

Project teams are encouraged to contact the Indigenous Relations Team prior to reaching out to the Indigenous Nations and Communities.

Refer to Indigenous Relations Manual OPG-MAN-08410.1-0001 [R31].

2.13 Performance Measurement and Reporting

Performance measures assess the extent to which performance is achieving the intended targets. A set of standard reports are produced for communicating program and project level performance to various stakeholders.

Accurate and timely project reporting will be the responsibility of each project manager. In addition, information may be requested from project teams to support the level 2 and 1 program level report requirements.

A Nuclear Refurbishment Reporting Website is maintained and utilised across the organization as a repository for official reports. Automated reports currently produced

include, but are not limited to:

- Cost performance reports using baseline cost data from EcoSys,
- Schedule performance reports based on Primavera P6,
- Actual cost collected from Financial Reporting & Analytics (FRA) source systems.
- Milestone reports using schedule data from Primavera P6 identifying progress on specific milestone types or reporting events at all levels from program down to the individual milestones.
- Engineering progress reports using schedule data from Primavera P6 and information regarding engineering scope entered into EPMX by the line of business.
- Risk Management status reports using actions, risks, issues and decisions entered into the ePMX tool.

2.14 Document Management

Records, documents, and data collectively form the history of the PRP. They constitute the business and intellectual assets of critical importance and are fundamental for knowledge transfer. Documents are to be maintained to meet both regulatory and business requirements and should be managed throughout their life cycle e.g. project planning, execution and program closure in accordance with Information Management. OPG-MAN-00120-0017 Appendix D provides guidance on documents and records creation and Associated Form or Template Number and Records Management System Filing Information/Retention.

ePMX has the capability to create and store project documentation including:

- Gate Package
- Business Case Summary (BCS)
- Gate Progression Form (GPF)
- Gate Tracker
- Decision
- Post Implementation Review
- Report of Equipment In-Service (REIS)
- Project Closure Report (PCR)

Each project is to maintain a SharePoint repository of critical documents including Correspondence and Technical data that are not available in other systems such as ePMX and AS9. Official Records shall be processed in accordance with OPG-PROC-0019, Records and Document Management [R23] and registered in the appropriate document management system.

2.15 Resource Management

The Refurbishment Project Controls organization has resources dedicated to the Refurbishment program. Staffing will follow the matrix model by assigning Project Controls staff to specific bundles in addition to centralized Program support. Labour charges will be assigned to cost accounts per the OPG Cost Model.

The Refurbishment Project Controls Office will also work with the Enterprise Project Management Office (EPMO) for supplementary support to ensure the processes are consistently applied and specialist resources are not duplicated.

Staffing and resourcing requirements will vary over the life cycle of the PRP. As each individual project or Bundle progresses through the project life cycle, resource requirements will be updated in the estimate based on current scope and assumptions. Project Estimating OPG-MAN-00120-0012 [R12] defines the process to develop resource requirements such as labour, material, and equipment.

Training requirements for employees is further defined in NK30-PLAN-00120-00017 Training Program Management Plan [R24].

Processes to support Resource Management are documented in NK30-PLAN-00120-00015 Resource Management/Staffing PgMP [R25].

A draft organization chart for the Project Controls group is available in Appendix D.

3.0 ROLES AND ACCOUNTABILITIES

Key OPG Project Controls personnel and responsibilities include but are not limited to the accountabilities as follows:

VP Planning & Project Controls, Enterprise Projects

- Is accountable for the effective design and implementation of a Project Planning & Controls organization capable of supporting and executing the strategies and processes outlined in this document.

Director, Refurbishment Project Controls

- Liaises with the senior members of the Project Execution organization on programmatic strategies, program performance and corrective actions required.
- Liaises with the Enterprise Project Office – Project Services Division to ensure that effective managed systems are in place for the planning, execution, monitoring, and reporting of scope, schedule, cost, risk, operating experience, gated process and records management for all of the PRP bundles and functions.
- Is accountable for ensuring accurate, timely performance reports to senior OPG management and other stakeholders.
- Responsible for integrating Work Management processes and tools into the Project Controls group.

- Is the owner of this document and is accountable for its definition, implementation and continuous improvement. Responsible for maintaining the Project Controls Program plan and or Project Charter

Sr Manager, Refurbishment Project Controls

- Conducts program level performance trends analysis and communicate accurate and timely performance reports to senior OPG management and stakeholders.
- Documents and tracks program and project level issues, risks, and scope changes.
- Reconciles project schedules with the program milestone schedule.
- Monitors progress to key program milestones, strategies and goals.
- Conducts periodic quality assurance audits of all of their constituent projects to ensure that project management processes are being followed.
- Provides a repository for program and project management metrics.
- Ensures that the program revenue and costs are controlled.
- Leads cross-project planning, as well as dependency and conflict resolution.
- Resolves issues that cannot be resolved at the project level.
- Escalates issues/risks to the governing body that cannot be resolved at the program level.
- Represents the program and provides status updates to the BoD.
- Ensures appropriate management of the day-to-day activities of the PMO.

Sr Manager Work Management

- Ensure refurbishment work is executed according to refurbishment standards and in a manner that will achieve the overall business objectives.
- Provide Site Work Management Integration.
- Responsible for Revision A,B,C,0 execution schedules.
- Responsible for subsequent Unit planning.
- Responsible for managing the Refurbishment Scoping Process.
- Responsible for managing the Planning Milestone process.

4.0 ACRONYMS

AS9	Asset Suite
BCS	Business Case Summary(ies)
BoD	Board of Directors
ePMX	Enterprise Project Management Extensions
EPMO	Enterprise Project Management Office
P6	Primavera Project Planner Scheduling Software
PgMP	Program Management Plan
PMIS	Project Management Information Systems
PMP	Project Management Plans
PRP	Pickering Refurbishment Program
RFBR	Retube, Feeder and Boiler Replacement
WBS	Work Breakdown Structure

5.0 REFERENCES

[R01] NK30-CHAR-09701-00001 Pickering Refurbishment Charter
[R02] OPG-MAN-00120-0019 Project Phase Gate Management
[R03] OPG-MAN-00120-0016 Project Integrated Change Control
[R04] OPG-MAN-00120-0010, Project Integration Management
[R05] OPG-MAN-00120-0011, Project Scope Management
[R06] NK30-TOR-09701-00002, Pickering Refurbishment Change Control Board
[R07] OPG-MAN-00120-0014, Project Schedule Management
[R08] NK30-MAN-09701-10005-MLST Standard Milestones
[R09] OPG-GUID-00120-0001 Project Scheduling Guide
[R11] OPG-MAN-00120-0013, Project Cost Management
[R12] OPG-MAN-00120-0012, Project Estimating Manual
[R13] COST-DTG-001 Forecasting
[R14] OPG-PROG-0038 Contract Management
[R15] OPG-PROC-0058 Procurement Activities
[R16] OPG-PROC-0060, Requisitioning Items and Services
[R17] OPG-PROC-0064, Purchasing Card
[R18] OPG-MAN-00120-0015, Project Risk Management
[R20] OPG-GUID-00120-10054 Lessons Learned Guide
[R21] OPG-MAN-00120-0017, Project Communication and Stakeholder Management
[R22] NK30-PLAN-00120-00013 Communications & Stakeholder Relations PgMP
[R23] OPG-PROC-0019, Records and Document Management
[R24] NK30-PLAN-00120-00017 Training Program Management Plan
[R25] NK30-PLAN-00120-00015 Resource Management/Staffing PgMP
[R26] N-GUID-09300-10000, Outage Scope Control Process

[R27] N-GUID-09300-10010, WCTL Desktop Guide for Nuclear Planned Outages

[R28] NK30-MAN-09701-10005 Pickering Refurbishment Unit Planning Milestones.

[R29] NK30-MAN-09701-10005 MLST Pickering Refurbishment Program Unit Planning Milestones

[R30] NK30-MAN-09701-10005 WIN Pickering Refurbishment Program Unit Planning Window Milestones

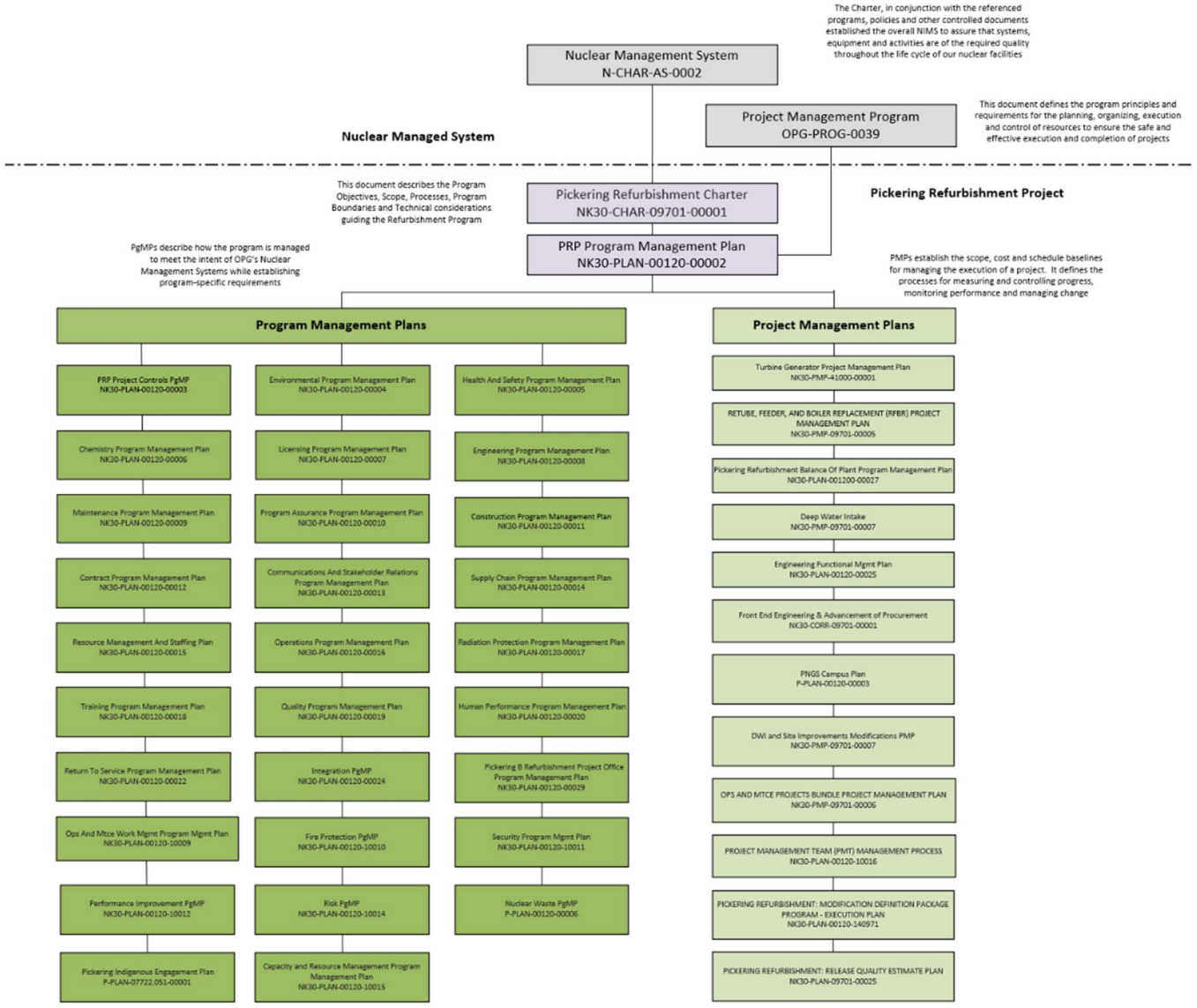
[R31] OPG-MAN-08410.1-0001 Indigenous Relations Manual

[R32] Pickering Refurbishment Program Gate Review Board Terms of Reference

[R33] NK30-PLAN-00120-10014 Pickering Refurbishment Risk Program Management Plan

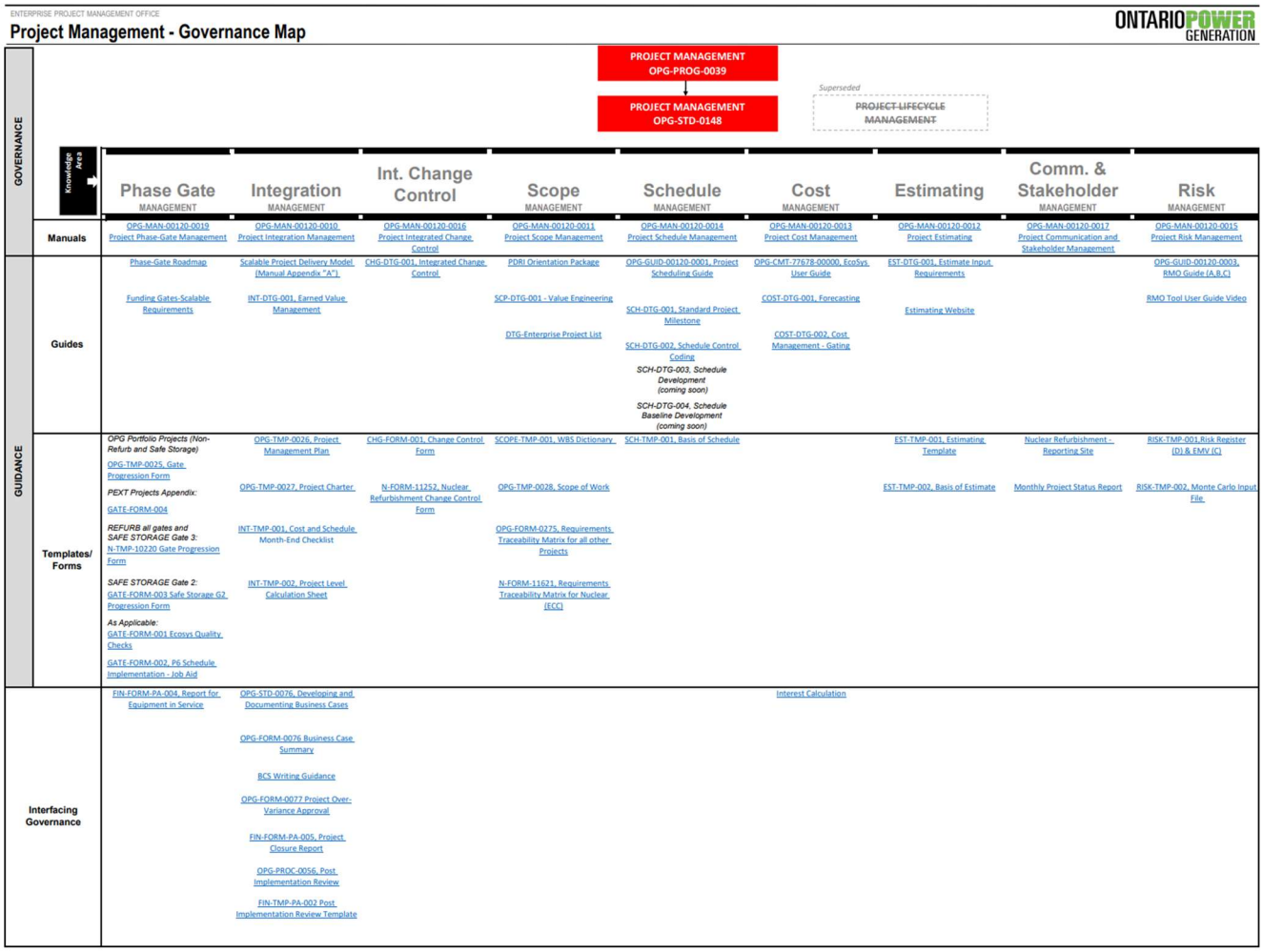
Appendix A Program Management Plan structure

Pickering Refurbishment Program Governance Structure



Appendix B Project Management Governance Framework

See latest version on Enterprise Project Management website



ENTERPRISE PROJECT MANAGEMENT OFFICE

Project Management - Governance Map

ONTARIO POWER GENERATION

GOVERNANCE

PROJECT MANAGEMENT OPG-PROG-0039

PROJECT MANAGEMENT OPG-STD-0148

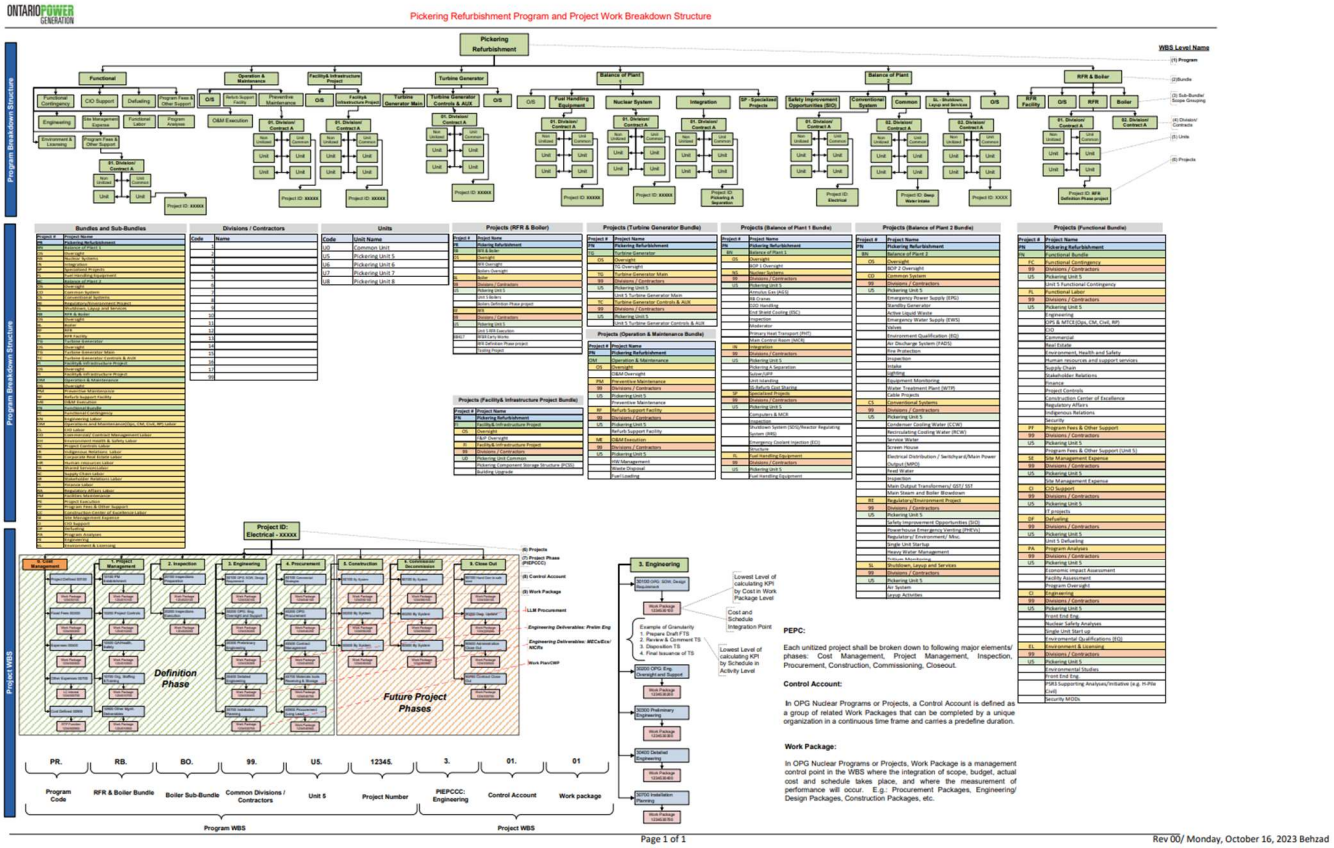
Superseded: ~~PROJECT LIFECYCLE MANAGEMENT~~

GUIDANCE

Knowledge Area	Phase Gate MANAGEMENT	Integration MANAGEMENT	Int. Change Control MANAGEMENT	Scope MANAGEMENT	Schedule MANAGEMENT	Cost MANAGEMENT	Estimating	Comm. & Stakeholder MANAGEMENT	Risk MANAGEMENT
Manuals	OPG-MAN-00120-0019 Project Phase-Gate Management	OPG-MAN-00120-0010 Project Integration Management	OPG-MAN-00120-0016 Project Integrated Change Control	OPG-MAN-00120-0011 Project Scope Management	OPG-MAN-00120-0014 Project Schedule Management	OPG-MAN-00120-0013 Project Cost Management	OPG-MAN-00120-0012 Project Estimating	OPG-MAN-00120-0017 Project Communication and Stakeholder Management	OPG-MAN-00120-0015 Project Risk Management
Guides	Phase-Gate Roadmap Funding Gates-Scalable Requirements	Scalable Project Delivery Model (Manual Appendix "A") INT-DTG-001, Earned Value Management	CHG-DTG-001, Integrated Change Control	PDRI Orientation Package SCP-DTG-001 - Value Engineering DTG-Enterprise Project List	OPG-GUID-00120-0001, Project Scheduling Guide SCH-DTG-001, Standard Project Milestone SCH-DTG-002, Schedule Control Coding *SCH-DTG-003, Schedule Development (coming soon)* *SCH-DTG-004, Schedule Baseline Development (coming soon)*	OPG-CMT-77678-00000, EcoSys User Guide COST-DTG-001, Forecasting COST-DTG-002, Cost Management - Gating	EST-DTG-001, Estimate Input Requirements Estimating Website		OPG-GUID-00120-0003, RMO Guide (A,B,C) RMO Tool User Guide Video
Templates/ Forms	*OPG Portfolio Projects (Non-Refurb and Safe Storage)* OPG-TMP-0025, Gate Progression Form *PEXT Projects Appendix:* GATE-FORM-004 *REFURB all gates and SAFE STORAGE Gate 3:* N-TMP-10220 Gate Progression Form *SAFE STORAGE Gate 2:* GATE-FORM-003 Safe Storage G2 Progression Form *As Applicable:* GATE-FORM-001 Ecosys Quality Checks GATE-FORM-002, P6 Schedule Implementation - Job Aid	OPG-TMP-0026, Project Management Plan OPG-TMP-0027, Project Charter INT-TMP-001, Cost and Schedule Month-End Checklist INT-TMP-002, Project Level Calculation Sheet	CHG-FORM-001, Change Control Form N-FORM-11252, Nuclear Refurbishment Change Control Form	SCOPE-TMP-001, WBS Dictionary OPG-TMP-0028, Scope of Work OPG-FORM-0275, Requirements Traceability Matrix for all other Projects N-FORM-11621, Requirements Traceability Matrix for Nuclear (ECC)	SCH-TMP-001, Basis of Schedule		EST-TMP-001, Estimating Template EST-TMP-002, Basis of Estimate	Nuclear Refurbishment - Reporting Site Monthly Project Status Report	RISK-TMP-001,Risk Register (D) & EMV (C) RISK-TMP-002, Monte Carlo Input File
Interfacing Governance	FIN-FORM-PA-004, Report for Equipment in Service	OPG-STD-0076, Developing and Documenting Business Cases OPG-FORM-0076 Business Case Summary BCS Writing Guidance OPG-FORM-0077 Project Over-Variance Approval FIN-FORM-PA-005, Project Closure Report OPG-PROC-0056, Post Implementation Review FIN-TMP-PA-002 Post Implementation Review Template				Interest Calculation			

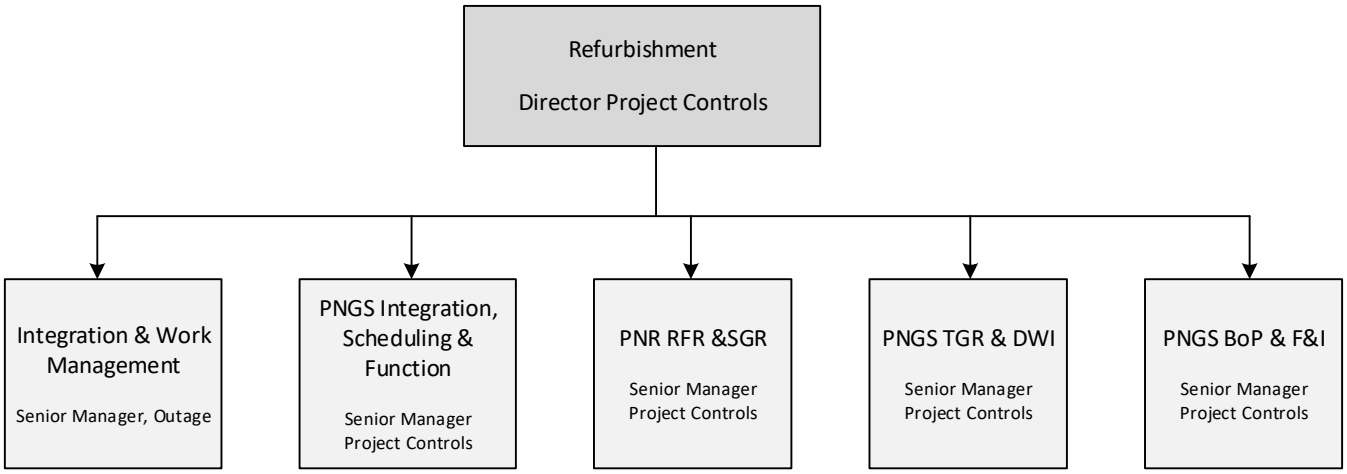
Appendix C Standard WBS

Contact Project Controls for a current copy.



Appendix D Refurbishment Project Management Office Organization

Jan'25



PICKERING REFURBISHMENT PROGRAM
INDEPENDENT STUDIES

1.0 INDEPENDENT REVIEW OF PLAN AND APPROACH TO PROGRAM EXECUTION

In September 2025, Pegasus Global Holdings, Inc. ("Pegasus-Global") was retained to conduct an assessment of OPG's project management and preparedness with respect to the Pickering Refurbishment Program ("PRP"). Pegasus-Global delivered its testimony in January 2026.[12]

Pegasus-Global concluded that, as OPG progresses through the Definition phase and prepares for the Execution phase, OPG has demonstrated an appropriate advancement towards readiness to execute the PRP through comprehensive pre-execution planning supported by a robust governance structure, extensive experience with megaproject execution, development of a Class 3 RQE, a mature governance framework, a contracting strategy that utilizes incentives and disincentives, implementation of a suite of project controls that align with recognized industry standards, and robust succession planning and knowledge management initiatives across the organization. Team and overall organization that enables the effective capture, documentation, evaluation, and incorporation and verification of lessons learned. Pegasus-Global also observed that the extensive pre-execution planning that was undertaken by OPG provides confidence that the PRP is governed under robust, auditable, and transparent controls, consistent with the expectations of a leading nuclear operator and owner. Pegasus-Global's testimony is included in Attachment 1.

LIST OF ATTACHMENTS

Attachment 1: Pegasus Global Holdings, Inc. – Testimony of Joseph Miller

Attachment 2: Pegasus Global Holdings, Inc. Engagement Letter

TESTIMONY OF JOSEPH MILLER
PRESIDENT AND CHIEF EXECUTIVE OFFICER
PEGASUS-GLOBAL HOLDINGS, INC.
ON BEHALF OF
ONTARIO POWER GENERATION, INC.
IN RESPECT TO THE PICKERING REFURBISHMENT PROGRAM
BEFORE THE
ONTARIO ENERGY BOARD

JANAURY 2026

List of Acronyms and Abbreviations

AACE International	AACE
Business Case Summary	BCS
Board of Directors	BOD
Basis of Estimate	BOE
Balance of Plant	BOP
Canadian Nuclear Safety Commission	CNSC
Cost Performance Index	CPI
Critical Path Method	CPM
Darlington Refurbishment Program	DRP
Deep Water Intake	DWI
Executive Leadership Team	ELT
Engineering, Procurement, and Construction	EPC
Extended Services Master Services Agreement	ESMSA
First-in-a-While	FIAW
First-of-a-Kind	FOAK
Government Accountability Office	GAO
Integrated Project Delivery	IPD
Integrated Project Schedule	IPS
Knowledge, Skills, and Qualifications	KSQ
Nuclear Safety Review Board	NSRB
Ontario Power Generation Inc.	OPG
Operations & Maintenance	O&M
Pegasus-Global Holdings, Inc.®	Pegasus-Global
PMI Project Management Body of Knowledge	PMBOK
Project Management Institute	PMI
Pickering Refurbishment Program	PRP or the Program
Program Management Plan	PMP
Qualitative Risk Assessment	QRA
Retube, Feeder, and Boiler Replacement	RFBR
Release Quality Estimate	RQE
Torys LLP	Torys
Turbine Generator	TG
Work Breakdown Structure	WBS

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I. EXECUTIVE SUMMARY

Section I of my testimony begins with a summary of my overall findings and conclusions from this assessment. **Section II** provides an introduction of my background, qualifications, the purpose of this assessment, an overview of the OPG documentation we reviewed, and the industry standards we relied upon while conducting this assessment. **Section III** provides an overview of the Pickering Refurbishment Program ("PRP" or "the Program"). **Section IV** contains our assessment of the pre-execution planning, also referred to as the Definition phase, undertaken by the Program which includes discussion of the Release Quality Estimate ("RQE") Schedule, RQE Cost Estimate, the pre-execution contracting strategy, and the lessons learned to date. **Section V** details the Execution phase planning which includes discussion of the overarching governance process and structure, contract management strategy, project controls, and the lessons learned program. The findings and conclusions from this assessment are summarized below.

OVERALL CONCLUSION

- Based on Pegasus-Global Holdings, Inc.'s ("Pegasus-Global's") review of Ontario Power Generation Inc.'s ("OPG's") pre-execution planning of the PRP, I conclude that as OPG progresses through the Definition phase and prepares for the Execution phase, it has demonstrated an appropriate advancement towards readiness to execute the PRP through comprehensive pre-execution planning supported by a robust governance structure, extensive experience with megaproject execution, development of a Class 3 RQE, a mature governance framework, a contracting strategy that utilizes incentives and disincentives, implementation of a suite of project controls that align with recognized industry standards, and robust succession planning and knowledge management initiatives across the organization.

SUMMARY OF SECTION III – BACKGROUND INFORMATION

- The PRP is OPG's initiative to extend the operating life of Units 5 through 8 of the Pickering Nuclear Generating Station for approximately 38 years. OPG is using a phased stage-gating approach to the planning, development, and execution of the PRP that provides defined "gates" for executive management to formally review, approve and fund

the progression of the Program to the next gate. At this time OPG has advanced the PRP through three gate approvals that were each tied to specific releases of funding to further advance the PRP to its next stage. The PRP scope is structured around major bundles of work including:

  - Retube, Feeder, and Boiler Replacement ("RFBR").
  - Turbine Generator ("TG").
  - Deep Water Intake ("DWI").
  - Balance of Plant ("BOP").
  - Facilities & Infrastructure.
  - Operations & Maintenance ("O&M").

- The PRP is considered a megaproject by every measure generally used within the industry, which is typically defined as large scale, complex investment that exceeds $1 billion in capital costs, has extended schedules that span multiple years, attracts public and political attention, and involves multiple stakeholders. OPG has recent experience with the successful management of its Darlington Refurbishment Program ("DRP") megaproject, which is tracking within its budget and ahead of its original schedule.
- The PRP is not specifically a First-of-a-Kind ("FOAK") project, which involves added degrees of unknown risks and unforeseen challenges, but does contain scopes of work that are FOAK for OPG and are appropriately managed according to their increased risks. OPG is managing these risks through a variety of means including utilizing lessons learned from other operating stations; performing field surveys, site assessments, and engineering calculations early in the project; and identifying appropriate areas for storage and material handling.

SUMMARY OF SECTION IV – PRE-EXECUTION PLANNING

- For the pre-execution planning portion of the assessment, Pegasus-Global conducted an evaluation of the development of the RQE for schedule and costs, the initial contracting strategy, and application of lessons learned to date.
- I found that OPG's RQE cost and schedule estimates were developed in alignment with industry standard practices, such as those prescribed by the Project Management Institute ("PMI"), AACE International ("AACE"), and the U.S. Government Accountability Office

("GAO"). The PRP's RQE is a Class 3 estimate and establishes the target cost and schedule for the Execution phase of the Program. The overall design was approximately 36% complete at the time of the Class 3 estimate, which is at the high end of the range of design progression required to support a Class 3 estimate. The RQE includes contingency based on a P90 confidence level calculated by Monte Carlo simulations and supported by a comprehensive basis of estimate and schedule. The selection of a P90 confidence level provides greater assurance that the Program will be completed on schedule and on budget based on what is currently known. As part of its estimate validation efforts, OPG engaged a third-party to perform an independent review of the RQE estimate, including both vetting the underlying processes and a detailed review of the estimate itself.

- OPG has implemented a well-thought-out and disciplined contracting strategy for the PRP. OPG is utilizing collaborative Engineering, Procurement, and Construction ("EPC") agreements for the RFBR, TG, and DWI bundles, while leveraging existing Extended Services Master Services Agreements ("ESMSAs") for vendors and contractors engaged in the BOP scope. The collaborative EPC agreements split the work into a Definition phase and Execution phase and use incentives and disincentives to motivate the contractors to focus their efforts on managing and controlling factors that can influence execution and productivity in delivering the Program. The ESMSAs also make use of incentives and disincentives, with the specific scopes of work issued through a controlled work request process. The contracting strategies implemented by OPG for the PRP also follow the "One Team" approach utilized on the DRP and allows OPG to leverage these existing frameworks and established relationships.
- I found that OPG diligently implemented lessons learned on the Program, including lessons learned that were captured on the DRP and from projects with similar scopes of work. The lessons learned incorporated to date include controls efficiencies, defueling flow path modifications, feeder removal and installation efficiencies, retention of experienced DRP staff, contractors, and vendors, application of the "One Team" integrated approach, workflow durations that reflect actual DRP performance, peak workforce planning, and establishing a return to service team. These efforts are consistent with what I would expect to see on a program of this size and complexity.

SUMMARY OF SECTION V – EXECUTION PHASE READINESS

- OPG has extensive experience in governing complex nuclear projects under a mature project management system. This framework has demonstrated sustained capabilities in areas such as project controls, engineering assurance, licensing, safety culture, and regulatory compliance.
- I found OPG's governance structure to be well-organized and supported by strong processes and procedures that enable a culture of accountability and continuous improvement. While the foundational elements of governance for the Program are in place, as OPG continues to advance towards the Execution phase of the PRP, Pegasus-Global identified opportunities to further strengthen program-level governance as the PRP transitions into execution. These include more explicit definition of cross-unit coordination responsibilities, enhanced articulation of program-level risk and assurance processes, and additional clarity on how contractor oversight, operational interfaces, and learning across units will be governed at the Program level. While the state of the current program-level governance is appropriate for the Planning phase of the Program, increased definition in these areas will enhance governance robustness during the Execution phase of this multi-unit refurbishment. The overall framework provides confidence that the Program is governed under robust, auditable, and transparent controls, consistent with the expectations of a leading nuclear operator and owner.
- OPG has established an appropriate contract program management plan that follows industry standard practices and establishes how the major contracts within the PRP will be defined, managed, and controlled. The *Contract Program Management Plan* also implements the "One Team" contracting approach intended to drive improved performance across safety, quality, cost, and schedule.
- Project control processes supporting the Execution phase of the Program were assessed in the areas of schedule management, cost management, risk management, scope/change management, and reporting. I found that the PRP's project control processes used to govern the Program match or exceed industry standards and best practices in their thoroughness and are appropriate for a program of this size and magnitude. The robust project controls will support OPG to appropriately plan, control, and monitor the execution of the Program.

- OPG's lessons learned efforts go above industry standards by implementing a comprehensive process across both the Program Team and overall organization that enables the effective capture, documentation, evaluation, and incorporation and verification of lessons learned.

II. INTRODUCTION

Q. Please state your name and occupation.

A. My name is Joe Miller, President and Chief Executive Officer of Pegasus-Global, an international consulting firm that provides services to the energy and infrastructure industries. Pegasus-Global is often engaged by clients to ensure that the appropriate governance, project controls, related processes and systems are in place to help support successful project execution. I am the Director of this engagement for Pegasus-Global and the sponsor of this assessment. I directed and actively participated in this assessment, and this testimony was prepared under my direction and supervision.

Q. Please summarize your educational background and professional experience.

A. I graduated from Purdue University with a Bachelor of Science degree in Mechanical Engineering. I have over 30 years of experience in the power sector. In the last 15 years, I have sponsored testimonies in 58 regulatory proceedings including base rate, fuel, Certificate of Public Convenience and Necessity, plant abandonment, prudence, and environmental cases. I have performed work on a wide range of engagements for a variety of public and private sector clients. My full experience and qualifications, including regulatory cases in which I have submitted testimony, are identified within my CV, and are attached as **Exhibit JM-1**.

Q. What is the purpose of your testimony?

A. Pegasus-Global was retained by Torys LLP ("Torys") on behalf of OPG to assess OPG's pre-execution planning, project management and preparedness for executing the PRP.

Q. Can you summarize how Pegasus-Global conducted the assessment?

A. Pegasus-Global reviewed the processes, policies, and procedures that are being utilized or will be utilized by OPG and the PRP organization to plan, manage, and control the Program and compared them to what Pegasus-Global would expect to see on a project of similar size and complexity as well as to current industry practices and recommendations. Pegasus-Global also conducted interviews with key PRP leadership from OPG to provide additional context and insight.

Q. What documentation did Pegasus-Global review and rely on?

A. Pegasus-Global requested, obtained, and reviewed Program documentation prepared to support the planning and execution of the PRP to conduct its assessment and develop conclusions. The documentation relied upon by Pegasus-Global in its assessment is referenced throughout this testimony and includes project management policies and procedures, project planning material, governance documentation, and related Program records.

Q. What industry standards did Pegasus-Global rely upon while conducting the review?

A. Pegasus-Global relied primarily on the industry standards published by the AACE and its Recommended Practices and the PMI and its Project Management Body of Knowledge ("PMBOK"). Other sources of industry standards are noted herein.

III. BACKGROUND INFORMATION

A. GENERAL

Q. Please provide an overview of the PRP.

A. The PRP is OPG's initiative to extend the operating life of Units 5 through 8 of the Pickering Nuclear Generating Station for approximately 38 years. The Program is organized as a multi-bundle megaproject governed through OPG's Nuclear Management System and a structured phase-gate process that requires progressive confirmation of scope, cost, schedule, engineering maturity, and risk. The PRP is structured around the following bundles of work:

- Retube, Feeder, and Boiler Replacement (RFBR): involving replacement of 380 fuel channel assemblies and 760 feeders in the reactor and removal and replacement of 12 boilers, per reactor unit.
- Turbine Generator (TG): involving the removal and replacement of major components including installation of new high pressure/low pressure spindles, upgrades to the Turbine Control System, and generator rotor and stator rewinds.
- Deep Water Intake (DWI): involving installation of a new 1,500-meter offshore intake tunnel and offshore intake tunnel shaft to bring in deeper and cooler lake water to improve the thermal efficiency of plant operations, support increased electrical power output, reduce biofouling events, decrease fish impingement and entrainment, and enhance resilience to climate change.
- Balance of Plant (BOP): involving multiple small projects intended to improve the safety and reliability of the station (e.g. inspection and replacement of Emergency Core Injection, Shut Down System/Reactor Regulating System, and Primary Heat

Transport components; fire protection system replacements and upgrades; electrical distribution upgrades; air system replacements and upgrades; civil structures inspections and repairs).

- Facilities & Infrastructure: includes various facilities and infrastructure-related activities ahead of breaker open to support the other Program bundles (e.g. shops and storage, road access and parking improvements, upgrading existing infrastructure). The Facilities & Infrastructure scope includes both renewal of existing infrastructure on the site and building new facilities where needed.
- Operations & Maintenance (O&M): involves O&M-led activities that support the overall Program (e.g. defueling reactor cores, system shutdown, lay-up and surveillance, returning units to service). This work is required to establish specific conditions for the shutdown of the Pickering units and layup of systems to maintain a protected environment until the systems are returned to service following completion of refurbishment activities. This bundle also includes defueling to safely remove all fuel from each reactor core (representing the first segment on the critical path once the breaker is open) and fuel handling work that involves improvements to fuel handling reliability through inspections and replacement of critical components.

Pegasus-Global's evaluation of the PRP predominantly focused on the RFBR, TG, DWI, and BOP bundles that represent the majority of the Program's scope.

Execution of the PRP is supported by integrated engineering, construction oversight, project controls, safety, and quality programs. In sum, the PRP is a comprehensive life-extension effort executed under disciplined governance intended to

ensure safe, predictable refurbishment and long-term reliable operation of the Pickering nuclear units 5-8.

Q. Please describe the phase-gate process OPG has implemented for the PRP.

A. Phase-gating is a common practice applied to large and complex projects to structure their planning, development, and execution around defined "gates" that represent points in the project life cycle for executive management to formally approve the advancement to the next stage of development based on a comprehensive review of the project/program status at the time of the phase gate.

For the PRP, the phase-gates began with Gate 0 that was completed in August 2023 and involved the formal initiation of the Program, including establishing the Program Charter and developing a feasibility estimate and business case summary. This was followed with the completion of Gate 1 (and funding release 1A-1) in February 2024, which included the development of preliminary cost estimates and schedules, advancement of preliminary engineering, and procurement of long lead materials for the first two units (U5/U6). Gate 2 (and funding release 1A-2) was completed in November 2024 and involved commencement of detailed planning for the PRP, including a preliminary engineering report, a program management plan, overall project scopes of work, risk assessments, and procurement of materials for all units. The next funding (funding release 1B), still in Gate 2, was the most recent funding and was completed in November 2025, which involved approval of the RQE estimate and schedule and provided funding for the

full execution of Units 5-8. The next phase-gate will be Gate 3, which will serve as a check on the RQE estimate immediately prior to breaker-open (planned for September 2026).[1]

Q. How does the PRP differ in scope from the DRP?

A. While both the PRP and DRP represent programs that feature the refurbishment of key components within these nuclear stations intended to extend the operating life of the stations, there are notable differences in scope and approach between these two programs. The DRP focused predominantly on retube and feeder replacement (fuel channels, pressure tubes, feeders), while the PRP includes this scope and adds a boiler replacement scope. The steam generators at Darlington were inspected, but not replaced as part of the DRP, while all steam generators across Units 5-8 at Pickering will be replaced as part of the PRP. Other notable differences between the DRP and PRP include the more extensive BOP scope and the inclusion of DWI scope within the PRP. Additionally, while the DRP was executed as a series of unit-by-unit outages, OPG is executing the PRP through a planned four-unit outage (until Unit 5 returns to service), which allows the site to function more as a construction site rather than working around an operating nuclear island and allows certified staff at Pickering to be dispersed to the work bundles rather than being utilized for the operation and maintenance of an operating environment like the DRP was executed within. With this, OPG must also manage the higher resource needs of executing the refurbishment work across the four units, rather than unit-by-unit.

[1] *Pickering Units 5-8 Refurbishment Program Charter, NK30-CHAR-09701-00001 – R000.* p. 6 (26 April 2024), *Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release.* (13 November 2025)

B. MEGAPROJECTS AND FOAK ASPECTS OF THE PRP

Q. What is a megaproject?

A. "Megaprojects" are generally defined as exceptionally large and complex investment projects that attract a prominent level of public attention or political interest because of the significant costs (generally over $1 billion) and the direct and indirect impacts on the community, environment, and companies undertaking such projects. Other attributes often include the execution of an engineered facility that is complex or unusual, may contain FOAK elements, has an extended schedule of more than four years, involves multiple equipment and material suppliers, and involves multiple stakeholders and investors.[2]

Q. Does PRP qualify as a "megaproject"?

A. Yes. The PRP is an exceptionally large and complex project that has attracted a prominent level of public and political attention, has a cost and schedule well in excess of $1 billion and four years, respectively, and has direct and indirect impacts on the community, environment, and companies undertaking the Project.

Q. Why is the distinction between a megaproject and a typical construction project important when assessing project management and readiness for a megaproject?

A. A sound understanding of the distinctions between a megaproject and a typical construction project is essential to evaluate the prudence and reasonableness of management's decisions and actions within a megaproject environment. Actual management of a megaproject is in itself more complex than the management of a typical construction project simply due to the size and scope of a megaproject, including its numerous interfaces, as well as much higher involvement from a larger number of stakeholders. Under *CSA N286-12* principles,

[2] Galloway, P., Nielsen, K., and Dignum, J., *Managing Gigaprojects: Advice from Those Who've Been There, Done That.* p.1 (2013)

the management of such projects is to be conducted within an established management system that integrates governance, safety, quality, cost, schedule, and risk management.[3] Challenges multiply across scope, interfaces, and stakeholder expectations, and the magnitude of risk and uncertainty increases significantly with megaprojects. Judging megaproject management actions against the standards of a typical project can result in conclusions that overlook the unique governance, integration, and risk-management demands inherent in such large-scale undertakings.

Each megaproject is inherently unique, even if the scope is similar to other projects. The technological, regulatory, and logistical challenges vary widely and directly shape the context in which management decisions must be made and evaluated. Because of this uniqueness, the framework for assessing management performance or prudence must be established specifically for each project, reflecting its particular risks, constraints, and execution environment.

Q. What are the characteristics of a FOAK project?

A. The key characteristic of a FOAK project is summarized by "you don't know what you don't know." As more information becomes available, it can potentially lead to changes and/or additional risks to the project, which can be further exacerbated on a megaproject with the numerous interfaces within the project. Examples of such FOAK challenges include:

- Risk analyses may not reasonably estimate the unknown aspects of FOAK projects.
- Traditional contracts may not anticipate or allocate FOAK risks.
- Good faith design efforts can prove to need changes as the project is built because of unforeseen circumstances.
- Project leaders may face challenges in finding qualified suppliers, who may be challenged to meet material, quality and schedule requirements.

[3] *CNSC Regulatory document REGDOC-2.1.1, Management System*

- Leaders may also face challenges in securing qualified and available craft labor for the FOAK aspects of the project and may further encounter lower than planned productivity rates and/or higher than planned quality issues.
- Constructability challenges including activity sequencing or area access, integration among disciplines, unique construction methods and tools, etc. may put additional pressure on the cost and schedule of the project.
- Integration of FOAK components and equipment can have unexpected challenges during startup and commissioning (including both FOAK components and equipment and the first time certain non-FOAK components have been integrated).

Therefore, the owner of a FOAK project must seek to continuously identify and mitigate what risks it can identify based on the information known at the time and seek to be prepared to respond to those risks it cannot identify at the start of the project.

Q. What is "First in a While" ("FIAW") scope or project?

A. As its name implies, FIAW means that the scope of work, although not completely unfamiliar to the project owner, is not routine. In addition, due to the potential time that has passed since this type of work was previously performed, the ones most familiar with the FIAW scope may no longer be part of the organization. The risks associated with FIAW are similar to FOAK risks, but generally not to the same degree of uncertainty that is present with truly FOAK risks, unless the expertise involved with the previous work is no longer available.

Q. Is PRP a FOAK or FIAW project?

A. At its highest level, the PRP is a nuclear refurbishment program similar to the DRP. However, the detailed scope of the PRP contains elements that represent FOAK scopes for OPG, such as cutting of the containment dome for the steam generator replacement; elements that represent FIAW-type scopes, such as the DWI scope (which due to the time passed and limited prior experience is more akin to a FOAK scope for OPG); and, elements that represent FOAK scopes due to the scale of the work performed, such as the digital

control computer replacement, which OPG has previously been done on a more limited scale.

Q. What are the FOAK risks associated with the removal and replacement of the boilers?

A. Removal and replacement of the boilers will involve creating two access holes in the containment building as well as managing the logistics of a heavy-lift crane, installation of containment dome platform on top for workers, interferences removal/restoration inside and outside the reactor building, and finally removal and installation of all interfacing systems with the steam generators. The work will also require suitable storage and travel routes for the 48 steam generators, both old and new.[4]

Q. What are Pegasus-Global's findings regarding OPG's preparation to address megaproject and FOAK/FIAW risks on the PRP?

A. OPG has recent experience in managing megaprojects with FOAK or FIAW elements through its successful management of the DRP megaproject. OPG has reported that the $12.8 billion DRP is forecasting within budget and ahead of its original schedule, with completion forecasted in the first half of 2026.[5] OPG's project management has been recognized as exceptional, receiving the 2021 Best Practice award from Electric Utility Cost Group for Excellence in Project Management and being named a finalist in the 2022 PMI Project Management Organization of the Year. In addition, OPG received recognition for "outstanding performance" at the 2023 PMO Global Awards.

I believe it is appropriate for OPG to recognize the FOAK-type risks associated with the PRP, including their first experience with boiler removal and replacement. OPG's

[4] *Pickering Retube, Feeder, and Boiler Replacement Project Management Plan, NK30-PMP-09701-00005 – R002.* p. 9 (08 Sep 2025)
[5] https://www.opg.com/reporting/darlington-refurbishment-reports/news/darlington-refurbishment-performance-update-q3-2025/ (accessed 14 Jan 2026)

strategy for managing the FOAK risks associated with the boiler removal and replacement is to review and use lessons learned from other stations, including Bruce Power's Major Component Replacement program; performing field surveys, site assessments, and engineering calculations early in the project; and identifying appropriate areas for storage and material handling.[6] For the DWI scope, OPG will rely upon the expertise of its vendor engaged for this scope and utilized a robust procurement process to identify and select a vendor partner that included a request-for-market-information phase ahead of request for prequalification and request for proposal stages to allow OPG to focus on evaluating and shortlisting the best capable entities on a consistent experience-based level prior to releasing detailed PRP requirements and terms and conditions to the bidders. By recognizing other elements of the Project as FIAW risks, OPG has a heightened awareness of the risks of the FIAW scope of work.

Q. What are your conclusions regarding the megaproject and FOAK/FIAW risks with the PRP?

A. Based on our assessment, I conclude that the extensive experience with refurbishment and the level of pre-execution planning that OPG has undertaken places OPG in a favorable position to have successful execution of the Program. OPG also has the tools and processes in place, including a collaborative execution environment, that supports early issue identification and resolution to address unexpected challenges as they arise. I find OPG's assessment and management of megaproject and FOAK/FIAW risks to be reasonable and appropriate to support the PRP, aligned with industry standard practices, and consistent with what I would expect for a program of this nature.

[6] *Pickering Retube, Feeder, and Boiler Replacement Project Management Plan, NK30-PMP-09701-00005 – R002.* pp. 19-20 (08 Sep 2025)

IV. PRE-EXECUTION PLANNING

A. PRE-EXECUTION PLANNING BACKGROUND

Q. What aspects of pre-execution planning of the PRP did Pegasus-Global evaluate?

A. Pegasus-Global evaluated the development of the RQE cost and schedule estimates as well as the initial contracting strategy and application of lessons learned during the pre-execution Definition phase of the PRP.

Q. What are the RQE cost and schedule estimates?

A. OPG has produced estimates for the PRP in a progression of intervals with increasing accuracy and detail based on the maturity of the project definition and engineering maturity aligning with AACE Estimate Classes of 4 and 3 leading to the establishment of the RQE. The RQE is a Class 3 estimate and establishes the initial control estimate and schedule for the PRP Execution phase and to secure OPG Board of Directors' ("BOD's") approval to proceed to execution.[7] As noted previously, a further check estimate is planned immediately prior to the breaker-open milestone.[8] A Class 3 estimate typically indicates that the completion level of project definition deliverables is between 10% and 40% and that there are semi-detailed unit costs with assembly level line items. Class 3 estimates are often the basis for project funding approval.[9] In the case of the PRP, the overall design was approximately 36% complete, which is at the upper range of design progression required to support a Class 3 estimate.[10] The RQE included a holistic analysis of the proposed expenditure to support and illustrate prudent decision-making along with costs, schedule,

[7] *Release Quality Estimate Plan, NK30-PLAN-09701-00025 R000.* p. 5 (12 April 2025), *Pickering Refurbishment Release Quality Estimate-Basis of Estimate (BOE) -R000. NK30-REP-00120-00001* p. 6 (30 November 2025)
[8] *Release Quality Estimate Plan, NK30-PLAN-09701-00025 – R000.* p. 5 (12 April 2025)
[9] *AACE Recommended Practice No. 115R-21, Cost Estimate Classification System.* p. 5 (05 Feb 2022)
[10] *Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release.* p. 2 (13 November 2025)

risks, and opportunities. The RQE was approved by the BOD in November 2025, and the approval released the funding to complete the Execution phase for Units 5-8 through to July 2034.[11]

B. RQE SCHEDULE

Q. What is the RQE schedule?

A. As stated above, the RQE schedule is the project-approved Level 3 resource-loaded schedule that depicts the total scope of the project, including integrated activity logic and a defined critical path that is based on the Definition phase advancement of detailed engineering and deliverables. The RQE schedule is tied to the corresponding Class 3 cost estimate and is used to monitor and control the execution of PRP.

Q. What are the industry standards related to developing the RQE schedule?

A. Pegasus-Global assessed the RQE schedule using industry standards such as *AACE's Recommended Practice 38R-06: Documenting the Schedule Basis*[12] and *AACE's Recommended Practice 61R-10: Schedule Design – As Applied in Engineering, Procurement, and Construction*, which states:[13]

> *Schedule design occurs after the project scope and execution strategy development process…has generated the project implementation basis, and translated that project implementation basis into controllable project scope definition and an execution strategy. … Schedule design is the collection, coordination, and organization of the inputs necessary to translate the execution strategy into a well-developed schedule. This should accurately represent the project's proposed means and methods for accomplishing the work. It also provides the basis for a technically sufficient [Critical Path Method ("CPM")] network which will allow for monitoring and control of the project.*

[11] *Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release.* (13 November 2025)
[12] *AACE International Recommended Practice No. 38R-06, Documenting the Schedule Basis.* (18 Jun 2009)
[13] *AACE International Recommended Practice No. 61R-10, Schedule Design – As Applied in Engineering, Procurement, and Construction.* p. 2 (11 October 2013)

Industry standard practice calls for the use of an Integrated Project Schedule ("IPS") that models the entire project work scope over time, and includes activities from engineering, procurement, construction and commissioning, as applicable. An IPS typically includes all trades, whether direct hire or subcontracted.

For a schedule on an engineering, procurement, and construction project to be realistic, it needs to be planned interactively by the project team members involved in these aspects of the project. In doing so, these team members use their expertise to predict the project's schedule of performance and agree to execute their portion of the project in accordance with the schedule, while monitoring performance and providing statuses on a regular basis to inform schedule updates.

Q. How did Pegasus-Global assess the RQE Schedule?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG related to schedule management for the Program. The evaluations were supplemented by interviews with key Program personnel. Pegasus-Global reviewed several schedule management policies and procedures to guide and control the scheduling objectives, including the *PRP Release Quality Estimate – Program Schedule Basis (R000),* the *Project Scheduling Guide (R006)*, and the *Project Schedule Management (R004)*.[14] The observations from the evaluations were assessed against industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

[14] *Pickering Refurbishment: Release Quality Estimate – Program Schedule Basis, NK30-SCH-00120-00001-R000.* (30-Nov-2025), *Project Scheduling Guide, OPG-GUID-00120-0001-R006.* (15 Mar 2025); and, *Project Schedule Management, OPG-MAN-00120-0014-R004.* (02 Mar 2023)

Q. What are Pegasus-Global's findings relative to the RQE schedule?

A. The duration of the RQE schedule for the four-unit refurbishment program is approximately 11 years across the planning and executions phases, with field execution spanning eight years. Units 5-8 are planned to be removed from service in September 2026 with the Units returning to service sequentially after refurbishment in 2031, 2032, 2033, and 2034, respectively. Unit-over-unit execution is planned in parallel on a stepped basis to enable crew efficiency from capturing and applying lessons learned from unit-to-unit. The RQE schedule was developed utilizing an industry standard scheduling software.

The results of the Monte Carlo schedule risk analysis resulted in the creation of a medium-confidence (P50 confidence level) working schedule and a high-confidence (P90 confidence level) schedule, which are discussed below. The working schedule will be used to calculate performance metrics and manage day-to-day activities. The high confidence schedule includes nine months of contingency (Nov 2033 – Jul 2034) based on the analyses of the Program risks. Key Program risks that were considered for contingency include:

- Projects planned by the city, region, and ministry of transportation may impact ingress and egress to the site.
- Long layup periods for subsequent units may increase return to service durations.
- The BOP scope of work is more complex than the DRP.
- The site has capacity constraints, with a peak employee headcount of 4,200.
- Delays to manufacturing and delivery of significant quantities of non-long lead time materials.

Q. What is meant by a 'confidence level'?

A. A confidence level reflects the probability that the actual result of implementing an estimate or schedule will be more favorable than the estimated amount or duration. Confidence levels are typically generated through probabilistic risk modeling, often using Monte Carlo analysis and simulations that represent probabilities based on what is currently known.

Q. What is a Monte Carlo analysis?

A. A Monte Carlo analysis is a risk quantification technique that uses a mathematical simulation to forecast the probability of completing the project on time or within budget. The analysis takes a range estimate for each project task and then generates a random number within that range for each task. The computer software performs this thousands of times during a simulation run. The modeling requires an identification of a probability for each critical item relative to the probability of occurrence and probability of impact if it occurs, along with the monetary and time impact. This modeling results in many iterations being run to generate a cumulative probability distribution curve for a complete estimate. The probability factors that are in the Monte Carlo simulations are commonly 30%, 50%, and 90%, meaning that there is a corresponding likelihood of an underrun on the estimate, and expressed as "P30", "P50", and "P90". For example, with a P50 confidence level, there is an equal chance (50% / 50%) of an underrun or overrun of the underlying estimate or schedule. By utilizing a higher confidence number (e.g. P90), the owner and stakeholders reduce a significant amount of risk due to cost overruns by utilizing a contingency amount that corresponds to the high confidence number selected to account for the impacts of those identified risks, should they emerge.

Q. How do confidence levels differ from a point estimate?

A. A point estimate typically provides the value most likely to be realized on a project, given the information available at the time it was developed. A confidence level, on the other hand, provides additional information in identifying the underlying uncertainty of the estimate by providing a range of possible costs based on the identified risks and their respective impacts against a specified probability level. For example, a project with a point estimate of $100 million could produce a range of $80 million to $120 million at a P90 confidence level.

Q. What are the reasons for selecting a higher or lower confidence level?

A. Selection of a confidence level is primarily reflective of the risk appetite of the owner. If the owner wishes to reduce the risk of overrunning the estimate, using a higher confidence level reduces the likelihood of a budget overrun and provides provisions for risks unknown at the time of the estimate, but likely to appear as the project progresses. On a megaproject, given the extended duration for execution and increased complexities compared to a typical project, it is common for a high confidence level to be selected as it provides more assurance that the estimate will be adequate for the duration of the program.

Q. What are your conclusions regarding the PRP's RQE schedule development?

A. The PRP's RQE level 3 schedule was developed in alignment with industry standards and practices and is in alignment with what I would expect for a program of this size and complexity. Given that this is a megaproject, there remains a high degree of uncertainty present on the Program, including risks not currently known and/or the impact of known risks beyond what was contemplated in the risk assessments that could potentially impact the on-schedule completion.

C. RQE COST ESTIMATE

Q. What is the RQE Cost Estimate?

A. As stated above, the RQE cost estimate represents the culmination of OPG's planning efforts to establish a high-confidence total program life cycle cost estimate. The RQE includes the costs of all bundle scope and functional support groups including facilities and infrastructure, turbine generators, BOP, retube and feeder replacement, boiler replacement, deep water intake, minor modifications for operations and maintenance. Functional groups include engineering, inspections, security, information technology and other support groups for the Program. This estimate is used to support investment decisions, regulatory filings, and operational readiness assessments.[15]

Q. Are there industry standards related to developing project estimates?

A. Yes. Many government bodies and project management or construction industry groups have written at great length about how to properly prepare and develop a cost estimate. Common themes reappear across these groups, constituting best practices in estimating. The US GAO has a twelve-step guide to estimating that is a good summary of industry standard steps for estimating project costs:[16]

1. Define estimate's purpose;
2. Develop estimating plan;
3. Define program characteristics;
4. Determine estimating structure;
5. Identify ground rules and assumptions;
6. Obtain data;
7. Develop point estimate and compare it to an independent cost estimate;
8. Conduct sensitivity analysis;
9. Conduct risk and uncertainty analysis;
10. Document the estimate;
11. Present estimate to management for approval; and,

[15] *Release Quality Estimate Management Plan, NK30-PLAN-09701-00025 – R000,* pp. 5-11 (12 April 2025)
[16] *U.S. Government Accountability Office, Cost Estimating and Assessment Guide, Best Practices for Developing and Managing Capital Program Costs, GAO-09-3SP.* pp 9-11 (Mar 2009)

12. Update the estimate to reflect actual costs and changes.

AACE summarizes the cost estimating process as including: "*...planning for the estimate, quantifying scope, applying cost to the scope, pricing of the project, reviewing, validating, and documenting the estimate.*"[17] AACE has defined five classes of estimates based on the various estimate characteristics, such as maturity level of project definition deliverables, end usage, estimating methodology, expected accuracy range, and effort to prepare estimate. The maturity level of project definition deliverables (e.g. scope definition, plans and schedules, drawings, calculations, etc.) is the primary characteristic in determining the class of estimate, as it relates to the quality and completeness of the information available to the estimators.[18] AACE adds that its cost estimate classification system, "*provides a generic and generally-acceptable classification system that can be used as a basis to compare against.*"[19]

Q. How did Pegasus-Global assess the RQE Cost Estimate?

A. Pegasus-Global began its evaluation by examining the documents provided by OPG related to the development of the RQE cost estimate for the Program. The evaluations were supplemented by interviews with key Program personnel. Pegasus-Global reviewed the *PRP Release Quality Estimate Management Plan (R000), OPG Project Estimating Manual (R002), PR Release Quality Estimate - Basis of Estimate (BOE) (R000),* and *PRP Controls Program Management Plan (R001).*[20] We also reviewed a third-party independent estimate

[17] *AACE International Recommended Practice No. 46R-11, Required Skills and Knowledge of Cost Estimating.* p. 2 (16 Jan 2013)
[18] *AACE International Recommended Practice No. 17R-97, Cost Estimate Classification System*. pp. 1-4 (29 Nov 2011); and, *AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries.* pp. 1-14 (7 Aug 2020).
[19] Ibid.
[20] *Release Quality Estimate Management Plan, NK30-PLAN-09701-00025-R000* (12 April 2025), *OPG Project Estimating Manual, OPG-MAN-00120-0012-R002.* (27 Jan 2023), *Pickering Refurbishment Release Quality*

review that OPG engaged to be performed as part of its RQE estimate validation.[21] The observations from the evaluation were assessed against industry standards to assess the RQE cost estimate.

Q. What are the industry standards related to defining and determining contingency?

A. AACE provides that contingency is "*[a]n amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs.*[22] AACE also identifies that contingency typically covers such uncertain "items, conditions, or events" as planning and estimating errors and omissions; minor price fluctuations; design developments and changes within the scope; and variations in market and environmental conditions. In summary, contingency typically falls into one of three categories: 1) cost estimating uncertainty; 2) schedule estimating uncertainty; and/or, 3) discrete risks. Contingency typically excludes major scope changes; large-impact extraordinary events (e.g. major strikes, global pandemics, natural disasters, geopolitical crises); management reserves; and escalation or currency effects. Owners establish contingency levels based on an acceptable risk level, degree of uncertainty, and the desired confidence levels for meeting baseline requirements. When used to absorb the impacts of uncertainty, contingency is a form of risk mitigation.[23] Contingency is appropriately included in the

Estimate - Basis of Estimate (BOE), NK30-REP-00129-00001-R001. (30 Nov 2025) and, *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003-R001.* (05 Sep 2025)
[21] KPMG, *Pickering Refurbishment Project Release Quality Estimate Independent Review.* (13 Nov 2025)
[22] *AACE International Recommended Practice No. 10S-90, Cost Engineering Terminology*. pp. 29-30 (23 Aug 2022)
[23] National Research Council of the National Academies. *The Owner's Role in Project Risk Management. Chapter 6, Contingency.* (2005)

cost estimate and is expected to be expended during the execution of a project or program as the risks and uncertainties manifest.[24]

Q. Are there industry standards that establish what an appropriate amount of contingency is?

A. While there is not a single standard method in which contingency is calculated, there are general methods that are commonly used within the industry based on the experience and preference of the estimating organization. Methods include expert judgment, quantitative methods such as standardized percentages or more complex scoring mechanisms, simulations that combine expert judgment with analytical models, or parametric modeling based on multi-variable analysis of quantified risk drivers. Contingency development typically combines more than one of the above methods.[25]

From a budget perspective, contingency is a separate project cost element or line item in the budget estimate. As a discrete line item, contingency is subject to the same processes as any other cost element, with one exception; unlike most cost elements, the contingency amount may increase or decrease from month-to-month as funds are used to address realized risks, or funds are returned to the program contingency when risks expire or projects are completed.

As noted above in the RQE Schedule section, confidence levels which reflect the probability that the result of risk actualization will be more favorable than the estimated amount or duration are typically generated through probabilistic risk modeling, often using Monte Carlo analysis and simulations that represent probabilities, not certainty. By

[24] *AACE International Recommended Practice No. 10S-90, Cost Engineering Terminology*. p. 30 (23 Aug 2022)
[25] *AACE International Recommended Practice No. 40R-08, Contingency Estimating – General Principles*. pp. 1-4 (25 Jun 2008)

utilizing a higher confidence number (e.g. P90), the owner and stakeholders reduce a significant amount of risk due to cost overruns. This is accomplished by utilizing a contingency amount that corresponds to the high confidence number selected to account for those identified risks, should they emerge. Given the extended duration for execution and increased complexities present on a megaproject as compared to a typical project, it is common for a megaproject to utilize a higher confidence level as it provides more assurance that the estimate will be adequate for the duration of the program.

Q. What are Pegasus-Global's findings related to the RQE cost estimate?

A. OPG established a baseline RQE cost estimate to establish the initial control estimate and budget for the Execution phase of the PRP. The RQE was approved by the BOD in November 2025 and is the benchmark for tracking and reporting costs on the Program. The RQE developed for the PRP is a Class 3 estimate, prepared from the bottom up, based on Program maturity and design progression to approximately 36% for all major scopes as of November 2025.[26]

Per AACE's *Recommended Practice 18R-97* on cost estimate classification for engineering, procurement, and construction in process industries, a Class 3 estimate provides an expected accuracy range of -10% to -20% on the low end and +10% to +30% on the high end. AACE notes that the expected accuracy range provides a general framework for likely outcomes of actual costs, but is affected by the state of technology, availability of applicable reference cost data, and other such risks.[27] More recently, in 2022, AACE issued *Recommended Practice 115R-21* that provides cost estimate classifications

[26] *Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release.* pp. 2-3 (13 November 2025)
[27] *AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries.* p. 3 (07 Aug 2020)

specific for the nuclear power industries and provides that a Class 3 estimate typically offers an expected accuracy range of -10% to -20% on the low end and +20% to +60% on the high end, reflecting the unique cost drivers to nuclear projects (e.g. higher quality assurance and control requirements, productivity factors associated with performance of work within security protected environments, etc.).[28] OPG relied on guidance from AACE's *Recommended Practice 115R-21* in developing the RQE cost estimate and assessing estimate maturity,[29] while utilizing the narrower general accuracy scales outlined within AACE's *Recommended Practice 18R-97* in presenting its estimate results.[30]

The RQE is based on a comprehensive Basis of Estimate ("BOE") document that details the information and assumptions utilized in developing the estimate, with AACE explaining that a well-written BOE clearly and concisely states *"…the purpose of the estimate being prepared (i.e., cost study, project options, funding, etc.), the project scope, pricing basis, allowance, assumptions, exclusions, cost risks and opportunities, and any deviations from standard practices."*[31] The BOE, along with the RQE, formed the basis of the cost estimate of $26.84 billion. The BOE and RQE were produced by a multidiscipline team across multiple organizations and by team members that have extensive experience in the preparation of estimates for nuclear and non-nuclear projects. The RQE package and total cost summary were reviewed in a series of comprehensive reviews and analyses on the whole lifecycle cost estimate including resource requirements, summaries of

[28] *AACE International Recommended Practice No. 115R-21, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Nuclear Power Industries.* pp. 4-5 (02 Feb 2022)
[29] *Pickering Refurbishment Release Quality Estimate-Basis of Estimate (BOE), NK30-REP-00120-00001-R000,* p. 17 (30 Nov 2025)
[30] *Release Quality Estimate Management Plan, NK30-PLAN-09701-00025-R000-,* p. 12 (12 April 2025); and *Pickering Refurbishment Release Quality Estimate-Basis of Estimate (BOE), NK30-REP-00120-00001-R000,* p. 17 (30 Nov 2025).
[31] *AACE International Recommended Practice No. 34R-05, Basis of Estimate.* p. 3 (05 October 2021)

unitization, functional support, estimate classification, vendor estimates, cost flows and staffing summaries. Each bundle/functional estimate was reviewed to ensure accuracy and understanding of estimate inputs. A Program-level review and analysis was also performed using standard cost management processes and techniques to produce conclusions to satisfy investment planning requirements. Finally, management reviews were held to validate the overall adequacy of the RQE estimate to ensure that the level of detail available for the estimate, the assumptions, estimating methods employed, and the skills of the estimating and project teams are accurately represented. The management review also included an explanatory discussion on how the Program contingency amount was developed including acceptance of the level of risk and how the contingency level reflects that risk. The OPG Enterprise Leadership Team, including corporate senior management and internal and external oversight, participated as part of the management reviews to ensure consistency of understanding across major project bundles and functions.[32]

As part of its estimate validation efforts, OPG engaged a third-party to perform an independent review of the RQE estimate, including both the underlying processes and a detailed review of the estimate itself (i.e. validating data accuracy and traceability, confirming unit rates, etc.). This independent review found that, *"The PRP RQE is in alignment with standard industry practices and has been developed by an experienced team that brings unique knowledge and expertise in the planning and delivery of large nuclear refurbishment programs…the RQE is* [sic] *leverages relevant experience and lessons-learned from* [DRP] *and a detailed assessment of the effort and time required to carry out the planning, design, and execution of the work."*[33]

[32] *Release Quality Estimate Management Plan, NK30-PLAN-09701-00025-R000.* p. 22 (12 April 2025)
[33] KPMG, *Pickering Refurbishment Project Release Quality Estimate Independent Review.* p. 4 (13 November 2025)

As noted in the RQE schedule discussion, key Program risks that were considered for contingency on the Program included:[34]

- Municipal infrastructure improvements in the immediate area planned for the next 10 years will impact access and egress from the site, potentially challenging the Program Schedule.
- Commissioning and return-to-service complexity involved with the integration of Digital Control Computer with plant commissioning, including Units 7 & 8 being in an extended lay-up state.
- BOP scope more complex than DRP.
- Site capacity constraints and related infrastructure challenges (e.g. parking, security, lunchrooms).
- Procurement and delivery of an extensive volume of non-long lead materials.

Q. What are your conclusions regarding the PRP's RQE cost estimate development?

A. I conclude that the RQE development process aligns with GAO's best practices and twelve step estimated process and with the guidelines of *A ACE's Recommended Practice 18R-97* (cost estimate classification for engineering, procurement, and construction in process industries).[35] The *Release Quality Estimate Management Plan (R000), OPG Project Estimating Manual (R002)* and *PRP Controls Program Management Plan (R001)* procedures demonstrate alignment with industry standards that define the estimate classification system and PMI's *PMBOK*.[36] As an example, the *Release Quality Estimate Management Plan* procedure incorporates the estimate classification system prescribed by AACE into the procedure.

OPG prepared a comprehensive BOE document that aligns with the guidelines established by AACE in its *Recommended Practice 34R-05, Basis of Estimate.*[37] OPG's

[34] *Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program Release Quality Estimate and Full Funding Release.* p.6 (13 November 2025)
[35] *AACE International Recommended Practice No. 18R-97, Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries.* p. 3 (07 Aug 2020)
[36] *Release Quality Estimate Management Plan, NK30-PLAN-09701-00025-R000.* (12 Apr -25), *OPG Project Estimating Manual, OPG-MAN-00120-0012-R002.* (27 Jan 2023) and *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003-R001.* (05 Sep 2025)
[37] *AACE International Recommended Practice No. 34R-05, Basis of Estimate.* (05 October 2021)

cost and schedule contingency development aligns with industry standards, such as those prescribed by AACE.[38] OPG has completed this bottoms-up risk review and analysis process by identifying risks, estimating the probability of occurrence, estimating the risk impact, considering risk responses, addressing cost and schedule dependency, assessing overall outcomes through Monte Carlo simulations, and estimating and evaluating contingency.[39]

OPG's estimating process is well-defined in its procedures and the results of the estimating process are fully explained within the BOE document as well as summarized in material presented to OPG's Board. OPG had a clear intent to ensure its process aligned with industry standards as prescribed by organizations such as AACE and followed through on that intent by holding itself to the industry standards. I find the estimating process OPG used to be reasonable and aligned with industry standards and what we have seen in other megaprojects.

I conclude OPG's method of determining its contingency amount for the RQE estimate was reasonable, including a comprehensive risk assessment, Monte Carlo simulations, vetting by parties internal and external to the Program, and the decision to use a P90 confidence level. I found the methodologies employed by OPG to develop the RQE estimate to be reasonable and appropriate. I found that the methodologies employed met accepted industry standards and guidelines as promulgated by AACE. However, given that this is a megaproject, there remains a high degree of uncertainty present on the Program,

[38] *AACE International Recommended Practice No. 57R-09, Integrated Cost and Schedule Risk Analysis Using Risk Drivers and Monte Carlo Simulation of a CPM Model.* (09 Jul 2019)
[39] *Pickering Nuclear Generating Station (Units 5-8) Refurbishment Program, Release Quality Estimate and Full Funding Release, Appendix 2.* (13 November 2025); and *Pickering Refurbishment Release Quality Estimate-Basis of Estimate (BOE), NK30-REP-00120-00001-R000* p. 30 (30 November 2025)

including risks not currently known and/or the impact of known risks beyond what was contemplated in the risk assessments, that could potentially impact on-budget completion of the Program.

D. CONTRACTING STRATEGY

Q. What are the industry standards related to contracting strategy?

A. The contracting strategy applied to a project or program should reflect the unique conditions and characteristics, and requirements of the investment, as PMI's *PMBOK* explains, *"The type of contracting vehicle depends on the size of the purchase, the stability of the scope of work, and the risk tolerances of the organizations."*[40] The contracting strategy is informed by examining the project components and developing an approach that optimizes the contracting to meet program objectives. As discussed below, OPG has selected collaborative EPC agreements for its RFBR, TG, and DWI bundles. Collaborative contracts support alignment during execution and *"…[focus] on the 'principles' of relational contract to change project participants' attitudes from being short-term and adversarial toward a more collaborative mind-set and behavior."*[41]

The contracting strategies include the use of incentives and disincentives to motivate the contractor and align with Program goals. In *Construction Contracting*, the authors explain *"…Using a cost-incentive-type of contract, the contractor and the owner agree to target estimates of cost and time for the construction. Bonus or penalty arrangements are tied to these target figures."*[42] This alignment of incentives and

[40] *PMI PMBOK*. p. 75 (7th ed. 2021)
[41] Suprapto, M., Bakker, H.L.M., Mooi, H.G., Hertogh, M.J.C.M., 2015. *How do contract types and incentives matter to project performance?* International Journal of Project Management
[42] Clough, R., Sears, G., and Sears S., *Construction Contracting – A Practical Guide to Company Management*. p. 141 (7th Ed. 2005)

disincentives with Program goals prompts the contractor to be more motivated to focus their effort in managing and controlling factors that influence the execution and productivity that is critical for the Program to achieve its schedule and cost goals. Industry studies have also found that incentive-based contracts are likely to display better relational attitudes towards collaboration and better teamworking quality than non-incentive contracts, which further supports the "One Team" approach implemented by OPG.[43]

Q. How did Pegasus-Global assess the PRP's project management and readiness related to contracting strategy?

A. Pegasus-Global began its evaluation by examining Program documentation concerning the contracting strategies established by OPG for the PRP. The documents reviewed included the *PRP Commercial Strategy (R000)* and contract summaries and strategies developed for the major bundles within the PRP.[44] The document reviews were supplemented with interviews held with OPG personnel involved in the contracting strategy and approach on the PRP. The observations from the evaluation were assessed against industry standard practices and Pegasus-Global's experience on other megaprojects to reach an informed decision on the contracting strategies implemented by OPG for the Program.

Q. What are Pegasus-Global's findings relative to contracting strategy for the PRP?

A. The overall contracting strategy established by OPG for the PRP is grounded in guiding principles that include: scope bundling and clarity, broadening vendor base, vendor capacity and capability, safety and quality requirements, integrity and transparency, risk

[43] Suprapto, M., Bakker, H.L.M., Mooi, H.G., Hertogh, M.J.C.M., 2015. *How do contract types and incentives matter to project performance?* International Journal of Project Management

[44] *Pickering Refurbishment Program Commercial Strategy, NK30-PLAN-09701-1355089*. (21 Nov 2023), *Contracting Strategy for the Deep-Water Intake Project, NK30-REP-09701-1368343-R001.* (31 Jul 2024); *Contracting Strategy for the Re-tube, Feeder, and Boiler Replacement Project, NK30-REP-09701-1669444-R000.* (06 Jan 2024); and *Contracting Strategy for the Turbine Generator Project, NK30-REP-09701-1670087-R000.* (16 Dec 2025).

sharing, indigenous engagement, and equity, diversity, and inclusion objectives. OPG structured its contracts for the RFBR, TG, and DWI major bundles into Definition and Execution phases, with the Definition phase relating to early works and execution planning and the Execution phase relating to the actual execution of the PRP (with the RFBR bundle also including a Commissioning phase). For the BOP bundle, ESMSAs were previously in place with primary vendors under an EPC arrangement with the PRP scope based on the issuance of work requests by OPG for specific scopes of work.

The Contract Management organization within OPG supported the Program teams in the development of the contracting strategies, while accountability for implementation of the contract strategy and guiding principles resides within each Project Manager on the PRP. OPG developed specific contracting strategies for each of the major projects/packages within the PRP (RFBR, TG, BOP, and DWI) and identified the adoption of collaborative EPC agreements as the preferred delivery model for the Project. Use of collaborative EPC agreements follows the "One Team" approach utilized on the DRP and allows for leveraging these existing frameworks and established vendor relationships. OPG also considered an Integrated Project Delivery ("IPD") contracting approach for the PRP similar to what it established for the Darlington New Nuclear Project, but found the collaborative EPC approach aligns with the commercial guiding principles established by OPG and does not require the restructuring and process redevelopment that an IPD approach would require.

Q. What are Pegasus-Global's findings relative to the contracting strategies established for the major project bundles?

A. In developing the contracting strategies for the major bundles, OPG assessed different contracting methods for each based on criteria including the cost certainty, schedule certainty, time to construction, risk allocation, and ability to achieve best value. OPG's distinct approach to the contracting strategies for these major project bundles is discussed below.

For the RFBR bundle, OPG utilized a direct award based on the contractor's knowledge and experience gained on the DRP, with OPG summarizing that,[45]

> *The contractor has (i) demonstrated successful delivery of substantively similar scope at* [Darlington Nuclear Generating Station]*, (ii) proven nuclear safety performance and regulatory compliance capability, (iii) established quality management systems and nuclear industry experience, (iv) verified financial capacity and bonding capability for project scale, and (v) existing security clearances and trained personnel availability. This approach captures knowledge transfer from previous project experience, reduces OPG oversight and integration costs through proven working relationship, provides schedule acceleration benefits and reduced outage duration impact, offers risk mitigation value through demonstrated contractor performance and leverages contractor's investment in specialized tooling and procedures.*

For the DWI bundle, OPG initiated a request-for-market-information effort in the first quarter of 2024 to gauge market interest and obtain relevant market information. Based on the market interest, OPG employed a two-stage bid process with OPG explaining that,[46]

> *The two-stage process allows OPG to evaluate multiple interested bidders based on company experience and qualifications prior to shortlisting a discrete set of RFP proponents. The benefits of a two-stage process vs. a single-stage process are that it allows OPG to focus on evaluating and shortlisting the best capable entities on a consistent experience-based level*

[45] *Contracting Strategy for the Re-tube, Feeder, and Boiler Replacement Project, NK30-REP-09701-1669444–R000.* p. 13 (06 Jan 2024)
[46] *Contracting Strategy for the Deep-Water Intake Project, NK30-REP-09701-1368343-R001.* p. 11 (31 Jul 2024)

> *prior to releasing detailed Project requirements and terms and conditions to the bidders.*

For the TG bundle, OPG bundled all TG work (e.g. high-pressure turbine replacements on Units 6 & 8, low pressure turbine rotor and casing replacement; generator rotor and stator rewinds; turbine controls upgrades; etc.) into a single package with OPG explaining that:[47]

> *Bundling all TG work into a package offers numerous advantages. Firstly, it can lead to cost savings through negotiating better pricing for a larger volume of work. Additionally, streamlined communication and coordination result from dealing with one point of contact, enhancing efficiency, and minimizing the risk of miscommunication. Consistency in quality across all bundled tasks is ensured, as the contractor is familiar with your expectations. Synergy and integration are promoted, allowing for the optimization of processes, and leveraging economies of scale. Furthermore, risk mitigation is achieved by consolidating risk management under one contractor, simplifying contract management, and fostering stronger long-term relationships through repeated collaboration and successful delivery.*

OPG's initial plan was to engage GE Steam Power for this scope, as GE Steam Power was an original equipment manufacturer ("OEM") for the TG Project in the DRP. Initial negotiations were not successful, prompting OPG to pursue a competitive bid process. OPG identified multiple global vendors as potential candidates, including Siemens Energy (who is the OEM for Pickering) and GE Steam Power as the prominent North American TG vendors. Proposals were received from GE Steam Power and Siemens Energy and evaluated by OPG's team, leading to the recommendation to award this scope to Siemens Energy.[48]

[47] *Contracting Strategy for the Turbine Generator Project, NK30-REP-09701-1670087-R000.* p. 11 (16 Dec 2025)
[48] *Contracting Strategy for the Turbine Generator Project, NK30-REP-09701-1670087-R000.* pp. 12-15 (16 Dec 2025)

For the BOP bundle, OPG is utilizing the ESMSAs it had previously executed with three vendors that provide support to OPG's nuclear generating stations and related facilities. This approach benefits from the vendors' experience in working with OPG and by engaging multiple vendors for this work, it allows OPG to increase competition between the vendors and mitigates resource capacity risks tied to a single contractor.

Q. Do the contracts include incentives and disincentives?

A. OPG has included defined incentives and disincentives within the terms of these respective agreements for both the Definition and Execution phases, with the specific structure of the incentive and disincentive mechanism based around the scope and approach to each of the major bundles. For example, the Definition phase of the DWI contract established a percentage target band for the work in this phase, with a cost incentive available to the contractor if the work is completed under this targeted band or a cost disincentive applied requiring payment from the contractor if the work is complete at a cost above the targeted band. As mentioned above, industry studies have found that contractual incentives/disincentives to be an important mechanism to align the goals and objectives of the parties while also supporting a more collaborative and unified Program Team.

Q. What are your overall conclusions about OPG's contracting strategy and approach for the PRP?

A. OPG's contracting strategy for the PRP reflects the experience gained on the DRP and provides a collaborative environment that balances shared decision-making with clear responsibilities and performance-based incentives that are aligned with the Program objectives, representing a reasonable and appropriate approach for the PRP. The use of Definition and Execution phases within the RFBR, TG, and DWI bundles allows OPG to

engage its contractors earlier in the planning process while providing a structure to incorporate the data and information developed in this phase to support the Execution phase, including informing the Execution phase target price and schedule. For the BOP bundle, leveraging the existing ESMSAs allows OPG to utilize contractors with intimate familiarity in working with OPG, including supporting the DRP, while also providing a formal work request structure to approve specific scopes of work for release after approving the contractor's cost and schedule proposal for that work.

The PRP contracting strategy also supports continued application of the "One Team" approach introduced in the DRP that provides the foundation for a high-performing Program team, with PMI identifying that high-performing project teams typically have elements common to the "One Team" approach, including open communication, shared understanding, trust, collaboration, and adaptability, among other factors.[49]

E. LESSONS LEARNED TO DATE

Q. How did Pegasus-Global review lessons learned?

A. Pegasus-Global considered two aspects of "lessons learned" applied to the PRP:

- How OPG incorporated lessons learned from previous OPG projects (notably the DRP) as well as external projects into the planning of the PRP.
- The "lessons learned" process established for the PRP.

I will address the first topic here and the second in the discussion on the Execution phase portion of this assessment.

[49] *PMI PMBOK*. pp. 22-23 (7th ed. 2021)

Q. What projects have OPG considered and examined for lessons learned?

A. The most readily available source of lessons learned is the experience OPG gained through the execution of the DRP, with the DRP utilizing a well-developed lessons learned process that included identification of more than 7,000 lessons learned that have been reviewed and applied, as warranted, to the PRP.[50] OPG has also sought to apply the lessons learned from the Bruce Power's Major Component Replacement Program.[51] Appropriately, OPG sought specific lessons learned to align with the current scopes of work planned for the PRP. For example, in preparation for the RFBR bundle, OPG reviewed the following projects for lessons learned and related experience to be incorporated into PRP planning:[52]

- Pickering Nuclear Units 1-4 pressure tube replacement
- Point Lepreau Generating Station refurbishment, single unit
- Wolsong refurbishment Unit 1
- Embalse refurbishment
- Darlington refurbishment Units 2, 3, 1, 4 Retube and Feeder Replacement
- Bruce Units 2, 1 Restart, Steam Generator replacement
- Bruce Major Component Replacement Program, Units 6, 3, 4, Steam Generator replacement

Similarly, for the DWI scope, OPG identified lessons learned from its Darlington Intake, Outfall, and Shoreline Protection project.[53]

Q. What are some examples of "lessons learned" OPG has incorporated into the Project to date?

A. In planning for the PRP, OPG identified and incorporated several lessons learned including applying the "One Team" execution approach with its vendors through the collaborative

[50] https://www.neimagazine.com/news/ontario-approves-pickering-refurb/?cf-view (accessed 18 December 2025)
[51] *Pickering Refurbishment Balance of Plant Program Management Plan, NK30-PLAN-00120-00027-R001*. pp. 28-29 (09 Jun 2025)
[52] *Pickering Retube, Feeder, and Boiler Replacement Project Management Plan, NK30-PMP-09701-00005-R002.* p. 17 (08 Sep 2025)
[53] *Pickering Deep Water Intake (DWI) and Site Improvement Modifications Project Management Plan, NK30-PMP-09701-00007-R002.* p. 49 (11 Nov 2025)

EPC agreements that was successfully introduced during the execution of the DRP. OPG also was able to engage several of its partners that supported the DRP to perform similar scopes on the PRP, allowing the leveraging of this experience. In developing the RQE schedule and cost estimate, OPG specifically assessed the DRP experience and incorporated relevant lessons learned into its plans.[54] For example, the TG scope utilizes an execution sequence based on the experience and best practices of the DRP.[55] Similarly, within the RFBR scope, tooling improvements to simultaneously extract pressure tubes and calandria tubes together, the optimization of shift patterns, and work crew optimizations identified from the DRP were incorporated.

Q. What were your conclusions relative to incorporation of lessons learned to date?

A. I found that OPG's lessons learned process was an integral part of the PRP planning, with lessons learned from other projects identified and incorporated, including from the experience OPG gained through the DRP. The identification and incorporation of these lessons learned provide OPG with mitigation against certain risks through the recognition of common issues and the advancement of mitigation steps and with increased efficiencies based on incorporation of best practices. OPG has a sound process in place for integrating lessons learned into the PRP. These efforts are consistent with what I would expect to see on a program of this size.

[54] *Release Quality Estimate Management Plan*, *NK30-Plan-09701-00025-R000*, p. 8 (12 April 2025)
[55] *Pickering Refurbishment: Release Quality Estimate – Program Schedule Basis, NK30-SCH-00120-00001,* p. 15 (30 Nov 2025)

V. EXECUTION PHASE READINESS

A. GOVERNANCE

i. Governance Processes and Structure

Q. What are the industry standards related to program governance?

A. The Program governance was evaluated using *PMI's PMBOK, AACE International Recommended Practices, CSA N286-12* (*Management System Requirements for Nuclear Facilities*), and the Treasury Board of Canada's *Project Management Policy Suite*.[56] In addition, the Program was evaluated using *REGDOC 2.1.2* and *INPO 14-004 (R3)*.[57]

Strong governance, established before execution, provides the framework for a megaproject to begin with defined authority, clear decision pathways, and approved baselines for scope, cost, and schedule. It establishes critical controls—such as risk management, change control, and assurance reviews—to be in place before significant financial or contractual commitments are authorized. A strong governance structure that aligns with PMI, AACE, and *CSA N286* guidance supports the traceability and accountability needed to manage complexity, maintain regulatory compliance, and achieve predictable, well-controlled results across the program lifecycle.

Q. How did Pegasus-Global assess the governance structure?

A. Pegasus-Global began its evaluation of OPG's governance structure on the PRP with a review of OPG's governance framework as established by its *Nuclear Management System*

[56] *PMI PMBOK.* (6th ed. 2017); *CNSC Regulatory document REGDOC-2.1.1, Management System*; and, *Treasury Board of Canada. Directive on the Management of Projects and Programmes.* pp. 2-5 (Nov 2019) https://publications.gc.ca/collections/collection_2019/sct-tbs/BT53-34-2019-eng.pdf

[57] *CNSC Regulatory document REGDOC-2.1.2, Safety Culture* and *Institute of Nuclear Power Operations, Conduct of Performance Improvement*. (2020); and INPO *Conduct of Performance Improvement*. 14-004 (Aug 2024)

and *Project Management Program*, which provide the overall nuclear management systems and principles for planning, organizing, executing, and controlling delivery of projects.[58] Pegasus-Global's review continued by examining the Program Charter for the PRP, which represents the first tier of the Program's specific governance structure. As explained by PMI, the charter is *"…a document issued by the project sponsor that formally authorizes the existence of a project and provides the project manager with the authority to apply organizational resources to project activities."*[59] The PRP Program Charter defines the need for the Program, the Program's objectives, the phase-gate strategy applied for funding releases, Program commitments, major milestones, and key stakeholders. Within the governance framework established by OPG for the PRP, under the Program Charter sits the top-level Program Management Plan that provides an overview of the Program, its governance, and the Program and project-specific plans developed and implemented to support the planning, organizing, execution, and control of the Program. The Program and project management plans and processes were similarly evaluated, which were supplemented by interviews with key Program personnel. Building from the Program Charter, Pegasus-Global reviewed the top-level Program Management Plan ("PMP") and the suite of PRP-specific management plans that sit beneath it. These documents collectively define the governance processes, organizational structure, roles and responsibilities, Program interfaces, and the controls used to plan, organize, execute, and oversee the PRP. Consistent with *CSA N286-12*, these plans demonstrate how nuclear

[58] *OPG Nuclear Management System, N-CHAR-AS-0002-R024.* (31 Jul 2025); and *OPG Project Management, OPG-STD-0148-R006.* (31 Jan 2025)
[59] *PMI PMBOK*. p. 34 (6th ed. 2017)

safety, quality, cost, schedule, risk, and configuration management expectations are integrated into execution of the Program.

Pegasus-Global further reviewed the governance framework applicable to design and engineering, including how requirements are developed, verified, and translated into field-ready construction work. The evaluation considered the documentation supporting construction readiness, commissioning, turnover, and field execution oversight; as well as processes that govern safety management, security, and emergency preparedness in the context of a refurbishment being performed within a nuclear station.

Pegasus-Global also reviewed PRP plans related to stakeholder engagement and Indigenous rights holder consultation, environmental protection, regulatory compliance, and station interface governance—each of which is essential for a multi-unit refurbishment executed adjacent to ongoing operations. In addition, OPG's plans related to workforce readiness, supply chain strategy, commercial controls, training, organizational effectiveness, and human performance were also reviewed.

The document review was supplemented by interviews with key PRP personnel, which provided additional context on how the governance model is implemented in practice, how interfaces are managed across refurbishment bundles and station operations, and how OPG maintains alignment with enterprise governance and nuclear industry practices.

Q. Does OPG have experience with governing nuclear projects?

A. Yes. OPG has extensive experience governing complex nuclear projects under a mature and well-established management system. OPG built and owns one of the largest nuclear fleets in North America—Darlington, Pickering, and the Western Waste Management

Facility— and operates Darlington and Pickering. OPG has successfully delivered large-scale, multi-year nuclear initiatives including the DRP, the Pickering Safe Storage Program, and numerous life-extension and waste-management programs.

OPG's governance model incorporates clearly defined accountabilities, independent oversight, and integrated assurance functions that are routinely audited by internal and external bodies. Through this framework, OPG has demonstrated sustained capability in areas such as project controls, engineering assurance, licensing, safety culture, and regulatory compliance—core competencies that directly support the PRP.

Q. What independent oversight mechanisms exist to support the PRP?

A. The PRP incorporates multiple layers of independent oversight in accordance with *CSA N286-12* expectations for independent assessment and nuclear oversight. Within OPG, independent assessments are conducted by Nuclear Oversight and the Nuclear Safety Review Board ("NSRB"), which provide objective evaluation of program performance, safety compliance, and management system effectiveness. These organizations operate independently from the PRP line organization and provide an additional level of scrutiny consistent with *INPO 14-004* and industry norms for nuclear megaprojects.

The Program also anticipates targeted independent reviews at major milestones to assess engineering maturity, execution readiness, and commissioning preparedness. These reviews are consistent with AACE and PMI guidance for an independent assessment of Program readiness and provide increased confidence in the Program's ability to meet its safety, schedule, and cost objectives.

Overall, the oversight structure is appropriately aligned with nuclear industry expectations and contributes positively to the governance and assurance framework for the PRP.

Q. Did your assessment find that OPG has sufficient organizational capacity and capability to support the PRP?

A. Organizational capacity and capability for the PRP have been developed in accordance with *CSA N286-12* requirements for competent personnel and sustained capability throughout a facility's lifecycle. OPG has implemented structured processes for assessing staffing needs, identifying required knowledge, skills, and qualifications, and coordinating resource planning across PRP execution bundles and enterprise support functions. Part of OPG's resourcing strategy for the PRP leverages use of its existing O&M staff at Pickering to support the Program. As the PRP is structured around all four units being shutdown (until Unit 5 returns to service), this allows OPG's O&M staff to support scopes of work that align with their proficiencies, with much of the normal outage maintenance work being similar in scope to aspects of the refurbishment.

The workforce strategy reflects PMI's resource management principles by establishing clear planning assumptions, integrating contractor and internal resource needs, and coordinating with other OPG nuclear initiatives to avoid workforce conflicts. Succession planning and knowledge transfer processes are also in place, consistent with *CSA N286-12* expectations for maintaining technical and managerial capability over long-duration nuclear projects.

Based on the documentation reviewed, OPG has positioned the organization with the structure and processes necessary to support execution, with plans to further mature detailed resource forecasts as the Program approaches field mobilization.

Q. How is integration being managed across units, bundles, and station operations?

A. The PRP has established formal processes and structures to manage integration across refurbishment bundles, supporting functions, and ongoing station operations. These processes are consistent with *CSA N286-12* requirements for coordination and control of interfacing activities and with PMI principles for program integration management.

Defined interfaces exist between major scope bundles—such as RFBR, TG, BOP, and station systems—and these are supported by structured planning, issue escalation mechanisms, and integrated scheduling across the Program. Operational integration is maintained through established configuration management, outage coordination, and safe-operating-envelope safeguards, ensuring refurbishment execution does not adversely impact station performance.

The Program also incorporates lessons learned from the multi-unit DRP execution and is developing mechanisms to support unit-to-unit learning, shared resourcing, and mitigation of interdependency risks. These practices align with megaproject best practices and support predictable execution across the four-unit refurbishment sequence.

Q. How is contractor readiness being evaluated and governed for refurbishment execution?

A. Contractor governance for the PRP has been developed to align with OPG's Nuclear Management System and *CSA N286-12* requirements for supplier oversight. The Program has defined contractor readiness expectations across engineering completion, staffing

plans, quality assurance, safety management, and integration with OPG's governance processes.

The Program's contractor oversight model reflects PMI procurement management principles and INPO expectations for work discipline, nuclear professionalism, and integrated team behaviors. Readiness reviews, joint planning sessions, and alignment workshops support the "One Team" delivery model and help ensure OPG and its contractors are prepared to execute safely and predictably within a nuclear environment.

Based on the information reviewed, contractor readiness processes are consistent with nuclear industry standards and appropriate for a program of this scale and complexity.

Q. What are Pegasus-Global's findings relative to governance structure?

A. Pegasus-Global found that OPG has established a governance framework for the PRP that is aligned with the expectations for a large, multi-unit nuclear refurbishment program. The governance structure is anchored in OPG's enterprise-level management system—particularly *OPG-PROG-0039, OPG-STD-0148*, and the Nuclear Management System—and these standards cascade into the PRP through the Program Charter, Program Management Plan, and associated Program and project-specific procedures. Collectively, these documents define the Program's objectives, decision authorities, phase-gate requirements, and the organizational roles and responsibilities necessary to manage safety, quality, cost, schedule, and risk.

Pegasus-Global observed that the governance model incorporates appropriate controls for planning and executing refurbishment work within a nuclear station. These include structured decision-making pathways, alignment of scope, cost, and schedule through documented baselines, defined change control processes, and integration with

engineering, configuration management, nuclear oversight, and regulatory interfaces. OPG has also established mechanisms for independent oversight through Nuclear Oversight and the NSRB, which is consistent with industry standard practices for nuclear megaprojects.

The state of the current Program-level governance is appropriate for the Planning phase of the Program and as OPG advances towards the Execution phase of the PRP, Pegasus-Global identified opportunities to further strengthen Program-level governance to support the successful delivery of the Program. These include more explicit definition of cross-unit coordination responsibilities, enhanced articulation of Program-level risk and assurance processes, and additional clarity on how vendor oversight, operational interfaces, and learning across units will be governed at the Program level. These observations represent areas where additional definition during the Execution Phase would enhance governance robustness for a multi-unit refurbishment of this scale.

Q. What are your conclusions relative to the governance of the PRP?

A. Based on Pegasus-Global's review of the PRP's governance documentation as well as interviews with key Program personnel, I conclude that OPG has established a governance framework that is appropriate for the size, complexity, and nuclear safety significance of the PRP. The governance structure reflects the principles of *CSA N286-12* by integrating safety, quality, cost, schedule, and risk into a cohesive management system, supported by defined roles, responsibilities, and decision-making authorities.

The governance framework demonstrates that OPG has applied lessons learned from the DRP and other major initiatives and has incorporated those lessons into the PRP's planning processes, organizational structure, and oversight mechanisms. The Program Charter and Program Management Plan provide clear direction and define the governance

architecture that will guide execution. OPG's enterprise standards and procedures further reinforce consistency, traceability, and disciplined control across all aspects of the Program.

As the PRP advances into execution, certain elements of Program-level governance—such as cross-unit integration, program assurance, and risk governance—will continue to mature and become increasingly detailed. Pegasus-Global views this as a natural progression for a megaproject transitioning from definition to execution.

In Pegasus-Global's opinion, the governance model established by OPG for the PRP provides a solid and credible foundation for the Program with ongoing maturation consistent with the Program's progression towards execution. The PRP governance is aligned with nuclear industry expectations and supports prudent, transparent, and accountable management of a complex, multi-unit nuclear refurbishment program.

ii. Organizational Structure

Q. What are the industry standards relative to organizational structures?

A. PMI provides in its *Project Management Standard* that: [60]

> *Organizational structures are any arrangement of or relation between the elements of project work and organizational processes. These structures can be based on roles, functions, or authority. They can be defined as being external to the project, tailored to fit the project context, or newly designed to meet a unique project need.*

PMI adds that project teams can tailor their structure to best accomplish the project objectives and, by fostering inclusive and collaborative environments, facilitate a better exchange of knowledge and expertise, which in turn enables better project outcomes.

[60] *PMI, The Project Management Standard.* p. 29 (2021)

Q. How did Pegasus-Global assess the organizational structure of the PRP?

A. Pegasus-Global reviewed the PRP governance documentation that defined the Program's organizational structure and approach. Specifically, Pegasus-Global examined the *Pickering Units 5 to 8 Refurbishment Program Charter (R000), Pickering Refurbishment Program Management Plan (R02), Pickering Refurbishment Project Assurance Program Management Plan (R001), Pickering Refurbishment: Capacity and Resource Management - Program Management Plan (R000), Pickering Refurbishment Program Management Plan - Human Performance (R000)*, which were supported by organizational charts developed by OPG for the Program.[61]

Q. What are Pegasus-Global's findings relative to organizational structure?

A. The organizational structure established by OPG for the PRP is led by a Senior VP for Nuclear Refurbishment and is essentially divided between project execution and functional support groups. Within the project execution side, VPs of Major Projects are assigned to lead the major work bundles (RFBR, TG, DWI, BOP, Facilities & Infrastructure, and O&M). Each of the major work bundles is further supported by a team of Directors. For example, the RFBR work bundle has four Directors supporting it, who in turn have a team of senior managers under them that have responsibility for specific areas of the major work bundles. The functional support groups include support from OPG's enterprise organization to support project execution in areas such as engineering, project controls, finance, supply chain, and commercial management, and follow a similar structure of

[61] *Pickering Units 5 to 8 Refurbishment Program Charter, NK30-CHAR-09701-00001.* (Apr 2024); *Pickering Refurbishment Program Management Plan, NK30-PLAN-001210-00002.* (Sep 2025); *Pickering Refurbishment Project Program Assurance Program Management Plan, NK30-PLAN-00120-00010.* (Jun 2025); *Pickering Refurbishment: Capacity and Resource Management - Program Management Plan, NK30-PLAN-00120-10015.* (Jun 2025); *Pickering Refurbishment Program Management Plan - Human Performance, NK30-PLAN-00120-00020.* (Apr 2024); and *PRP Organizational Structure* (undated).

having each function led by a VP and further support by Directors and Senior Managers with specific expertise. The specific PRP responsibilities for the directors are defined within the Program Charter and further supported by the program and project management plans established to support the planning, execution, and control of the PRP.

Q. How has OPG prepared for resource turnover during execution?

A. A concern in a long duration program is loss of resources over the course of the program. At an enterprise level, OPG has robust succession planning and knowledge management processes in place to ensure that the required knowledge, skills, and qualifications ("KSQs") are identified within the organization to mitigate risks associated with resource turnover. The risks associated with KSQs are assessed for safety, financial, reputational, and operational consequences, including how critical the KSQ is and how difficult it would be to re-acquire it if lost. The assessment of the KSQs informs the development of Knowledge Management Plans that help organize, capture, store, and share important information to address current and future challenges with workforce transitions and knowledge retention.

For OPG's Projects Organization, which leads major Program initiatives, the succession planning process is structured around the major Program milestones. This ensures that OPG has identified and prepared for workforce transitions to ensure knowledge is retained and minimizes the Program risk.

Q. What are your conclusions related to the PRP's organizational structure?

A. Pegasus-Global concludes the organizational structure established by OPG for the PRP has appropriately allocated the execution work into major work bundles and has also identified the appropriate functional support required for the Program. OPG actively monitors the

resource needs for the Program and across its organization with robust succession and knowledge retention plans and processes in place. Additionally, the application of the "One Team" approach aids the Program organization in establishing more transparent and collaborative conditions that support a healthy program environment.

B. CONTRACT MANAGEMENT

Q. What are the industry standards related to contract management during the Execution phase?

A. *PMI's PMBOK* explains that:[62]

> *Control Procurements is the process of managing procurement relationships; monitoring contract performance, and making changes and corrections as appropriate; and closing out contracts.*
>
> PMI adds that,
>
> *Control Procurements includes application of the appropriate project management processes to the contractual relationship(s) and integration of the outputs from these processes into the overall management of the project.*

It further provides that because of the uniqueness of each project, the procurement management processes may need to be tailored to adapt to project-specific characteristics.

Q. How did Pegasus-Global assess the PRP's contract management?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG to provide contract management for the Program. Pegasus-Global focused its assessment of PRP's contract management on a review of the *PRP Contract Program Management Plan (R000)*, which was supplemented through reviews of related documents (such as the *RFBR Contract Management Plan (R000)*) and by interviews

[62] *PMI PMBOK.* pp. 492 & 494 (6th ed. 2013)

conducted with OPG personnel.[63] The observations from the evaluation were assessed against industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

Q. What are Pegasus-Global's findings relative to OPG's contract management?

A. The *PRP Contract Program Management Plan* defines how the major contracts within the PRP will be defined, managed, and controlled, including roles and responsibilities of OPG's Commercial Management Organization that manages all commercial aspects for OPG's strategic projects (including the PRP). The contracting process is defined across five primary contract lifecycle phases described as follows:

1. Planning: preparation of the contracting strategy, which takes into consideration various factors including nature and scope of the work, vendor marketplace, contracting structure, pricing mechanism, and similar factors.
2. Procurement: sourcing and awarding the contracts based on the contracting strategy developed. In this phase, contract terms are negotiated, key milestones established, and the contract ultimately is awarded.
3. Post-Award: vendor mobilization and execution planning. The contract management processes are established to provide the systems and principles that ensure the vendor complies with the terms and conditions through the performance of the contract.
4. Execution: OPG and its vendor partners seek to continuously work in a collaborative environment under the "One Team" approach within the guiding principles developed in the post award stage to further support integration and transparency, remove organizational silos, optimize processes, and streamline redundant functions/positions. OPG's Commercial Management Organization provides the overall management of the contract during this phase, including management of contract changes and disputes, while the PRP Program Team primarily focuses on monitoring vendor performance, verification of milestone completion certificates, and review of sub-vendor contracts.
5. Closeout: ensures all products and services have been delivered and accepted, contract requirements fulfilled, and any deficiencies and

[63] *Pickering Refurbishment Contract Program Management Plan, NK30-PLAN-00120-00012.* (15 Feb 2025); and, *Pickering Refurbishment Retube, Feeder and Boiler Replacement (RFBR) Project – Contract Management Plan, NK30-PLAN-09701-1669210.* (4 Feb 2025).

> claims have been resolved. This phase includes the capture of any commercial lessons learned for implementation on future OPG programs and projects.

The PRP Contract Program Management Plan also specifies several collaboration methods that support implementation of the "One Team" contracting approach intended to drive improved performance across safety, quality, cost, and schedule. Specific "One Team" principles were identified and agreed to by OPG and its contractors and incorporated into the PRP contract management plans to further emphasize the commitment to implementing and strengthening a partnership approach to the Program.

For the RFBR, DWI, and TG bundles, both the Definition and Execution phases are governed by a milestone schedule, a target schedule, and a submittal schedule. The milestone schedules establish high-level milestones for the respective scopes of work that serve as contractor commitments for completing defined aspects of the work. The target schedules provide a detailed schedule for monitoring and controlling the work and include references to each milestone while the submittal schedules define the dates or time periods for delivery of contractually required submittals.

Within the BOP bundle, the scope of work is managed through the issuance of work requests by OPG to its BOP contractors, which includes a listing of the relevant specifications, pricing model applicable to the work, interface requirements, and other relevant information. The BOP contractors respond to the work requests by providing OPG with information including estimated costs and schedule for completing the requested work. If OPG accepts the contractor's response, a purchase order is issued for the work. The BOP contractors are responsible for developing and maintaining a master status report to track all work performed under the agreement, including providing an integrated

schedule, capacity metrics and forecasting for all purchase orders, work loading of contractor's personnel, and tracking any required corrective actions.

Q. What are your conclusions regarding on-going contract management?

A. I found that the PRP contract management process is aligned with industry standard practices and is consistent with what I would expect for a megaproject of this size. The roles and responsibilities and support provided towards contract management from the Contract Management organization and PRP Program Team are clearly defined across the different contract phases. The continued application of the "One Team" approach implemented during the DRP supports effective collaboration during execution, with OPG appropriately emphasizing this approach in its processes and ensuring the vendor partners are similarly aligned heading into the Execution phase.

Within the BOP bundle, the structure of issuing work requests, receiving vendor proposals, issuing a purchase order for the work, and utilizing a master status report provides an appropriate structure around this scope of work to allow effective monitoring and control during execution.

C. PROJECT CONTROLS

Q. What are the industry standards related to project controls?

A. Pegasus-Global evaluated the program controls and compared the controls to the industry standards published by AACE, PMI, and other relevant industry publications. Project controls is a general term used in the construction industry to describe the systems used by project management to measure progress towards an objective, evaluate the work

remaining to be completed to achieve that objective, and report the status of progress to stakeholders in a timely manner. As noted in *Construction Project Management*: [64]

> *… project control is an action-based process that encourages continual monitoring of operations. To be successful, the actual work with its cost and duration must be completely and accurately documented.*

The process also needs to ensure that feedback loops are established to allow the project team to monitor the status of the Project and adjust to circumstances.[65] In the construction industry, the key project controls are schedule, cost, risk, change, and reporting. These are discussed individually below. Both cost and schedule controls are aligned with risk controls because realized risks generally have a cost and/or schedule impact. Project changes in scope can also have cost and/or schedule impacts and associated risks. The accurate reporting of cost, schedule, and risk is necessary to allow project management to make decisions regarding changes.

Project controls also enable project management to take corrective action if necessary to ensure an objective is achieved on time and on budget. Depending on the specific conditions of a given project, the project controls are typically customized to meet the needs of the project's owner and each individual project. PMI recommends that projects design the project development approach for each project based on its governance, stakeholders, and the environment.[66] The typical long durations of construction projects lead to them being executed in dynamic environments, where events or issues that arise during execution can influence or impact the project. Revising the project controls as

[64] Gould, F., and Joyce, N., *Construction Project Management.* p. 241 (3rd ed. 2009)
[65] Ibid.
[66] *PMI PMBOK*. p. 28 (6th ed. 2017)

needed allows project management to improve them as new information and needs are discovered.

Q. How did Pegasus-Global assess the PRP's project control processes?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG related to project controls for the Program. The evaluations were supplemented by interviews with key Program personnel. Pegasus-Global assessed PRP plans and procedures governing cost management, schedule development and management, risk identification and mitigation, quantification practices, change control, and reporting. This included evaluating the extent to which OPG's enterprise-level standards, such as *OPG-PROG-0039, OPG-STD-0148*, and the engineering and configuration management standards, are embedded in the PRP execution approach. The evaluation also considered the processes used to ensure traceability between scope definition, design maturity, baselines, phase-gate approvals, and executive reporting.

For the purposes of this evaluation, Pegasus-Global examined a number of control processes, including the *Pickering Refurbishment Project Controls Program Management Plan (R001), Pickering Refurbishment Risk Program Management Plan (R001)* along with a number of other documents related to project controls.[67] The observations from the

[67] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003.* (05 Sep 2025); *Pickering Refurbishment Risk Program Management Plan, NK30-PLAN-00120-10014.* (08 Sep 2025); *OPG Project Scheduling Guide, OPG-GUID-00120-0001-R006.* (15 Mar 2025); *OPG Project Schedule Management, OPG-MAN-00120-0014-R004.* (02 Mar 2023); *OPG Project Controls EcoSys End User Training Manual, OPG-CMT-77678-00000-R002.* (25 Aug 2023); *OPG Project Cost Management, OPG-MAN-00120-0013-R003.* (21 Feb 2023); *OPG Desktop Guide 001 – Cost Forecasting, COST-DTG-001 Forecasting* (May 2021); *OPG Desktop Guide Earned Value Management, INT-DTG-001.* (Mar 2019); *OPG Project Phase-Gate Management, OPG-MAN-00120-0019-R0003.* (11 Apr 2024); and *OPG Desktop Guide 002 – Cost Management – Gating, COST-DTG-002-R01.* (Feb 2023); *Pickering Refurbishment Project - Refurbishment Change Control Board, NK30-TOR-09701-00002-R02.* (19 Aug 2025); *OPG Project Integrated Change Control, OPG-MAN-00120-0016-R4.* (31 May 2022)

evaluation were assessed against industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

Q. What are Pegasus-Global's findings relative to project controls?

A. Pegasus-Global found that as a sophisticated utility, OPG has developed and implemented policies and procedures at its corporate or enterprise level that provide guidance on a variety of functions, including project management and project controls. The enterprise level procedures provide guidance that informs the Program-specific procedures developed for the PRP. The majority of the Program-specific procedures developed for the PRP are the result of enhancements from the procedures in place on the DRP. I discuss the individual key project controls below.

Q. What are your conclusions regarding the PRP's project control processes?

A. I conclude that PRP's project control processes used to govern the Program match or often exceed industry standards in their thoroughness and are appropriate for a project of this size and complexity. The robust project controls will allow OPG to accurately plan, control, and monitor the execution of the Program.

i. Schedule

Q. What are the industry standards relative to schedule management?

A. Industry standards on schedule management are provided by *PMI's PMBOK* and by AACE.[68] As explained by PMI, "plan schedule management" is the process of establishing the policies, procedures, and documentation for planning, developing, managing, executing, and controlling the project schedule.[69] The planning of schedule management

[68] *PMI PMBOK.* (6th ed. 2017); and, *AACE International Recommended Practice No. 61R-10: Schedule Design – As Applied in Engineering, Procurement, and Construction.* (11 October 2013)
[69] *PMI PMBOK.* p. 179 (6th ed. 2017)

on a project provides the project team with specific direction and guidance on how the project schedule should be developed and controlled throughout the project. The general objectives of schedule controls are to update the actual status of the activities and measure that progress against the schedule baseline, including identifying what activities are of a critical nature to the project, how those activities relate to one another, to track actual progress of activities to ensure that the project meets key milestones as planned, and to provide early awareness of variances and trends to the plan to allow for corrective actions to be implemented. PMI provides that, *"Schedule analysis uses common tools and techniques throughout the project life cycle to identify deviations from the baseline schedule model. Schedule model analysis is the responsibility of the project team. The primary objective of the analysis is the early identification of threats and opportunities to the project objectives"*[70]

AACE's Recommended Practice 53R-06 "*Schedule Update Review – As Applied in Engineering, Procurement and Construction*" offers guidance for creating schedule updates and assessing the reasonableness of changes made in the schedule due to a change in project status and progress. This *AACE Recommended Practice 53R-06* provides that:[71]

> *The schedule update should be evaluated using the following criteria:*
> - *Requirements included in the contract specifications*
> - *Physical dimensioning and instructions found in the contract plans*
> - *Resource availability*
> - *Professional scheduling practices and guidelines generally accepted for use by professional scheduling practitioners.*

[70] *PMI Practice Standard of Scheduling.* p. 71 (3rd ed. 2019)
[71] *AACE International Recommended Practice No. 53R-06, Schedule Update Review – As Applied in Engineering, Procurement, and Construction*. p. 11 (14 August 2008)

Q. How did Pegasus-Global assess the PRP's schedule management?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG related to schedule management for the Program. The evaluations were supplemented by interviews with key Program personnel. Pegasus-Global reviewed several schedule management policies and procedures to guide and control the scheduling objectives, including the *Pickering Refurbishment: Release Quality Estimate –Program Schedule Basis (R000),* the *OPG Project Scheduling Guide (R006)*, and the *OPG Project Schedule Management (R004)*.[72] The review also examined the planned schedule management for the major Program bundles of RFBR, TG, DWI, and BOP.[73] The observations from this review were assessed against industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

Q. What are Pegasus-Global's findings relative to schedule management?

A. OPG's *Project Schedule Management* serves as an enterprise-level procedure within OPG to provide guidance and direction on the processes, tools, and roles and responsibilities related to planning, developing, and controlling project schedules. Direction on schedule management specific to the PRP relies on the guidance provided by the enterprise-level *Project Schedule Management* as detailed within the *Pickering Refurbishment Project Controls Program Management Plan (R001)*, which establishes the primary schedule

[72] *Pickering Refurbishment: Release Quality Estimate – Program Schedule Basis, NK30-SCH-00120-00001.* (30 Nov 2025), *OPG Project Scheduling Guide, OPG-GUID-00120-0001.* (15 Mar 2025); and, *Project Schedule Management, OPG-MAN-00120-0014.* (02 Mar 2023)

[73] *Pickering Retube, Feeder, and Boiler Replacement (RFBR) Project Management Plan, NK30-PMP-09701-00005-R002*. (08 Sep 2025); *Pickering Deep Water Intake (DWI) and Site Improvement Modifications Project Management Plan, NK30-PMP-09701-00007-R002.* (11 Nov 2025); *Pickering Refurbishment Balance of Plant Program Management Plan, NK30-PLAN-00120-00027-R001.* (09 Jun 2025); and *Pickering Refurbishment Turbine Generator (TG) Project – Contract Management Plan, NK30-PLAN-09701-1767004-R000.* (17 Dec 2025).

management requirements for the PRP.[74] This includes use of individual project schedules in conjunction with a Program master schedule that depicts interdependencies between other project work, with each project schedule also using standard milestones and coding to support consistent Program reporting. The Project Management Plans developed for the major PRP bundles provide further direction to the schedule management requirements for these bundles, including specifying the schedule review and update processes. For example, on the RFBR bundle, the project schedule will be maintained and reviewed weekly, while the schedule progress reports (including earned value metrics) will be produced on a monthly basis.

Q. What are your conclusions relative to schedule management?

A. Based on Pegasus-Global's review of the Program's schedule management, I conclude that OPG's processes are robust, aligned with industry standard practices, and support effective schedule management through consistent principles applied across the PRP, including use of a logic-based network and standard Work Breakdown Structure ("WBS") structure, milestones, and activity naming conventions. The schedule structure supports tracking earned value performance during execution, such as Schedule Performance Index, Schedule Variance, and Labor Units Percentage Complete, to provide project management with additional measurements on the actual performance of the Program. The schedule quality checks and regular review and updating process provide further assurance that accurate schedules are maintained during execution, providing project management with visibility on the progress being made and allowing informed decisions to be made.

[74] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003.* (22 Sept 2025).

ii. Cost

Q. What are the industry standards relative to how owners apply cost management?

A. Pegasus-Global assessed the cost management process for the Program using PMI's *PMBOK* which provides standards for cost management.[75] Cost management involves planning, managing, forecasting, and controlling costs to help facilitate a project being completed within its approved budget. PMI's *PMBOK* notes that cost management begins with development of the policies, procedures, and processes to be used during execution. Cost estimating allows the owner to identify the expected costs of the individual components of the project, based on the information known at the time of the estimate, and facilitates the establishment of a control or baseline budget.[76]

During execution, cost management focuses on monitoring the status of the project relative to the budget. This is typically accomplished by comparing actuals to the estimate or plan, evaluating metrics (i.e. earned value), and trending and forecasting to predict future values based on current performance.[77] These tools provide management with necessary information as to the status of the project, allowing management to make informed decisions.

Q. How did Pegasus-Global assess the PRP's cost management?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG to provide cost management of the Program. The evaluations were supplemented by interviews with key Program personnel. The documents reviewed included the *Pickering Refurbishment Project Controls Program Management Plan*

[75] *PMI PMBOK*. p. 235 (6th ed. 2017)
[76] *PMI PMBOK*. p. 231 (6th ed. 2017)
[77] *PMI PMBOK*. p. 261 (6th ed. 2017)

(R001), the *Project Controls EcoSys End User Training Manual (R002)*, *OPG Project Cost Management Manual (R003), OPG Desktop Guide 001 - Cost Forecasting (May 2021), OPG Desktop Guide DTG-001 – Earned Value Management (Mar 2019), OPG Project Phase-Gate Management (R0003),* and *OPG Desktop Guide 002 – Cost Management Gating (Rev 01).*[78] The observations from the evaluation were assessed against industry standards to ensure the processes and procedures in place are effective tools for cost management.

Q. What are Pegasus-Global's findings regarding cost management for the Program?

A. The *PRP Controls Management Plan (R001)* outlines the cost management processes, tools, roles, and responsibilities to plan, estimate, budget, monitor, and control costs to enable completion within the approved budget.

The PRP is using a stage gate process to ensure costs are managed effectively and efficiently. Checkpoints are provided at each major project phase to ensure the Program is on track with regard to scope, cost, quality, and schedule. The Gate Review Board has responsibility for the gated process and is made up of representatives from the relevant areas of the Program.

Costs are tracked through the WBS that provides the framework for the cost management plan and allows consistency between the estimate, budget, schedule, and control of costs based on the approved scope. Both schedule and costs utilize the common Program WBS for easy integration of scope, schedule, and cost. All cost management on

[78] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003.* (05 Sep 2025); *OPG Project Controls EcoSys End User Training Manual, OPG-CMT-77678-00000.* (25 Aug 2023); *OPG Project Cost Management Manual, OPG-MAN-00120-0013.* (21 Feb 2023); *OPG Desktop Guide 001 – Cost Forecasting, COST-DTG-001 Forecasting* (May 2021); *OPG Desktop Guide Earned Value Management, INT-DTG-001.* (Mar 2019); *OPG Project Phase-Gate Management, OPG-MAN-00120-0019.* (11 Apr 2024); and *OPG Desktop Guide 002 – Cost Management – Gating, COST-DTG-002.* (Feb 2023)

PRP is administered through OPG's enterprise cost management tool, EcoSys. Work packages within the WBS are rolled up to cost estimates to the appropriate point for analysis and reporting. Cost forecasting is performed each month with the PRP utilizing a Forecast Accuracy Factor key performance indicator to identify areas where forecasting accuracy may need to be improved. After the budget has been approved for funding, the individual projects are to be released from the overall Program funding through the stage gate approval process. Detailed gate strategy and release plans for each bundle are included in the bundle-specific Project Management Plans.

Q. What processes does PRP have in place to calculate and manage contingency?

A. The assessment of PRP's contingency development is discussed previously in conjunction with the RQE Cost Estimate. All Program contingency changes are documented and reflected in the Program risk register, which is discussed later in this report, and reviewed and dispositioned by the Bundle Director, Refurbishment Change Control Board ("RCCB"), Senior Vice President Refurbishment Execution, Nuclear Refurbishment Executive Leadership Team ("ELT"), or CEO/CFO as needed according to the RCCB approval limits and the *Organizational Authority Register (R022)*.[79]

When a risk or trend cannot be fully mitigated, a drawdown of contingency will occur to address the cost exposure from that risk or trend. For the PRP, authority limits for contingency usage are established based on cost and schedule impacts. For example, for a bundle contingency drawdown of less than $5M, the bundle director's approval is sufficient. The RCCB can approve contingency draws of up to $10M, with the SVP of Refurbishment Execution and Refurbishment ELT approval required for contingency

[79] *OPG Organizational Authority Register, OPG-STD-0017.* (05 Dec 2025)

draws above $10M. Contingency draws can also be escalated up to the CEO/CFO as required.

Contingency amounts are reviewed and analyzed for trends and adequacy. The Qualitative Risk Assessment ("QRA") is refreshed each quarter to ensure the remaining contingency amounts are within the bounds of the budget with the QRA results being reported to the appropriate stakeholders.

Q. How is contingency typically managed and controlled on a megaproject?

A. It is common practice for contingency to be both distributed to individual projects within a megaproject and to an overall program contingency. This is a reflection of acknowledging the identification of both project-specific risks and overall program risks. Use of contingency typically is approved by the project manager, senior management, or possibly the president/board of directors, depending on the amount needed and the thresholds for its use. A review of remaining contingency is made periodically and encompasses current risks and changes since the last review, progress on the project to date, and contingency expended to date. Contingency is included in the cost estimate and is expected to be expended over the course of the project as risks are realized.

Q. What are your conclusions regarding the Program's Cost Management Process?

A. Based on Pegasus-Global's review of the Program's cost management processes and procedures, as well as interviews with PRP personnel, I conclude the PRP's cost management processes are well-defined for the Execution phase of PRP. There are clear responsibilities, and the Program is organized similar to other megaprojects I have evaluated. The Cost Management procedures continue to demonstrate alignment with

industry standards for program financial monitoring and control, even exceeding industry standards in some instances.

The cost management processes have sufficient detail for effective cost monitoring, reporting, and responding to issues. It is my opinion that OPG has established appropriate processes and controls for management of contingency during the Program's execution. These activities align with the program financial monitoring and control activities prescribed by PMI in *The Standard for Program Management*.[80] The OPG cost management process is in accordance with industry best practices and typical of what I have found on other megaprojects similar to the size and complexity of PRP.

Regarding the process for contingency management, I conclude that the process aligns with industry standard practices. OPG has established appropriate processes and controls for management of contingency during the Program's execution. Program contingency changes are monitored and tracked each month and changes documented and reflected in the Program risk register, which I discuss later in my testimony, and reviewed and dispositioned by the Change Review Board, the Vice President of Refurbishment Execution, and BOD as needed for level of authorization. When a risk or trend cannot be fully mitigated, a drawdown of contingency will occur. Contingency consumed will be reported each month and analyzed for any trends or applicability to other areas of the Program.

[80] *PMI, The Standard for Program Management.* (6th ed. 2017)

iii. Risk

Q. What are the industry standards relative to risk management?

A. The risk management of the Program was evaluated using PMI and AACE standards.[81] Risk is an uncertain event or condition that, should it occur, would affect at least one program objective either as a positive or negative effect. Risk is unpredictable and involves uncertainty, whether that is in the form of a threat or an opportunity. Based on experience, those involved in project execution and the program risk assessment can predict what items or events may happen and their likely impact. An expected prediction of risks can be made based on items or events that have happened before but may not manifest on the particular project being assessed, what is called "known unknowns."[82] While "unknown unknowns" reflect risks that cannot be identified or recognized until they occur, another category of risks includes very high-impact, low-probability risks, commonly called "black swan events", which due to their low probability nature are typically outside risk analyses. Proactive risk management practices continually assess new information on a project, which can lead to early warnings and identification on potential black swan events.

The general objectives of risk controls in a risk management program are to reduce the likelihood and impact of potential risks to an acceptable level. The key objectives are to reduce the probability of risk events occurring (or reduce their potential impact), ensure compliance with regulatory and legal requirements, protect assets (including human assets), maintain project operation during and after risk events, implement cost-effective

[81] *PMI PMBOK.* p. 395 (6th ed. 2017); *AACE International Recommended Practice No. 62R-11, Risk Assessment: Identification and Qualitative Analysis.* (18 Feb 2022); and *ACCE International Recommended Practice No. 63R-11, Risk Treatment.* (23 Aug 2012)
[82] *National Science Foundation, Risk Management Guide for Large Projects.* (10 Feb 2012)

controls that balance risk reduction and costs, and establish clear accountability for managing risk.

Effective risk management involves project teams seeking to maximize positive risks (opportunities) and decrease exposure to negative risks (threats). Threats may result in issues such as delay, cost overrun, technical failure, performance shortfall, or loss of reputation. Opportunities can lead to benefits such as reduced time and cost, improved performance, increased market share, or enhanced reputation.

There are typically five steps project management undertakes in development of a risk management program:

1. planning how risk will be approached for the program;
2. identifying the risks that would potentially emerge in the program;
3. assessing, quantifying, and prioritizing those risks;
4. developing a response to those risks; and,
5. monitoring and managing risk, both those identified and new emerging risks, during program execution.

The risk response portion of risk management consists of addressing each high priority risk and developing a risk response (mitigation plan) or countermeasure (for threats) or an enhancement plan (for opportunities). Project teams also monitor the overall project risk which is the effect of uncertainty on the project as a whole. Management of overall project risk aims to keep project risk exposure within an acceptable range. Management strategies include reducing drivers of threats, promoting drivers of opportunities, and maximizing the probability of achieving overall project objectives.

Individual project risks are different from overall program risks. Overall program risk represents the effect of uncertainty on the program as a whole. It is more than the sum of the individual risks within a program, since it includes all sources of program uncertainty. It represents the exposure of stakeholders to the implications of variations in

program outcomes, both positive and negative.[83] As part of the cost estimating industry standard, it is important to conduct a risk and uncertainty analysis to identify the areas within the estimate with a significant risk or opportunity.[84]

Q. How did Pegasus-Global assess the PRP's risk management?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG to provide risk management for the Program. The evaluations were supplemented by interviews with key Program personnel. The documents reviewed included the *Pickering Refurbishment Project Controls Program Management Plan (R001)* and the *Pickering Refurbishment Risk Program Management Plan (Rev R001).*[85] The *Pickering Risk Program Management Plan* provides direction as to both the day-to-day risk management activities and the risk management preparations for authorization packages presented at funding gates/committees.

PRP also uses a risk register to identify, categorize, and track risks. The primary purpose of the risk register is to support the owner's management decisions and actions and to avoid and/or minimize cost overruns and delays. The likelihood of occurrence and the nature and magnitude of the risks are used for prioritizing risk mitigation actions. The risk register is a tool for allocating managerial responsibility for specific tasks and for reporting and monitoring the status of the risks. A key facet of the PRP Risk Program is there is just one risk register for all Program participants, including vendors.[86] It is common for many projects to have the owner utilizing one risk register for the project/program and

[83] *PMI PMBOK.* p. 397 (6th ed. 2017)
[84] *AACE International Recommended Practice No. 34R-05, Basis of Estimate.* (05 Oct 2021)
[85] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003.* (05 Sep 2025); *Pickering Refurbishment Risk Program Management Plan, NK30-PLAN-00120-10014.* (08 Sep 2025)
[86] *Pickering Refurbishment Release Quality Estimate-Basis of Estimate (BOE), NK30-REP-00120-00001,* p. 29 (30 Nov 2025)

contractors/vendors will having their own risk registers for their respective scope risks (potentially leading to gaps or duplication in the risk management efforts). OPG's approach for the PRP is to have all Program risks, whether a vendor or the owner has ownership or responsibility for a particular risk, captured in one register that provides a more transparent view of the Program's risk status to stakeholders.

Q. What are Pegasus-Global's findings relative to risk management?

A. OPG has developed a robust risk management program for identifying, assessing, quantifying, monitoring, and managing risks, with clear lines of accountability established. Risks are identified through a number of sources, including operating experience and external lessons learned, meetings with subject matter experts, risk management meetings, project status meetings, project manager direction, and through the Project Controls Risk Department proactively seeking input and providing oversight support. Specific activities that were performed included: facilitated risk workshops by PRP risk management team and OPG's Enterprise Project Risk Management team, BOE and contingency development reviews, and project schedule reviews. Risk owners are assigned to each risk with actions created based on risk responses and any co-relations of risks to each other are recorded. Risks are then qualitatively assessed for schedule and cost impact using a defined Program risk assessment matrix for PRP. In addition to the qualitative assessment, the risks are assessed quantitatively, using a QRA methodology.[87]

The risks are tracked in a risk register, common to all Program members. The risk register identifies FOAK-specific risks.[88] Having one risk register for the Program that captures not only the owner's risks but also the vendors' risks is a best practice.

[87] *Pickering Refurbishment Risk Program Management Plan, NK30-PLAN-00120-10014 (R001).* (08 Sep 2025)
[88] *Risk Register – 08081(v 2).* (27 Aug 2025)

Pegasus-Global determined through its review of the Program record and interviews with OPG personnel that risks are reported as part of the monthly reporting cycle, including top risks from each bundle and function and key PRP risks. Additional reporting is provided through a Risk Oversight Committee, Program and Board reports, and stakeholder reports and reviews. The type of information included in the risk reporting includes a description of the risk, response strategy and status, current risk score, post-risk response risk score, and target date for reaching post-risk response score. The risk scores measure the probability of occurrence, schedule impact, and financial impact of a given risk and assist those inside and outside the Program in quickly identifying the biggest risks to the Program at a given point in time.

OPG evaluated risks and uncertainties for each segment of the Program, leading to the development of schedule and estimate contingency and the basis for the high-confidence (P90) schedule and estimate.

OPG's risk management process provides the authority that ties together all the activities that are described earlier in this report – i.e., risk identification, analysis, and mitigation – with a functional complete perspective. The process is an integral part of the overall Program planning that informs members of the PRP of the risks to the Program, how they will be managed, and who will manage them through execution. OPG's risk management process is also supported through the incorporation of risks specific to scope or scope related items into the individual project management plans.

Q. What are your conclusions regarding the Program's risk management process?

A. Based on Pegasus-Global's review of the Program's risk management to date and the processes and procedures, as well as interviews with PRP personnel, I conclude that PRP's

risk management processes are consistent with industry standards for the overall program process and analysis of the risks. The risk management process provides OPG with the necessary guidance and direction to ensure risks are closely monitored and managed to minimize threats to the $26.84 billion RQE. PRP's risk management processes utilize the fundamental steps of planning, identification, assessment, treatment, and monitoring and control, which align with industry standard practices such as those prescribed by PMI and AACE.[89] This alignment ensures that the risk management processes established and utilized by OPG on the PRP encompass the industry standard practices that support robust risk management. Regarding FOAK/FIAW risks, as I noted above in the Pre-Execution Planning section of this report, I find OPG's assessment and management of megaproject and FOAK/FIAW risks to be reasonable and appropriate to support the PRP, aligned with industry standard practices, and consistent with what I would expect for a program of this nature.

Q. In your opinion, will OPG's risk management process assist OPG in maintaining confidence that the PRP can be executed within the $26.84 billion estimate?

A. Yes. Through a reasonable process, OPG has identified those known risks that could potentially impact the Program's cost and schedule and has instituted risk management practices in accordance with industry standards. These practices should allow for early identification should any of those risks emerge, allowing OPG to quickly implement the mitigation plans, thereby either avoiding or minimizing the impact of that risk. Further, OPG has developed, through its Monte Carlo risk simulation modeling, the appropriate risk

[89] *PMI PMBOK.* p. 395 (6th ed. 2017); *AACE International Recommended Practice No. 62R-11, Risk Assessment: Identification and Qualitative Analysis.* (18 Feb 2022); and, *AACE International Recommended Practice No. 63R-11, Risk Treatment.* (23 Aug 2012)

contingency to address such risks, thereby increasing confidence that the Program can be executed within the $26.84 billion RQE based on what is currently known.

iv. Scope / Change

Q. What are the industry standards relative to how owners apply scope and change controls?

A. Change is inevitable on a megaproject and PMI explains that:[90]

> *A single change can create several impacts. For example, on a large construction project, a change in requirements can cause contractual changes with the primary contractor, subcontractors, suppliers, or others. In turn, those changes can create an impact on project cost, schedule, scope, and performance. Subsequently, these changes could invoke a change control protocol for obtaining approvals from entities in external systems, such as the service providers, regulators, finances, and government authorities.*
>
> *While it is possible to predict some of the changes in advance, many of the changes that can impact the project during its life cycle emerge in real time. With system thinking, including constant attention to internal and external conditions, the project team can navigate a wide spectrum of changes and impacts to keep the project in agreement with the relevant stakeholders.*

The primary objective of scope/change control is to ensure that each proposed change to scope, cost or schedule is adequately defined, reviewed and approved before implementation by the project. Pegasus-Global evaluated the scope and change controls for the Program using PMI standards. As explained by PMI:[91]

> *Change control is the process of reviewing all change requests; approving changes and managing changes to deliverables, project documents, and the project management plan; and communicating the decisions. This process reviews all requests for changes to project documents, deliverables, or the project management plan and determines the resolution of the change requests. The key benefit of this process is that it allows for documented changes within the project to be considered in an integrated manner while*

[90] *PMI, The Standard for Project Management.* p. 38 (2021)
[91] *PMI PMBOK*. p. 113 (6th ed. 2017)

addressing overall project risk, which often arises from changes made without consideration of the overall project objectives or plans.

Q. How did Pegasus-Global assess the change/scope management process?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG to provide scope and change management of the Program. The evaluations were supplemented by interviews with key Program personnel. Pegasus-Global reviewed the *Pickering Refurbishment Project Controls Program Management Plan (R001)* procedure which provides a high-level overview of how change management will be performed on the PRP.[92] The *Pickering Refurbishment Program - Refurbishment Change Control Board (R02)* procedure was also reviewed which explains the roles and responsibilities of the RCCB.[93] Pegasus-Global also reviewed the *Project Integrated Change Control (R4)* procedure which explains the integrated change control process.[94] The observations from the evaluations were assessed against industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

Q. What are Pegasus-Global's findings relative to change/scope management for the Program?

A. As detailed in the project controls plan, the formal change control process ensures that all changes are properly controlled and documented to:[95]

- *Minimize the impact to program cost, schedule and scope by documenting, analyzing, and approving the nature and cause of project changes.*
- *Manage updates to project scope, schedule and/or cost project performance baselines.*

[92] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003-R001.* (05 Sep 2025)
[93] *Pickering Refurbishment Program - Refurbishment Change Control Board, NK30-TOR-09701-00002-R02.* (19 Aug 2025)
[94] *OPG Project Integrated Change Control, OPG-MAN-00120-0016-R4.* (31 May 2022)
[95] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003-R001.* p. 12 (05 Sep 2025)

- *Manage program contingency fund allocation.*

The change control process will utilize the ePMX Change Control Module, with baseline cost updates utilizing EcoSys, and baseline schedule updates utilizing Primavera P6. The RCCB is responsible for the approval of new scope additions and changes to existing scope, which may have impacts to schedule and cost. The RCCB meets monthly, with the results of the meeting being distributed to the project teams. The voting members of the RCCB include:

- Director of Refurbishment Engineering
- Director of Refurbishment Operations & Maintenance
- Director of Refurbishment Project Controls
- Refurbishment Finance Controller

The approval authority limits for the RCCB are cost impacts that do not exceed $10 million and schedule impacts that do not impact the critical path by more than two days. For potential changes that exceed the RCCB approval authority limits, the potential change is escalated to the SVP of Refurbishment Execution for approval. The SVP of Refurbishment Execution may then escalate the potential change to the Refurbishment ELT if necessary. The exception to the RCCB process is for potential changes to approved scope for realized risks or uncertainty that request a drawdown from bundle contingency which may be approved by the bundle director and then provided to the RCCB.

Q. What are your conclusions relative to scope and change management?

A. I conclude that the PRP's approach to change and scope management is consistent with the expectations outlined by PMI. The change management process is sound and clearly lays

out the process flows and responsibilities for implementation of changes from initiation through to review and approval.

v. Reporting

Q. What are the industry standards relative to reporting on megaprojects?

A. Effective reporting ensures timely and accurate delivery of progress metrics, which allow project management to make timely and informed decisions to improve project performance. Pegasus-Global assessed the reporting process for the Program using PMI standards. As explained by PMI:[96]

> *Establishing effective measures helps to ensure that the right things are measured and reported to stakeholders. Effective measures allow for tracking, evaluating, and reporting information that can communicate project status, help improve project performance, and reduce the likelihood of performance deterioration. These measures allow the project team to use information to make timely decisions and take effective actions.*

Q. How did Pegasus-Global assess PRP's reporting process?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG to address the reporting process for the Program. The evaluations were supplemented by interviews with key Program personnel. Pegasus-Global reviewed the *Project Controls Program Management Plan (R001)* procedure which provides a high-level overview of the performance measurement and reporting.[97] I also reviewed the *Project Communication and Stakeholder Management Plan (R006)* which provides details on how the Program will ensure that the information needs of the Program Team and stakeholders are met.[98] The observations from the evaluation were assessed against

[96] *PMI PMBOK.* p. 95 (7th ed. 2021)
[97] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003_R001.* (05 Sep 2025)
[98] *OPG Project Communication and Stakeholder Management, OPG-MAN-00120-0017.* (31 Jan 2024)

industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

Q. What are Pegasus-Global's findings relative to reporting?

A. The individual project managers will be responsible for providing accurate measurement and reporting for their scopes of work. The PRP will maintain a Nuclear Refurbishment Reporting Website to function as the repository for official reports. The generated reports include:[99]

- *Cost performance reports using baseline cost data from EcoSys.*
- *Schedule performance reports based on Primavera P6.*
- *Actual cost collected from Financial Reporting & Analytics source systems.*
- *Milestone reports using schedule data from Primavera P6 identifying progress on specific milestone types or reporting events at all levels form program down to the individual milestones.*
- *Engineering progress reports using schedule data from Primavera P6 and information regarding engineering scope entered into ePMX by the line of business.*
- *Risk Management statistics reports using actions, risks, issues and decisions entered into the ePMX tool.*

The *Project Communication and Stakeholder Management Plan* ensures that the information needs of the Program and the stakeholders are met through effective information reporting and communications. It also provides the processes to identify potential stakeholders, their expectations, and the development of effective engagement strategies. The Integrated Reporting Plan outlines how the Program performance information flows from the project teams up to the BOD and ELT. It supports timely, insight driven decisions at the proper organizational level.

[99] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003-R001.* pp. 15-16 (05 Sep 2025)

Q. What are your conclusions relative to reporting?

A. I conclude that the reporting controls are consistent with what we have seen on other projects of a similar size and magnitude and align with industry standards and best practices. The reporting controls will ensure that accurate information is reported in a timely manner to the proper stakeholders. The software tools and systems selected are well known and utilized throughout the construction industry.

D. LESSONS LEARNED PROCESS

Q. What are the industry standards related to lessons learned?

A. Industry standards, such as PMI's *PMBOK* or AACE's recommended practice on *Project Planning*, recognize the importance of lessons learned, but generally limit their discussion to the importance of capturing such knowledge, such as through maintaining a lessons learned register.[100]

Q. How did Pegasus-Global assess the lessons learned process for PRP?

A. Pegasus-Global began its evaluation by examining the policies and procedures implemented by OPG to direct the lessons learned process for the Program. The evaluations were supplemented by interviews with key Program personnel. We evaluated the *OPG Lessons Learned Guide (R003)* which serves as an OPG guide that details and defines OPG's lessons learned program.[101] We also evaluated other documents that were related to or referenced lessons learned, including the *Pickering Refurbishment Project Controls Management Plan (R001),* the *Pickering Retube, Feeder, and Boiler Replacement (RFBR) Project Management Plan (R002),* the *Pickering Deep Water Intake (DWI) and Site*

[100] *PMI, Governance of Portfolios, Programs, and Projects: A Practice Guide.* p. 38 (2016); *PMI PMBOK*. pp. 151, 180, 185 (7th ed. 2021); *AACE International, Recommended Practice No. 39R-06, Project Planning – As Applied in Engineering and Construction for Capital Projects.* p. 8 (Dec. 2011)
[101] *Lessons Learned Guide, OPG-GUID-00120-10054.* (25 Jun 2025)

Improvement Modifications Project Management Plan (R002), and the *Pickering Refurbishment Balance of Plant Program Management Plan (R001).* [102] The observations from the evaluation were assessed against industry standards to ensure the policies and procedures in place are effective tools to plan and manage the Program.

Q. What are Pegasus-Global's findings related to OPG's lessons learned process?

A. OPG recognizes the value of lessons learned to establish and sustain a culture of continuous improvement.[103] The *Lessons Learned Guide* establishes a process that uses a three-phased approach: identification and documentation; validation and analyzation; and retrieval and incorporation, which we found to be consistent with lesson learned practices used in other large and complex programs. The identification and documentation phase encourages capture of lessons learned in real time and throughout the Program and offers an extensive list of key sources of lessons learned. The process also recognizes lessons learned workshops as a significant source of lessons learned. The process establishes a single repository for lessons learned. The process includes automated reminders to complete lessons learned documentation. In the validation and analyzation phase, lessons learned are divided into a prioritized tiering system. Tier 1 (highest priority) includes lessons learned that have significant opportunities or threats associated with them (i.e. potential savings or avoidance of >20% of overall Program cost) and/or changes that impact the overall Program. Tier 1 lessons learned require formal action tracking and may require additional assessments and workshops to fulfill. In the retrieval and incorporation phase, the Project

[102] *Pickering Refurbishment Project Controls Program Management Plan, NK30-PLAN-00120-00003-R001.* (05 Sep 2025); *Pickering Retube, Feeder and Boiler Replacement (RFBR) Project Management Plan, NK30-PMP-09701-00005.* (08 Sep 2025); *Pickering Deep Water Intake (DWI) and Site Improvement Modifications Project Management Plan, NK30-PMP-09701-00007.* (11 Nov 2025); and *Pickering Refurbishment Balance of Plant Program Management Plan, NK30-PLAN-00120-00027.* (09 Jun 2025)
[103] *Lessons Learned Guide, OPG-GUID-00120-10054.* p. 4 (25 Jun 2025)

Teams are encouraged to access and incorporate lessons learned into their project, including documenting how lessons learned were reviewed and incorporated into the project planning. Roles and accountabilities are defined to ensure responsibilities are clear with regard to lessons learned.[104]

In review of the project management plans established by OPG for the major bundles of the PRP, the planning and application of lessons learned on the PRP is described.[105] By incorporating the lessons learned process into the project planning and execution plans, OPG ensures that lessons learned are appropriately both applied to the current works and identified from the current experience to apply to future works.

Q. What are your conclusions regarding lessons learned on the PRP?

A. I found that the lessons learned process, as detailed in the *Lessons Learned Guide,* is a robust guide for effectively identifying, evaluating, incorporating, and verifying lessons learned on the Program. I found OPG's lessons learned process goes beyond industry standards by establishing a process that ensures effective and continued capture, documentation, evaluation, and incorporation and verification of lessons learned. Further, I found that OPG's recognition in the project management plans of each bundle demonstrates a commitment to rigorous attention to and incorporation of lessons learned.

[104] *Lessons Learned Guide, OPG-GUID-00120-10054.* pp. 5-12 (25 Jun 2025)
[105] *Pickering Retube, Feeder and Boiler Replacement (RFBR) Project Management Plan, NK30-PMP-09701-00005-R002.* p. 44 (08 Sep 2025); *Pickering Deep Water Intake (DWI) and Site Improvement Modifications Project Management Plan, NK30-PMP-09701-00007-R002.* p. 48 (11 Nov 2025); and *Pickering Refurbishment Balance of Plant Program Management Plan, NK30-PLAN-00120-00027- R001.* p. 28 (09 Jun 2025)

VI. CONCLUSION

Q. What is your conclusion regarding your assessment of the PRP?

A. Based on Pegasus-Global's evaluation of the pre-execution planning, project governance, and project controls in comparison to generally accepted industry standards and practices, I conclude that OPG has effective tools and processes in place, has a robust enterprise program management organization, and is properly preparing to execute a program of this size and complexity.

Q. Does this conclude your report?

A. Yes, this concludes my report.

Joseph Miller

President & Chief Executive Officer

Pegasus-Global Holdings, Inc.

Contact

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+1-513-312-1641

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j.miller@pegasus-global.com

Address
964 Wessington Manor Lane, Fort Mill, SC 29715

Website
www.pegasus-global.com

Education

University of North Carolina at Chapel Hill
Strategic Leadership Program, 2009

Indiana State University
Business Administration Coursework (12 of 16 MBA courses completed), 1997

Purdue University
Bachelor Degree in Mechanical Engineering, 1991

Areas of Expertise

- Energy Transition
- Engineering
- Environmental Compliance Planning
- Expert Witnessing
- Financial Analysis
- Generation and Regulatory Strategy
- Mergers & Acquisitions
- Operations Management

Career Summary

2022 - present
President & Chief Executive Officer, Pegasus-Global Holdings, Inc.

2019 - 2022
Executive Consultant, Pegasus-Global Holdings, Inc.

2014 - 2019
Vice President/Central Services & Compliance, Charlotte, NC, Duke Energy Corporation

2012 - 2014
General Manager/Strategic Engineering, Charlotte, NC, Duke Energy Corporation

2010 - 2012
General Manager/Generation Support, Charlotte, NC, Duke Energy Corporation

2006 - 2010
Station Manager/Power Operations, Zimmer Station, OH, Duke Energy Corporation

2002 - 2006
Station Manager/ Power Operations, East Bend Station, KY, Duke Energy Corporation

2000 - 2002
Group Manager/Power Operations, Cincinnati, OH, Duke Energy Corporation

1997 - 2000
Support Team Group Leader/Power Operations, Cayuga Station, IN, Duke Energy Corporation

1991 - 1997
Staff Engineer/Power Operations, Cayuga Station, IN, Duke Energy Corporation

Profile

Mr. Miller is an accomplished energy executive valued for leadership in operations, engineering, generation fleet modernization, and both generation and regulatory strategy. His experience includes sponsoring testimony before utility commissions in 58 regulatory proceedings, including base rate, fuel, CPCN, plant abandonment and environmental cases in multiple states. He has held several leadership positions at power plant and corporate levels, including managing both regulated and merchant power plants. Mr. Miller has proven to be a strong, effective communicator and problem solver who thrives in environments that require the capacity to prioritize concurrent projects both calmly and efficiently. Mr. Miller is a sought-after keynote speaker, panelist, and industry conference presenter.

Prior to joining Pegasus-Global, Mr. Miller provided leadership and regulatory support in modernizing one of the largest generation fleets in the United States. Mr. Miller led the analysis and program development for fleet compliance with complex environmental regulations, including MATS, CSAPR, 316(b), ELG and CCR. He generated the idea and strategy to convert three coal plants to also burn natural gas, significantly reducing fuel cost and carbon emissions. He has had significant involvement in acquisition and divestiture due diligence, evaluation and negotiations.

Experience

Pegasus-Global Holdings, Inc.

President & Chief Executive Officer, 2022-Present
Executive Consultant, 2019-2022

Leading a firm that is globally recognized for providing expert technical, strategic and dispute services to the energy and infrastructure sectors.

Duke Energy Corporation

Vice President/Central Services & Compliance, Charlotte, NC, 2014-2019

- Provided oversight of 550 employees, engineering, environmental compliance planning, generation and regulatory strategy, NERC and regulatory compliance, technical services and maintenance services for the company's fleet of approximately 100 fossil and renewable power plants in North Carolina, South Carolina, Ohio, Indiana, Kentucky and Florida.
- Chaired enterprise engineering council.

General Manager/Strategic Engineering, Charlotte, NC, 2012-2014

- Negotiated agreement with Indiana Office of Utility Consumer Counselor on $400 million environmental filing.
- Led multi-department initiative resulting in early retirement of fossil plants.
- Identified unique compliance method that allowed Crystal River units 1 & 2 (900MW) to comply with BART and MATS rules, reducing grid reliability concerns and avoiding $200 million in transmission projects.
- Implemented plant retrofits to improve fuel flexibility to achieve $168 million in savings and maintain reliability.
- Led the evaluation and negotiation of generation asset purchase.
- Represented company in numerous regulatory proceedings.

Experience

General Manager/Generation Support, Charlotte, NC, 2010-2012

- Headed up financial and engineering analysis of capital projects and project controls responsibility for the company's fleet of nuclear, fossil and hydroelectric plants.
- Facilitated and carried out all facets of environmental compliance planning and strategy.
- Served as Merger Integration Team Leader of Fossil Hydro Generation Operations Services Team (2011).

Station Manager/Power Operations, Zimmer Station, OH, 2006-2010

- Personally surpassed 13 years and 2.75 million worked-hours leading employees without a lost-time injury.
- Introduced improvements to gypsum processing and scrubber waste operations, saving $5 million per year.
- Facilitated and executed needed modifications to allow station to burn lower cost coal from the Illinois Basin.
- Served on the management committee during labor negotiations with IBEW 1347 (2006).

Station Manager/Power Operations, East Bend Station, KY, 2002-2006

- Led efficiency-improvement effort allowing station to achieve its second-best heat rate in 25-year history.
- Improved SO2 scrubbing and fuel cost to become the cheapest plant in the Cincinnati region.
- Led corporate Human Resources and Benefits teams through a continuous improvement process resulting in annual cost savings of $10 million.

Group Manager/Power Operations, Cincinnati, OH, 2000-2002

Support Team Group Leader/Power Operations, Cayuga Station, IN, 1997-2000

Staff Engineer/Power Operations, Cayuga Station, IN, 1991-1997

Fortis Inc. Holdings, Inc.

Appendix

Nature of Proceeding	Petition Date	Company	Regulatory Body	Docket #
Ongoing Review of Edwardsport IGCC Project	1/27/2010	Duke Energy Indiana	IURC	43114
Fuel and Fuel-Related Cost Adjustment	10/18/2011	Duke Energy Carolinas	PSC of SC	2012-3-E
Fuel and Fuel-Related Cost Adjustment	3/7/2012	Duke Energy Carolinas	NCUC	E-7 Sub 1002
Environmental Cost Recovery	4/26/2012	Duke Energy Indiana	IURC	ECR - 19
CPCN for Pollution Control Equipment	6/28/2012	Duke Energy Indiana	IURC	44217
Fuel and Fuel-Related Cost Adjustment	10/23/2012	Duke Energy Progress	PSC of SC	2013-1-E
Environmental Cost Recovery	10/26/2012	Duke Energy Indiana	IURC	ECR - 20
Fuel and Fuel-Related Cost Adjustment	12/28/2012	Duke Energy Carolinas	PSC of SC	2013-3-E
Base Rate Adjustment	1/4/2013	Duke Energy Carolinas	NCUC	E-7 Sub 1026
Base Rate Adjustment	2/15/2013	Duke Energy Carolinas	PSC of SC	2013-59-E
Fuel and Fuel-Related Cost Adjustment	3/6/2013	Duke Energy Carolinas	NCUC	E-7 Sub 1033
Environmental Cost Recovery	4/29/2013	Duke Energy Indiana	IURC	ECR - 21
Fuel and Fuel-Related Cost Adjustment	6/12/2013	Duke Energy Progress	NCUC	E-7 Sub 1031
Fuel and Fuel-Related Cost Adjustment	10/8/2013	Duke Energy Progress	PSC of SC	2014-1-E
Fuel and Fuel-Related Cost Adjustment	10/8/2013	Duke Energy Carolinas	PSC of SC	2014-3-E
Environmental Cost Recovery	10/28/2013	Duke Energy Indiana	IURC	ECR - 22
CPCN for Pollution Control Equipment	11/7/2013	Duke Energy Indiana	IURC	44418
Fuel and Fuel-Related Cost Adjustment	2/24/2014	Duke Energy Carolinas	NCUC	E-7 Sub 1051
Environmental Cost Recovery	4/28/2014	Duke Energy Indiana	IURC	ECR - 23
Fuel and Fuel-Related Cost Adjustment	5/28/2014	Duke Energy Progress	NCUC	E-7 Sub 1045

Appendix

Nature of Proceeding	Petition Date	Company	Regulatory Body	Docket #
Fuel and Fuel-Related Cost Adjustment	10/7/2014	Duke Energy Progress	PSC of SC	2015-1-E
Fuel and Fuel-Related Cost Adjustment	10/7/2014	Duke Energy Carolinas	PSC of SC	2015-3-E
Environmental Cost Recovery	10/28/2014	Duke Energy Indiana	IURC	ECR - 24
Fuel and Fuel-Related Cost Adjustment	2/10/2015	Duke Energy Carolinas	NCUC	E-7 Sub 1072
Environmental Cost Recovery	4/28/2015	Duke Energy Indiana	IURC	ECR - 25
Fuel and Fuel-Related Cost Adjustment	4/29/2015	Duke Energy Progress	NCUC	E-7 Sub 1069
Fuel and Fuel-Related Cost Adjustment	10/1/2015	Duke Energy Progress	PSC of SC	2016-1-E
Fuel and Fuel-Related Cost Adjustment	10/1/2015	Duke Energy Carolinas	PSC of SC	2016-3-E
Environmental Cost Recovery	10/28/2015	Duke Energy Indiana	IURC	ECR - 26
Fuel and Fuel-Related Cost Adjustment	2/3/2016	Duke Energy Carolinas	NCUC	E-7 Sub 1104
Environmental Cost Recovery	4/28/2016	Duke Energy Indiana	IURC	ECR - 27
Fuel and Fuel-Related Cost Adjustment	5/17/2016	Duke Energy Progress	NCUC	E-7 Sub 1107
Base Rate Adjustment	6/2/2016	Duke Energy Progress	PSC of SC	2016-227-E
CPCN for Dry Bottom Ash Conversion	7/28/2016	Duke Energy Kentucky	KY PSC	2016-00268
Fuel and Fuel-Related Cost Adjustment	10/12/2016	Duke Energy Progress	PSC of SC	2017-1-E
Fuel and Fuel-Related Cost Adjustment	10/12/2016	Duke Energy Carolinas	PSC of SC	2017-3-E
Environmental Cost Recovery	10/28/2016	Duke Energy Indiana	IURC	ECR - 28
Fuel and Fuel-Related Cost Adjustment	1/5/2017	Duke Energy Carolinas	NCUC	E-7 Sub 1129
Base Rate Adjustment	4/18/2017	Duke Energy Progress	NCUC	E-2 Sub 1142
Environmental Cost Recovery	4/28/2017	Duke Energy Indiana	IURC	ECR - 29

Fortis Inc. Holdings, Inc.

Appendix

Nature of Proceeding	Petition Date	Company	Regulatory Body	Docket #
Fuel and Fuel-Related Cost Adjustment	5/3/2017	Duke Energy Progress	NCUC	E-7 Sub 1146
CPCN for Alternate Fuel Source	5/31/2017	Duke Energy Kentucky	KY PSC	2017-00186
Base Rate Adjustment	6/7/2017	Duke Energy Carolinas	NCUC	E-7 Sub 1146
Base Rate Adjustment	9/15/2017	Duke Energy Kentucky	KY PSC	2017-00321
Fuel and Fuel-Related Cost Adjustment	10/4/2017	Duke Energy Progress	PSC of SC	2018-1-E
Fuel and Fuel-Related Cost Adjustment	10/4/2017	Duke Energy Carolinas	PSC of SC	2018-3-E
Environmental Cost Recovery	10/25/2017	Duke Energy Indiana	IURC	ECR - 30
Fuel and Fuel-Related Cost Adjustment	1/4/2018	Duke Energy Carolinas	NCUC	E-7 Sub 1163
Fuel and Fuel-Related Cost Adjustment	3/16/2018	Duke Energy Progress	NCUC	E-7 Sub 1173
Environmental Cost Recovery	4/23/2018	Duke Energy Indiana	IURC	ECR - 31
CPCN for New Landfill	6/15/2018	Duke Energy Kentucky	KY PSC	2018-00156
Base Rate Adjustment	10/9/2018	Duke Energy Progress	PSC of SC	2018-318-E
Base Rate Adjustment	10/9/2018	Duke Energy Carolinas	PSC of SC	2018-319-E
Environmental Cost Recovery	10/22/2018	Duke Energy Indiana	IURC	ECR - 32
Environmental Cost Recovery	4/22/2019	Duke Energy Indiana	IURC	ECR - 33
Plant Decertification and Abandonment	4/2/2021	Public Service Co. of New Mexico	NM PRC	21-00083-UT
Base Rate Adjustment	12/5/2022	Public Service Co. of New Mexico	NM PRC	22-00270-UT
Vogtle 3 & 4 Prudence Review and Rate Adjustment	8/30/2023	Georgia Power Co.	Ga PSC	29849

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BY EMAIL

CONFIDENTIAL — PRIVILEGED

September 19, 2025

Pegasus-Global Holdings, Inc.
1750 Emerick Road
Cle Elum WA USA 98922

Attention: Mr. Joe Miller

Re: Retainer Letter Agreement – Ontario Power Generation – Pickering Refurbishment Project -Management Assessment

Dear Mr. Miller:

Torys LLP ("Torys" or "we") represents Ontario Power Generation ("OPG") in connection with its planned application to the Ontario Energy Board (the "Board") for payment amounts in respect of its prescribed electricity generation facilities for a period starting in 2027 (the "Application").

We confirm that, on behalf of and to assist us in providing legal advice to OPG in connection with the Application, Torys has agreed to retain Pegasus-Global Holdings, Inc. (the "Consultant" or "you"), effective as of the date first written above (the "Effective Date"), to provide consulting services as described in this letter. By signing back a copy of this letter, the Consultant agrees that this letter contains the agreed-upon terms and conditions of its retainer with Torys effective on the Effective Date, subject to amendment by written agreement between the parties (the "Retainer Agreement").

1. **No Conflict**

The Consultant does not have any conflict of interest or other constraints on its ability to provide expert advice in connection with this Retainer Agreement. You confirm that you are free to provide your services to Torys in connection with Torys' representation of OPG in the Application. You agree that during this engagement you will not provide, directly or indirectly, any services to any other party in connection with the matters at issue in the Application.

2. Consultant Expertise

The Consultant has been selected to provide consulting services to Torys in connection with the Application as further described in Section 3 below. The sponsors of the work of the Consultant and the persons who have the relevant expertise will be:

- Joe Miller President and CEO
- Jeremy Clark Senior Vice President
- Glen Palmer Senior Executive Consultant
- Steve Owens Senior Executive Consultant
- David Oliver Senior Consultant
- Jacob Odiaga Senior Consultant
- Other experienced professionals from the Consultant, as may be required and agreed to by the parties in advance.

(collectively referred to as the "Sponsors").

3. Scope of Services and Work Product

The Consultant will:

(a) conduct an assessment of OPG's project management and preparedness with respect to the Pickering Refurbishment Project (the "Study");

(b) if requested by Torys, produce a written report detailing the Study's methodology, analysis performed and the Consultant's findings and conclusions (the "Report"), which may be filed by Torys with the Board in connection with the Application; and

(c) if requested by Torys, provide support during the hearing of the Application in connection with the scope of the services provided hereunder ("Application Support Services" and, together with the Study and any Report(s), the "Services"), which may include:

(i) assistance in responding to interrogatories applicable to the Report;

(ii) appearance at a technical conference to respond to oral questions on the Report;

(iii) testifying about the Report as an expert witness either orally or in writing; and

(iv) assisting in responding to undertakings (i.e., written questions during a hearing) on the Report.

4. **Fees and Invoices**

By entering into this Retainer Agreement, the Consultant acknowledges that:

(a) the price for the Consultant to perform the Study, participate in the Discussion of Findings, and prepare and deliver a Report (if requested by Torys) shall be determined based on the actual time spent and the hourly rates set forth in paragraph (c) below and shall in no event exceed [redacted] (net of HST) without prior written approval from Torys or OPG; and

(b) the price for the Consultant to provide Application Support Services (if requested by Torys) will be charged at the following hourly rates:

- President and CEO [redacted]
- Senior Vice President [redacted]
- Senior Executive Consultant [redacted]
- Senior Consultant [redacted]

All amounts stated herein are in Canadian dollars unless otherwise specified herein.

Any disbursements for additional incidentals incurred by the Consultant in relation to this Retainer Agreement must be pre-approved by Torys or OPG in writing and shall be in accordance with Schedule "C" (OPG's Business Expense Standards). In the event of conflict between any provisions of Schedule "C" and any policies or fee schedules of the Consultant relating to the charging of travel expenses or other incidentals, the relevant provisions of Schedule "C" shall prevail. Torys reserves the right to deduct any applicable non-resident withholding taxes from any amounts owing to the Consultant under this Retainer Agreement and remit such amounts to the applicable taxation authority.

The Consultant shall direct all invoices relating to Services performed by it under this Retainer Agreement to Torys, to the attention of:

Mr. Charles Keizer
Torys LLP
79 Wellington St. W., 30th Floor
Box 270, TD South Tower
Toronto, ON M5K 1N2
ckeizer@torys.com

with a copy to OPG, to the attention of:

Ms. Aimee Collier
Vice-President, Law Division
Ontario Power Generation
700 University Avenue, H18 E27.1
Toronto, ON M5G 1X6
aimee.collier@opg.com

Invoices shall include at least the following information:

(a) identification of the billing period to which the account relates;

(b) an itemized summary of the services that have been undertaken by you, including a brief description thereof, the date on which the services were rendered, the time spent on the services, the individual who performed the services, and the billing rate of such individual; and

(c) an itemized and brief description of all expenses incurred during the billing period, with copies of supporting invoices.

Torys will send your invoice to OPG for its approval and if OPG does not approve your invoice, Torys will send it back to you for revision. Once OPG approves the invoice, Torys will submit the invoice to OPG's payment system. OPG pays invoices once per month (on the 25th of each month) and, for payment to be made on the 25th of a particular month, the invoice must have been approved in OPG's payment system by the 25th of the prior month. Once Torys receives the payment from OPG, Torys will send payment to you.

5. **Confidentiality**

All work performed by the Consultant in connection with this Retainer Agreement, including all findings, opinions and conclusions the Consultant reaches in relation to this Retainer Agreement, and any communications relating thereto, are strictly privileged and confidential and shall not be disclosed to any other person or party without the prior written consent of Torys or OPG. The Consultant agrees to designate all written communications and material accordingly. The Consultant further agrees to promptly notify Torys in the event that the Consultant receives a request to disclose information relating to this matter, and agrees to cooperate with Torys, to the fullest extent permitted by law, to prevent or limit the disclosure of such material or otherwise preserve the privileged and confidential status of such material.

The Consultant agrees to hold in confidence: (a) all information provided to the Consultant, and (b) the Consultant's opinions to Torys and to OPG as they relate to the information, whether the information or opinions are documentary or oral (collectively, the "Confidential Information"). The Consultant will not disclose the Confidential Information to any person unless Torys or OPG authorizes you in writing to do so. All documents given to the Consultant in connection with this Retainer Agreement remain the property of Torys or of OPG and are held in trust by the Consultant as agent. The Consultant agrees to return these documents on request. During the engagement, the Confidential Information shall be segregated from other OPG data (including on electronic information systems) and shall not be accessible to individuals other than the Consultant, Torys, and OPG employees requiring access).

The Consultant will not refer to Torys or to OPG, directly or indirectly, in connection with the promotion of its services, without obtaining the prior written consent of Torys or OPG, as the case may be.

6. Intellectual Property

Nothing in this Retainer Agreement shall be deemed to transfer, license, assign, permit the use of, or otherwise convey an interest in whole or in part to the Consultant of any intellectual property belonging to OPG or any of its representatives or any third party whose intellectual property is in OPG's custody or control, and the use by the Consultant of any such intellectual property shall be subject to the prior written approval of OPG.

Torys and OPG shall at all times have full rights and title to all works prepared, generated or created by the Consultant pursuant to this Retainer Agreement, including without limitation any reports, presentations, status updates, or other documents created by the Consultant, and any related works, modifications or additions thereto (the "Work Product"), and may at all times take possession of or use any completed or partially completed Work Product, notwithstanding any provision, express or implied, to the contrary. Without limiting the generality of the foregoing, OPG shall own all intellectual property rights in all Work Product, and the Consultant hereby waives and assigns to OPG any such rights, and agrees to give OPG and its representatives all assistance as may be reasonably required to perfect such rights including, without limitation, obtaining waiver of moral rights from any of the Consultant's employees, partners or other representatives.

Notwithstanding the foregoing, the Consultant shall retain sole and exclusive ownership of any pre-existing Consultant tools, methodologies, proprietary research and data, together will all intellectual property rights therein (the "Consultant Property"). Consultant grants to Torys and OPG a fully paid up, irrevocable, perpetual, non-exclusive, royalty-free license to use the Consultant Property contained within the Work Product for the purposes intended in this Retainer Agreement.

7. Intellectual Property Protection

The Consultant expressly warrants that the delivery, sale or use of the Consultant's Services will not infringe any Canadian or foreign patents, trademarks, copyrights, industrial design or other intellectual property rights and the Consultant shall indemnify and save Torys and OPG harmless from all claims, judgments and decrees that may be entered against Torys, OPG or its representatives and against all damages, liability, costs and expenses (including legal fees and other attendant costs and expenses) Torys or OPG incurs by reason of any infringement or claim thereof.

8. Controlled Nuclear Information

The Consultant has been made aware of certain Canadian federal requirements relating to the import and export of controlled nuclear information, and recognizes that it is an offence for any person to export controlled nuclear information from Canada without an export permit issued for the purpose by the Canadian Nuclear Safety Commission. The Consultant agrees not to remove or cause to be removed from Canada any controlled nuclear information during the performance of the Services, and will promptly raise the issue with OPG where the Consultant is in doubt as to whether information to be removed from Canada as part of the Services may be – or contain – controlled nuclear information.

9. **Termination**

Torys may terminate this Retainer Agreement at any time on written notice to the Consultant. Torys will pay, or will cause OPG to pay, for work performed up to the date of the notice of termination. Upon the termination or expiration of this Retainer Agreement, the Consultant shall return to Torys or destroy any hard copies, and to return to Torys and delete any electronic copies the Consultant may have of all documents and materials in its possession relating to the Services or this Retainer Agreement, including all Confidential Information (defined above) and Work Product, whether completed or not. The Consultant shall, upon request, provide Torys with a certificate of an officer of the Consultant certifying such destruction of hard copies and deletion of electronic copies.

10. **Liability and Indemnification**

The Consultant shall be liable for and shall indemnify and hold harmless Torys and OPG from all claims, demands, actions, penalties, damages, losses, judgments and settlements, liabilities, costs, expenses, including legal fees and other related costs and expenses arising out of, related to, or incident to, the Consultant or any of its representatives' performance of the Services under this Retainer Agreement, including, without limitation:

(a) any breach, violation or non-performance by the Consultant or any of its representatives of any terms, conditions, warranties, obligations or covenants contained in this Retainer Agreement;

(b) any breach or violation by the Consultant or any of its representatives of any applicable laws; and

(c) any actions, omissions, negligence or willful misconduct of the Consultant or any of its representatives.

11. **Limitation of Liability**

Except for breach of obligations under section 5 (Confidentiality), gross negligence, willful misconduct, fraud, breach of applicable laws, including but not limited to privacy laws, and the Consultant's obligation to indemnify under section 7 (Intellectual Property Protection), the Consultant's total liability for any claim arising out of the performance of the Services, regardless of the form of claim, will in no event exceed total fees paid to Consultant hereunder and under no circumstances will either party be liable for any damages in respect of any incidental, punitive, special, indirect or consequential loss, even if that party had been advised of the possibility of such damages including, but not limited to, loss of profits, loss of revenues, failure to realize expected savings, loss of data, loss of business opportunity, or similar losses of any kind.

12. **Insurance**

(a) Unless otherwise specified in this Retainer Agreement, the Consultant shall, during the term of this Retainer Agreement, and at its own expense, maintain and keep in full force and effect:

(i) commercial general liability insurance on an occurrence basis having a minimum inclusive coverage limit, including personal injury and property

damage, of not less than one million dollars ($1,000,000.00) per occurrence, which shall be extended to cover contractual liability, products and completed operations liability, owners/contractors protective liability and must also contain a cross liability clause and a severability of interest clause, and must name OPG and its affiliates as additional insureds; and

(ii) errors and omissions insurance (professional liability) in the amount of not less than two million dollars ($2,000,000.00);

(b) All insurance coverages and limits required to be maintained by the Consultant shall be primary to any insurance maintained by OPG, which shall be excess and non-contributory. Prior to the commencement of the delivery of the Services, the Consultant shall deliver to OPG a certificate of insurance which evidences the Consultant's compliance with this Section, including the provision of a thirty (30) day prior written notice of cancellation, non-renewal or adverse material change, to OPG. The Consultant agrees that the insurance described herein does in no way limit the Consultant's liability pursuant to the indemnity provisions of this Retainer Agreement.

13. **Independence**

By entering into this Retainer Agreement, the Consultant acknowledges and agrees that the Sponsors have received a copy of Rule 13A of the Board's *Rules of Practice and Procedure* concerning expert evidence, and agree to accept the responsibilities that are or may be imposed on them by that rule with respect to testimony before the Board. A copy of the rule and the relevant form are attached as Schedules 'A' and 'B' hereto.

14. **Responsibility Statement**

The Consultant agrees that the Services provided for herein will be performed in a timely, competent, professional manner in accordance with recognized professional consulting standards for similar services to be performed by a leading consulting advisory firm, and that adequate qualified personnel will be assigned for that purpose. If, during the performance of the Services or prior to the Board's issuance of final, non-appealable order(s) disposing of all relevant relief sought in the Application, such Services prove to be faulty or defective by reason of a failure to meet such standards, the Consultant agrees that upon prompt written notification from Torys, such faulty or defective portion of the Services will be redone at no cost to Torys or OPG, up to a maximum amount equivalent to the cost of the Services rendered under this Retainer Agreement, or, at Torys' request, the Consultant will refund an amount equal to the amount paid for the faulty or defective portion of the Services.

15. **Entire Agreement**

This Retainer Agreement, together with all Schedules attached hereto and any agreements and other documents to be delivered pursuant to this Retainer Agreement, constitute the complete agreement between Torys and the Consultant or their respective agents with respect to the subject matter hereof and supersedes any and all prior agreements and understandings. This Retainer

Agreement may be amended only in a written agreement that refers to this Retainer Agreement and is signed by both parties.

16. **Governing Law**

This Retainer Agreement shall be construed and otherwise governed pursuant to the laws of the Province of Ontario and the federal laws of Canada applicable therein.

Sincerely,

TORYS LLP

Per: _____
Name: Charles Keizer

Accepted and agreed to by Pegasus-Global Holdings, Inc.

Signed _____

Name (please print) Joseph A. Miller
(I have the authority to bind the Consultant

TORYS LLP

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SCHEDULE "A"

Rule 13A of the Board's Rules of Practice and Procedure

13A. Expert Evidence

13A.01 A party may engage, and two or more parties may jointly engage, one or more experts to give evidence in a proceeding on issues that are relevant to the expert's area of expertise.

13A.02 An expert shall assist the Board impartially by giving evidence that is fair and objective.

13A.03 An expert's evidence shall, at a minimum, include the following:

- the expert's name, business name and address, and general area of expertise;
- the expert's qualifications, including the expert's relevant educational and professional experience in respect of each issue in the proceeding to which the expert's evidence relates;
- the instructions provided to the expert in relation to the proceeding and, where applicable, to each issue in the proceeding to which the expert's evidence relates;
- the specific information upon which the expert's evidence is based, including a description of any factual assumptions made and research conducted, and a list of the documents relied on by the expert in preparing the evidence;
- in the case of evidence that is provided in response to another expert's evidence, a summary of the points of agreement and disagreement with the other expert's evidence; and
- an acknowledgement of the expert's duty to the Board in **Form A** to these Rules, signed by the expert.

13A.04 In a proceeding where two or more parties have engaged experts, the Board may require two or more of the experts to:

(a) in advance of the hearing, confer with each other for the purposes of, among others, narrowing issues, identifying the points on which their views differ and are in agreement, and preparing a joint written statement to be admissible as evidence at the hearing; and

- at the hearing, appear together as a concurrent expert panel for the purposes of, among others, answering questions from the Board and others as permitted by the Board, and providing comments on the views of another expert on the same panel.

13A.05 The activities referred to in **Rule 13A.04** shall be conducted in accordance with such directions as may be given by the Board, including as to:

(b) scope and timing;

- the involvement of any expert engaged by the Board;
- the costs associated with the conduct of the activities;
- the attendance or non-attendance of counsel for the parties, or of other persons, in respect of the activities referred to in paragraph (a) of **Rule 13A.04**; and
- any issues in relation to confidentiality.

13A.06 A party that engages an expert shall ensure that the expert is made aware of, and has agreed to accept, the responsibilities that are or may be imposed on the expert as set out in this **Rule 13A** and **Form A**[1].

[1] Attached as Schedule 'B' herein.

SCHEDULE "B"

FORM A

Proceeding: .....

ACKNOWLEDGMENT OF EXPERT'S DUTY

1. My name is .....(*name)*. I live at ..... (*city)*, in the ..... (*province/state*) of .....

2. I have been engaged by or on behalf of..... (*name of party/parties)* to provide evidence in relation to the above-noted proceeding before the Ontario Energy Board.

3. I acknowledge that it is my duty to provide evidence in relation to this proceeding as follows:

(a) to provide opinion evidence that is fair, objective and non-partisan;
(b) to provide opinion evidence that is related only to matters that are within my area of expertise; and
(c) to provide such additional assistance as the Board may reasonably require, to determine a matter in issue.

4. I acknowledge that the duty referred to above prevails over any obligation which I may owe to any party by whom or on whose behalf I am engaged.

Date.....

_____
Signature