Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Written submission from Ontario Power Generation Inc.

Mémoire d' Ontario Power Generation Inc.

In the Matter of

À l'égard d'

Ontario Power Generation Inc.

Ontario Power Generation Inc.

Application to amend the Pickering Waste Management Facility to authorize construction and operation of the Pickering component storage structure

Demande de modification du permis de l'installation de gestion des déchets de Pickering pour autoriser la construction et l'exploitation de la structure de stockage des composants de Pickering

Public Hearing - Hearing in writing based on written submissions

Audience Publique - Audience par écrit fondée sur des mémoires

July 2025

Juillet 2025

Canada

ONTARIO POWER GENERATION

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February 18, 2025

CD# 92896-CORR-00531-01606 P

MS. CANDACE SALMON
Commission Registrar,
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
Ottawa, Ontario, K1P 5S9

Dear Ms. Salmon:

Pickering Waste Management Facility –Pickering Component Storage Structure, Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment Commission Member Document

The purpose of this letter is to submit to the Canadian Nuclear Safety Commission, referred to as "the Commission", an addendum to the Pickering Waste Management Facility (PWMF), Waste Facility Operating Licence (WFOL) WFOL-W4-350.00/2028, amendment request to construct and operate the Pickering Component Storage Structure (PCSS) for storage of Low and Intermediate Level Waste (L&ILW) that will be generated by Pickering Nuclear Generating Station (NGS).

This additional interim storage capacity, intended for radioactive component waste/material, will be required to support Pickering NGS Units 5 through 8 refurbishment and Pickering NGS Units 1 through 4 decommissioning activities.

This submission includes the following documentation:

- Attachment 1 provides the compliance matrix for the *Nuclear Safety and Control Act*, and the associated regulations required for the amendment of the PWMF WFOL to construct and operate the PCSS.

- Attachment 2 provides updates to enhance the information provided in Reference 1 to the licence impact assessment of the proposed new licensed activity on PWMF's licensing basis for each of the 15 Safety and Control Areas of PWMF's WFOL. It also provides the description and key attributes of the PCSS, provides the proposed wording for the amendment to PWMF WFOL-W4-350.00/2028 and provides the preliminary assessment of impacts on Aboriginal and/or Treaty rights.

- Enclosure 1 provides 92896-REP-01320-00019 R002, "*Pickering Component Storage Structure Safety Assessment*", which continues to demonstrate that the operation of the PCSS and the storage of L&ILW components will have a negligible effect on the safe facility operation, public and worker safety (R000 previously submitted as Enclosure 1 of Reference 1).

- Enclosure 2 provides 92896-REP-07701-00019 R002, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*", which continues to conclude that the construction and operation of the PCSS will have a negligible impact on the environment (R001 previously submitted as Enclosure 2 of Reference 1).

OPG is requesting the Commission to amend the PWMF, WFOL-W4-350.00/2028, to construct and operate the PCSS for interim storage of L&ILW from Pickering NGS.

In summary, OPG remains committed to the safe operation of the PWMF and re-affirms that the construction and operation of the PCSS will be implemented in accordance with the PWMF licensing basis. L&ILW will be stored safely in the PCSS as presented in the associated safety case without compromise to continued safe facility operation, public and worker safety, and environmental protection. OPG will continue to meet Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

Should you have any questions, please contact Soo Chae, Senior Manager, Strategic Projects Regulatory Affairs at soo.chae@opg.com.

Sincerely,

Kapil Aggarwal M. Eng., P. Eng
Vice President
Nuclear Sustainability Services
Ontario Power Generation Inc.

Encl.

cc:	N. Greencorn	- CNSC (Ottawa)
	M. McLaughlin	- CNSC (Ottawa)
	T. Kalindjian	- CNSC (Ottawa)
	R. van Hoof	- CNSC (Ottawa)
	J. Truong	- CNSC (Ottawa)

References:

1. OPG Letter, K. Aggarwal to C. Salmon, "Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure", May 31, 2024, e-Doc# 7293912, CD# 92896-CORR-00531-01544.

2. OPG Letter, K. Aggarwal to N. Petseva, "Pickering Waste Management Facility – Letter of Intent to Construct the Pickering Component Storage Structure", February 1, 2024, e-Doc# 7214316, CD# 92896-CORR-00531-01485.

ATTACHMENT 1

OPG Letter, K. Aggarwal to C. Salmon, "Pickering Waste Management Facility – Pickering Component Storage Structure, Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment Commission Member Document".

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Licence Compliance Matrix – Nuclear Safety Control Act and Associated Regulations

Prepared By: P. Hendrix

Checked By: B. Noye

ATTACHMENT 1

Licence Compliance Matrix – Nuclear Safety Control Act and Associated Regulations

This Attachment, along with the accompanying letter and Attachment 2 of this submission, provides the information required by the Nuclear Safety and Control Act and the applicable Nuclear Regulations made pursuant to the Act, and constitutes an application by OPG to amend the current Pickering Waste Management Facility (PWMF) Waste Facility Operating Licence WFOL-W4-350.00/2028 to construct and operate the Pickering Component Storage Structure (PCSS) for storage of low and intermediate level waste from Pickering NGS.

The tables below are divided by applicable Regulation and demonstrate how OPG has addressed each applicable regulatory requirement of the subject Regulation.

Nuclear Safety and Control Act		
Section	**Requirement**	**OPG Response**
Licences		
24(2)	***Application*** *The Commission may issue, renew, suspend in whole or in part, amend, revoke, or replace a licence, or authorize its transfer on receipt of an application:* *(a) in the prescribed form;*	This submission (letter and attachments) provides the information required by the Nuclear Safety and Control Act (referred to as the Act) and the applicable Regulations made pursuant to the Act and provides supplemental information in support of OPG's application for licence amendment. This requirement has been met.
	(b) containing the prescribed information and undertakings and accompanied by the prescribed documents; and	See response above under clause 24 (2) (a).
	(c) accompanied by the prescribed fee.	OPG is in good standing with respect to the provision of CNSC licensing fees and will provide any additional fees associated with this WFOL amendment request, if requested.
24(4)	***Conditions for issuance, etc.*** *No licence may 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*	OPG understands that qualification will be determined through consideration by the Commission of this application and the associated supporting material, as well as deliberation through the Commission decision-making process. OPG is qualified to safely undertake the additional activities associated with the storage of Low and Intermediate Level Waste (L&ILW) at the PWMF.

Nuclear Safety and Control Act		
Section	**Requirement**	**OPG Response**
	(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.	Attachment 2 of this submission documents the assessments and provisions in support of the licence amendment request. Specifically: • documents worker health and safety provisions. • documents assessments and impact on environmental protection. • documents the security considerations.
25	***Renewal, etc.*** *The Commission may, on its own motion, renew, suspend in whole or in part, amend, revoke or replace a licence under the prescribed conditions.*	OPG understands this requirement and will continue to comply.
26	***Prohibitions*** *Subject to the regulations, no person shall, except in accordance with a licence:* *(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;* *(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;* *(c) produce or service prescribed equipment;* *(d) operate a dosimetry service for the purposes of this Act;* *(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or* *(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada.*	OPG staff understand these requirements and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
Licences – General Application Requirements		
3(1)	*An application for a licence shall contain the following information:* *(a) the applicant's name and business address;*	Applicant's name and business address: **Ontario Power Generation, Inc** **1908 Colonel Sam Dr.** **Oshawa, Ontario, L1H 8W8** Official Language: **English** Contact person, signing authority and licence holder: **Kapil Aggarwal** **Vice President** **Nuclear Sustainability Services,** **Ontario Power Generation** **Telephone: 416-402-6484**
	(b) the activity to be licensed and its purpose;	OPG requests an amendment to the PWMF WFOL, WFOL-W4-350.00/2028, to construct and operate the PCSS for storage of L&ILW from Pickering NGS.
	(c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence;	L&ILW from refurbishment of Pickering NGS Units 5 through 8 and decommissioning activities. Per unit, the quantity of waste will be but is not limited to: • 12 Steam Generators • 380 Fuel Channels (comprising of end fittings, pressure tubes, calandria tubes, annulus spacers and calandria tube inserts). Details of the quantity and form of the waste can be found in Enclosure 1 of this submission.
	(d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence;	A description of the PWMF is provided in Attachment 2 of this submission.
	(e) the proposed measures to ensure compliance with the Radiation	OPG understands this requirement and will remain in compliance with the current licence

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	Protection Regulations, the Nuclear Security Regulations and the Packaging and Transport of Nuclear Substances Regulations, 2015;	conditions documented in WFOL-W4-350.00/2028 and with the Radiation Protection Regulations, the Nuclear Security Regulations, and the Packaging and Transport of Nuclear Substances Regulations as described in Attachment 2 of this submission.
	(f) any proposed action level for the purpose of section 6 of the Radiation Protection Regulations;	The requested WFOL amendment will not require changes to the radiation protection action levels.
	(g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;	The requested WFOL amendment will not require changes to the measures to control PWMF site access, the nuclear substance, prescribed equipment or prescribed information.
	(h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;	The requested WFOL amendment will not require changes to the measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information.
	(i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;	The requested WFOL amendment to authorize the storage of L&ILW in the PCSS at the PWMF is supported by a robust safety case that is summarized in Attachment 2 of this submission.
	(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;	See response above under clause 3 (1) (c). This waste will be managed in accordance with OPG's current programs and processes.
	(k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the regulations made under the Act, including the internal allocation of functions, responsibilities and authority;	The organizational management structure will not change as a result of the requested licence amendment.
	(l) a description of any proposed financial guarantee relating to the activity to be licensed; and	OPG understands the regulatory requirement to maintain a financial guarantee for its facilities per REGDOC-3.3.1. The financial impact related to the PCSS will be included in the 2027-2031

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
		CNSC Financial Guarantee submission associated with the updated PWMF PDP.
	(m) any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence.	OPG understands this requirement and will continue to comply.
(1.1)	*The Commission or a designated officer authorized under paragraph 37(2)(c) of the Act, may require any other information that is necessary to enable the Commission or the designated officer to determine whether the applicant* *(a) is qualified to carry on the activity to be licensed;* *(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.*	OPG understands this requirement and will continue to comply.
Application for Amendment, Revocation or Replacement of Licence		
6	*An application for the amendment, revocation or replacement of a licence shall contain the following information:* *(a) a description of the amendment, revocation or replacement and of the measures that will be taken and the methods and procedures that will be used to implement it;* *(b) a statement identifying the changes in the information contained in the most recent application for the licence;*	(a) Attachment 2 of this submission documents the description of the amendment (Appendix A) and of the measures that will be taken and the methods and procedures that will be used to implement it. (b) Attachment 2 of this submission documents the changes that will be required to any licensing basis documents. The L&ILW will be stored within a specified array in the PWMF PCSS, a shielded building.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	(c) a description of the nuclear substances, land, areas, buildings, structures, components, equipment and systems that will be affected by the amendment, revocation or replacement and of the manner in which they will be affected; and	(c) This licence amendment request is to operate the Pickering Waste Management Facility (hereinafter "the facility"), to include the PCSS in addition to the Pickering Used Fuel Dry Storage Facility located at the Pickering Nuclear Generating Station, City of Pickering, Regional Municipality of Durham, Province of Ontario.
	(d) the proposed starting date and the expected completion date of any modification encompassed by the application.	(d) The first steam generators (SGs) would arrive between 2027 and 2028. The remaining wastes will follow pending the refurbishment activities on each unit with completion expected in 2034.
Incorporation of Material in Application		
7	*An application for a licence or for the renewal, suspension in whole or in part, amendment, revocation or replacement of a licence may incorporate by reference any information that is included in a valid, expired or revoked licence.*	OPG understands and has provided applicable references to information contained in the existing licence and Licence Conditions Handbook.
Obligations		
12(1)	***Obligations of Licensees*** *Every licensee shall*	OPG understands the requirements and will continue to comply. Specifically:
	(*a) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;*	OPG will ensure a sufficient number of qualified workers will be available to safely carry out the activities requested under this licence amendment.
	(b) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;	OPG staff will be trained on operation and maintenance activities associated with the requested licence amendment.
	(c) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities and of nuclear substances;	Refer to section 2.9, LC 9.1 in Attachment 2 of this submission for details on environmental protection.
	(d) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	(e) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence;	OPG understands this requirement and will continue to comply.
	(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;*	OPG understands this requirement and will continue to comply. Refer to section 2.9, LC 9.1 in Attachment 2 for further details on control of releases.
	(g*) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;*	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security.
	(h) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security.
	(i) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;	OPG understands this requirement and will continue to comply.
	(j) instruct the workers on the physical security program at the site of the licensed activity and on their obligations under that program;	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security.
	(k) keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers.	OPG understands this requirement and will continue to comply.
12(2)	*Every licensee who receives a request from the Commission or a person who is authorized by the Commission for the purpose of this subsection, to conduct a test, analysis, inventory or inspection in respect of the licensed activity or to review or to modify a design, to modify equipment,*	OPG understands this requirement and will continue to comply. Testing and commissioning procedures and reports associated with the storage of L&ILW will

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	to modify procedures or to install a new system or new equipment shall file, within the time specified in the request, a report with the Commission that contains the following information: *(a) confirmation that the request will or will not be carried out or will be carried out in part;* *(b) any action that the licensee has taken to carry out the request or any part of it;* *(c) any reasons why the request or any part of it will not be carried out;* *(d) any proposed alternative means to achieve the objectives of the request; and* *(e) any proposed alternative period within which the licensee proposes to carry out the request.*	be made available to facilitate the regulatory role of CNSC staff.
Transfers		
13	*No licensee shall transfer a nuclear substance, prescribed equipment or prescribed information to a person who does not hold the licence, if any, that is required to possess the nuclear substance, prescribed equipment or prescribed information by the Act and the regulations made under the Act*.	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	Notice of Licence	
14	*(1) Every licensee other than a licensee who is conducting field operations shall post, at the location specified in the licence or, if no location is specified in the licence, in a conspicuous place at the site of the licensed activity,* *(a) a copy of the licence, with or without the licence number, and a notice indicating the place where any record referred to in the licence may be consulted; or* *(b) a notice containing* *(i) the name of the licensee,* *(ii) a description of the licensed activity,* *(iii) a description of the nuclear substance, nuclear facility or prescribed equipment encompassed by the licence, and* *(iv) a statement of the location of the licence and any record referred to in it.* *(2) Every licensee who is conducting field operations shall keep a copy of the licence at the place where the field operations are being conducted.* *(3) Subsections (1) and (2) do not apply to a licensee in respect of* *(a) a licence to import or export a nuclear substance, prescribed equipment or prescribed information;* *(b) a licence to transport a nuclear substance; or* *(c) a licence to abandon a nuclear substance, a nuclear facility, prescribed equipment or prescribed information.*	OPG understands this requirement and will continue to comply with this requirement.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
Publication of Health and Safety Information		
16	*(1) Every licensee shall make available to all workers the health and safety information with respect to their workplace that has been collected by the licensee in accordance with the Act, the regulations made under the Act and the licence.* *(2) Subsection (1) does not apply in respect of personal dose records and prescribed information.*	OPG understands this requirement and will continue to comply. OPG's Health and Safety Policy is posted on the OPG intranet website.
Obligations of Workers		
17	*Every worker shall:* *(a) use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances, in a responsible and reasonable manner and in accordance with the Act, the regulations made under the Act and the licence;* *(b) comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment;* *(c) promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be* *(i) a significant increase in the risk to the environment or the health and safety of persons,* *(ii) a threat to the maintenance of the security of nuclear facilities and of*	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	nuclear substances or an incident with respect to such security, *(iii) a failure to comply with the Act, the regulations made under the Act or the licence,* *(iv) an act of sabotage, theft, loss or illegal use or possession of a nuclear substance, prescribed equipment or prescribed information, or* *(v) a release into the environment of a quantity of a radioactive nuclear substance or hazardous substance that has not been authorized by the licensee;* *(d) observe and obey all notices and warning signs posted by the licensee in accordance with the Radiation Protection Regulations; and* *(e) take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of the security of nuclear facilities and of nuclear substances.*	

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	Licence Applications – General Requirements	
3	*An application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the General Nuclear Safety and Control Regulations:* *(a) a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;*	The changes to the site are described in Section 1 of Attachment 2. A map showing the site layout is shown in Figure 1 of Attachment 2.
	(b) plans showing the location, perimeter, areas, structures and systems of the nuclear facility;	
	(c) evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;	The requested WFOL amendment will not require changes to site ownership.
	(d) the proposed management system for the activity to be licensed, including measures to promote and support safety culture;	OPG understands this requirement and will continue to comply. Refer to section 2.1, LC 1.1 in Attachment 2 of this submission for further details on management system.
	(d.1) the proposed human performance program for the activity to be licensed, including measures to ensure workers' fitness for duty.	OPG understands this requirement and will continue to comply. Refer to section 2.2, LC 2.1 in Attachment 2 of this submission for further details on human performance and fitness for duty.
	(e) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on;	Similar to the Retube Waste Storage Building at the Darlington Waste Management Facility, it is expected there will be minimal hazardous material.
	(f) the proposed worker health and safety policies and procedures;	OPG understands this requirement and will continue to comply. Refer to sections 2.7 and 2.8 (LC 7.1 and LC 8.1) in Attachment 2 of this submission for further details on radiation protection and conventional health and safety respectively.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	(g) the proposed environmental protection policies and procedures;	OPG understands this requirement and will continue to comply. Refer to section 2.9, LC 9.1 in Attachment 2 of this submission for further details on environmental protection including environmental monitoring.
	(h) the proposed effluent and environmental monitoring programs;	
	(i) if the application is in respect of a nuclear facility referred to in paragraph 2(b) of the Nuclear Security Regulations, the information required by section 3 of those Regulations;	Not Applicable
	(j) the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed; and	OPG understands this requirement and will continue to comply. Refer to Section 3 in Attachment 2 of this submission for further details on public information and Indigenous Nations engagement.
	(k) the proposed plan for the decommissioning of the nuclear facility or of the site.	OPG understands this requirement and will continue to comply. Refer to section 2.11, LC 11.2 in Attachment 2 of this submission for further details on decommissioning plans.
Licence to Operate		
6	*An application for a licence to operate a Class 1 nuclear facility shall contain the following information in addition to the information required by section 3:* *(a) a description of the structures at the nuclear facility, including their design and their design operating conditions;* *(b) a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions;*	OPG understands this requirement and will continue to comply.
	(c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility;	OPG understands this requirement and will continue to comply.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
		Refer to section 2.4, LC 4.1 in Attachment 2 of this submission for further details on safety analysis.
	(d) the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility;	OPG understands this requirement and will continue to comply. Refer to section 2.3, LC 3.1 in Attachment 2 of this submission for further details on operating performance.
	(e) the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances;	OPG understands this requirement and will continue to comply. Refer to section 2.14, LC 14.1 in Attachment 2 of this submission for further details on packaging and transport.
	(f) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;	OPG understands this requirement and will continue to comply. Refer to section 2.13, LC 13.1 in Attachment 2 of this submission for further details on safeguards.
	(g) the proposed commissioning program for the systems and equipment that will be used at the nuclear facility;	OPG understands this requirement and will continue to comply.
	(h) the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;	OPG understands this requirement and will continue to comply. Refer to sections 2.7, 2.8, and 2.9 (LC 7.1, LC 8.1 and LC 9.1 respectively) in Attachment 2 of this submission for further details on radiation protection, conventional health and safety respectively and environmental protection.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	(i) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics; *(j) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;*	OPG understands this requirement and will continue to comply. Refer to section 2.9, LC 9.1 in Attachment 2 of this submission for further details on environmental protection.
	(k) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including measures to *(i) assist off-site authorities in planning and preparing to limit the effects of an accidental release,* *(ii) notify off-site authorities of an accidental release or the imminence of an accidental release,* *(iii) report information to off-site authorities during and after an accidental release,* *(iv) assist off-site authorities in dealing with the effects of an accidental release, and* *(v) test the implementation of the measures to prevent or mitigate the effects of an accidental release;*	OPG understands this requirement and will continue to comply. Refer to section 2.10, LC 10.1 in Attachment 2 of this submission for further details on emergency preparedness.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	(l) the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility, including measures to alert the licensee to such acts;	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security program.
	(m) the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and *(n) the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility.*	OPG understands this requirement and will continue to comply. Refer to section 2.2, LC 2.2 in Attachment 2 of this submission for further details on training program.

Radiation Protection Regulations		
Section	**Requirement**	**OPG Response**
4	*Every licensee must implement a radiation protection program and must, as part of that program,* *(a) keep the effective dose and equivalent dose received by and committed to persons as low as reasonably achievable, taking into account social and economic factors, through the implementation of* *(i) management control over work practices,* *(ii) personnel qualification and training,* *(iii) control of occupational and public exposure to radiation, and* *(iv) planning for unusual situations; and* *(b) ascertain the quantity and concentration of any nuclear substance released as a result of the licensed activity* *(i) by direct measurement as a result of monitoring, or* *(ii) if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the quantity and concentration using that method, by estimating them.*	OPG has a well-established radiation protection program that complies with all elements of the Radiation Protection Regulations. Further details are provided in Section 2.7, LC 7.1 on OPG's radiation protection considerations for the storage of L&ILW.

Nuclear Security Regulations
OPG will continue to adhere to all facets of the Nuclear Security Regulations and keep in place all current security processes in the handling and storage of L&ILW from Pickering NGS.

ATTACHMENT 2

OPG Letter, K. Aggarwal to C. Salmon, “Pickering Waste Management Facility – Pickering Component Storage Structure, Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment Commission Member Document”.

CD# 92896-CORR-00531-01606 P

Licence Impact Assessment
in Support of Construction and Operation of the Pickering Component Storage Structure at the Pickering Waste Management Facility

Prepared By: **H. Patel**

Checked By: **J. Vanderheyden**

ATTACHMENT 2
CD# 92896-CORR-00531-01606

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Licence Impact Assessment in Support of Construction and Operation of the Pickering Component Storage Structure at the Pickering Waste Management Facility

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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.

PNGS is within the territory of the Gunshot Treaty 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.

1.0 Introduction

1.1 Background

The purpose of this document is to provide technical information in support of Ontario Power Generation's (OPG) request for amendment to the Pickering Waste Management (PWMF) Waste Facility Operating Licence (WFOL), WFOL-W4-350.00/2028, to allow for the construction and operation of a new Pickering Component Storage Structure (PCSS) that will support the refurbishment of PNGS Units 5 through 8 and decommissioning activities.

OPG currently operates the PWMF which is composed of two sites:

- PWMF Phase I site: This is located within the PNGS protected area, south-east of PNGS Unit 8, adjacent to the east side of the station security fence.
- PWMF Phase II site: This is located approximately 500 m north-east of the site in the East Complex.

The proposed PCSS location will be adjacent to the northern boundary of Phase II (See Figure 1). Ownership and operation of the PCSS will reside with the PWMF.

It was determined that in order to support the refurbishment of PNGS Units 5 through 8 and decommissioning activities, construction and operation of the PCSS will provide storage of the Low and Intermediate Level Waste (L&ILW).

The refurbishment project will include activities such as Steam Generators (SG), Pressure Tube, Feeders, and Calandria Tube replacements, that will produce Low Level Waste (LLW) and Intermediate Level Waste (ILW) that will need to be accommodated in PCSS. Similar to the Darlington NGS refurbishment project, Retube Waste Containers (RWC) will be used to store the ILW. Based on the expected waste streams that will be produced, the PCSS is expected to have an area of approximately 3,700 m^2 (40,000 square feet).

The information provided in this Attachment is divided into the following sections:

Section 1: Provides the background, summary and operational considerations for the request of the licence amendment to construct and operate the PCSS.

Section 2: Summarizes regulatory compliance for the construction and operation of the PCSS and impact on OPG's governance, programs and processes for each of PWMF's WFOL's 15 Safety and Control Areas (SCA).

Section 3: Summarizes public, Indigenous Nations and Métis engagement related to this application for a licence amendment.

Appendix A: Provides the proposed wording for the amendment to the PWMF WFOL-W4-350.00/2028.

Appendix B: Provides the preliminary assessment on impacts on Aboriginal and/or Treaty rights, the Indigenous Engagement summary to date, a description of planned engagement activities, and the proposed schedule for interim reporting to CNSC staff on the engagement activities.

1.2 Summary of Proposed Activity Requiring Licence Amendment

OPG intents to construct the PCSS with main phases of the project including design, site preparation, construction, operation, and maintenance. *Site preparation* includes all activities associated with preparing the project area for construction of the PCSS. Activities may include clearing the site, excavation, grading, and installation of utilities and infrastructures. *Construction* includes all activities associated with constructing the PCSS immediately following site preparation. *Operation and maintenance* includes all activities associated with normal operation of the PCSS and includes accepting waste, storing waste, performing regular inspections, and general maintenance activities.

Pending the licence amendment, OPG targets to have the PCSS operational by April 2027 in order to support additional interim storage capacity for radioactive component waste from refurbishment and decommissioning activities.

Long term management and permanent disposal facilities are planned per Canada's Integrated Strategy for Radioactive Waste (ISRW), which was developed by the Nuclear Waste Management Organization (NWMO) at the request of Natural Resources Canada. The recommendations for the strategy were endorsed by the Minister of Energy and Natural Resources in October 2023. Per the ISRW, LLW will be permanently disposed of in near surface disposal facility, and it will be the responsibility of OPG as the waste generator and owner to develop such a facility. At OPG, we treat our role as a steward of nuclear by-products and waste with utmost importance. In 2024, OPG initiated provincewide outreach to find solutions for permanent disposal of our LLW. The outreach begins with a learning phase, in which OPG reaches out to Indigenous Nations and Communities across Ontario, followed by municipalities, to begin two-way dialogue on the role of nuclear energy and disposal of LLW. For ILW, the ISRW determined that a Deep Geologic Repository (DGR) is appropriate for permanent disposal, and the NWMO will implement a consent-based siting process for this. The planning process for this work is now underway.

Figure 1 below is a layout of the proposed PCSS and PWMF.

Figure 1: PCSS and NSS-PWMF Layout

1.3 Safety Case

Safety of the workers, public, and environment is OPG's over-riding priority, proven over many years of both Power Reactor operation and radioactive waste management and storage. OPG is responsible for the continued safe operation of the PWMF and confirms that the construction and operation of the PCSS will be implemented based on a robust safety case and in accordance with OPG's Engineering Change Control process. This is supported by 92896-REP-01320-00019 R002, "*Pickering Component Storage Structure Safety Assessment*" (Enclosure 1 of this submission), which demonstrates the continued safe facility operation, public and worker safety, and environmental protection.

The safety case for the construction and operation of the PCSS can be defined based on the following elements:

1. **Design:** OPG has and will continue to follow its Engineering Change Control (ECC) process, as described in N-PROG-MP-0001, "*Engineering Change Control*", for ensuring the design complies with applicable regulatory requirements as defined in the PWMF Licence Condition Handbook (LCH), LCH-W4-350.00/2028, Revision 2, and that configuration management will be maintained.

2. **Continued Safe Operation:** The safety case, 92896-REP-01320-00019 R002 (Enclosure 1 of this submission), demonstrates that the operation of the PCSS and storage of L&ILW components will have a negligible effect on the safe operation, public and worker safety.

3. **Environmental Protection:** The predictive environmental risk assessment completed for PCSS, 92896-REP-07701-00019 R002, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*", provided as Enclosure 2 of this submission, concludes that the construction and operation of the PCSS will have negligible impact on the environment.

4. **Licensing Basis:** The construction and operation of the PCSS will have a negligible impact on PWMF's licensing basis, governance, programs, and processes. Attachment 1 of this submission provides the compliance matrix for the Nuclear Safety Control Act and associated regulations required for the amendment of the PWMF WFOL.

Overall, there are no significant safety or operational issues resulting from construction and operation of the PCSS.

2.0 Safety and Control Areas

This section provides the impact assessment of the proposed new activities on the licensing basis for each of the PWMF WFOL SCAs. OPG is responsible for the continued safe operation of the PWMF and confirms that all modifications made with respect to the construction and operation of the PCSS, will be implemented based on a robust safety case and in accordance with OPG's ECC process. This is supported by safety assessments, which demonstrate continued safe operation of the PWMF, public safety, worker safety and environmental protection.

2.1 Management System

2.1.1 Management System

Licence Condition 1.1 states "*the licensee shall implement and maintain a management system*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2). OPG's proven Nuclear Management System provides a framework that establishes the processes and programs required to ensure that OPG achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy nuclear safety culture.

Table 2.1.a: List of Management System Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Management System Requirements for Nuclear Facilities	CSA N286 (2012)	Continued compliance as applied to all aspects of operation and modifications at PWMF.

Table 2.1.b: Impact of the Construction and Operation of the PCSS on PWMF's Management System Licensing Basis Documents

OPG Management System Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Items and Services Management	OPG-PROG-0009	No Change
Environment Health and Safety Managed Systems	OPG-PROG-0005	No Change
Nuclear Management Systems Organizations	N-STD-AS-0020	No Change
Nuclear Safety and Security Culture Assessment	N-PROC-AS-0077	No Change
Nuclear Safety Oversight	N-STD-AS-0023	No Change
Nuclear Safety Policy	N-POL-0001	No Change
Nuclear Management System	N-CHAR-AS-0002	No Change

2.1.2 Quality Assurance, CSA Standard N286-12 Compliance

OPG is compliant with CSA Standard N286-12, "*Management system requirements for nuclear facilities*". The Nuclear Charter, N-CHAR-AS-0002, "*Nuclear Management System*", establishes the Nuclear Management System for OPG Nuclear. The Nuclear Management System will not change because of the proposed construction and operation of the PCSS.

2.1.3 Nuclear Safety and Security Culture

OPG routinely monitors the health of its nuclear safety culture through Nuclear Safety Monitoring Panels. These panels were established based on the industry best practices documents in the Nuclear Energy Institute's NEI-09-07, "*Fostering* a *Strong Nuclear Safety Culture*". The Nuclear Safety Monitoring Panel examines information from a variety of the processes that have been implemented, such as the corrective action process, the human performance program, audits and self-assessments, external inspections such as CNSC staff's inspections or industry evaluations, employee concerns, and business performance monitoring. This information is evaluated against the traits of a healthy nuclear safety culture to identify strengths and areas for focused attention within the organization. The panel is composed of all the managers senior leadership within OPG. The panel evaluates the information and approves any initiatives or reinforces communications as needed. The construction and operation of the PCSS will not impact the Nuclear Safety and Security Culture requirements.

2.1.4 Management of Contractors

Licence Condition 1.2 requires that "*the licensee shall ensure that every contractor at the facility complies with this licence*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Vendors and contractors are qualified by OPG Supply Chain Quality Services under a process that ensures that the contractors have developed and implemented a management system that meets the applicable requirements outlined in the CSA Standard N286 series of standards.

OPG is ultimately responsible for ensuring that all on-site contractor activities comply with OPG's safety requirements. Day-to-day operations at PWMF are generally maintained by full-time staff of OPG.

2.2 Human Performance Management

2.2.1 Human Performance Program

Licence Condition 2.1 states "*the licensee shall implement and maintain a human performance program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Human performance relates to reducing the likelihood of human error in work activities. It refers to the outcome of human behaviour, functions, and actions in a specified environment, reflecting the ability of workers and management to meet the system's defined performance under the conditions in which the system will be employed.

Table 2.2.a: List of Human Performance Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Fitness for Duty: Managing Worker Fatigue	REGDOC-2.2.4 (2017)	Continued compliance, no impact.
Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3	REGDOC- 2.2.4 (2021)	Continued compliance, no impact.
Safety Culture	REGDOC-2.1.2 (2018)	Continued compliance, no impact.

Table 2.2.b: Impact of Construction and Operation of the PCSS on PWMF's Human Performance Management Licensing Basis Documents

OPG Human Performance Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Human Performance	N-PROG-AS-0002	No Change
Hours of Work Limits and Managing Worker Fatigue	N-PROC-OP-0047	No Change

The objective of OPG's Human Performance program, N-PROG-AS-0002, "*Human Performance*" is to minimize human performance events and errors by managing defenses in pursuit of zero events of consequence.

The Human Performance program integrates proactive (prevention) and reactive (detection and correction) human performance initiatives, which includes the following:

- Providing oversight and monitoring of department human performance.
- Identifying emerging human performance issues and determining strategies for related improvement.
- Approving site-wide human performance improvement initiatives and overseeing the implementation progress.
- Use of the human performance toolbox
- Identifying and implementing human performance improvement communication, education, and training opportunities.

2.2.2 Fitness for Duty

As part of OPG's fitness for duty program, OPG has a continuous behaviour observation program in place which trains supervisors and managers to monitor workers for signs of fatigue or other factors which could adversely impact worker performance. OPG has in place hours of work requirements in N-PROC-OP-0047, "*Hours of Work Limits and Managing Worker Fatigue*" which sets limits for the number of hours within a specified time period that station staff can work. The limits, which are in place to guard against fatigue in the workplace, are strict in comparison to other jurisdictions.

The construction and operation of the PCSS will not impact OPG's fitness for duty program or compliance to hours-of-work requirements.

2.2.3 Training Program

Licence Condition 2.2 states "*the licensee shall implement and maintain a training program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2). Similar to the Re-tube Waste Service Building (RWSB), personnel at the PCSS will be fully trained in the storage of L&ILW and on mitigative measures for backout when required. All required staff will be fully trained before the first SG/RWC is received and stored in the PCSS.

Table 2.2.c: List of Training Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Personnel Training	REGDOC-2.2.2 (2016)	Continued compliance, no impact.

Table 2.2.d: Impact of the Construction and Operation of the PCSS on PWMF's Training Program Licensing Basis Documents

OPG Human Performance Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Systematic Approach to Training	N-PROC-TR-0008	No Change
Training	N-PROG-TR-0005	No Change

2.3 Operating Performance

2.3.1 Operating Performance

Licence Condition 3.1 states "*the licensee shall implement and maintain an operating program, which includes a set of operating limits*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Operations and Maintenance of the PCSS will be conducted in accordance with the PWMF Operating Policies and Principles (OP&Ps) and within the conditions of the operating licence to be issued for the facility by the CNSC. Operations and Maintenance standards will be such that equipment performance and reliability in accordance with design specifications is maintained.

Table 2.3.a Impact of the Construction and Operation of the PCSS on PWMF's Operating Performance Related Licensing Basis Documents

OPG Document Title	OPG Document Number	Impact from Construction and Operation of PCSS
Application for Renewal of Pickering Waste Management Facility Operating Licence	92896-CORR-00531-01031	No Change
Additional Information to Support the Application for Renewal of Pickering Waste Management Facility Operating Licence	92896-CORR-00531-01075	No Change
Nuclear Waste Management	W-PROG-WM-0001	No Change
Operating Policies and Principles, Pickering Waste Management Facility	92896-OPP-01911.1-00001	There are no unique aspects that warrant a significant change. Updates to the OP&Ps will include PCSS in the scope and identify PCSS as part of the PWMF OP&Ps. These updates will be completed prior to operation of the PCSS.
Pickering Waste Management Facility – Safety Report	92896-SR-01320-10002	Changes will be reflected in the next update of the PWMF Safety Report scheduled for 2028.

The updates to the OP&Ps for the PWMF will be completed utilizing existing OPG processes and the PWMF LCH requirements prior to the operation of the PCSS.

2.3.2 Reporting Requirements

Licence Condition 3.2 states "*the licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.3.b: List of Reporting Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Public Information and Disclosure	REGDOC-3.2.1 (2018)	Continued compliance, no impact.
Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills	REGDOC-3.1.2 (2018)	Continued compliance, no impact.

Table 2.3.c: Impact of the Construction and Operation of the PCSS on PWMF's Reporting Requirements Related Licensing Basis Documents

OPG Document Title	OPG Document Number	Impact from Construction and operating of the PCSS
Conduct of Regulatory Affairs	N-PROG-RA-0002	No Change
Performance Improvement	N-PROG-RA-0003	No Change
Preliminary Event Notification	N-PROC-RA-0020	No Change
Operating Policies and Principles, Pickering Waste Management Facility	92896-OPP-01911.1-00001	No Change

2.3.3 Quarterly and Annual Operational Reporting

The annual operational reports will continue as currently conducted and will account for the construction and operation of the PCSS. The quarterly operational reporting to the CNSC is no longer required (Reference 2-3).

2.4 Safety Analysis

2.4.1 Safety Analysis Program

Licence Condition 4.1 states "*the licensee shall implement and maintain a safety analysis program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

2.4.2 Safety Analysis

The preliminary safety analysis, also referred to as the "safety case" of the PCSS, 92896-REP-01320-00019 R002 is provided as Enclosure 1 of this submission. The normal operations safety analysis considered several design options for the PCSS and assessed the corresponding dose rate impact to the public during normal operations. The annual normal operations public dose estimates have increased compared to that of the existing PWMF configuration due to the proximity of the PCSS to the nearest public receptor. The annual dose to an individual member of the public with the most favorable design option of the PCSS is still a small percentage of the 1 mSv limit and meets the 100 μSv annual target for the PWMF.

The normal operations safety analysis demonstrates that compliance with the radiation safety requirements during normal operation of the PCSS can be achieved and several recommendations are given to guide the detailed design of the structure. With respect to malfunction and potential accident scenarios, the estimated bounding doses to members of the public are less than the 1 mSv acceptance criterion. The dose to workers following a postulated bounding accident scenario involving a building collapse of the PCSS is found to be much less than the 50 mSv limit. It is concluded that the dose consequences to workers and members of the public following credible postulated malfunction / accident scenarios will meet all acceptance criteria.

The safety analysis will be updated with the final design requirements of the PCSS and will be provided to CNSC staff prior to the commencement date of construction.

Table 2.4.a: List of Safety Analysis Program Related Regulatory Requirements

Licensing Basis Document Title	Document Title	Impact from Operation of the PCSS
General principles for the management of radioactive waste and irradiated fuel	CSA N292.0 (2014)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.
Interim Dry Storage of Irradiated Fuel	CSA N292.2 (2013)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.
Management of Low and Intermediate Level Radioactive Waste	CSA N292.3 (2014)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.
Quality Assurance of Analytical, Scientific and Design Computer programs	CSA N286.7 (2016)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.

Table 2.4.b: Impact of the Construction and Operation of the PCSS on PWMF's Safety Analysis Licensing Basis Documents

OPG Safety Analysis Licensing Basis Document Title	OPG Document Number	Impact From Operation of the PCSS
Pickering Waste Management Facility – Safety Report	92896-SR-01320-10002	Changes will be reflected in the next update of the PWMF Safety Report scheduled for 2028.
Reactor Safety Program	N-PROG-MP-0014	No Change

2.5 Physical Design

2.5.1 Design Program

Licence Condition 5.1 states "*the licensee shall implement and maintain a design program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

The design and any modifications to the PCSS shall comply with applicable codes, standards, and regulations including adequate consideration for human factors. For all designs, the licensee shall modify and otherwise carry out work related to the PCSS in compliance with the applicable versions of the National Building Code of Canada and the National Fire Code of Canada.

Table 2.5.a: List of Design Program Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Fire protection for facilities that process, handle, or store nuclear substances	CSA N393	The PCSS's design will comply with the requirements in this code
National Building Code of Canada (2020)	NRC	The PCSS's design will comply with the NRC National Building Code of Canada (2020) requirements.
National Fire Code of Canada (2020)	NRC	The PCSS's design will comply with the NRC National Fire Code of Canada (2020) requirements.

The PCSS design requirements will be provided to CNSC staff prior to the commencement date of construction activities.

Table 2.5.b: Impact of the Construction and Operation of the PCSS on PWMF's Design Program Related Licensing Basis Documents

OPG Physical Design Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Conduct of Engineering	N-STD-MP-0028	No Change
Configuration Management	N-STD-MP-0027	No Change
Design Management	N-PROG-MP-0009	No Change
Engineering Change Control	N-PROG-MP-0001	No Change

2.5.2 Pressure Boundary

Licence Condition 5.2 states "*the licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.5.c: List of Pressure Boundary Program Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Power Piping	ASME B31.1 (2010)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
Boiler, pressure vessel, and pressure piping code	CSA B51 (2009 and Update No. 1)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
General requirements for pressure-retaining systems and components in CANDU nuclear power plants	CSA N285.0 (2008 and Updates No. 1 and 2; and Annex N of N285.0-12 and Update No. 1)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
Standard for the Installation of Private Fire Service Mains and Their Appurtenances	NFPA-24 (2010)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
Standard for the Installation of Stationary Pumps for Fire Protection	NFPA-20 (2010 and Amendment 1 and Amendment 2)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.

Table 2.5.d: Impact of the Construction and Operation of the PCSS on PWMF's Pressure Boundary Related Licensing Basis Documents

OPG Physical Design Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Index to OPG Pressure Boundary Program Elements	N-LIST-00531-10003	No Change
Pressure Boundary Program Manual	N-MAN-01913.11-10000	No Change
Authorized Inspection Agency Service Agreement	N-CORR-00531-20012	No Change

Design Registration	N-PROC-MP-0082	No Change
Pressure Boundary	N-PROG-MP-0004	No Change
System and Item Classification	N-PROC-MP-0040	No Change

2.6 Fitness for Service

Licence Condition 6.1 states "*the licensee shall implement and maintain a fitness for service program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.6.a: List of Fitness for Service Program Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Aging Management	REGDOC-2.6.3 (2014)	Continued compliance.

OPG has a robust Aging Management Process where the scoping and screening process will evaluate if formal aging management plans are required for SGs and RWCs. If deemed required, the development of those aging management plans will include the identification of degradation mechanisms as well as monitoring and mitigating activities for SGs and RWCs stored in the PCSS.

N-PROC-MP-0060, "*Aging Management Process*" uses a systematic and integrated approach to establish, implement, and assess the effectiveness of aging management plans and addresses aging related issues. The process includes scoping, screening, condition assessment, and tracking the recommended aging management actions. The SGs and RWCs stored in the PCSS will be managed in accordance with N-PROC-MP-0060 for the aging management-related activities.

Table 2.6.b: Impact of the Construction and Operation of the PCSS on PWMF's Aging Management Program Related Licensing Basis Documents

OPG Fitness for Service Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Conduct of Engineering	N-STD-MP-0028	No Change
Design Management	N-PROG-MP-0009	No Change
Equipment Reliability	N-PROG-MA-0026	No Change
Integrated Aging Management	N-PROG-MP-0008	No Change
Nuclear Waste Management	W-PROG-WM-0001	No Change

Ontario Power Generation Dry Storage Container – Base (Underside) Inspection Plan	00104-PLAN-79171-00002	No Change
Used Fuel Dry Storage Container Aging Management Plan	00104-PLAN-79171-00001	No Change

2.7 Radiation Protection

2.7.1 Radiation Protection

Licence Condition 7.1 states "*the licensee shall implement and maintain a radiation program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

As per OPG's N-PROG-RA-0013, "*Radiation Protection*", the overriding objective of the Radiation Protection program at OPG is the control of occupational and public exposure to radiation. For the purposes of controlling radiation doses to workers and the public, this program has five implementing objectives:

- Keeping individual radiation doses below regulatory limits,
- Avoiding unplanned radiation exposures,
- Keeping individual risk from lifetime radiation exposure to an acceptable level
- Keeping collective radiation doses ALARA, social and economic factors taken into account
- Keeping public exposure to radiation well within regulatory limits.

2.7.2 Dose Rate Impact on the Public and Environment

An assessment has been conducted on the impact of calculated dose rates on OPG personnel, the public and the environment.

The PCSS will store steam generators (SGs) and retube waste containers (RWCs) from Pickering NGS activities. Since both waste forms will be sealed, the only radiological hazard to contend with are expected to be low levels of external gamma radiation (SGs and RWCs) and low levels of neutron radiation (RWC only). The Waste Acceptance Criteria will require that no external loose contamination be permitted and will specify upper limits for external radiation hazards to ensure that conditions will be bound by the safety analysis per OPG's process. Consistent with the PWMF itself, it is expected that the PCSS itself will be a Radiologically Zone 2 area.

Based on experience at the Western Waste Management Facility (WWMF) which stored similar waste forms from Major Component Replacement (MCR) campaign, these waste forms will present minimal impact to worker safety and impact on public dose. It has been evaluated and studied that low levels of neutron radiation will exist near RWCs due to trace amounts of Californium-252 which has been created within the pressure tube and calandria tube waste. This isotope has a relatively short half-life (approximately 2.6 years) and it is expected that any temporary shielding that will be needed can be removed after sufficient time has elapsed.

During the safety assessment and analysis evaluation of the PCSS, multiple scenarios of facility design and waste acceptance criteria with respect to dose rate were evaluated. Characterization of the neutron source term and anticipated dose rates from RWCs have been modelled and submitted to the CNSC (Enclosure 1 of Reference 2-4). Enclosure 1 of this submission, 92896-REP-01320-00019 R002, shows that when additional moveable shielding is incorporated in the planned building design, the subsequent dose rates at the building perimeter and at land and water-based receptor locations comply with the derived licence dose rate limits. This will be facilitated by adequate shielding of the PCSS itself as well as operational controls and use of additional shielding. Similarly, operating experience from MCR campaigns at WWMF show that doses to workers are managed ALARA and within OPG exposure control levels and administrative limits both of which are set well below regulatory limits.

The existing Thermoluminescent Dosimeters around PWMF Phase I and Phase II will measure the dose rates and will be reported to CNSC staff in the annual compliance report pursuant to REGDOC 3.1.2. Routine radiological surveys consisting of neutron measurements will also be established to ensure that overall dose rates (gamma + neutron) are below the derived dose rate limit of 0.50 μSv/hr averaged over a quarter.

Personnel radiation exposures associated with the storage and placement of L&ILW will be managed within the framework of the existing Radiation Protection Program (N-PROG-RA-0013).

OPG's Radiation Protection Program, N-PROG-RA-0013 and associated dosimetry programs, N-MAN-03416.1-10000 "*Radiation Dosimetry Program – External Dosimetry*" and N-MAN-03416.2-10000, "*Radiation Dosimetry Program – Internal Dosimetry*" have approved dosimetry and methodology to ensure neutron surveys and required dose ascertainment and assignment are in place. OPG is also looking at new state of the art equipment to detect and assign neutron dose to facilitate and optimize field execution. Specialized Radiation Exposure Permit (REPs) will be in place along with support from qualified staff.

Table 2.7.a: List of Radiation Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Radiation Protection Regulations	SOR/2000-203	No Impact

Table 2.7.b: Impact from the Construction and Operation of the PCSS on PWMF's Radiation Protection and ALARA Licensing Basis Documents

OPG Radiation Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Occupational Radiation Protection Action Levels for Nuclear Waste Management Facilities	N-STD-RA-0045	No Change
Radiation Protection	N-PROG-RA-0013	No Change

2.8 Conventional Health and Safety

Licence Condition 8.1 states "*the licensee shall implement and maintain a conventional health and safety program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.8.a: Regulatory Requirements Related to Conventional Health and Safety

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
General Nuclear Safety and Control Regulations	SOR/2000-202	Continued compliance

Table 2.8.b: Impact from the Construction and Operation of the PCSS on PWMF's Conventional Safety Program Licensing Basis Documents

OPG Conventional Safety Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Employee Health and Safety Policy	OPG-POL-0001	No Change
Environment Health and Safety Managed Systems	OPG-PROG-0005	No Change

2.9 Environmental Protection

2.9.1 Environmental Protection

Licence Condition 9.1 states "*the licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.9.a: List of Environmental Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Addition of the PCSS
Environmental Protection: Environmental Principles, Assessments and Protection Measures	REGDOC-2.9.1, Version 1.2 Section 4.6 (2020)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements.

Environment management of nuclear facilities: Common requirements of the CSA N288 series of Standards	CSA N288.0 (2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	CSA N288.1 (2020)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	CSA N288.3.4 (2013 R2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Environmental monitoring program at nuclear facilities and uranium mines and mills	CSA N288.4 (2019)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Effluent and emissions monitoring programs at nuclear facilities	CSA N288.5 (2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Environmental risk assessments at nuclear facilities and uranium mines and mills	CSA N288.6 (2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Groundwater protection programs at Class I nuclear facilities and uranium mines and mills.	CSA N288.7 (2015)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Establishing and implementing action levels for releases to the environment from nuclear facilities	CSA N288.8 (2017 R2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements

Table 2.9.b Impact from the Storage of the addition of the PCSS on PWMF's Environmental Protection Licensing Basis Documents

OPG Environmental Protection Licensing Basis Document Title	OPG Document Number	Impact from the Addition of the PCSS
Environment Health and Safety Managed Systems	OPG-PROG-0005	No Change
Environment Policy	OPG-POL-0021	No Change
Management of the Environmental Monitoring Programs	N-PROC-OP-0025	No Change

Monitoring of Nuclear and Hazardous Substances in Effluents	N-STD-OP-0031	No Change
Environmental Risk Assessment Report for Pickering Nuclear	P-REP-07701-00001	No Change
Derived Release Limits and Environmental Action Levels for Pickering Nuclear	P-REP-03482-00006	No Change
Action Levels for Environmental Releases - Pickering Nuclear	P-REP-03482-00007	No Change

2.9.2 Effluent and Emissions Control (Releases)

OPG is committed to complying with the requirements of the CSA Standard N288 series documents, as required in the PWMF LCH. The licensee shall control radiological releases to ALARA, thereby minimizing dose to the public resulting from PWMF/PCSS operation.
The PWMF adheres to approved Derived Release Limits (DRLs) under PNGS, which are defined in CSA Standard N288.1 as the release rate that would cause an individual of the most highly exposed group to receive and be committed to a dose equal to the regulatory annual dose limit, due to release of a given radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year.

Because radiological releases are very small in comparison with the DRLs and Action Levels, lower Internal Investigation Levels (IILs) are used to demonstrate and maintain adherence to the ALARA principle. There will be no changes to the DRLs, Action Levels or IILs as a result of the PCSS. Consistent with current performance, the cumulative public dose resulting from the PCSS will remain well below 1% of the regulatory public dose limit of 1,000 μSv per year.

During operation and maintenance of the PCSS, radiological waste will be contained and as a result, no radiological emissions are expected during normal operations.

2.9.3 Environmental Management System (EMS)

OPG's OPG-POL-0021, "*Environmental Policy*" requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001, "*Environmental Management System Standard*".

Operation of the PCSS will continue to be in accordance with OPG's EMS as described in OPG-PROG-0005, "*Environment Health and Safety Managed Systems*" and OPG-POL-0021. The EMS provides specific directions on how the Environmental Policy is implemented while meeting the expectations of OPG-POL-0032, "*Safe Operations Policy*", N-POL-0001, "*Nuclear Safety & Security Policy"*, and N-CHAR-AS-0002, "*Nuclear Management System*".

2.9.4 Continued Validity of Prior Submissions to the CNSC/Licensing Documents

92896-REP-07701-00019 R002, (Enclosure 2 of this submission) provides the results of the assessment that reviewed the applicable Environmental Assessments and the Environmental Risk Assessment licensing documents.

2.9.5 Environmental Assessment Follow-Up Program

Licence Condition 9.2 states "*the licensee shall implement an environmental assessment follow- up program"* and the details in the PWMF LCH outline the regulatory requirements. This licence condition was specific to expanding the capacity of the PWMF by constructing and operating two additional storage buildings (#3 and #4) at the PWMF Phase II site. The EA process for that project identified the need for an EA follow-up program for the PWMF Phase II project which was completed.

The construction and operation of the PCSS will not impact the EA follow up program and as such, this licence condition is not applicable.

Table 2.9.c Impact from the Construction and Operation of the PCSS on PWMF's Environmental Assessment Follow-Up Plan Licensing Basis Documents

OPG Environmental Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Impact of the PCSS
Pickering Waste Management Facility Phase II – Environmental Assessment Follow-Up Plan	92896-REP-07701.8-00001	No Change

2.10 Emergency Management and Fire Protection

2.10.1 Emergency Preparedness Program

Licence Condition 10.1 states "*the licensee shall implement an emergency preparedness program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the previous PWMF Licence Renewal application (Reference 2-2) is still applicable and follows the requirements set by the overall program document N-PROG-RA-0001, "*Consolidated Nuclear Emergency Plan (CNEP)*". The CNEP adheres to the Provincial Nuclear Emergency Response Plan (PNERP); CNSC REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*; and CSA N1600, *General Requirements for Nuclear Emergency Management Programs*. The program ensures compliance through evaluated drills and exercises, internal and external audits, equipment monitoring, and corrective actions where required.

Table 2.10.a: List of Emergency Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Impact of the PCSS
Nuclear Emergency Preparedness and Response, Version 2	REGDOC-2.10.1 (2017)	No Change

Table 2.10.b: Impact from the Construction and Operation of the PCSS on PWMF's Emergency Management Licensing Basis Documents

OPG Emergency Management and Fire Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Impact of the PCSS
Radioactive Materials Transportation Emergency Response Plan	N-STD-RA-0036	No Change
Consolidated Nuclear Emergency Plan	N-PROG-RA-0001	No Change

2.10.2 Fire Protection Program

Licence Condition 10.2 states "*the licensee shall implement a fire protection program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2) where the Fire Protection Program key document is N-PROG-RA-0012, "*Fire Protection*". The fire protection program at PWMF complies with the CSA N393 standard, National Building Code of Canada and National Fire Code of Canada, ensuring fire prevention, protection, emergency procedures, and fire drill training are maintained. Fire suppression and detection systems meet applicable codes and standards, maintained through regular inspections, testing, and third-party reviews, with design modifications assessed for fire safety impact, internal audits conducted to improve governance, and corrective actions implemented, as needed, to maintain compliance and operational effectiveness.

Table 2.10.c: List of Fire Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Fire protection for facilities that process, handle, or store nuclear substances	CSA N393-22 (2022)	No Change
National Building Code of Canada (2020)	NRC	No Change
National Fire Code of Canada (2020)	NRC	No Change

Table 2.10.d: Impact from the Construction and Operation of the PCSS on PWMF's Fire Protection Licensing Basis Documents

OPG Emergency Management and Fire Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Fire Protection	N-PROG-RA-0012	No Change

2.11 Waste Management

2.11.1 Waste Management Program

Licence Condition 11.1 states "*the licensee shall implement a waste management program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.11.a: List of Waste Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Wate Management Volume 1: Management of Radioactive Waste	REGDOC-2.11.1	The interim storage of L&ILW waste complies with the requirements in this CNSC regulatory document.
Interim dry storage of irradiated fuel	CSA N292.2 (2013)	The interim storage of L&ILW waste complies with the requirements in this CNSC regulatory document.
General principles for the management of radioactive waste and irradiated fuel	CSA N292.0 (2019)	The interim storage of L&ILW waste complies with the requirements in this CSA standard.
Management of low and intermediate-level radioactive waste	CSA N292.3 (2014)	The interim storage of L&ILW waste complies with the requirements in this CSA standard.

Table 2.11.b: Impact of the Construction and Operation of the PCSS on PWMF's Waste Management Licensing Basis Documents

OPG Waste Management Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Segregation and Handling of Radioactive Waste	N-PROC-RA-0017	No Change

Management of Waste and Other Environmentally Regulated Materials	OPG-STD-0156	No Change
Nuclear Waste Management	W-PROG-WM-0001	No Change
Radiation Protection	N-PROG-RA-0013	No Change

OPG has a robust waste characterization program that will account for the wastes that will be accepted for storage in the PCSS. The characterization data will be used in container and PCSS shielding/dose rate analyses where appropriate.

All waste going into the PCSS must meet the Waste Acceptance Criteria (WAC) for the PCSS which includes meeting the conditions of the characterization procedure, W-PROC-WM-0096, "*Nuclear Waste Characterization*". The WAC will include limits on the total dose rates (gamma plus neutron) for each RWC to be received and stored in the PCSS. Internal controls (e.g. radiation surveys, records) as part of the WAC process, will ensure that any RWCs being transferred from PNGS to the PCSS are compliant waste.

2.11.2 Decommissioning Plan

Licence Condition 11.2 states "*the licensee shall maintain a decommissioning plan"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.11.c List of Decommissioning Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Decommissioning	REGDOC-2.11.2 (2021)	The PWMF Preliminary Decommissioning Plan (PDP) will comply to these requirements and reflect implementation of these requirements.
Decommissioning of facilities containing nuclear substances	CSA N294-19 (2019)	The PWMF PDP complies to these requirements.

Table 2.11.d: Impact of the Construction and Operation of the PCSS on PWMF's Decommissioning Licensing Basis Documents

OPG Waste Management Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Decommissioning Program	W-PROG-WM-0003	No Change.

Preliminary Decommissioning Plan Pickering Waste Management Facility	92896-PLAN-00960-00001	PWMF PDP updates for the PCSS will be included for the submission of the 2027 Financial Guarantee (FG) in accordance with REGDOC-2.11.2.

2.11.3 Preliminary Decommissioning Plan

A PDP, 92896-PLAN-00960-00001, "*Preliminary Decommissioning Plan – Pickering Waste Management Facility*" is in place for the PWMF. The PWMF PDP complies with regulatory requirements of CSA N294-19, "*Decommissioning of Facilities Containing Nuclear Substances*". The PDP is updated every five years, with the next update scheduled for submission to CNSC staff in 2027. The next PDP update will reflect the implementation of REGDOC-2.11.2, "*Decommissioning*" and the addition of the PCSS.

As per the requirements in LC 11.2, OPG is required to maintain annual financial guarantee for the decommissioning of OPG Class 1 facilities, including the PWMF, in accordance with CNSC REGDOC-3.3.1, "*Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*". Decommissioning cost estimates in support of the OPG FGs are updated on a five-year cycle in accordance with REGDOC-2.11.2, REGDOC-3.3.1, and CSA Guide N294-19. The financial impact related to the PCSS will be included in the next 2027-2031 FG submission associated with the updated PDP.

2.12 Security

2.12.1 Security Program

Licence Condition 12.1 states "*the licensee shall implement and maintain a security program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

2.12.a: List of Security Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Nuclear Security Regulations	SOR/2000-209	Continued compliance
Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	REGDOC-2.2.4 (2018)	Continued compliance.
High Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	REGDOC-2.12.1 (2018)	Continued compliance.

Site Access Security Clearance	REGDOC- 2.12.2 (2013)	Continued compliance.

2.12.b: Impact from the Construction and Operation of the PCSS on PWMF's Security Program Licensing Basis Documents

OPG Security Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Pickering Waste Management Facility Phase II Security Report	92896-REP-08160-00001	No Change
Pickering Waste Management Facility Security Report Addendum	92896-REP-08160-00001 ADD 001	No Change
Nuclear Security	N-PROG-RA-0011	No Change
Cyber Security	N-PROC-RA-0135	No Change
Nuclear Waste Management Cyber Essential Assets	W-LIST-08161-00001	No Change

2.12.2 Facilities and Equipment

The construction and operation of the PCSS will not require changes to security related facilities or equipment because it will be storing L&ILW.

2.12.3 Response Arrangements

The construction and operation of the PCSS will not require changes to security response arrangements or processes.

2.12.4 Construction

Licence Condition 12.2 states "*The licensee shall not carry out the activities referred to in paragraph (iii) of Part IV of this licence that relate to completed construction activities in paragraph (iv) of Part IV of this licence until the submission of the proposed security arrangements and measures for the new building, or any potential modifications to the protected area that may be associated with this new building, that is acceptable to the Commission or a person authorized by the Commission*."
The construction of the PCSS will not require security arrangements, measures, or modifications to the protected area.

2.13 Safeguards and Non-Proliferation

2.13.1 Safeguards Program

Licence Condition 13.1 states "*the licensee shall implement and maintain a safeguards program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.13.a: List of Safeguards and Non-Proliferation Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Safeguards and Nuclear Material Accountancy	CNSC REGDOC-2.13.1 (2018)	Continued compliance

Table 2.13.b: Impact from the Construction and Operation of the PCSS on PWMF's Safeguards Program Licensing Basis Documents

OPG Safeguards and Non-Proliferation Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Safeguards and Nuclear Material Accountancy	N-PROG-RA-0015	No Change
Safeguards and Nuclear Material Accountancy Implementation	N-STD-RA-0024	No Change

2.14 Packaging and Transport

2.14.1 Packaging and Transport Program

Licence Condition 14.1 states "*the licensee shall maintain a packaging and transport program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-2).

Table 2.14: Impact from the Construction and Operation of the PCSS and storage of L&ILW on PWMF's Packaging and Transport Licensing Basis Documents

OPG Transportation and Packaging Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Radioactive Material Transportation	W-PROG-WM-0002	No Change
Radioactive Materials Transportation Emergency Response Plan	N-STD-RA-0036	No Change
Radiation Protection	N-PROG-RA-0013	No Change

2.15 Facility Specific

2.15.1 Construction Plans

Licence Condition 15.1 states "*The licensee shall submit an environmental management plan, a construction verification plan and the project design requirements prior to the commencement of construction activities described in paragraph (iv) of Part IV of this licence*."

Table 2.15: List of Construction Plans Related Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction of the PCSS
Fire protection for facilities that process, handle, or store nuclear substances	CSA N393-13	The PCSS design will adhere to these requirements.
NRC National Building Code of Canada (2020)	N/A	The PCSS design will adhere to the NRC National Building Code of Canada (2020) requirements.
NRC National Fire Code of Canada (2020)	N/A	The PCSS design will adhere to the NRC National Fire Code of Canada (2020) requirements.

The submission of environmental management plan, construction verification plan and design requirements will be provided to CNSC staff prior to the commencement date of construction activities.

2.15.2 Commissioning Report

Licence Condition 15.2 states "*The licensee shall not carry out the activities referred to in paragraph (ii) of Part IV of this licence that relate to completed construction activities in paragraph (iv) of Part IV of this licence until the submission of a commissioning report that is acceptable to the Commission or a person authorized by the Commission*."

OPG shall not operate the PCSS until a commissioning report has been submitted that is acceptable to the Commission or a person authorized by the Commission.

The PCSS final commissioning report will be provided to CNSC staff for acceptance prior to the operation date of the PCSS.

3.0 Other Matters of Regulatory Interest

3.1 Public Information and Engagement

OPG believes in timely open and transparent communication to maintain positive and supportive relationships and confidence of key stakeholders. OPG's Corporate Relations and Communications organization adheres to the principles and process for external communications as governed by the nuclear standard N-STD-AS -0013, "*Nuclear Public Information and Disclosure".*

Table 3.1.a List of Public Information and Disclosure Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Public Information and Disclosure	REGDOC-3.2.1 (2018)	Continued compliance

Table 3.1.b Impact from the Construction and Operation of the PCSS on PWMF's Public Information and Disclosure Licensing Basis Documents

Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Nuclear Public Information and Disclosure	N-STD-AS-0013	No Change

OPG provides responses to issues and questions raised by stakeholders and the public, and tracks issues and questions to identify trends in order to further refine proactive communications. Two-way dialogue with community stakeholders and residents is facilitated through personal contact, community newsletters, speaking engagements, advertising, and educational outreach.

Through this regular outreach of an on-going nature, OPG continues to provide members of the public and interested parties with information regarding the activities carried out at the PWMF.

3.2 Community Committees

The Pickering Community Advisory Council (CAC) is made up of citizens, representatives of non-government organizations and members of local government staff who examine a number of issues associated with the existing and future activities of the Pickering Nuclear site. The CAC assists PNGS in identifying and responding effectively to the concerns of the community. The Council's purpose is to identify community issues and concerns and define the actions members believe will be required to continuously improve operations at the site and promote the well-being of the community, among other purposes. The Council's advice focuses on, but is not limited to, the effects of PNGS operations on the environmental, health, safety, social and economic interests of the community.

In addition to the CAC, OPG has a representative on the Durham Nuclear Health Committee (DNHC). DNHC is a committee of Durham Regional Council chaired by the Region's Commissioner and Medical Officer of Health. The DNHC is a forum for discussing and addressing potential radiation and environmental human health impacts. OPG Nuclear staff make regular presentations to the DNHC on a variety of environmental, community outreach and operational issues.

3.3 Community Publications

OPG provides a community newsletter called "*Neighbours*" on a quarterly basis that is circulated by mail to residents throughout Durham Region (specific to the proximity of the respective nuclear power reactor stations). This provides an update of activities and events that occur at the respective stations.

This forum will be used as an opportunity to communicate and engage the public by providing updates on major OPG initiatives at PNGS including PWMF.

4.0 Indigenous Engagement

OPG acknowledges the Aboriginal and Treaty Rights as recognized in the *Constitution Act, 1982*. Under its Indigenous Relations Policy, OPG regularly engages with Indigenous Nations and communities with established, asserted rights, and/or interests in the areas surrounding OPG operations.

OPG's PNGS and PWMF are located on Williams Treaties First Nations (WTFN) traditional and Treaty Territory. Located in Pickering (just east of Toronto), it is one of the largest nuclear stations in the world and has been safely and reliably providing Ontario with electricity for decades.

OPG values the relationship it holds with the WTFN and remains committed to meaningful engagement with these Rights Holders. Rights Holders are defined as those who have signed treaties over the lands upon which the PNGS is located. The team at the PNGS and the PWMF have begun, and will continue to, engage with the WTFN. Other Indigenous Nations and communities who have an interest in its current nuclear operations and future projects, such as the PCSS will also be notified and engaged as necessary to respect the constitutionally protected rights and interests that exist. Through ongoing engagement, OPG will aim to identify concerns and thoughts on the future of the PNGS and PWMF. Engagement will involve frequent dialogue and regular updates regarding ongoing operations, economic opportunities, and environmental monitoring activities, both general and technical.

Appendix B of this document provides the preliminary assessment on impacts on Aboriginal and/or Treaty rights, the Indigenous Engagement summary to date, a description of planned engagement activities, and the proposed schedule for interim reporting to CNSC staff on the engagement activities.

In collaboration with the CNSC, it has been determined that the following Indigenous Nations and communities have established Aboriginal and Treaty Rights, have asserted Aboriginal and treaty rights, or have expressed an interest in the PWMF project area.

A) Identified Indigenous Communities with Established Aboriginal and/or Treaty Rights

Aboriginal and Treaty Rights refer to those rights that are recognized and affirmed in section 35 of the *Constitution Act, 1982.* For the purposes of the Duty to Consult, both established and potential rights are considered. Indigenous Nations and communities identified below have established treaty rights in the PNGS area that have been acknowledged by the Crown.

- Alderville First Nation
- Curve Lake First Nation
- Hiawatha First Nation
- Mississaugas of Scugog Island First Nation
- Chippewas of Beausoleil First Nation
- Chippewas of Georgina Island First Nation
- Chippewas of Rama First Nation

B) Identified Indigenous Communities with Asserted Aboriginal and/or Treaty Rights

Indigenous Nations and communities identified below have claimed Aboriginal and/or treaty rights but have not had these potential rights established in court or acknowledged by the Crown.

- Kawartha Nishnawbe

C) Identified Indigenous Nations and Communities Expressing an Interest

Indigenous Communities identified below do not claim Aboriginal or treaty rights, but who have expressed an interest in PNGS will be provided with information as the project progresses, as requested and as appropriate.

- Huron-Wendat Nation, Quebec
- Métis Nation of Ontario Region 8
- Mississaugas of Credit First Nation
- Mohawks of the Bay of Quinte (MBQ)
- Saugeen Ojibway Nation
- Six Nations of the Grand River

OPG has a long-standing and ongoing relationship with the WTFN and so, during Quarter 1 of 2024, meetings were held for the activities related to the Pickering Nuclear site and engagement with the WTFN was focused on providing information regarding activities at the PNGS and the PWMF. This included collaborating with the Nations on a Pickering Indigenous Engagement Plan (IEP), which will serve as a guide to discussions, engagement and involvement with regards to all developments at the PNGS and the PWMF. The final working version of the IEP was shared with the Nations in May 2024 and further revised in January 2025. A subsequent kick-off workshop for WTFN was conducted to provide an overview of the activities including the PCSS and provided an opportunity for the Nations to give feedback, ask questions and voice concerns, as well as to advance the opportunity for ongoing dialogue through collaboration on all aspects of the IEP outlined in an established Memorandum of Understanding (MOU).

OPG will continue to proactively engage the WTFN and all interested Indigenous Nations and communities through various activities such as staff briefings, community information sessions, written communication and/or workshops as outlined in the PNGS IEP. OPG also has monthly meetings with the Michi Saagig First Nations and is working to establish an engagement approach with the Chippewa First Nations. In addition, bi-monthly Waste Table meetings with the Miichi Saagig First Nations also facilitate waste-focused dialogue. The objective is to ensure there is an established forum for two-way dialogue with Indigenous Nations and communities around the PWMF which provides capacity support to discuss key topics of Indigenous interest related to the licence amendment application.

Over the course of the engagement activities, other Indigenous Nations and communities, not currently identified in the PNGS IEP, may express interest in the PNGS and the PWMF and OPG will work with the CNSC staff and the Indigenous Nation or community to determine a path forward. Furthermore, some Indigenous Nations and communities may determine they are not interested in further engagement on PNGS and/or PWMF activities and OPG will respect their requests. These changes may be reflected in future revisions of the IEP.

5.0 Conclusion

The initiative to construct the PCSS that will store L&ILW components on an interim basis is essential for OPG to support the refurbishment of PNGS Units 5 through 8 and decommissioning activities of Units 1 through 4. OPG is requesting an amendment of the PWMF WFOL-W4-350.00/2028 to construct and operate the PCSS for interim storage of L&ILW generated at PNGS.

OPG is responsible for continued safe operation of the PWMF and confirms that the construction and operation of the PCSS will be implemented based on a robust safety case. The proposed activities to support the construction and operation PCSS will not compromise continued safe operation at PWMF nor the public and employee safety, and environmental protection.

The safety case for this project can be summarized as follows:

- **Design:** OPG has and will continue to follow its Engineering Change Control process, as described in N-PROG-MP-0001, "*Engineering Change Control*", for ensuring the design complies with applicable regulatory requirements as defined in the LCH, LCH-W4-350.00/2028, and that configuration management will be maintained.

- **Continued Safe Operation:** The safety case, 92896-REP-01320-00019 R002 (Enclosure 1 of this submission), demonstrates that the operation of the PCSS and storage of L&ILW components will have a negligible effect on the safe operation, public and worker safety.

- **Environmental Protection:** The predictive environmental risk assessment completed for PCSS, 92896-REP-07701-00019 R002 (Enclosure 2 of this submission), concludes that the construction and operation of the PCSS will have negligible impact on the environment.

- **Licensing Basis:** The construction and operation of the PCSS will have a negligible impact on PWMF's licensing basis, governance, programs, and processes. Attachment 1 of this submission provides the compliance matrix for the Nuclear Safety Control Act and associated regulations required for the amendment of the PWMF WFOL.

References:

2-1. OPG Letter, K. Aggarwal to C. Salmon, "Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure," May 31, 2024, CD# 92896-CORR-00531-01544.

2.2 OPG Letter, K. Aggarwal to M. Leblanc, "Application for Renewal of Pickering Waste Management Facility Operating Licence," October 28, 2016, CD# 92896-CORR-00531-01031.

2-3. CNSC Letter, K. Campbell to K. Aggarwal, "OPG WMF – Discontinuation of Quarterly Operations Reports for OPG's Waste Management Facilities," May 3, 2024, e-Doc 7274580, CD# W-CORR-00531-02005.

2-4. OPG Letter, K Aggarwal to N. Greencorn, "Pickering Waste Management Facility – Pickering Component Storage Structure – Submission of the Neutron Dose Rate Assessment and Revised Safety Assessment", November 22, 2024, CD# 92896-CORR-00531-01571.

APPENDIX A

Proposed Amendment to PWMF WFOL-W4-350.00/2028

Current WFOL W4-350.00/2028	Requested Amendment to WFOL W4-350.00/2028 (Revised proposed amendment in bold and italic)
IV) LICENSED ACTIVITIES: This licence authorizes the licensee to: (i) operate the Pickering Waste Management Facility ("the facility") located at the Pickering Nuclear Generating Station, City of Pickering, Regional Municipality of Durham, Province of Ontario; (ii) possess, transfer, use, process, package, manage, and store nuclear substances that are required for, associated with or arise from the activities described in (i); (iii) transport Category II nuclear materials that are associated with the activities described in (i) on the site of the Pickering Nuclear Generating Station; (iv) carry out the site preparation, construction, or construction modifications at the facility associated with the authorized additional processing and storage buildings, when on completion will result in a total of no more than 1 dry storage container processing building and no more than 6 used fuel dry storage buildings; and, (v) possess and use prescribed equipment and prescribed information that are required for, associated with or arise from the activities described in (i), (ii), (iii), and (iv).	**IV) LICENSED ACTIVITIES:** This licence authorizes the licensee to: (i) operate the Pickering Waste Management Facility ("the facility") located at the Pickering Nuclear Generating Station, City of Pickering, Regional Municipality of Durham, Province of Ontario; (ii) possess, transfer, use, process, package, manage, and store nuclear substances that are required for, associated with or arise from the activities described in (i); (iii) transport Category II nuclear materials that are associated with the activities described in (i) on the site of the Pickering Nuclear Generating Station; (iv) carry out the site preparation, construction, or construction modifications at the facility associated with the authorized additional processing and storage buildings, when on completion will result in a total of no more than 1 dry storage container processing building and no more than 6 used fuel dry storage buildings; and, (v) possess and use prescribed equipment and prescribed information that are required for, associated with or arise from the activities described in (i), (ii), (iii), and (iv). ***(vi) carry out the site preparation, construction, or construction modifications and operate the Pickering Component Storage Structure for interim storage of Low and Intermediate Level Waste from Pickering NGS.***

APPENDIX B

Indigenous Nations and Communities

PCSS Impacts on the Treaty Rights

The construction and operation of a new Pickering Component Storage Structure is not expected to give rise to any novel adverse impacts on Aboriginal and/or Treaty rights.

In undertaking this preliminary assessment, OPG considered impacts to Aboriginal and/or Treaty rights that could potentially result from the site preparation, construction and operation of the PCSS, including:

- Dust and noise during site preparation and construction activities
- Gamma radiation during operations

OPG also looked at the significance and likelihood of the potential impacts by considering the spatial extent of the proposed PCSS as well as assessing the nature, degree and duration of the potential impacts. OPG's preliminary assessment that the PCSS is not expected to give rise to any novel adverse impacts on Aboriginal and/or Treaty rights is based on:

- The location of the PCSS being within the developed area of the Pickering Nuclear Site, a site that is already heavily disturbed and inaccessible.
- Adverse effects to human health are not expected since air concentrations and noise levels during site preparation and construction activities are expected to be below criteria developed to be protective of health and the environment.
- The expected doses from gamma radiation during the operation of the PCSS will be a small fraction of the public dose limit and natural background level, and below the radiation benchmark for terrestrial biota.
- Adverse effects to ecological receptors during site preparation and construction are not anticipated since all predicted air quality concentrations are expected to be below criteria developed to be protective of health and the environment.
- Wildlife in the area is accustomed to noise levels associated with an urban environment.
- OPG's Environmental Management System will continue to assess environmental risks associated with site preparation, construction and operation of the PCSS.
- Thermoluminescent dosimeters will be installed around the PCSS to monitor ambient dose rates during operation and confirm that gamma dose rates remain below dose rate targets.

OPG is committed to working with Indigenous Nations and communities to inform OPG's understanding of how the site preparation, construction and operation of a new PCSS may impact Aboriginal and/or Treaty rights, and address those impacts, as required and as appropriate.

Indigenous Engagement Summary (to date) for PCSS

From January to February 2024, OPG developed a draft Indigenous Engagement Plan (IEP) (see details in Section 4.0 of this document) to guide engagement activities on ongoing and proposed programs and initiatives at Pickering NGS, which includes the PCSS. OPG has not been delegated the Crown's Duty to Consult on this application This comprehensive IEP was developed based on comments from Rightsholders, Indigenous Nations and communities for a site wide engagement strategy that supports a holistic, comprehensive and coordinated approach across Pickering. Individual Memorandums of Understanding (MoUs) have been developed to provide a mutually agreed upon regular dialogue for engagement at Pickering NGS, which includes ongoing PWMF activities, like PCSS, throughout the remainder of 2025. Signed MoUs are in place for Alderville First Nation (FN), Curve Lake FN, Hiawatha FN, and Mississaugas of Scugog Island FN.

The Rightsholders, Indigenous Nations and communities had the opportunity to review, comment and provide feedback on the draft IEP. In May 2024, OPG updated the IEP based on feedback received and issued a final working version of the IEP in June 2024. A further IEP revision occurred and was issued in January 2025. Going forward, the IEP is intended to be a dynamic document and, as such, can continue to be updated, as appropriate, to respond to new comments that come forward from Indigenous Nations and communities and/or any shifts in engagement priorities and needs.

An **OPG-Michi Saagig FN "Waste Table"** relationship meeting has been established. The kick-off meeting took place on August 7, 2024. The purpose of the meeting is to identify key waste topics WTFN would like to discuss; provide project updates (i.e. PCSS); seek input into a Terms of Reference (ToR) and regulatory roadmap; and determine the cadence of the meetings.The Michi Saagig agreed to meet every eight weeks as recorded at the October 28, 2024 Waste Table meeting and requested that these meetings focus on high level policy discussions and get more education about Nuclear Waste in general. The most recent meeting occurred on January 29, 2025, with an update on the PCSS provided in the Appendix of the meeting materials.

An **OPG-Michi Saagiig FN "Pickering Table"** relationship meeting has also been established on a monthly basis. The purpose of this meeting is to provide space to share and discuss information related to the Pickering NGS. Topics are varied and do include waste, to which the PCSS is included.
The PCSS PERA was shared with the seven (7) WTFNs for feedback in Q4 2024. To date OPG has only received feedback from Curve Lake FN, requesting the inclusion of a Harvester receptor. OPG is awaiting feedback from the other Michi Saagiig Nations. The team will have discussions and assess the feedback received to determine updates needed to the PCSS PERA.

Identified Indigenous Communities with Established/Asserted Aboriginial and/or Treaty Rights

Community	Summary
Alderville First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS. • Invited to and attended Pickering Engagement Kick-Off Meeting in April 2024, which included PCSS overview. • No comments received on IEP. Final working version of IEP shared in May 2024. • Draft MoU to provide capacity funding for implementation of the Pickering IEP shared in May 2024. • Pickering Kick-Off follow-up meeting held with Alderville on May 28, 2024. More detail on PCSS including purpose of the facility, application

Community	Summary
	submission date, and CNSC hearing dates. • Received guidance from the Michi Saagiig WTFNs that for Pickering the Nations wish to work together at a single table, like DNNP. • OPG received feedback from Alderville on the MoU in July 2024. Included edits to the MoU as well as a request for a regulatory roadmap, permit list and Site Activity Description for the PNGS. • OPG shared revised MoU, regulatory roadmap, short term permit list in early August 2024, with commitment to provide Site Activity Description in the MoU. • Initiation of Waste Table on August 7, 2024. Alderville did not attend. Meeting materials were shared. • Initiation of OPG-Michi Saagiig Pickering Engagement Table on October 15th, 2024. • Waste Table meeting held on October 28, 2024 which provided updates to PCSS project. Meeting materials were shared. • Received comments from Alderville to finalize MoU in October 2024. OPG shared final MoU for execution early November 2024. MoU has been signed. • PCSS PERA document shared with Alderville in November 2024. • Site Activity Description shared in November 2024, includes information on PCSS. • Extension to MoU shared in draft January 2025, including logistics to enable capacity invoicing. • Pickering Indigenous Engagement Plan (IEP) update shared in January 2025. • PCSS overview and upcoming permitry presentation update shared at the OPG-Michi Saagiig Pickering Table on February 6, 2025. • Overall, no concerns raised specific to the PCSS to date. Engagement will be ongoing via Pickering Table. • Engagement will be ongoing via Pickering Table.
Beausoleil First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS. • Invited to Pickering Engagement Kick-Off Meeting in March and April 2024, which included PCSS overview. Beausoleil did not attend. • No comments received on IEP. Final working version of IEP shared in May 2024. • Continued follow-up with Beausoleil every 1-2 months over email and via phone (leave voicemails) to provide opportunity to provide an overview of ongoing and proposed initiatives at PNGS. No response to date. No concerns raised to date. OPG will continue to reach out to provide opportunities for engagement. • PCSS PERA was shared in December 2024. • Pickering Indigenous Engagement Plan (IEP) update shared in January 2025.
Curve Lake First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS. • Invited to and attended Pickering Engagement Kick-Off Meeting in March 2024, which included PCSS overview.

Community	Summary
	• No comments received on IEP. Final working version of IEP shared in May 2024. • Draft MoU to provide capacity funding for implementation of the Pickering IEP shared in May 2024. • Received guidance from the Michi Saagiig WTFNs that for Pickering the Nations wish to work together at a single table, like DNNP. • OPG shared revised MoU, regulatory roadmap, short term permit list in early August 2024, with commitment to provide Site Activity Description in the MoU. • Initiation of Waste Table on August 7, 2024. Curve Lake attended. • Initiation of OPG-Michi Saagiig Pickering Engagement Table on October 15th, 2024. • Waste Table meeting held on October 28, 2024 which provided updates to PCSS project. Meeting materials were shared. • Received comments from Curve Lake to finalize MoU in October 2024. OPG shared final MoU for execution early November 2024. MoU has been signed. • PCSS PERA document shared with Curve Lake in November 2024. • Site Activity Description shared in November 2024, includes information on PCSS. • Extension to MoU shared in draft January 2025, including logistics to enable capacity invoicing. • Pickering Indigenous Engagement Plan (IEP) update shared in January 2025. • PCSS PERA feedback received January 2025 with request to include a Harvester receptor. • PCSS overview and upcoming permitry presentation update shared at the OPG-Michi Saagiig Pickering Table on February 6, 2025. • Overal, no concerns raised specific to the PCSS to date. Engagement will be ongoing via Pickering Table. • Engagement will be ongoing via Pickering Table.
Georgina Island First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS. • Invited to Pickering Engagement Kick-Off Meeting in March and April 2024, which included PCSS overview. Georgina Island did not attend. • No comments received on IEP. Final working version of IEP shared in May 2024. • Continued follow-up with Georgina every 1-2 months over email and via phone (leave voicemails) to provide opportunity to provide an overview of ongoing and proposed initiatives at PNGS. OPG receives acknowledgement emails from Georgina Island when sending materials, but no comments received to date. OPG will continue to reach out to provide opportunities for engagement. • PCSS PERA was shared in December 2024. • Pickering Indigenous Engagement Plan (IEP) update shared in January 2025.
Hiawatha First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS

Community	Summary
	• Invited to and attended Pickering Engagement Kick-Off Meeting in March 2024, which included PCSS overview. • No comments received on IEP. Final working version of IEP shared in May 2024. • Draft MoU to provide capacity funding for implementation of the Pickering IEP shared in May 2024. • Received guidance from the Michi Saagiig WTFNs that for Pickering the Nations wish to work together at a single table, like DNNP. • OPG received feedback from Hiawatha on the MoU in July 2024. Included edits to the MoU as well as a request for a regulatory roadmap, permit list and Site Activity Description for the PNGS. • OPG shared revised MoU, regulatory roadmap, short term permit list in early August 2024, with commitment to provide Site Activity Description in the MoU. • Initiation of Waste Table on August 7, 2024. • Initiation of OPG-Michi Saagiig Pickering Engagement Table on October 15th, 2024. • Waste Table meeting held on October 28, 2024 which provided updates to PCSS project. Meeting materials were shared. • PCSS PERA document shared with Hiawatha in November 2024. • Site Activity Description shared in November 2024, includes information on PCSS. • MoU finalized January 2025, including logistics to enable capacity invoicing. • Pickering IEP update shared in January 2025. • PCSS overview and upcoming permitry presentation update shared at the OPG-Michi Saagiig Pickering Table on February 6, 2025. • Overall, no concerns raised specific to the PCSS to date. • Engagement will be ongoing via Pickering Table.
Mississaugas of Scugog Island First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS. • Invited to and attended Pickering Engagement Kick-Off Meeting in April 2024, which included PCSS overview. • Comments received on IEP in April 2024. Final working version of IEP shared in May 2024. • Draft MoU to provide capacity funding for implementation of the Pickering IEP shared in May 2024. • Received guidance from the Michi Saagiig WTFNs that for Pickering the Nations wish to work together at a single table, like DNNP. • OPG received feedback from Scugog Islan on the MoU in June 2024. Included edits to the MoU as well as a request for a regulatory roadmap, permit list and Site Activity Description for the PNGS. • OPG shared revised MoU, regulatory roadmap, short term permit list in early August 2024, with commitment to provide Site Activity Description in the MoU. • Initiation of Waste Table on August 7, 2024. • Initiation of OPG-Michi Saagiig Pickering Engagement Table on October 15th, 2024. • Waste Table meeting held on October 28, 2024 which provided updates to PCSS project. Meeting materials were shared.

Community	Summary
	• Received comments from Scugog Island to finalize MoU in September and October 2024. OPG shared final MoU for execution in October 2024. MoU has been signed. • PCSS PERA document shared with Scugog Island in November 2024. • Site Activity Description shared in November 2024, includes information on PCSS. • Extension to MoU shared in draft January 2025, including logistics to enable capacity invoicing. • Pickering IEP update shared in January 2025. • PCSS overview and upcoming permitry presentation update shared at the OPG-Michi Saagiig Pickering Table on February 6, 2025. • Overall, no concerns raised specific to the PCSS to date. Engagement will be ongoing via Pickering Table. • Engagement will be ongoing via Pickering Table.
Rama First Nation	• Shared draft version of IEP in January 2024. IEP is inclusive of the PCSS. • Invited to Pickering Engagement Kick-Off Meeting in March and April 2024, which included PCSS overview. Rama attended April 2024 Meeting. • Comments received on the IEP in June 2024. Final working version of IEP shared in May 2024. • OPG attended Chief and Council Meeting in July 2024 to provide overview of ongoing and proposed activities at PNGS, including PCSS. • Shared draft MoU to provide capacity funding for implementation of the Pickering IEP in July 2024. • Continued follow-up with Rama every 1-2 months over email and via phone (leave voicemails) to provide opportunity for further engagement for PNGS. No response to date. No concerns raised to date. OPG will continue to reach out to provide opportunities for engagement. • PCSS PERA was shared in December 2024. • Pickering Indigenous Engagement Plan (IEP) update shared in January 2025.

Indigenous Nations and Communities Expressing an Interest

Community	Summary
Huron-Wendat Nation, Quebec	• Shared draft version of the IEP in January 2024. IEP inclusive of the PCSS. • No substantive comments received on the IEP. Final working version of IEP shared in June 2024. • Pickering IEP update shared in January 2025. • OPG is ready and willing to provide and share information about the PCSS and Pickering more broadly upon request. • No comments or concerns received on the PCSS to date.
Mohawks of Bay of Quinte	• Shared draft version of the IEP in January 2024. IEP inclusive of the PCSS. • No comments received on the IEP. Final working version of IEP shared in June 2024.

Community	Summary
	• Pickering IEP update shared in January 2025. • OPG is ready and willing to provide and share information about the PCSS and Pickering more broadly upon request. • No comments or concerns received on the PCSS to date.
Métis Nation of Ontario Region 8	• Shared draft version of the IEP in January 2024. IEP inclusive of the PCSS. • No comments received on the IEP. Final working version of IEP shared in May 2024. • Meeting to share information and updates on ongoing and proposed initiatives at PNGS in June 2024. • Pickering IEP update shared in January 2025. • OPG is ready and willing to provide and share information about the PCSS and Pickering more broadly upon request. • No comments or concerns received on the PCSS to date.
Saugeen Ojibway Nation (comprised of Saugeen First Nation and Chippewas of Nawash Unceded First Nation)	• Shared draft version of the IEP in September 2024. IEP inclusive of the PCSS. • No comments received on the IEP. • OPG is ready and willing to provide and share information about the PCSS and Pickering more broadly upon request. • No comments or concerns received on the PCSS to date.
Six Nations of the Grand River	• Shared draft version of the IEP in January 2024. IEP inclusive of the PCSS. • Received comments on the IEP. Final working version of IEP shared in May 2024. • Meeting to share information and updates on ongoing and proposed initiatives at PNGS in October 2024. • Pickering IEP update shared in January 2025. • OPG is ready and willing to provide and share information about the PCSS and Pickering more broadly upon request. • No comments or concerns received on the PCSS to date.
Mississaugas of the Credit First Nation	• The comments received from the CNSC in November 2024 with respect to adherence to REGDOC-3.2.2 is the first time OPG has heard that the Mississaugas of the Credit First Nation is interested in learning more about ongoing and proposed activities at PNGS. • With this new information, OPG will reach out to Mississaugas of the Credit First Nation to understand their interest.

Planned Engagement Schedule:

Pickering IEP capacity agreements are planned with the Michi Saagiig Nations for future engagement beginning Q1 2025.

Forum	First Nations	Topics / forum	Frequency
Nuclear Waste Table	Alderville FN Curve Lake FN Hiawatha FN Mississaugas of Scugog Island FN	All OPG nuclear waste topics of interest to the WTFN. For example: Waste topics through various Operating Licences (Darlington NGS/Darlington Waste Management Facility, Pickering NGS/Pickering Waste Management Facility including PCSS, Western Waste Management Facility), and other OPG nuclear projects such as Decommissioning, Refurbishment, DNNP, as well as the 2023 Natural Resources Canada Waste Policy and Integrated Strategy for Radioactive Waste, etc. - Written updates - Briefing notes - Presentations - Tours	Approx. Every four to six weeks
Pickering Table	Alderville FN Curve Lake FN Hiawatha FN Mississaugas of Scugog Island FN	- Life Extension to 2026 - Operations of Units 5-8 to 2026 - Pickering Units 5 to 8 Refurbishment - Pickering Safe Storage of Units 1-4 - Pickering Decommissioning - Nuclear Sustainability Services (NSS), Pickering Waste Management Facility	Monthly

OPG is committed to continue to share information and provide opportunities for engagement with the Chippewa Nations, based on the level of interest and concern that may be expressed, as well as capacity. OPG will also continue to reach out to Indigenous Nations and communities that express an interest and is both ready and willing to provide and share information about the PCSS and Pickering more broadly upon request.

CNSC Reporting (Indigenous Engagement)

OPG currently meets monthly with CNSC staff to provide updates on Indigenous Engagement; updates about PCSS are provided at this meeting. If further information or additional meetings are required, OPG will work with CNSC staff to establish an alternative reporting regime, as appropriate.

ENCLOSURE 1

OPG Letter, K. Aggarwal to C. Salmon, "Pickering Waste Management Facility – Pickering Component Storage Structure, Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment Commission Member Document".

CD# 92896-CORR-00531-01606 P

Pickering Component Storage Structure Safety Assessment

92896-REP-01320-00019 R002

(178 total pages)

REPORT

KINECTRICS

PICKERING COMPONENT STORAGE STRUCTURE SAFETY ASSESSMENT

PV209/RP/0001 R04

November 15, 2024

Prepared for

Ontario Power Generation

Security Classification: Kinectrics Confidential

Unless otherwise noted, redactions are made according to exemptions from Freedom of Information and Protection of Privacy Act (FIPPA) S. 18 and Access to Information and Privacy (ATIP) S.13.

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ONTARIO POWER GENERATION

Safety Analysis Improvement Project Dept.	
Document No.:	92896-REP-01320-00019
Revision No.:	R002
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OPG Proprietary	

OPG Purchase Order Number:		
Kinectrics:	300215	☑
Worley Parsons:	300216	☐
Candu Energy:	300217	☐
Calian Ltd:	300219	☐
Other:	PO ______	

This acceptance does not relieve the contractor from responsibility for errors or omissions or from any obligations or liability under this contract.

Revision History

Rev	Date	Author	Description of Revision
R00	December 15, 2023	E. Heritage, J. Peng	Initial Issue
R01	March 18, 2024	E. Heritage, J. Peng	Updated in response to OPG comments
R02	September 13, 2024	A. Alves	Updated to include the revised layout shielding assessment (Sections 3.1.2.3, 5.3.3, & 5.3.6)
R03	October 9, 2024	A. Alves	Updated in response to OPG comments and to include the final PCSS layout assessment (Sections 3.1.2.4, 5.3.4, & 5.3.6)
R04	November 15, 2024	A. Alves	Updated to include the neutron dose rate assessment and in response to OPG comments on the ALARA assessment

Certification Statement

I, the undersigned, being a licensed professional engineer in the province of Ontario and being competent in the applicable field, have prepared or directly supervised the preparation of this document, following the procedures of the Kinectrics quality management system.

Kinectrics document and revision no. PV209/RP/0001 R04

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Registration no. 100185374

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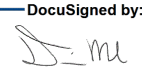

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Date: November 15, 2024

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1.0 Introduction

Ontario Power Generation (OPG) currently operates the Nuclear Sustainability Service Pickering Waste Management Facility (PWMF). The PWMF is composed of 2 sites. The PWMF Phase I site is located within the Pickering Nuclear Generating Station (PNGS) protected area, south-east of Pickering NGS Unit 8, adjacent to the east side of the station security fence [1]. The PWMF Phase II site is located approximately 500 m north-east of the site in the East Complex. The PWMF Phase I site consists of the following sub-facilities: Used Fuel Dry Storage for interim storage of Pickering used fuel in Dry Storage Containers (DSCs); and Retube Component Storage for interim storage of PNGS A irradiated reactor components in Dry Storage Modules (DSMs). The PWMF Phase II site contains a security kiosk, DSC Storage Buildings 3 and 4 and the site for additional DSC storage.

OPG is planning to construct the Pickering Component Storage Structure (PCSS) on the PWMF Phase II site directly to the northeast of SB3, and directly north of the future SB5. The PCSS will fall under the ownership of Pickering Waste Management. The structure will be used to support the refurbishment of Pickering B.

2.0 Objectives and Scope of Work

To support the construction of the PCSS, a safety assessment must be prepared, similar to what has been prepared for other waste storage buildings at the Pickering site. The assessment will consist of the following scopes of work:

1. Normal Operations Safety Assessment
2. Malfunctions/Accident Safety Assessment
3. ALARA Assessment

3.0 Safety Assessment Methodology

The methodology to be used for each piece of the safety assessment for the PCSS are outlined in the sub-sections below. The methodology used is informed by and consistent with OPG's Guideline For Safety Assessment [2].

3.1 Normal Operations Safety Assessment

3.1.1 Public Dose from Chronic Emissions

The emissions from the PWMF during normal operations and the doses to public were calculated recently [3]. In this work, the emissions from the expanded PWMF were evaluated based on the latest emission data for PWMF and the potential emissions from the PCSS taking into account the design of the PCSS. On this basis, it would be determined if the previous assessment sufficiently represented the radiological impact on public health resulting from the expanded PWMF.

3.1.2 Public and Worker Dose from External Gamma Radiation

An MCNP assessment was performed to calculate the external dose rates from the PCSS. This assessment followed the two stage MCNP calculation method outlined in the OPG reference methodology for heavily shielded containers [4]. The first stage is to generate a single container surface source for each waste type and container using MCNP's surface source write function. The second stage is to use the surface sources generated for the waste containers to calculate a full site dose rate. OPG provided the MCNP model used to perform an analysis of the dose rates due to used fuel within SB 3, 4, and a conceptual layout for SB5 [5]. This model was used as the basis for the external dose calculations. Additional shielding calculations were subsequently performed, which consider an updated PCSS waste layout and sensitivity cases associated with the concrete wall thickness, SG and RWC dose rates and SB5 DSC contributions. Based on these results, a final layout was defined for the PCSS and the dose rates with this layout were assessed. The purpose of the latest set of calculations was to demonstrate that dose rates can meet the dose limits for the PCSS.

3.1.2.1 Single Container MCNP Models

For the first stage of this methodology, three single container MCNP models were developed:

- A Retube Waste Container (RWC) containing Pressure Tubes (PTs) or Calandria Tubes (CTs) or Calandria Tube Inserts (CTIs). This container is known as the RWC-PT
- An RWC containing End Fittings (known as an RWC-EF)
- A Pickering B Steam Generator (SG)

The models for the RWC-PT and SG were developed based on models provided by OPG. Only a single RWC-PT model was required to address the modelling of an RWC containing PTs, CTs, or CTIs since those containers all have the same dimensions and are assumed to produce dose rates at the Waste Acceptance Criteria (WAC). The model for the RWC-EF was provided by OPG from a shielding analysis of the preliminary design for the container described in Reference [6].

Source terms for each container type were developed and scaled to meet the WAC provided by OPG in the Task Order Request for this project [7]. Following the scaling, a surface source write run was performed in MCNP to create a surface source for use in full building calculations (stage 2 of the MCNP reference methodology).

<u>RWC-PT Geometry</u>

The dimensions assumed for the RWC-PT at the conceptual stage were provided by OPG in Reference [8]. The container was assumed to be a simple symmetric carbon steel box with dimensions as shown in Table 1.

Table 1: Dimensions for RWC-PT [8]

[redacted]

The MCNP model for this container was a straightforward box, as shown in Figure 1. The waste stored in the box was treated as a homogenous mass, as with other analysis of RWC-PTs from other OPG waste facilities [9], since the PTs and CTs stored in the container will be cut up and compacted into coupons and stored in the central cavity.

[redacted]

Figure 1: RWC-PT MCNP Model

<u>RWC-EF Geometry</u>

The MCNP model of the RWC-EF used in the shielding analysis for the conceptual design of the container in Reference [6] was provided by OPG. The geometry was left unchanged from the previous shielding analysis. [redacted] as shown in Figure 2.

[redacted]

Figure 2: RWC-EF MCNP Model

<u>Steam Generator Geometry</u>

A simplified model of the SGs was created in MCNP based on the dimensions from the general arrangement drawing [10]. The SG is a complex assembly of thousands of tubes and plates. To simplify the modelling, a similar approach was taken as with previously modelled SGs from the Western Waste Management Facility (WWMF) [9]. The major modelling simplifications were as follows:

- The main components modelled were the u-tube bundle, the tubesheet, the head drum, and the shell.
- The shell was assumed to have constant thickness, the thinnest dimensions available for thickness was used.
- The u-tube bundle was represented by a single homogenized cylinder with a spherical cap.
- The head drum components were modelled as a single homogenized cylinder.
- The tubesheet was modelled as a single homogenized cylinder.
- The gap between the u-tube bundle and the shroud was assumed to be 0.5 inches.
- The nozzles on the SG were not modelled. At the WWMF, metal plates were welded to the nozzles so that the dose emanating from the nozzles was not different than the rest of the SG body. It was assumed this will also be the case for Pickering B.

The geometry of the MCNP model of the Pickering B SG is shown in Figure 3.

[redacted]

Figure 3: MCNP Model of Pickering B SG

<u>Materials</u>

A detailed description of the materials used in the single container MCNP models is provided in Appendix D.

<u>Source Terms</u>

The source activity of each waste container and SG was scaled to ensure that the dose rates around the containers were consistent with OPG's WAC. To do so, tallies were added at contact and at 1 m for each container.

OPG's Waste Acceptance Criteria are as follows:

- RWCs:
    - Case 1 – 200 mrem/h on contact and 10 mrem/h at 1 m
    - Case 2 – 200 mrem/h on contact, 20 mrem/h on the sides, 40 mrem/h on the top and bottom at 1 m

- SGs:
  - 40 mrem/h at 1 m

MCNP's surface source write (SSW) card was used to create surface source files for use in the full building calculations (stage 2 of the MCNP reference methodology). The details of the source for each container are outlined below.

RWC-PT Source Term

The source region for the RWC-PT was the entire homogenized PT/CT volume inside the container. As a simplifying assumption for the purpose of scaling the source strength to the WAC, the source spectrum was treated as entirely composed of Co-60. For Case 1, no source biasing was used, and the entire source was treated as homogenous. The source strength was scaled until the WAC was achieved at either contact or at 1 m.

For Case 2, to achieve a higher dose rate on the top and bottom, the source was biased towards the top and the bottom so that the ratio of dose rates at the side and the top was consistent with the WAC.

For the purpose of performing the source calibration, tallies were placed outside the container at the centre of each of the RWC's faces, at both contact (5 cm) and at 1 m.

RWC-EF Source Term

For the RWC-EF, the existing source used in the conceptual design shielding analysis of the RWC-EF was re-used. It is described in Section 2.3.3 of Reference [6]. The source for each component in the end fitting assembly was modelled explicitly. The only difference from the previous source term was that the source strength was scaled until the WAC was achieved at either contact or at 1 m.

For the purpose of performing the source calibration, tallies were placed outside the container, centered on each of the six sides of the container and placed at 5 cm and at 1 m from it. The tallies placed at 5 cm correspond to the contact point and were moved 5 cm from the container to avoid having a tally located at a boundary between two materials. For the bottom and the lid of the container, second dose points were added to confirm that the maximum dose rate was considered for the scaling.

Steam Generator Source Term

The source regions used in the SGs were the homogenized u-tube bundle, the tubesheet, and the homogenized head drum. As with the RWC-PT, the source spectrum was modelled as Co-60 and the strength was adjusted until the WAC was achieved.

For the purpose of performing the source calibration, tallies were placed outside the SG at 5 cm (corresponding to contact with the SG) and at 1 m from the SG shell side. A total of four dose points (two sets of two dose points) diametrically opposite were used to calibrate the source.

3.1.2.2 Initial Full Building MCNP Calculations (Conceptual)

The second stage of the MCNP calculations was performed by updating the previously prepared MCNP model of the PWMF, which was outlined in Reference [5]. This model of the PWMF included what's known as Phase II of the PWMF, including buildings SB3 and SB4, as well as the conceptual design for future building SB5. It did not include Phase I of the PWMF[1]. The model was updated to include the PCSS as well as the RWC and SG container models described in Section 3.1.2.1 above.

As shown in Figure 4, the proposed location for the PCSS is directly to the northeast of SB3, and it will be directly north of the future SB5. The co-ordinates for the 4 corners of the PCSS were provided in email from OPG [11] and are also shown in Figure 4.

The distance from the proposed location for the PCSS to the northeast corner was then estimated by entering the building corner co-ordinates and measuring the distance to the northeast corner of SB3 using Google Earth. These distances were used to place the PCSS geometry in the MCNP model relative to the other buildings, as shown in Figure 5.

Label	X	Y	Lat	Long
PCSS	656385	4852755	43.811322	-79.0556
PCSS	656366	4852812	43.811839	-79.055817
PCSS	656418	4852829	43.811982	-79.055162
PCSS	656437	4852772	43.811466	-79.054946

Figure 4: Proposed Location of the PCSS [11]

[1] The dose rate contribution from waste stored in the Phase I area of PWMF is insignificant at the Phase II area.

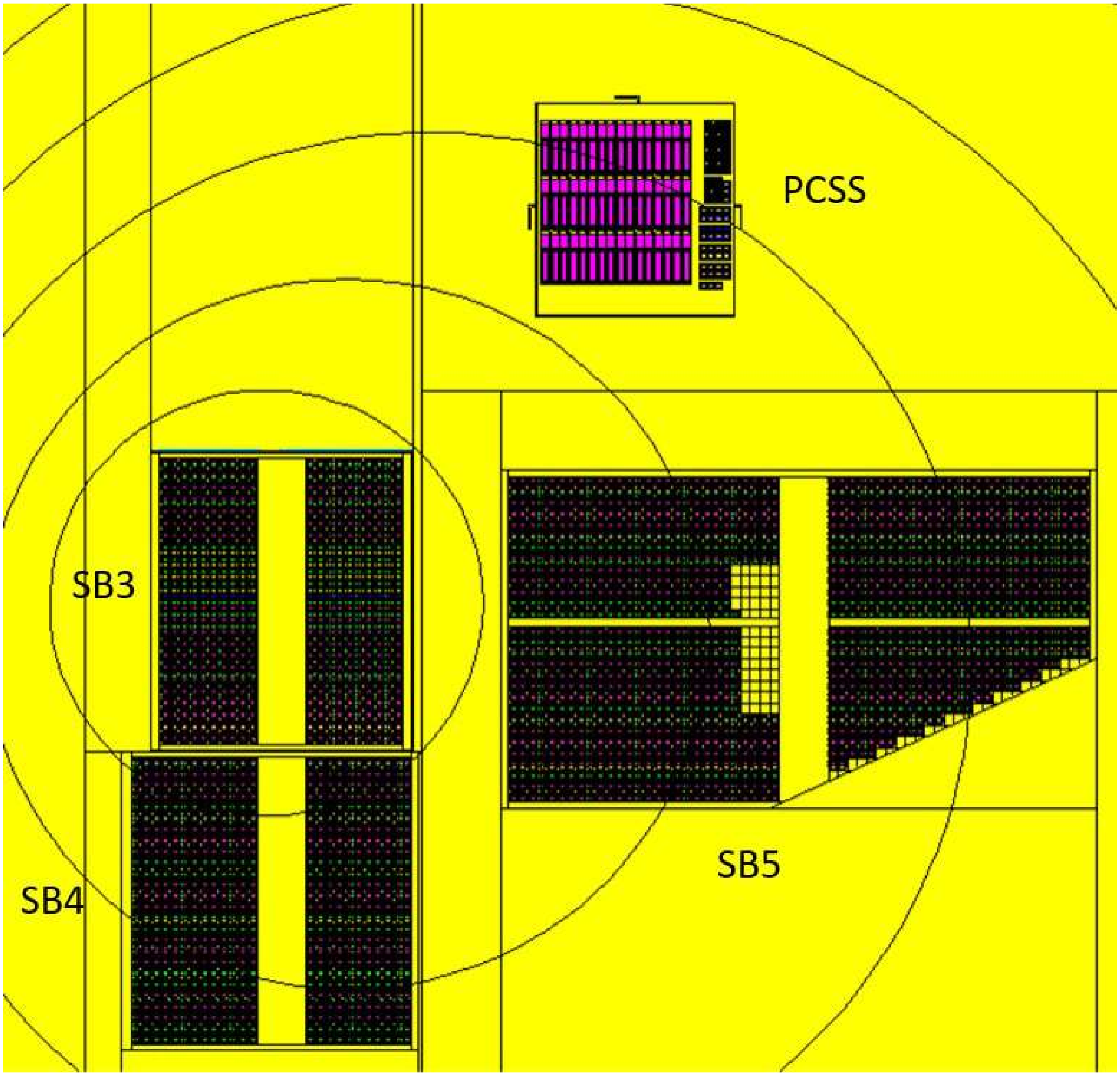

Figure 5: MCNP Model of PWMF with PCSS

Supporting the initial design, three configurations were considered for the analysis of the PCSS. The base case considered a PCSS design based on the Darlington Waste Management Facility (DWMF) Retube Waste Storage Building (RWSB), which has concrete shielding panels and an industrial roof [12]. Three sensitivity cases were then also considered. The first sensitivity case considered a building with a shielded roof, similar to the Steam Generator Storage Building (SGSB) at the WWMF [13]. The second sensitivity considered the same building design as the base case, but with additional shielding added to the area around the overhead door which serves as the main entry point for waste packages into the building. The purpose of adding this second sensitivity case was to demonstrate that with additional shielding around the door, the dose rates can be controlled As Low As Reasonably Achievable (ALARA). The last sensitivity case considered a reduced SG dose rate of 10 mrem/hr at a distance of 1 m. The geometry for these cases is described below. For all cases, the geometry of SB3, SB4, and SB5 were left unchanged from the previously developed model described in Reference [5].

Base Case
The configuration of the PCSS considered in the base case was based on the DWMF RWSB. To do this, the wall and roof thicknesses for the PCSS were taken from the shielding analysis of the DWMF in Reference [12]. Concrete shielding panels with a thickness of [redacted] and a height of [redacted] were used around the entire building. Above the shielding panels, an industrial roof was modelled with [redacted] of rockwool insulation between a [redacted] steel sheet on the inside, and a 0.46 mm steel sheet on the outside. The floor of the building was modelled as 30 cm thick concrete. The total length of the building modelled was [redacted] and the total width modelled was [redacted] These dimensions were calculated from the co-ordinates provided by OPG in Figure 4. As with the other buildings in the MCNP model of the PWMF, the area outside of the PCSS was modelled as dirt with no vegetation or gradient modelled.

The doors for the building were assumed to be similar to the RWSB. One personnel door was added to the centre of each of the north, west, and east walls. These personnel doors included a shielded labyrinth on the exterior of the building to reduce streaming through the unshielded door. An overhead door was added on south wall with an adjacent personnel door. No labyrinths were added to the south wall as it was assumed this would not be compatible with the loading of steam generators into the building. The personnel doors were modelled with a height of [redacted] and a width of [redacted]. The overhead door was modelled with a height of [redacted] and a width of [redacted]. The labyrinths were made of [redacted] thick concrete, the same as the shielding panels, and extended to a height of [redacted] The geometry of the base case PCSS is shown in Figure 6.

[redacted]

Figure 6: Geometry of PCSS, Base Case

<u>Sensitivity 1: Shielded Roof</u>

For the first sensitivity case, a PCSS with a shielded roof was considered. This configuration is based on the design of the SGSB and the WWMF. The shielding analysis of the SGSB in Reference [13] was used as the basis for the MCNP modelling of this sensitivity case. This configuration maintained the same PCSS dimensions, doors, labyrinths, and concrete shielding panel thickness [redacted] as the base case but extended them up to a height of [redacted] The roof was modelled as 10 cm thick ordinary concrete. The shielded roof geometry for this sensitivity case is shown in Figure 7.

[redacted]

Figure 7: Shielded Roof Sensitivity Case Geometry

Sensitivity 2: Shielded Overhead Door

The second sensitivity case considered added shielding to the overhead and personnel doors. The shielding configuration considered was similar to a sensitivity case analyzed for the SGSB at the WWMF in Reference [14]. A concrete wall representing a temporary wall of 8” thick hollow cinder blocks (with an effective shielding thickness of 10.6 cm of concrete) was added 5 cm away from the overhead door. It extends 15 cm past the edge of the overhead and personnel doors and to a height of 555 cm. As with the base case, the industrial roof was considered for this case. The geometry of the shielding added to the overhead door is shown in Figure 8.

[redacted]

Figure 8: Geometry of Shielded Door Sensitivity Case

Sensitivity 3: 10 mrem/hr SG Dose Rate

The third sensitivity case considers an SG dose rate below the 40 mrem/hr at 1 m assumed in the base case and first two sensitivity cases. For this sensitivity case, the dose rate from the SGs was reduced to 10 mrem/hr at 1 m. This was achieved by dividing the MCNP results for the SG by a factor of 4, and keeping the uncertainty the same. This is mathematically equivalent to reducing the source strength within MCNP itself.

Materials

A detailed description of the materials used in the full building (PCSS) MCNP model is provided in Appendix D.

Layout of Waste Containers Within PCSS

The conceptual layout for the wastes stored in the PCSS was provided by OPG in Reference [15], which is shown in Figure 9. All waste containers were kept a minimum of 1 m from the walls of the PCSS. For the RWCs, a space of 50 cm in the north/south direction was kept between containers within the same group, and a space of 110 cm was kept between groups of containers. In the east/west direction, a space of 24 cm was kept between RWC-PTs, and a space of 30.935 cm kept between RWC-EFs. For the SGs, a separation of 14 cm between SGs was used in the east/west direction, and a separation of 10 cm was used in the north/south direction. The SGs were modelled as essentially laying on the ground (3 cm off the ground).

The number and location of containers was taken from Figure 9. The RWC-PTs were stacked 2 containers high, and the RWC-EFs were stacked 3 containers high. The only difference is that the conceptual layout shows a stack containing a single RWC-EF (labelled EF64 in the figure). For flexibility, it was assumed in the model that this would be a full 3-high stack of RWC-EFs. Therefore, the total number of containers included in the model were 66 RWC-EFs, 76 RWC-PTs (note that for the MCNP modelling, RWCs containing PT/CTs are not treated differently than those containing CTIs), and 48 SGs.

The MCNP surfaces and cells from the containers and SGs used to generate the surface sources in Section 3.1.2.1 were incorporated into the full building.

[redacted]

Figure 9: Conceptual Layout of Wastes within PCSS [15]

<u>Other Buildings and Wastes</u>

The models and layouts for SB3, SB4, SB5, and the DSCs within them were left unchanged from the previous MCNP model of the PWMF in Reference [5]. The DSC surface sources that were used in the current analysis were those generated in Reference [16].

<u>Dose Points</u>

The existing dose points from the previously developed model of the PWMF [5] were re-used for this analysis. The title and location of the main site dose points are shown in Figure 10. The dose acceptance criteria for these dose points are discussed in Section 3.4.

A new tally was added to the model for the purpose of determining where a facility fence might need to be located. This tally extended from 2 m south and 2 m west of the southwest corner of the PCSS to 50 m north and 50 east of the PCSS. This tally is shown schematically in Figure 11.

The previous model included many tallies, not all of which were needed for this analysis. They were left in the input files, however the main tallies of interest for this work are listed in Table 2. These include the site dose points, as well as the PCSS mesh tally, and the mesh tally which surrounds the dry storage buildings SB3/SB4/SB5, which is shown in Figure 12. The dose conversion factors that were used for each of the tallies are listed in Table 2, and these dose conversion factors are discussed in Section 3.1.2.7.

Table 2: Description of MCNP Tallies

Dose Point	Dose Conversion Factors	Description
PW10	ICRP 116 AP	1ft below TMB roof peak (height 41 ft above TMB floor)
PW24	ICRP 116 ROT	Montgomery Park Rd turnaround
PW26	ICRP 116 ROT	Bend in bike path northeast of PWMF Phase II
LS03	ICRP 116 ROT	Off shoreline
LS04	ICRP 116 ROT	Off shoreline
LS05	ICRP 116 ROT	Lake 282 m off shoreline
LS06	ICRP 116 ROT	Lake 144 m off shoreline
LS07	ICRP 116 ROT	Lake, where shoreline intersects with land site boundary
-	ICRP 116 AP	Mesh tally around SB3/SB4/SB5
-	ICRP 116 AP	Mesh tally around PCSS

*AP=Anterior-Posterior, ROT=Rotational

Figure 10: PWMF Site Dose Points

Figure 11: Mesh Tally Around PCSS

Figure 12: Mesh Tally Around SB3/SB4/SB5

3.1.2.3 Updated Full Building MCNP Calculations

The conceptual layout of waste in the PCSS documented in Section 3.1.2.2 has changed to the layout shown below in Figure 13 [17]. This update to the conceptual layout significantly changes the positions of the SGs and RWCs within the PCSS, compared to the previous layout, shown above in Figure 9. These changes were made to reduce dose rates at the PWMF site dose points shown above in Figure 10. The MCNP model was updated to reflect the new layout, as shown in Figure 14, and calculations were performed to assess how these layout changes affect the dose rates at the PWMF site dose points and the PCSS perimeter. Additionally, sensitivity calculations with variations in the PCSS roof thickness, SG and RWC dose rates, and SB5 DSC layout were also performed.

[redacted]

Figure 13: Conceptual PCSS Layout [17]

[redacted]

Figure 14: MCNP Model of PCSS – Bases Cases

The number and location of containers were taken from Figure 13. The RWC-PTs and RWC-EFs were each stacked 3 containers high. The total number of containers included in the model were 64 RWC-EFs, 76 RWC-PTs (note that for the MCNP modelling, RWCs containing PT/CTs are not treated differently than those containing CTIs), and 48 SGs.

A total of 30 cases were assessed with the updated PCSS layout, including base cases, roof thickness sensitivity cases, and SGs, RWCs, and DSCs sensitivity cases.

<u>Base & Roof Thickness Cases:</u>
The base cases consider the PCSS roof thickness of 10 cm while the roof sensitivity cases consider 15 cm. For these cases, the RWC and SG source activities were scaled such that the

resulting dose rates are consistent with the Waste Acceptance Criteria (WAC) below. The following base cases were run for each container type:

RWCs:

- Case 1: 200 mrem/h on contact and 10 mrem/h at 1 m
- Case 2: 200 mrem/h on contact, 20 mrem/h on the sides, 40 mrem/h on the top and bottom at 1 m

SGs:

- Case 1: 40 mrem/h at 1 m
- Case 2: 20 mrem/h at 1 m
- Case 3: 10 mrem/h at 1 m

The combination of the 2 RWC and 3 SG cases comprises the 6 base cases considered for each building configuration. The roof thickness sensitivity calculations comprise 6 additional cases.

The year assumed for the waste configuration is taken to be 2028. The year of first acceptance to the PCSS is 2027. It is assumed that the waste will enter the PCSS at their respective WAC and the waste types will be decayed by 1 year. This decay is applied in post-processing. Similarly, the 20 mrem/h at 1 m & 10 mrem/h at 1 m SG cases are determined by post-processing the SG 40 mrem/h at 1 m case by scaled down by a factor of 2 and 4 respectively.

<u>SG Sensitivity Cases:</u>
In order to further reduce dose rates, SG sensitivity scenarios consider the staggered loading of SGs in the PCSS and also credit unit-specific survey data [18] [19] [20] [21]. Since Unit 8 had its primary side full during the survey, Unit 8 dose rates were assumed to be the same as Unit 6, which has the highest surveyed dose rates. Scenario 1 considers a schedule with a final placement year in 2032, and Scenario 2 considers that it will be in 2031. In each scenario, the decay between the unit shutdown date and the final placement year was considered. The summaries for each scenario are shown in Table 3 and Table 4. The dose rates were calculated in MCNP for Scenario 2. For Scenario 1, the dose rates were calculated by rescaling the results from Scenario 2.

Table 3: Scenario 1 – Schedule per Unit

[redacted]

Table 4: Scenario 2 – Schedule per Unit

[redacted]

The dose rates for each SG placement year case were also calculated. This was done to identify which year would represent the bounding dose rates for determining building wall shield thickness. Starting with only the Unit 5 SGs in the northeast of the PCSS, subsequent units were added and their actual decay was credited. The SGs for the units that are not present in the placement year had their materials changed to air in the MCNP model, as shown in Figure 15.

[redacted]

Figure 15: Per Placement Year PCSS MCNP Model SG Layouts – U5 top, U5+U6 mid, U5+U6+U7 bottom

RWC Sensitivity Case:
An RWC sensitivity configuration was considered based on the RWC CTI Release & Removal schedule from Reference [17]. In this case, the RWC Case 2 results were considered with a decay of 1.7 years (620 days) in addition to the contributions from the SGs Scenario 2 and DSC Case 2.

DSC Sensitivity Case:
The DSC base case, labelled as DSC Case 1, was calculated in Reference [22] and considers 480 DSCs in SB3, 624 DSCs in SB4, and 1322 DSCs in SB5. For this case, the contributions of the DSCs in SB3, SB4, and SB5 were left unchanged from the previous analysis [23] [24]. Since SB5 will only be partially loaded when the PCSS is full, the previous assumption was refined to consider fewer DSCs contributing to the dose rates outside the PCSS. This case considered 446 DSCs in SB5. SB5 is not projected to be fully loaded until ~2040, which represents a factor of more than 5x reduction in the contributions from waste inside the PCSS. The additional DSC sensitivity case was labelled DSC Case 2, considering the same DSC number in SB3 and SB4, and 446 DSCs in SB5. The DSC layout in SB5 for DSC Case 2 was confirmed by OPG in [25] and is shown in Figure 16, the numbers represent the DSC ages. The MCNP model with this layout is shown in Figure 17.

[redacted]

Figure 16: DSC Layout in SB5 – DSC Case 2

[redacted]

Figure 17: MCNP Model with the DSC Case 2 SB5 Layout

Following the geometry and source term updates to the MCNP models, MCNP simulations were performed, and the dose rates were calculated using the existing surface sources developed in the previous revision of this report were used in these calculations.

A series of MCNP cases were run with no additional shielding. These cases use the WAC for the RWCs and SGs outlined above. The MCNP calculations also include the contributions from the full SB3-5 buildings to represent a holistic dose rate assessment.

For the roof, the 10 cm shielding thickness was used for the base cases, and a shielding thickness of 15 cm was assessed as a sensitivity case.

Hand calculations were performed to estimate the additional shielding thicknesses that need to be added to the walls and roll-up door of the PCSS in order to reduce dose rates at all dose points and along the outer walls of the PCSS below acceptance criteria.

The MCNP cases were then updated with additional concrete added to the PCSS and re-run to confirm that the additional shielding was effective in reducing dose rates below acceptance criteria at all dose points and along the outer walls of the PCSS.

All 30 cases considered (regarding source terms, PCSS shielding, and year assessed) are summarized in Table 5.

Table 5: Case Summary

DSCs		RWCs			SGs					Roof Thickness		Year(s)
Case 1	Case 2	Case 1	Case 2	Case 2 (1.7 y decay)	Case 1	Case 2	Case 3	Scenario 1	Scenario 2	10 cm	15 cm	
Base Cases												
✓		✓			✓					✓		2028
✓			✓		✓					✓		
✓		✓				✓				✓		
✓			✓			✓				✓		
✓		✓					✓			✓		
✓			✓				✓			✓		
Roof Thickness Sensitivity Cases												
✓		✓			✓						✓	2028
✓			✓		✓						✓	
✓		✓				✓					✓	
✓			✓			✓					✓	
✓		✓					✓				✓	
✓			✓				✓				✓	
SG Schedule Sensitivity Cases												
✓		✓						✓		✓		2028 2029 2030 2032
✓			✓					✓		✓		
	✓	✓						✓		✓		
	✓		✓					✓		✓		
✓		✓						✓			✓	
✓			✓					✓			✓	
	✓	✓						✓			✓	
	✓		✓					✓			✓	
✓		✓							✓	✓		2027 2028 2029 2031
✓			✓						✓	✓		
	✓	✓							✓	✓		
	✓		✓						✓	✓		
✓		✓							✓		✓	

DSCs		RWCs			SGs					Roof Thickness		Year(s)
Case 1	Case 2	Case 1	Case 2	Case 2 (1.7 y decay)	Case 1	Case 2	Case 3	Scenario 1	Scenario 2	10 cm	15 cm	
✓			✓						✓		✓	
	✓	✓							✓		✓	
	✓		✓						✓		✓	
Additional Wall Shielding & Roll-up Door Sensitivity Cases												
	✓		✓						✓	✓		2031
	✓			✓					✓	✓		

3.1.2.4 Final PCSS Layout Full Building MCNP Calculations

Following the analysis of the first two layouts, described in Sections 3.1.2.2 and 3.1.2.3 above, the PCSS layout was further updated. This was done to include floorplan details, such as personnel doors and the rooms at the southwest corner of the building, accounting for the shielding recommendations from the updated layout calculations. The locations of SGs and RWCs were updated slightly to accommodate the fire exit routes added in the drawing. The double doors are [redacted] wide and [redacted] tall [26], and the dimensions in the MCNP model match this. The single doors are [redacted] wide and [redacted] tall. When not explicitly defined in the drawing, the positions of the doors were estimated based on the drawing.

The PCSS labyrinth walls are [redacted] tall [26]. The final PCSS layout drawing is shown in Figure 18. The MCNP model layout was updated according to this drawing. The model includes all internal and external walls with the same thicknesses as the drawing, except for the north wall, which included only a portion of the added [redacted] shielding wall, extending to about [redacted] from the west wall and the remainder of the north wall is the standard [redacted], as shown in Figure 19. OPG is pursuing this concept into detailed design.

Dose rates were calculated with the updated MCNP model for the following configuration: SG 2031 Scenario 2, RWC Case 2, DSC Case 2, and PCSS Roof 10 cm.

Additional results were also calculated for this same configuration, with an additional decay time of 620 days (1.7 years) for the RWCs, based on the CTI Release & Removal schedule from Reference [27]. This additional decay time was accounted for by rescaling the results of the RWC Case 2 runs.

[redacted]

Figure 18: Final PCSS Layout

[redacted]

Figure 19: Final PCSS Layout MCNP Model (Thickness & Length × Thickness)

3.1.2.5 PCSS Neutron Dose Rates

The neutron hazards associated with the RWC containing Pressure Tubes (PT) and Calandria Tubes (CT) that will be stored in the PCSS at the PWMF were assessed and documented in Reference [28]. The MCNP assessment was performed to calculate the external neutron dose rates from the PCSS. The final PCSS layout, described above in Section 3.1.2.4, has a total of 60 RWC-PT/CTs in stacks of three, highlighted in red in Figure 20.

The neutron source term was generated from the activities of components due to neutron activation of the bulk metal and due to surface deposits, reported in Reference [29]. These activities include the uranium impurities in the bulk metal, whose irradiation leads to the creation of Cf-252 and other neutron emitters, and actinides found in the surface deposits. The RWC-PT/CT neutron source term was modelled as 35 PTs, 35 CTs, and 140 Annulus Spacers (AS). Two types of AS (Inconel X-750 and Zr-Nb-Cu) are present in Pickering B Units. The 140 AS were conservatively assumed to be Zr-Nb-Cu as it produces a more intense neutron energy spectrum. Additionally, the source term considered a decay of 1.7 years (~620 days), based on the RWC CTI Release & Removal schedule, listed in Reference [30]. This is also conservative as the RWC-PT/CT are scheduled to be removed after the RWC CTI. The reactor defuel is scheduled to start in 2026, per Reference [30], and the PCSS will only be full in around 2031, per the scheduled Scenario 2 SG placement dates shown above in Table 4. So, the dose rates calculated with 1.7 years decay are conservative compared to the 4-5 years period between shutdown and the full building date.

Reference [28] also includes an assessment of the dose rates with Borated Polyethylene (BPE) to minimize the impact of neutron dose rates from the RWC-PT/CTs along the PCSS perimeter. Various thicknesses of BPE with a density of 0.995 g/cm^3 and 5% boron by weight were evaluated. This boron concentration was chosen because it is the most commonly available type of BPE sheet. The BPE layers were added around the RWC-PT/CTs, covering two sides (south and east) or four sides (south, east, west, and top). The secondary gamma production from neutron capture interactions (n,γ) was also tallied in these cases. OPG will pursue the addition of temporary neutron shielding with the recommended configuration.

[redacted]

Figure 20: Final PCSS Layout MCNP Model (Thickness & Length × Thickness) – RWC-PT/CT Group Highlighted in Red

3.1.2.6 Cross-Section Libraries

The cross-section libraries used in both the single container and full building MCNP calculations were those installed on the Kinectrics technical computing platform for use with MCNP. They rely primarily on the ENDF/B-VI R8 and ENDF/BVII.1 data libraries [31]. Consistent with the previous MCNP model of the PWMF site, the cross-section library used in this work was the MCLIB04 photon library, based on ENDF/B-VI cross sections.

3.1.2.7 Dose Conversion Factors

The Dose Conversion Factors (DCF) used in both the single container and full building MCNP calculations were the International Commission on Radiation Protection (ICRP) 116 Anterior-Posterior DCF [32] for the on-site tallies, and ICRP 116 Rotation DCF for the site boundary dose points. These are internationally recognized and accepted conversion factors and are specifically identified in the OPG reference methodology for heavily shielded containers [4].

3.2 Malfunctions/Accidents Safety Assessment

OPG guidelines for safety assessment in support of safety report updates for OPG waste facilities [2] were used for screening of potential accident scenarios, radionuclide inventory and release estimates, and dose assessment including public dose and worker dose resulting from malfunctions and accidents. REGDOC-2.4.4 [33] was adopted and applied in this assessment as well.

3.2.1 Hazard Identification, Screening and Classification of Bounding Accidents

Hazard screening of construction, transfer, handling and storage activities was carried out based on analysis of the activities involved, the characterization of the waste of concern (i.e., SG and RWCs), OPEX and the OPG internal hazard [34] and external hazard [35] screening guides. The following general steps will be performed as part of the hazard identification and screening process [2]:

- Perform hazard identification study,
- Pre-screening of internal and external hazards, and
- Detailed qualitative and quantitative event screening.

If the frequency of occurrence estimated for any postulated accident scenario is less than 10^{-6} events per year (refer to CSA N292.0:19 [36] and REGDOC-2.4.4 [33]), it is considered incredible and is not considered for further assessment.

The hazards include human induced hazards and external hazards. Transfer hazards from the station to the PCSS were considered.

As required by REGDOC-2.4.4 [33], the credible events will be classified into the following facility states:

- Anticipated Operational Occurrence (AOO),
- Design-Basis Accident (DBA), and
- Design Extension Conditions (DEC).

The frequency ranges of these states were as per Appendix C.2 of REGDOC-2.4.4 [33].

3.2.2 Radiological Releases

To calculate the radiological releases to the environment, estimates of the radionuclide inventories for SG and RWC are required:

- Inventories for SG: Gamma spectroscopy survey information from PNGS boilers with the secondary/primary side drained was taken into account to derive the source term for SG. Specifically, Co-60 activities from the gamma spectroscopy survey results for PNGS boilers were compared with the previous work [37]] and the bounding value was used to determine the inventory of SG (refer to Table 4-9 of [37]).
- Inventories for RWC: Bounding fuel channel source terms was used to derive the source term for RWC, accounting for the total inventory in the RWC. Specifically, bounding inventories for the RWCs at WWMF was used (refer to Table 5-9 of Reference [37]) in this work. These source terms were derived for the WWMF which has similar reactor

component materials and a similar container design, and were considered conservative and acceptable for PNGS.

The release fractions for airborne radionuclide releases of L&ILW were calculated using the following equation [2][2]:

$$Airborne\ Source\ Term = MAR \times DR \times ARF \times RF \times LPF$$

Where

MAR = Material-at-Risk (Bq),

DR = Damage Ratio,

ARF = Airborne Release Fraction (or Airborne Release Rate for continuous release),

RF = Respirable Fraction, and

LPF = Leak Path Factor.

The radionuclide releases are a product of the inventory and release fraction of the respective radionuclides. The ARF, RF, and LPF used will be similar to previous assessments from the WWMF.

3.2.3 Dose to Public from the Postulated Malfunctions/Accidents

ADDAM analysis was performed to calculate doses to public resulting from the airborne releases to the environment following accidents and malfunctions. The modelling was performed as follows:

- ADDAM input files for the bounding scenarios identified above were prepared. Specifically, the release activity data files were based on the analysis of source term generated above using the methods described above. The ADDAM dataset was based on that used in the previous PWMF assessment [3] with the exception of the meteorological data. The meteorological data used in Reference [3] was for the year 2021. That data is not compliant with the requirements of CSA N288.2 as it does not represent the most recent one-year period. Meteorological data for the Pickering site for the period of 2017-2021 was recently prepared in Reference [38]. This data meets the requirements of CSA N288.2 and was therefore used for this assessment.
- The receptors selected for the dose assessment were those in all habitable sectors of interest including the site boundary and representative group locations defined in Environmental Monitoring Program (EMP) for Pickering site [3]. Specifically, the receptors selected were consistent with the previous work, that is, those identified in Reference [3].

The 95th percentile individual dose for an exposure period of 30 days was calculated, consistent with the recommendations of REGDOC-2.4.1 and CSA N288.2-19. Note in this work, the release duration was extended to 100 hours with a negligible, small tail representing 0.01% of the estimated release to avoid zero doses for some sectors due to infrequent wind directions and short duration release. This is aligned with the recommendations made in [39].

[2] Note the scaling factors used for ALARA assessment (refer to Section 3.3.2) were not applied here, which makes the source term estimate more conservative.

3.2.4 Dose to Workers from the Postulated Malfunctions/Accidents

The doses to workers resulting from exposure to radioactivity during the postulated accidents were calculated based on the bounding scenario identified. Three exposure pathways were considered, that is, inhalation which includes skin absorption, cloudshine (immersion) and groundshine. Excel spreadsheet calculations were carried out for dose calculations based on the assumed releases, exposure time, inhalation rate, and other parameters. The equations for the calculation of doses from these pathways were the same as those used in the previous update of the PWMF Safety Assessment [3] and are given below:

Dose from Inhalation:

$$D_{inhalation} = \sum_{n=1} (R_n \times BR \times sk_{a,n} \times DCF_{inhalation,n}) \times T/V$$

Where

$D_{inhalation}$ = worker dose from inhalation (Sv)

R_n= released activity of nuclide n during the exposure time (Bq)

BR = worker's inhalation rate (m^3/s)

$sk_{a,n}$ = skin absorption factor for nuclide n ($sk_{a,n}$ =1.5 for tritium as HTO and 1 for other radionuclides)

$DCF_{inhalation,n}$ = inhalation dose coefficient of nuclide n (Sv/Bq)

T = exposure time (s)

V = contaminated cloud volume (m^3)

Dose from Cloudshine:

$$D_{cloudshine} = \sum_{n=1} (R_n \times DCF_{cloudshine,n}) \times T/V$$

Where

$D_{cloudshine}$ = worker dose from cloudshine (Sv)

$DCF_{cloudshine,n}$ = cloudshine dose coefficient of nuclide n (Sv-m^3/(Bq-s))

Dose from Groundshine (if applicable):

$$D_{groundshine} = \sum_{n=1} (R_n \times DCF_{groundshine,n}) \times T/A$$

where

$D_{groundshine}$ = worker dose from groundshine (Sv)

$DCF_{groundshine,n}$ = groundshine dose coefficient of nuclide n (Sv-m^2/(Bq-s))

A = area contamination (m^2)

The total dose to workers was calculated as:

$$Total\ Dose\ =\ D_{inhalation} + D_{cloudshine} + D_{groundshine}$$

The estimated doses to workers were compared against the dose criteria specified in Section 3.4.

3.3 ALARA Assessment

The objective of the ALARA assessment was to:

- assess potential individual and collective doses to workers resulting from the placement of wastes into the preliminary waste storage configuration option shown in Figure 9.
- determine whether they comply with the regulatory limits, applicable OPG governance and PWMF licensing requirements.
- to provide recommendations to ensure that doses resulting from the chosen option are ALARA.

The individual and collective doses estimated refer to operations taking place at the PCSS. Doses incurred during the removal and transportation of waste to the PWMF were not included in this work, nor were doses incurred from waste segmentation. The task involved the estimation of potential individual and collective worker dose for the following cases:

I. The handling and emplacing of one SG, one EF RWC, and one PT/CT/CTI RWC exclusive of surrounding waste packages (per the WAC);

II. Handling and emplacing of all SGs, EF RWCs, and PT/CT/CTI RWCs.

It was assumed that the waste in the PCSS is the same regardless of whether the building will be used to support Pickering-B retube or decommissioning (i.e., only one ALARA assessment is performed).

It was also assumed that data from previous ALARA assessments for the WWMF (such as transfer operations to be performed, durations, frequencies, personnel, etc.) can be used in the ALARA assessment for the PCSS, such as the North Site Safety Assessment [40], which includes the dose rates for existing wastes in WWMF from Reference [41], and Reference [42], which includes estimated doses for placement of SGs at WWMF.

Note that it was assumed that the SGs and RWCs are sealed prior to all transfer operations within the scope of this ALARA assessment. As such, internal uptakes are expected to be negligible and no accounting for internal doses (i.e., committed effective doses) was considered.

3.3.1 Container Dose vs. Distance Estimates

The ALARA assessment accounted for activities which take place at varying distances from the RWCs and SGs. It was therefore necessary to produce a rough estimate of the dose rate as a function of distance for each container type. This was done by creating a simplified MicroShield model for each container type. The gamma spectra was created using the radionuclide inventories for the limiting waste type (the same inventories outlined in Section 3.2.2). The dose rate for each container type was then scaled to the WAC for each container, and the dose rate was calculated at distances of contact, 30 cm, 1 m, and 5 m.

3.3.2 Dose Calculations

The external gamma dose received by workers, while storing SGs and RWC in the PCSS is determined by the average external gamma dose rate during the task multiplied by the exposure time for the task. A given task may be broken down to sub tasks so as to better approximate the distance and dose rates.

The individual dose for each task was calculated as follows:

$$Dose(mSv) = DoseRate(mSv \bullet h^{-1}) \times Exposure\ Time\ per\ task(h) \times \#\ times\ task\ is\ conducted$$

While most of the space inside the PCSS will be taken up by the 48 SG cartridges, these are anticipated to be emplaced after the RWCs.

The proposed RWCs layout is currently such that the RWC-EFs are stacked three high and the RWC-PT/CT/CTIs are stacked two high (see Figure 9). Only a small amount of PCSS space is to be taken-up by the 140 RWCs.

There are preparatory tasks prior to handling the package that result in minor exposures and these have been accounted for (e.g., starting-up the ventilation system, walkdown, inspection of forklift, etc.).

The tasks required for handling and emplacement result in more significant exposures, of course, and these are described below.

3.3.2.1 Retube Waste RWCs

The following steps are carried out in order to store 140 RWCs inside the PCSS.

- Receive and inspect the Pickering-B RWCs and confirm dose rates
- Remove tie-downs
- Perform contamination scan of the forklift and personnel prior to exit from PCSS
- Align Forklift and Remove RWC from Flatbed Truck
- Move RWC inside PCSS and Emplace at appropriate location

Note that, in the case of RWC- EFs, these will be stacked three high and the RWC-PT/CT and RWC-CTIs will be stacked two high.

3.3.2.2 SG Cartridges

The following steps are required to store singly-stacked SG cartridges inside the PCSS.

- Setting-up the rigging (gantry and track system) inside PCSS (see Figure 21);

- Receiving the 48 SG cartridges from the Pickering-B;
- Transferring SG cartridges on to the storage saddles inside the PCSS;

Figure 21: Gantry Crane

3.4 Dose Acceptance Criteria

The radiation safety requirements under normal operation of the PWMF are the following [1]:

- ≤ 0.5 μSv/h outside the RCS and Used Fuel Dry Storage (UFDS) areas, on a quarterly average basis, based on the CNSC dose limit of 1 mSv per year for a member of the public, over a maximum of 2,000 hours per year occupancy for non-NEWs (Nuclear Energy Workers).
- For a member of the public, the dose constraint is ≤ 100 μSv per year at the Pickering site boundary. This is an administrative dose target of ten percent of the CNSC dose limit of 1 mSv per year.
- For NEWs, the dose limit is 50 mSv in any single year and 100 mSv over 5 years.

The resulting acceptance criteria for each of the dose points considering the occupancy are outlined in Table 6.

Table 6: Dose Acceptance Criteria

Dose Points	Annual Dose Acceptance Criteria	Occupancy	Hourly Dose Acceptance Criteria
PW24, PW26	100 μSv/yr	2000 hr	0.05 μSv/hr

LS03, LS04, LS05, LS06, LS07	100 μSv/yr	1000 hr	0.1 μSv/hr
PW10, mesh tallies (outside of buildings)	1 mSv/yr	2000 hr	0.5 μSv/hr

The ALARA assessment considered the Exposure Control Levels (ECLs) and Administrative Dose Limits (ADLs) which are set in OPG procedure N-PROC-RA-0019 [43]. Adherence to these levels and limits maintains control on personal dose when working in a radioactive area. ECLs are set lower than ADLs to alert employees and supervisors that dose control measures are required to ensure the ADLs are not exceeded. ECLs and ADLs are presented in Table 7 and Table 8.

Table 7: OPG Exposure Control Levels

Organ or Tissue	Nuclear Energy Worker (NEW)	Pregnant NEW rem/balance of pregnancy	Nursing NEW rem/CY for balance of nursing	Non-NEWs (Public) (rem/CY)
Whole Body (Effective Dose) Including tritium committed dose	1 rem/CY	0.010	1 (no radioactive work with risk of tritium exposure or internal contamination is allowed)	0.010
Skin	25 rem/CY	N/A	25	N/A
Hands and Feet	25 rem/CY	N/A	25	N/A
Eye Lens	3 rem/CY	N/A	3	N/A

Table 8: OPG Administrative Dose Limits

	Whole Body Dose Limits in Ontario Power Generation (rem/CY)	
	Ontario Power Generation Employees	Contract and Building Trades Union Employees(1)
NEW	2	4
NEW with a lifetime Whole Body dose greater than 50 rem	1	N/A
Non-NEW	0.050	0.050
Whole Body Dose Limits (rem/rolling 5 CY)		
NEW	5	9

3.5 Use of Software

3.5.1. MCNP

The code that was used for the normal operation dose analysis was MCNP 6.1. MCNP is a general-purpose continuous energy Monte Carlo code that can be used for simulating photon and neutron transport phenomenon. MCNP is qualified for static calculations using k-code or source term methods for various CANDU-related analyses. It is a Grade 1 code based on Section 4.2 of the Kinectrics Software Qualification Procedure, AWI-4-30 [44]. It is qualified for use in radiation shielding applications, as documented in Reference [45]. MCNP 6.1 was used to model photon transport in this analysis, and MCNP 6.1 was found to be suitable for this application as per the code applicability report [46].

3.5.2. ADDAM

ADDAM-IST v1.4.2, the latest version of the ADDAM-IST code, was used in this work [47]. ADDAM is a safety analysis computer program developed by Atomic Energy of Canada Limited for use by the CANDU Owners Group community. ADDAM calculates doses to the public due to a postulated accident release of radioactive material to the atmosphere from a nuclear facility in the form of gases, vapours or particulates, taking into account the following processes:

- Plume rise;
- Downwash;
- Modification of effective height release due to building entrainment;
- Plume broadening due to building entrainment;
- Fumigation;
- Reflection at an elevated inversion;
- Plume transport;
- Plume diffusion;
- Wet deposition;
- Dry deposition;
- Plume depletion;
- Exposure to cloudshine;
- Exposure to groundshine;
- Internal exposure due to inhalation.

ADDAM calculates doses for various organs, age groups, and receptor locations, and are categorized by different release pathways including stack, inlet, leakage, or hole and different exposure pathways of inhalation, cloudshine, and groundshine. The calculations of atmospheric dispersion and doses were based on the CSA N288.2-M91 standard [48].

The ADDAM 1.4.2 qualification report [49] documents all qualification activities performed by CANDU Owner Group (COG) and concludes that ADDAM v1.4.2 is qualified for this work. A recent code assessment documented in Reference [50] has confirmed that ADDAM is also in compliance with CSA N288.2-14. Following the issue of the latest revision of the standard (CSA

N288.2:19), an impact assessment of ADDAM against CSA N288.2:19 is currently being prepared under COG Work Package 50115. The code applicability for ADDAM for this work is summarized in the previous assessment [3].

3.5.3 MicroShield

The code used in the ALARA assessment was MicroShield 9.05 [51]. MicroShield is a general-purpose point-kernel code that can be used for simulating photon shielding problems. MicroShield is qualified for static calculations for various CANDU-related analyses. It is a Grade 3 code based on Section 4.2 of the Kinectrics Software Qualification Procedure, AWI-4-30 [44]. It is qualified for use in radiation shielding applications, as documented in Reference [52].

3.5.4 ORIGEN-S

ORIGEN-S was used in this work to calculate the decayed neutron energy spectra. ORIGEN-S is an isotope generation and depletion code used in nuclear safety-related analyses to calculate time-dependent isotopic inventories in irradiated nuclear reactor fuel and activated components, together with associated quantities including decay heat, and neutron and gamma radiation spectra. It is part of the SCALE suite of codes developed by Oak Ridge National Laboratory (ORNL). ORIGEN-S is a module within the Scale version 6.1.3 suite of codes [53]. Qualification of SCALE 6.1 is documented in Reference [54].

4.0 Key Technical Assumptions

Assumption #1

The only types of waste expected to be stored at the PCSS are steam generators and fuel channel components from the Pickering Nuclear Generating Station.

Basis/ Rationale: This is similar to the storage of retube and refurb components at both the Darlington and Western Waste Management Facilities.

Assumption #2

The geometry, materials, layouts, and DSC fuel decay times used in Reference [5] was assumed for the MCNP modelling of Storage Buildings 3/4/5.

Basis/ Rationale: This is the most recent MCNP dose rate assessment of the PWMF and should be used for consistency.

Assumption #3

For calculation of worker dose resulting from SG/RWC drop event, the worker was assumed to be present in the vicinity of the location where the accident occurs, wearing no Personal Protective Equipment (PPE). The worker’s response time to leave the accident location under emergency back-out conditions was assumed to be 120 seconds. For the earthquake event, it is assumed that workers at the PWMF will be able to evacuate. Therefore, the dose consequence to the worker would be similar to the dose calculated for members of the public.

Basis/ Rationale: It is conservative and consistent with the existing PWMF Safety Report [1] and WWMF Safety Assessment [55].

Assumption #4

The radionuclides considered in the malfunction and accident assessment is consistent with the previous work [37].

Basis/Rationale: The previous work [37] represented the results of comprehensive study and the radionuclides in that work was considered representative.

Assumption #5

The SG radionuclide inventory was based on direct measurements and using calculated scaling factors based on the measured Co-60 activity, which was further compared with the scaling factor reported in other work [37] . Radionuclides were not estimated using scaling factors based on used fuel radionuclides inventories or predicted using fission product release and activation models.

Basis/Rationale: This approach is justified on the basis of the low scaling factors in Table A-2 of Reference [37], based on used fuel radionuclides inventories or predicted using fission product release and activation models.

Assumption #6

The activity scaling factor based on the ALARA assessment was not applied to source term estimates.

Basis/Rationale: The scaling factor based on the ALARA assessment reduces the waste inventory. Therefore, the results are more conservative without applying the scaling factor to the source term estimate.

Assumption #7

A Fire Hazard Assessment (FHA) for the PCSS was not prepared during the time frame of this project. The FHA report for similar storage buildings on another waste management facility [56] was used instead.

Basis/Rationale: An FHA report is required for the screening process for fire scenarios and any consequence assessment (dose calculation). The buildings at another waste management facility are of similar design and contain similar waste, ignition sources, etc. and so are expected to be similar to the eventual PCSS FHA.

Assumption #8

For the earthquake event, it is assumed that workers at the PWMF will be able to evacuate. Therefore, the dose consequence to the worker would be similar to the dose calculated for members of the public.

Basis/Rationale: This assumption is consistent with worker dose assessment for earthquake event for other waste management facility safety assessment [55]. Additionally, as noted in Section 6.1.2.6, the Design Basis Earthquake (DBE) is defined as an earthquake with a peak ground acceleration of 0.05g. The PCSS will be built to the National Building Code of Canada and is therefore not expected to collapse following the DBE. The conservative assumption of building collapse was included for the purpose of defining a bounding Design Extent Condition (DEC). An analysis of the Processing Building at the WWMF, which features concrete shielding panels, concluded that an earthquake strong enough to cause the building to collapse would have a frequency between $4x10^{-6}$ and $6x10^{-6}$. This frequency aligns with the DEC category, suggesting that assessing building collapse as a DEC is reasonable. However, following loading, the PCSS will not be occupied, so scenarios involving complete blockage of evacuation routes or worker incapacitation due to a building collapse are unlikely. The building is expected to be occupied only about one hour per week. As a result, the concurrent occurrence of an earthquake causing building collapse while the building is occupied would not be within the 1x10-6 cut-off frequency for evaluation, even without accounting for scenarios where evacuation is still possible following the collapse.

Assumption #9

It is assumed that 50% of the PCSS is occupied by RWCs and only this portion of the PCSS was taken into account the calculation of cumulative aircraft crash frequency for safety containers [57]. The crash frequency for the rest of the building used for the storage of SGs was calculated separately.

Basis/Rationale: Based on the arrangement of RWCs and SGs in the PCSS, RWCs will occupy less than 30% of the PCSS. Therefore, the assumption of 50% descried above is conservative. In addition, the calculation of cumulative frequency only applies to safety related packages including DSCs, DSM and RWCs, which is consistent with other assessment [55].

5.0 Normal Operations Safety Assessment

5.1 Total Public Dose

The maximum individual dose to members of the public can be calculated by adding together the maximum individual dose from chronic releases which is 1.88E-03 µSv per year (see Section 5.2), and the dose rate from external gamma radiation at the most conservative public dose point (PW26).

For the initial conceptual layout, as shown in Section 5.3.2 below, the dose rates calculated from external gamma radiation at PW26 for all cases except for the 10 mrem/h SG sensitivity cases with a shielded roof in Section 5.3.2.4, were above the acceptance criteria of 0.05 µSv/h which equates to 100 µSv per year (assuming 2,000h occupancy). The lowest dose rate from external gamma radiation calculated at PW26 was 0.0228 µSv/h (Shielded Roof Case 1 - Sensitivity in Table 24), which equates to 45.6 µSv per year.

The updated PCSS waste layout, using updated SG source terms and updated removal/placement schedules, has been demonstrated to meet all land and water based dose limits. This includes the PCSS wall perimeter, which can be maintained at 0.5 µSv/h with the addition of additional internal shielding walls. For this updated layout, discussed in Section 5.3.3, the dose rates from external gamma radiation at PW26 for all cases are below the acceptance criteria of 0.05 µSv/h, except for two of the base cases (RWC Case 1 + SG Case 1 and RWC Case 2 + SG Case 1), discussed in Section 5.3.3.1.

For the Final PCSS layout, assessed in Section 5.3.4, the dose rate from external gamma radiation calculated at PW26 was 0.0139 µSv/h (SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm in Table 56), which equates to 27.8 µSv per year. Adding the contributions from the neutrons and secondary gammas from the RWC-PT/CTs, the dose rate at PW26 was 0.0175 µSv/h (with the recommended borated polyethylene shielding).

Therefore, the dose contribution from chronic releases is negligible compared to the dose contribution from external gamma radiation. The administrative dose target of 100 µSv per year is not exceeded considering the dose from external gamma radiation for the PCSS additional wall shielding calculations, described in Section 5.3.3.5.

5.2 Public Dose from Chronic Emissions

The chronic emissions from the PWMF during normal operations and the doses to public were calculated recently [3]. The locations of the receptors of concerns are shown in Figure 22 and Figure 23.

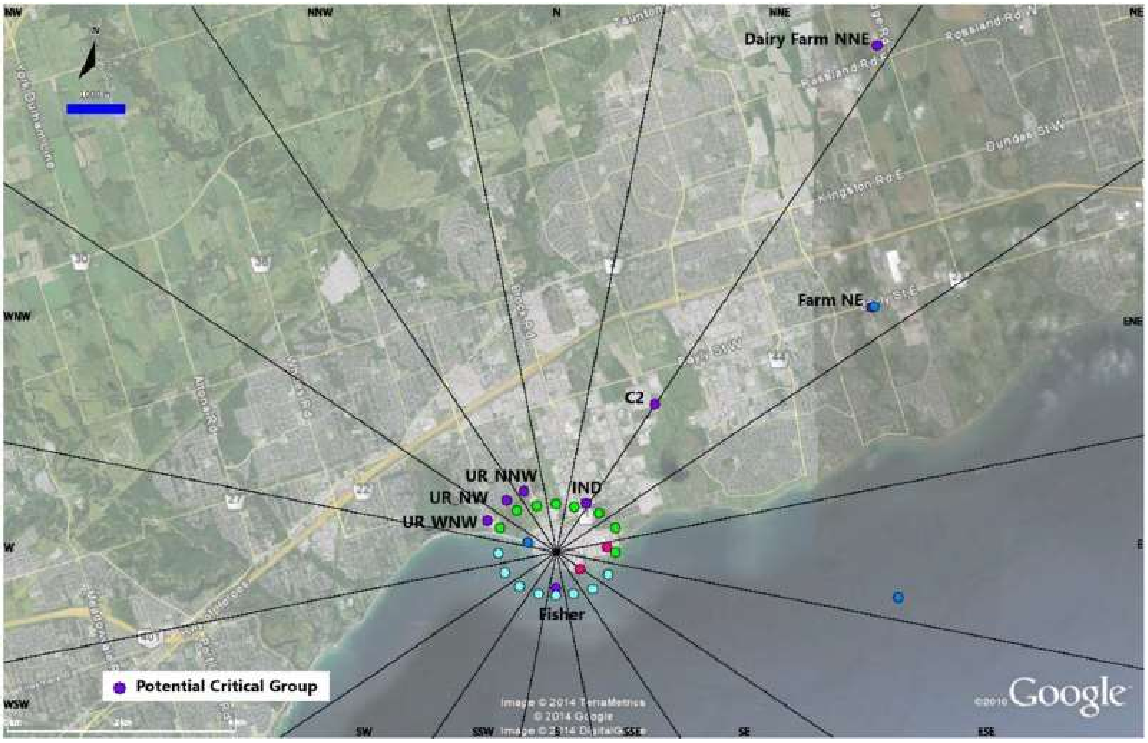

Figure 22: Locations of Representative Persons [3].

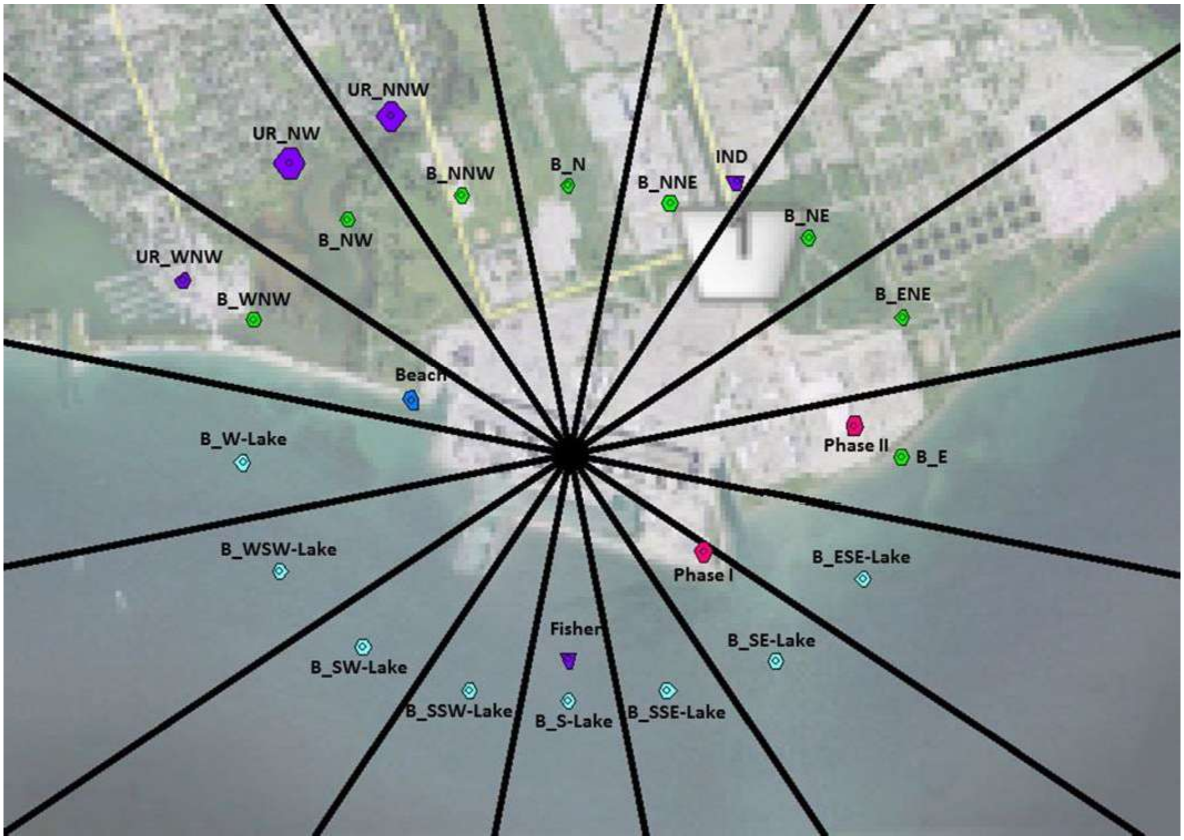

Figure 23: Locations of Representative Persons, Showing Details on Hypothetical Locations [3]

The dose calculation accounted for the following aspects:

- Update of chronic emission estimate to include the latest measurements.
- A revision of the IMPACT models to incorporate the latest meteorological data, representative persons, routine emission, and the latest code version.
- Incorporation of information from the DSC Storage Building (SB) 4 safety assessment [58].

The results are shown in Table 9 [3]. As shown in the table, the maximum individual dose at the landside receptor locations from chronic releases is 1.88E-03 µSv per year, which occurs for an infant at the dairy farm group, NNE from the PWMF facility. The maximum individual dose at the lakeside receptor locations from chronic releases is 1.00E-03 µSv per year for a child, which occurs at the hypothetical receptor location at SSE direction from the PWMF. These doses are both less than the administrative dose target of 100 µSv per year as discussed in Section 3.4.

Table 9: Public Dose during Normal Operation of PWMF [3]

	Annual individual dose (µSv/a)		
Location	Adult	Child	Infant
B_E	4.63E-04	5.29E-04	4.51E-04
B_ENE	2.19E-04	2.49E-04	2.17E-04

Location	Annual individual dose (μSv/a)		
	Adult	Child	Infant
B_NE	1.65E-04	1.87E-04	1.66E-04
B_NNE	5.84E-05	6.63E-05	5.80E-05
B_N	7.49E-05	8.48E-05	7.51E-05
B_NNW	9.15E-05	1.03E-04	9.35E-05
B_NW	9.97E-05	1.11E-04	1.04E-04
B_WNW	1.20E-04	1.33E-04	1.25E-04
B_W-Lake	4.51E-05	5.32E-05	4.03E-05
B_WSW-Lake	5.52E-05	6.51E-05	4.93E-05
B_SW-Lake	7.22E-05	8.51E-05	6.45E-05
B_SSW-Lake	1.35E-04	1.59E-04	1.21E-04
B_S-Lake	3.15E-04	3.72E-04	2.82E-04
B_SSE-Lake	8.51E-04	1.00E-03	7.60E-04
B_SE-Lake	7.53E-04	8.88E-04	6.72E-04
B_ESE-Lake	3.41E-04	4.02E-04	3.05E-04
Fisher	2.86E-05	3.37E-05	2.55E-05
C2	1.35E-04	1.52E-04	0.00E+00
IND	5.02E-05	0.00E+00	0.00E+00
UR_NNW	8.29E-04	8.66E-04	7.23E-04
UR_NW	9.15E-04	9.55E-04	8.05E-04
UR_WNW	1.06E-03	1.11E-03	9.40E-04
Dairy Farm NNE	1.21E-03	1.15E-03	1.88E-03
Farm NE	8.21E-04	5.24E-04	4.46E-04

It should be noted that the above dose calculations were based on the radiological emissions up to the end of 2021 taking into account the postulated releases during DSC processing and postulated releases from DSMs during storage. The releases in 2022 [59] [redacted] per year, were lower than 2021 values of [redacted] per year [60], which was further bounded by the historical emission value used in the assessment [3]. Also, it is expected that there are no emissions from SB5 to be built within the PWMF area for the storage of DSCs [58] . Furthermore, the preliminary design of the PCSS is based on Steam Generator Storage Building (SGSB)/ Retube Component Storage Building (RCSB) at the WWMF and it is expected that there will be negligible releases to the air and water from PCSS under normal conditions. In addition, the characteristics of public receptors as described in 2022 assessment [3] is up to date. Given all these factors, the dose calculations performed in the previous assessment sufficiently represented the radiological impact on the public, taking into account the operation of the proposed PCSS. Therefore, no revision to public dose calculations is required at this time.

5.3 Public and Worker Dose from External Gamma Radiation

5.3.1 Single Container MCNP Dose Rates

The dose rates that were calculated using the single container MCNP models are discussed in the subsections below. These models were then used to generate the surface sources that were used for the full building calculations.

5.3.1.1 RWC-PT

The calibration for Case 1 and Case 2 are shown in Table 10. For Case 1, the WAC was first achieved at the 1 m distance for the long side of the container. The 1 m dose rates were all generally much closer to the WAC than the contact dose rates. For Case 2, the WAC was also achieved first at 1 m. The ratio of 40 mrem/hr on top and bottom with 20 mrem/hr on the sides was achieved. After biasing the source towards the top and bottom of the container, the contact dose rates on the sides were quite low, in fact below the 1 m dose rate.

Table 10: Dose Rate Calibration for RWC-PTs

Dose Point	Case 1 Dose Rate (mrem/hr)	Uncertainty	Case 2 Dose Rate (mrem/hr)	Uncertainty
Short Side (5 cm)	20.384	2.13%	11.974	5.23%
Short Side (1 m)	8.4145	0.41%	20.016	0.67%
Long Side (5 cm)	21.074	1.53%	12.002	5.81%
Long Side (1 m)	10.099	0.29%	20.272	0.74%
Top (5 cm)	11.82	3.07%	188.95	2.51%
Top (1 m)	0.5874	0.72%	40.217	0.35%
Bottom (5 cm)	11.859	3.09%	185.84	1.22%
Bottom (1 m)	0.58895	0.55%	40.467	0.57%

5.3.1.2 RWC-EF

The RWC-EF source activity was scaled twice:

- To reach 200 mrem/h on contact and 10 mrem/h at 1 m (Case 1)
- To reach 200 mrem/h on contact, 20 mrem/h on the sides, 40 mrem/h on the top and bottom at 1 m (Case 2).

The limiting criterion for both cases was the dose rate at 1 m. The limiting criterion for both cases occurred at 1 m. The dose rates calculated before and after scaling for each case are described in Table 11.

Table 11: Summary of Dose Rates Calculated for RWC-EF

Tally description	Case 1			Case 2		
	Waste Acceptance Criteria (mrem/hr)	Dose rate (mrem/hr)	Relative error	Waste Acceptance Criteria (mrem/hr)	Dose rate (mrem/hr)	Relative error
Contact back edge lid	200	24.26	5.39%	200	48.75	5.39%
Contact front edge lid	200	24.17	4.62%	200	48.58	4.62%
Contact right edge lid	200	39.20	15.29%	200	78.78	15.29%

Contact left edge lid	200	35.28	14.29%	200	70.89	14.29%
Contact bottom	200	27.76	2.79%	200	55.78	2.79%
Contact bottom (second point)	200	4.68	12.65%	200	9.41	12.65%
Contact Top Lid	200	26.87	2.80%	200	54.00	2.80%
contact Top Lid (second point)	200	10.63	19.14%	200	21.36	19.14%
1m back edge lid	10	3.79	0.91%	20	7.62	0.91%
1m front edge lid	10	4.02	0.82%	20	8.08	0.82%
1m right edge lid	10	9.49	2.10%	20	19.06	2.10%
1m left edge lid	10	9.38	2.15%	20	18.84	2.15%
1m bottom	10	4.34	0.88%	40	8.71	0.88%
1m Top Lid	10	5.40	2.04%	40	10.85	2.04%

5.3.1.3 Steam Generators

SG source activity was scaled to reach 40 mrem/h at 1 m. The dose rates calculated at various dose points are described in Table 12.

Table 12: Summary of Dose Rates Calculated for SGs

Tally description	Waste Acceptance Criteria (mrem/hr)	Dose rate (mrem/hr)	relative error
Contact	/	1.11E+02	11.60%
1m	40	4.00E+01	0.49%
Contact - second point	/	9.14E+01	2.67%
1m - second point	40	3.95E+01	0.33%

5.3.2 Initial Full Building MCNP Dose Rates

An MCNP run was performed for each source in the base case, as well as the two sensitivities. For each case, the total dose rate was calculated by summing the contributions from all sources. The results for the DSCs were only run for the base case and re-used for the three sensitivity cases. This assumes that the dose rates from the DSCs are not significantly impacted by the design of the PCSS, which is reasonable as the dose from the DSCs to the site dose points is dominated by skyshine, and the dose to the areas around the SBs and the PCSS are dominated by the nearby wastes. Detailed results are presented in the sub-sections below.

5.3.2.1 Base Case

The best estimate dose rates for the base case site dose points are shown in Table 13 and Table 14. As with the previous analyses of the PWMF site [5] [16], the dose rates were highest at site dose points PW10, PW24, and PW26 all located on the land near the waste storage buildings. The dose rates were lower at the lake dose points, which are further from the buildings.

The Steam Generators contribute around 80% of the dose rate to the land dose points, indicating that they are not only the major contributor of the PCSS wastes, but also exceed the dose rate of all the DSCs combined for the site dose points on the land. The SGs contributed a smaller fraction to the site dose points on the lake, however they still contributed more than all other sources combined.

As expected, the dose rates were higher for Case 2 where the RWC-EF and RWC-PT container dose rates were higher. However, as the SGs form such a large part of the overall dose rate, the difference in RWC dose rates from the two cases did not have a large overall impact on the dose rates.

Table 13: Base Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (µSv/hr)					
	PW24	**Error**	**PW26**	**Error**	**PW10[3]**	**Error**
Acceptance Criteria	**5.00E-02**	**-**	**5.00E-02**	**-**	**5.00E-01**	**-**
Steam Generators	8.44E-02	2.9%	1.84E-01	2.0%	1.74E+00	4.1%
RWC-EF Case 1	7.69E-04	2.0%	2.39E-03	1.2%	3.92E-02	12.5%
RWC-PT Case 1	7.48E-04	4.3%	1.55E-03	1.8%	6.30E-02	4.1%
Base Case 1	**1.05E-01**	**2.6%**	**1.97E-01**	**1.8%**	**2.07E+00**	**3.5%**
RWC-EF Case 2	1.54E-03	2.0%	4.81E-03	1.2%	7.87E-02	12.5%
RWC-PT Case 2	4.54E-03	3.1%	9.21E-03	1.7%	1.97E-01	9.9%
Base Case 2	**1.10E-01**	**2.5%**	**2.07E-01**	**1.8%**	**2.24E+00**	**3.3%**

Table 14: Base Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	**Error**	**LS04**	**Error**	**LS05**	**Error**	**LS06**	**Error**	**LS07**	**Error**
Acceptance Criteria	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**
Steam Generators	3.15E-05	7.3%	4.16E-04	6.4%	3.42E-03	6.7%	9.60E-03	5.0%	2.80E-02	2.8%
RWC-EF Case 1	1.15E-06	8.8%	1.88E-05	5.0%	5.76E-05	4.1%	1.17E-04	3.9%	2.85E-04	2.4%
RWC-PT Case 1	7.45E-07	5.0%	8.35E-06	3.7%	4.37E-05	3.3%	1.06E-04	3.1%	2.36E-04	2.4%
Base Case 1	**4.88E-05**	**4.8%**	**7.00E-04**	**3.9%**	**5.20E-03**	**4.4%**	**1.38E-02**	**4.9%**	**3.89E-02**	**2.1%**
RWC-EF Case 2	2.32E-06	8.8%	3.77E-05	5.0%	1.16E-04	4.1%	2.35E-04	3.9%	5.73E-04	2.4%
RWC-PT Case 2	1.85E-06	9.5%	2.71E-05	6.3%	2.15E-04	6.1%	5.41E-04	5.3%	1.43E-03	2.9%
Base Case 2	**5.11E-05**	**4.6%**	**7.37E-04**	**3.7%**	**5.43E-03**	**4.3%**	**1.44E-02**	**3.4%**	**4.04E-02**	**2.0%**

As outlined in the OPG methodology for shielding analysis of thick walled waste containers [4], the dose rates were compared against the dose acceptance criteria after adding 2σ to the best estimate to account for code uncertainty. This is shown in Table 15. The dose acceptance criteria for the base case are exceeded for dose points PW24, PW26, and PW10. This was largely the result of the SGs, as they exceeded the dose rate acceptance criteria on their own,

[3] The tally for PW10 was mistakenly removed from the cases for SB4 and SB5. The dose contributions for these buildings were taken from the previous calculations in Reference [5]. This was considered acceptable as the PCSS is not located between the buildings and the tally.

though for PW26 and PW10, the dose acceptance criteria were nearly exceeded without the SGs as well.

Table 15: Base Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[3]
	Dose Rate (μSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Base Case 1	1.11E-01	2.05E-01	5.35E-05	7.55E-04	5.67E-03	1.52E-02	4.05E-02	2.21E+00
Base Case 2	1.15E-01	2.15E-01	5.58E-05	7.93E-04	5.90E-03	1.54E-02	4.20E-02	2.39E+00

The dose rates around the buildings for Base Case 1 were also plotted for the purpose of planning access fence locations. These are shown in Figure 24 for the area around the PCSS and Figure 25 for the area around the used fuel dry storage buildings. As shown, the dose rate around the PCSS does not drop below the acceptance criterion for non-NEW worker access (0.5 μSv/hr) within 50 m of the building. Around the dry storage buildings, the proposed fence lines for the buildings (shown in Figure 10) would no longer be sufficient to meet the acceptance criterion. This is especially the case along the north fence line closest to the PCSS, which exceeds the criterion for its entire length.

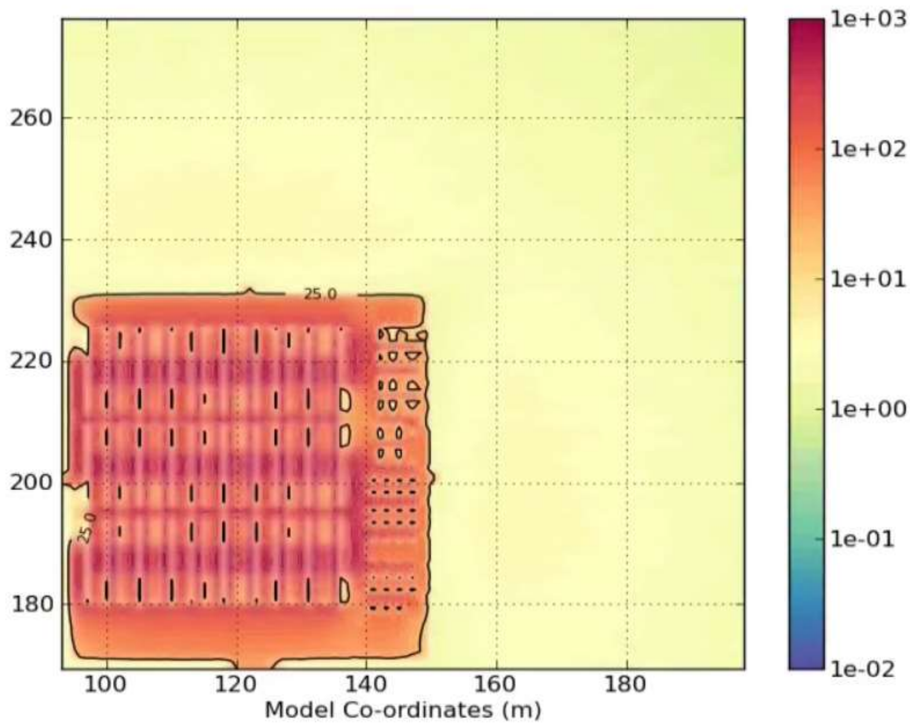

Figure 24: Base Case 1 Best Estimate Dose Rates (μSv/hr) Around PCSS

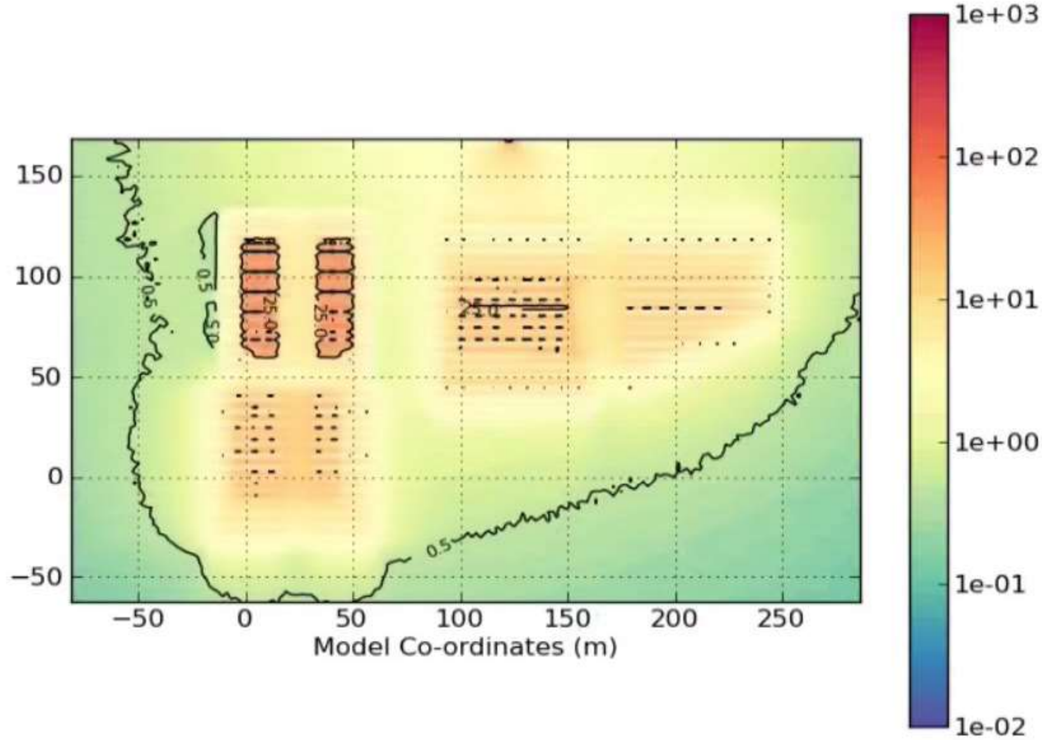

Figure 25: Base Case 1 Best Estimate Dose Rates (μSv/hr) Around DSC Storage Buildings

5.3.2.2 Sensitivity 1: Shielded Roof

The best estimate door rates for the shielded roof cases are shown in Table 16 and Table 17. Compared to the base case, the shielded roof reduces the dose rates at the site dose points on the land by between 60-70%, and the lake dose points by 50-60%.

However, as shown in Table 18, the reduction in dose rate produced by the shielded roof is not enough to meet the acceptance criteria at all dose points. The dose rates at PW26 and PW10 both exceed the criteria.

Table 16: Shielded Roof Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (μSv/hr)					
	PW24	Error	PW26	Error	PW10[3]	Error
Acceptance Criteria	**5.00E-02**	**-**	**5.00E-02**	**-**	**5.00E-01**	**-**
Steam Generators	1.92E-02	2.8%	4.53E-02	1.9%	5.03E-01	5.8%
RWC-EF Case 1	2.12E-04	4.7%	6.17E-04	2.2%	2.50E-03	7.3%
RWC-PT Case 1	2.68E-04	17.3%	3.49E-04	6.4%	2.49E-03	11.6%
Shielded Roof Case 1	**3.88E-02**	**3.6%**	**5.62E-02**	**1.6%**	**7.38E-01**	**4.1%**
RWC-EF Case 2	4.26E-04	4.7%	1.24E-03	2.2%	5.03E-03	7.3%
RWC-PT Case 2	1.33E-03	7.2%	2.83E-03	5.1%	1.97E-02	18.1%
Shielded Roof Case 2	**4.01E-02**	**3.5%**	**5.93E-02**	**1.5%**	**7.57E-01**	**4.0%**

Table 17: Shielded Roof Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-
Steam Generators	5.78E-06	10.4%	8.72E-05	5.2%	7.51E-04	5.7%	2.24E-03	5.4%	6.38E-03	3.0%
RWC-EF Case 1	8.80E-08	27.3%	9.81E-07	14.3%	5.81E-06	5.7%	1.80E-05	6.4%	5.16E-05	4.5%
RWC-PT Case 1	7.19E-08	19.6%	8.73E-07	21.5%	4.86E-06	8.7%	1.40E-05	8.1%	4.80E-05	8.8%
Shielded Roof Case 1	**2.14E-05**	**3.5%**	**3.45E-04**	**2.3%**	**2.45E-03**	**2.2%**	**6.29E-03**	**2.2%**	**1.69E-02**	**1.9%**
RWC-EF Case 2	1.77E-07	27.3%	1.97E-06	14.3%	1.17E-05	5.7%	3.62E-05	6.4%	1.18E-04	3.8%
RWC-PT Case 2	2.77E-07	27.3%	5.40E-06	16.1%	3.52E-05	11.7%	1.14E-04	10.5%	4.30E-04	11.3%
Shielded Roof Case 2	**2.17E-05**	**3.5%**	**3.51E-04**	**2.3%**	**2.48E-03**	**2.2%**	**6.41E-03**	**2.1%**	**1.73E-02**	**1.9%**

Table 18: Shielded Roof Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[3]
	Dose Rate (µSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Shielded Roof Case 1	4.16E-02	5.79E-02	2.29E-05	3.61E-04	2.56E-03	6.57E-03	1.76E-02	7.97E-01
Shielded Roof Case 2	4.29E-02	6.11E-02	2.32E-05	3.67E-04	2.59E-03	6.69E-03	1.80E-02	8.18E-01

The addition of a shielded roof does reduce the distance required for access fencing around both the PCSS and the used fuel storage buildings. The fence around the PCSS would still have to extend more than 50 m from the north and east walls, but as shown in Figure 26, it is reduced compared to the base case.

As shown in Figure 27, around the used fuel storage buildings the shielded roof reduces dose rates below the acceptance criterion within the existing proposed fence lines to the west, south, and east of the storage buildings. However, the dose rates around the fence to the north of the storage buildings would exceed the criterion; due to the dose contributions from the PCSS.

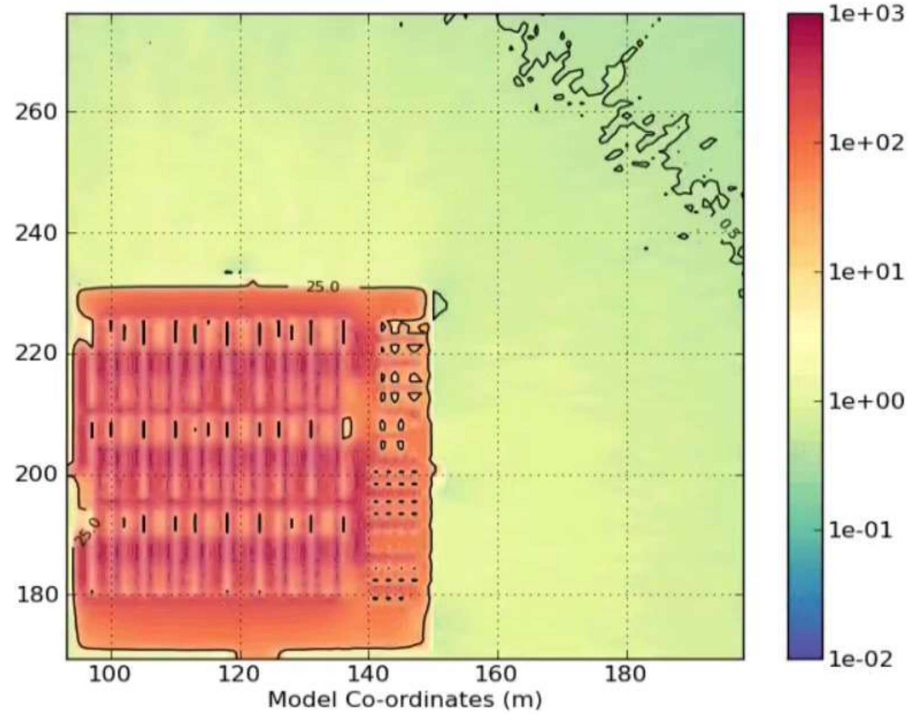

Figure 26: Shielded Roof Case 1 Best Estimate Dose Rates (µSv/hr) Around PCSS

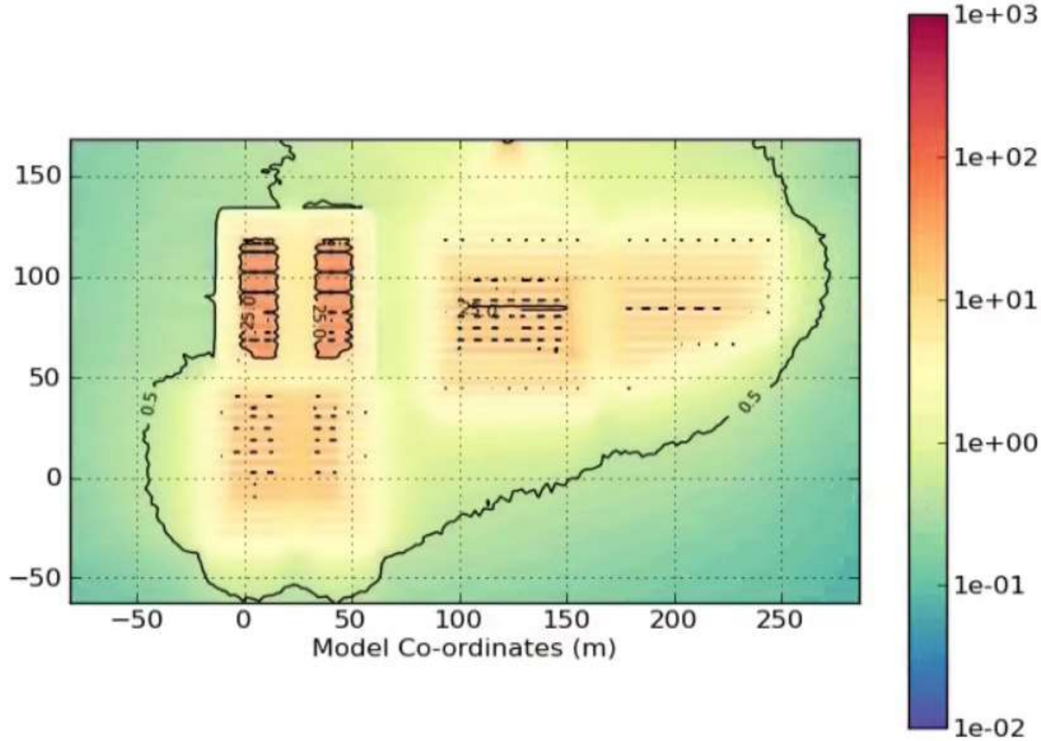

Figure 27: Shielded Roof Case 1 Best Estimate Dose Rates (µSv/hr) Around DSC Storage Buildings

5.3.2.3 Sensitivity 2: Shielded Door

The best estimate dose rates for the shielded door case are shown in Table 19 and Table 20. At the site dose points, the dose rates from the shielded door case are very similar to the base case and are within the uncertainty of the calculation. This is to be expected since the main impact of the shielded door is to the areas immediately to the south of the PCSS around the overhead door.

As shown in Table 21, the same set of dose point exceed the acceptance criteria in the shielded door cases as the base case: PW24, PW26, and PW10, by the same margin.

Table 19: Shielded Door Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (µSv/hr)					
	PW24	Error	PW26	Error	PW10[3]	Error
Acceptance Criteria	**5.00E-02**	**-**	**5.00E-02**	**-**	**5.00E-01**	**-**
Steam Generators	9.38E-02	3.2%	1.89E-01	2.1%	1.97E+00	4.5%
RWC-EF Case 1	7.79E-04	2.0%	2.39E-03	1.2%	3.98E-02	15.0%
RWC-PT Case 1	6.64E-04	6.5%	1.54E-03	2.3%	6.93E-02	6.5%
Shielded Door Case 1	**1.14E-01**	**2.8%**	**2.03E-01**	**1.9%**	**2.30E+00**	**3.9%**
RWC-EF Case 2	1.56E-03	2.0%	4.81E-03	1.2%	7.99E-02	15.0%
RWC-PT Case 2	4.30E-03	5.1%	9.95E-03	4.2%	2.36E-01	14.6%
Shielded Door Case 2	**1.19E-01**	**2.7%**	**2.13E-01**	**1.8%**	**2.51E+00**	**3.8%**

Table 20: Shielded Door Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**
Steam Generators	3.02E-05	8.2%	3.86E-04	4.4%	3.08E-03	3.7%	9.77E-03	3.6%	2.86E-02	2.5%
RWC-EF Case 1	1.14E-06	8.1%	1.81E-05	5.0%	5.65E-05	5.3%	1.15E-04	4.1%	2.83E-04	2.3%
RWC-PT Case 1	7.58E-07	7.2%	9.00E-06	8.2%	4.40E-05	5.4%	9.31E-05	4.1%	2.44E-04	3.5%
Shielded Door Case 1	**4.76E-05**	**5.3%**	**6.69E-04**	**2.7%**	**4.86E-03**	**2.5%**	**1.40E-02**	**2.5%**	**3.95E-02**	**1.9%**
RWC-EF Case 2	2.30E-06	8.1%	3.63E-05	5.0%	1.14E-04	5.3%	2.31E-04	4.1%	5.68E-04	2.3%
RWC-PT Case 2	1.79E-06	18.6%	3.10E-05	10.9%	1.95E-04	8.2%	5.47E-04	7.3%	1.45E-03	5.2%
Shielded Door Case 2	**4.98E-05**	**5.1%**	**7.09E-04**	**2.6%**	**5.07E-03**	**2.4%**	**1.46E-02**	**2.4%**	**4.10E-02**	**1.9%**

Table 21: Shielded Door Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[3]
	Dose Rate (µSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Shielded Door Case 1	1.21E-01	2.10E-01	5.26E-05	7.05E-04	5.10E-03	1.47E-02	4.11E-02	2.48E+00
Shielded Door Case 2	1.25E-01	2.21E-01	5.49E-05	7.46E-04	5.31E-03	1.53E-02	4.26E-02	2.70E+00

The primary impact of the shielded door is to the dose rates immediately to the south of the PCSS. As shown in both Figure 28 and Figure 29, the dose rates outside the PCSS overhead door are reduced compared to the base case. However, given the high overall dose rates from the PCSS, this local effect is not sufficient to reduce the dose rates on the proposed fence lines around the used fuel storage buildings below the acceptance.

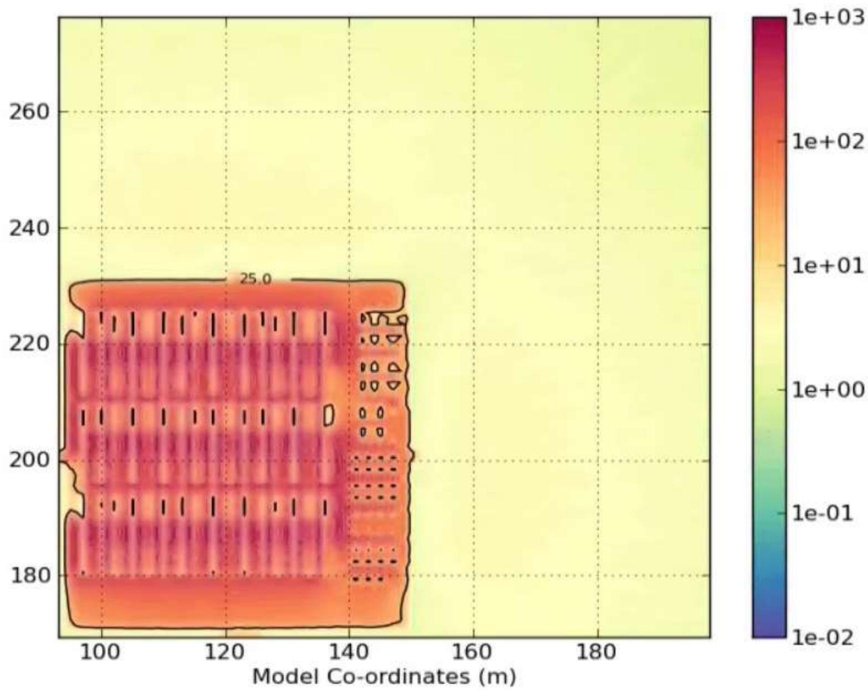

Figure 28: Shielded Door Case 1 Best Estimate Dose Rates (μSv/hr) Around PCSS

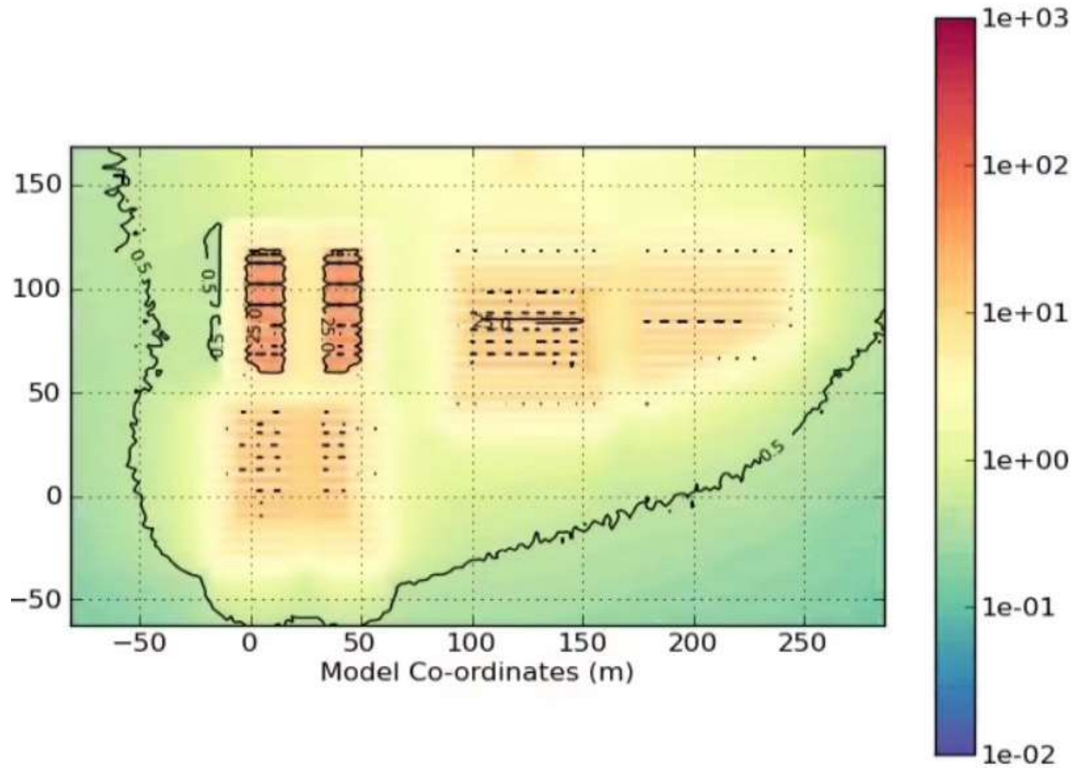

Figure 29: Shielded Door Case 1 Best Estimate Dose Rates (μSv/hr) Around DSC Storage Buildings

5.3.2.4 Sensitivity 3: 10 mrem/hr SG Dose Rate

As described in Section 3.1.2.2, this sensitivity considers SG dose rates reduced from 40 mrem/hr at 1m to 10 mrem/hr at 1 m. The MCNP results for the SGs were reduced by a factor of 4 to achieve this change, while leaving the uncertainty for the SGs unchanged. This was done for the base case as well as the shielded roof and shielded door cases. The best estimate results for this sensitivity are shown in Table 22 and Table 23. The best estimate + 2σ results are shown in Table 24. With the reduction in SG dose rate, the shielded roof cases have dose rates below the acceptance criteria at all dose points. Based on the ratio of dose rates observed between the dose points in Sensitivity 3 shielded roof case and the Sensitivity 1 shielded roof results from Section 5.3.2.2, the required fence line around the PCSS for Sensitivity 3 is estimated to be between 20m and 30m from the PCSS walls. The base case and the shielded door case however remain above the acceptance criteria at multiple points.

Table 22: 10 mrem/hr SG Sensitivity, Land Dose Points

Dose Point	Dose Rate (µSv/hr)					
	PW24	Error	PW26	Error	PW10[3]	Error
Acceptance Criteria	**5.00E-02**	**-**	**5.00E-02**	**-**	**5.00E-01**	**-**
Base Case 1 – Sensitivity	4.17E-02	3.4%	5.98E-02	1.6%	7.66E-01	2.6%
Base Case 2 – Sensitivity	4.63E-02	3.1%	6.98E-02	1.4%	9.39E-01	3.1%
Shielded Roof Case 1 – Sensitivity	2.44E-02	5.4%	2.22E-02	1.4%	3.60E-01	2.9%
Shielded Roof Case 2 – Sensitivity	2.57E-02	5.1%	2.53E-02	1.1%	3.80E-01	2.1%
Shielded Door Case 1 – Sensitivity	4.40E-02	3.4%	6.10E-02	1.6%	8.29E-01	3.0%
Shielded Door Case 2 – Sensitivity	4.84E-02	3.1%	7.18E-02	1.5%	1.04E+00	4.2%

Table 23: 10 mrem/hr SG Sensitivity, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**
Base Case 1 - Sensitivity	2.52E-05	2.9%	3.87E-04	2.4%	2.64E-03	2.5%	6.65E-03	2.0%	1.79E-02	1.8%
Base Case 2 - Sensitivity	2.75E-05	2.8%	4.25E-04	2.3%	2.87E-03	2.4%	7.20E-03	1.9%	1.94E-02	1.7%
Shielded Roof Case 1 - Sensitivity	1.71E-05	2.8%	2.80E-04	2.4%	1.88E-03	1.9%	4.62E-03	1.5%	1.21E-02	2.3%
Shielded Roof Case 2 - Sensitivity	1.73E-05	2.6%	2.85E-04	2.3%	1.92E-03	1.8%	4.73E-03	1.3%	1.26E-02	2.2%
Shielded Door Case 1 - Sensitivity	2.49E-05	3.1%	3.80E-04	2.1%	2.55E-03	1.7%	6.68E-03	1.6%	1.81E-02	1.8%
Shielded Door Case 2 - Sensitivity	2.71E-05	3.2%	4.20E-04	2.1%	2.76E-03	1.7%	7.25E-03	1.6%	1.96E-02	1.7%

Table 24: 10 mrem/hr SG Sensitivity Best Estimate + 2σ Dose Rates

Dose Point	Dose Rate (µSv/hr)							
	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[3]
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Base Case 1 - Sensitivity	4.46E-02	6.16E-02	2.67E-05	4.06E-04	2.77E-03	6.92E-03	1.86E-02	8.06E-01
Base Case 2 - Sensitivity	4.92E-02	7.17E-02	2.90E-05	4.45E-04	3.01E-03	7.48E-03	2.01E-02	9.97E-01
Shielded Roof Case 1 - Sensitivity	2.70E-02	2.28E-02	1.80E-05	2.93E-04	1.96E-03	4.76E-03	1.27E-02	3.81E-01
Shielded Roof Case 2 - Sensitivity	2.83E-02	2.58E-02	1.83E-05	2.99E-04	1.99E-03	4.86E-03	1.31E-02	3.96E-01
Shielded Door Case 1 - Sensitivity	4.70E-02	6.30E-02	2.65E-05	3.96E-04	2.64E-03	6.89E-03	1.87E-02	8.79E-01
Shielded Door Case 2 - Sensitivity	5.14E-02	7.40E-02	2.88E-05	4.37E-04	2.86E-03	7.48E-03	2.02E-02	1.12E+00

5.3.3 Updated Full Building MCNP Dose Rates

An MCNP run was performed for each source in the base case, as well as the additional sensitivity cases, as described above in Section 3.1.2.3. For each case, the total dose rate was calculated by summing the contributions from all sources (SGs, RWCs, and DSCs). Detailed results are presented in the sub-sections below.

5.3.3.1 Base Case

The best estimate dose rates for the base case site dose points are shown in Table 25 and Table 26. As with the previous analysis of the PWMF site [22], the dose rates were highest at site dose points PW10, PW24, and PW26 all located on the land near the waste storage buildings. The dose rates were lower at the lake dose points, which are further from the buildings.

In SG cases 1 and 2, the SGs contribute the majority of the dose rate to the land dose points. They are not only the major contributor of the PCSS wastes, but also exceed the dose rate of all the DSCs combined for the site dose points on the land. The SGs contributed a smaller fraction to the site boundary dose points on the lake.

As expected, the dose rates were higher for RWC Case 2 where the RWC-EF and RWC-PT container dose rates were higher. However, as the SGs form such a large part of the overall dose rate, the difference in RWC dose rates from the two cases did not have a large overall impact on the dose rates.

Table 25: Base Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (µSv/hr)					
	PW24	Error	PW26	Error	PW10	Error
DSC Case 1 (SB3/SB4/SB5)	1.91E-02	6.8%	9.92E-03	2.3%	2.29E-01	3.2%
SG Case 1	2.09E-02	5.8%	4.68E-02	3.0%	3.75E-01	9.4%
SG Case 2	1.04E-02	5.8%	2.34E-02	3.0%	1.87E-01	9.4%
SG Case 3	5.22E-03	5.8%	1.17E-02	3.0%	9.37E-02	9.4%
RWC-EF Case 1	1.44E-04	4.4%	4.10E-04	3.0%	7.54E-03	6.3%
RWC-PT Case 1	1.89E-04	5.9%	3.41E-04	2.3%	3.07E-03	7.2%
RWC-EF Case 2	2.90E-04	4.4%	8.23E-04	3.0%	1.52E-02	6.3%
RWC-PT Case 2	1.16E-03	15.9%	1.94E-03	3.6%	1.93E-02	10.8%
RWC Case 1 + SG Case 1	**4.03E-02**	**4.4%**	**5.75E-02**	**2.5%**	**6.14E-01**	**5.8%**
RWC Case 2 + SG Case 1	**4.14E-02**	**4.3%**	**5.95E-02**	**2.4%**	**6.38E-01**	**5.6%**
RWC Case 1 + SG Case 2	**2.99E-02**	**6.0%**	**3.41E-02**	**4.2%**	**4.27E-01**	**8.4%**
RWC Case 2 + SG Case 2	**3.10E-02**	**5.8%**	**3.61E-02**	**3.9%**	**4.51E-01**	**8.0%**
RWC Case 1 + SG Case 3	**2.47E-02**	**7.2%**	**2.24E-02**	**6.3%**	**3.33E-01**	**10.7%**
RWC Case 2 + SG Case 3	**2.58E-02**	**6.9%**	**2.44E-02**	**5.8%**	**3.57E-01**	**10.0%**

Table 26: Base Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 1 (SB3/SB4/SB5)	1.54E-05	2.9%	2.56E-04	2.6%	1.69E-03	2.0%	4.03E-03	1.6%	1.04E-02	2.6%
SG Case 1	6.39E-06	18.8%	7.33E-05	9.9%	5.93E-04	6.5%	1.94E-03	5.6%	7.05E-03	10.0%
SG Case 2	3.19E-06	18.8%	3.66E-05	9.9%	2.96E-04	6.5%	9.68E-04	5.6%	3.52E-03	10.0%
SG Case 3	1.60E-06	18.8%	1.83E-05	9.9%	1.48E-04	6.5%	4.84E-04	5.6%	1.76E-03	10.0%
RWC-EF Case 1	3.00E-08	16.3%	7.55E-07	14.1%	4.40E-06	6.4%	1.31E-05	5.1%	4.21E-05	4.1%
RWC-PT Case 1	8.36E-08	13.5%	1.43E-06	8.3%	7.88E-06	9.1%	2.15E-05	6.5%	6.15E-05	5.7%
RWC-EF Case 2	6.03E-08	16.3%	1.52E-06	14.1%	8.83E-06	6.4%	2.63E-05	5.1%	8.47E-05	4.1%
RWC-PT Case 2	3.77E-07	31.4%	7.40E-06	14.0%	3.59E-05	7.4%	1.37E-04	8.5%	3.62E-04	13.7%
RWC Case 1 + SG Case 1	**2.19E-05**	**5.8%**	**3.32E-04**	**3.0%**	**2.29E-03**	**2.2%**	**6.00E-03**	**2.1%**	**1.76E-02**	**4.3%**
RWC Case 2 + SG Case 1	**2.23E-05**	**5.8%**	**3.38E-04**	**2.9%**	**2.32E-03**	**2.2%**	**6.12E-03**	**2.0%**	**1.79E-02**	**4.2%**
RWC Case 1 + SG Case 2	**1.88E-05**	**6.8%**	**2.95E-04**	**3.3%**	**1.99E-03**	**2.6%**	**5.03E-03**	**2.5%**	**1.40E-02**	**5.4%**
RWC Case 2 + SG Case 2	**1.91E-05**	**6.8%**	**3.02E-04**	**3.3%**	**2.03E-03**	**2.5%**	**5.16E-03**	**2.4%**	**1.44E-02**	**5.2%**
RWC Case 1 + SG Case 3	**1.72E-05**	**7.5%**	**2.77E-04**	**3.5%**	**1.85E-03**	**2.8%**	**4.54E-03**	**2.7%**	**1.23E-02**	**6.1%**
RWC Case 2 + SG Case 3	**1.75E-05**	**7.4%**	**2.83E-04**	**3.5%**	**1.88E-03**	**2.7%**	**4.67E-03**	**2.7%**	**1.26E-02**	**6.0%**

As outlined in the OPG methodology for shielding analysis of thick-walled waste containers [61], the dose rates were compared against the dose acceptance criteria after adding 2σ to the best estimate to account for code uncertainty. This is shown in Table 27. The dose acceptance criteria for the base case of SG case 1 are exceeded for dose points PW26, and PW10, and for SG Case 2 + RWC Case 2 are exceeded for dose points PW10. This was largely the result of the SGs, as they exceeded the dose rate acceptance criteria on their own. However, this is an improvement from the previous analysis [24] and the initial conceptual layout calculations (shown above in Table 15), where the dose acceptance criteria were exceeded for dose points PW24, PW26, and PW10. The other three cases (SG Case 3, & SG Case 2 + RWC Case 1) meet the acceptance criteria for these dose points without any additional shielding.

Table 27: Base Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
	Dose Rate (μSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
RWC Case 1 + SG Case 1	4.39E-02	**6.03E-02**	2.45E-05	3.51E-04	2.39E-03	6.25E-03	1.91E-02	**6.86E-01**
RWC Case 2 + SG Case 1	4.50E-02	**6.23E-02**	2.48E-05	3.58E-04	2.43E-03	6.38E-03	1.94E-02	**7.10E-01**
RWC Case 1 + SG Case 2	3.34E-02	3.69E-02	2.13E-05	3.15E-04	2.10E-03	5.28E-03	1.55E-02	4.99E-01
RWC Case 2 + SG Case 2	3.46E-02	3.89E-02	2.17E-05	3.21E-04	2.13E-03	5.41E-03	1.59E-02	**5.23E-01**
RWC Case 1 + SG Case 3	2.82E-02	2.52E-02	1.97E-05	2.96E-04	1.95E-03	4.79E-03	1.38E-02	4.05E-01
RWC Case 2 + SG Case 3	2.93E-02	2.72E-02	2.01E-05	3.03E-04	1.98E-03	4.92E-03	1.41E-02	4.29E-01

The dose rates around the buildings for the Base Cases were above the acceptance criterion for non-NEW worker access (0.5 μSv/hr) both at the PCSS overhead door as well as along each wall of the PCSS perimeter. The maximum dose rates around the PCSS are shown in Table 28 and Figure 30 shows the dose rates around the PCSS for the highest dose rate scenario.

Table 28: Base Case Maximum PCSS Perimeter Mesh Tally Best Estimate + 2σ Dose Rates

Dose Point	Dose Rate (μSv/hr)	
	Overhead Door	PCSS Perimeter
RWC Case 1 + SG Case 1 [4]	17.35	4.71
RWC Case 2 + SG Case 1	17.92	4.73
RWC Case 1 + SG Case 2	9.08	2.42
RWC Case 2 + SG Case 2	9.65	3.27
RWC Case 1 + SG Case 3	4.94	1.56
RWC Case 2 + SG Case 3	5.54	3.03

[4] RWC Case 1: 200 mrem/h on contact and 10 mrem/h at 1 m. SG Case 1: 40 mrem/h at 1 m, SG Case 2: 20 mrem/h at 1 m, SG Case 3: 10 mrem/h at 1 m.

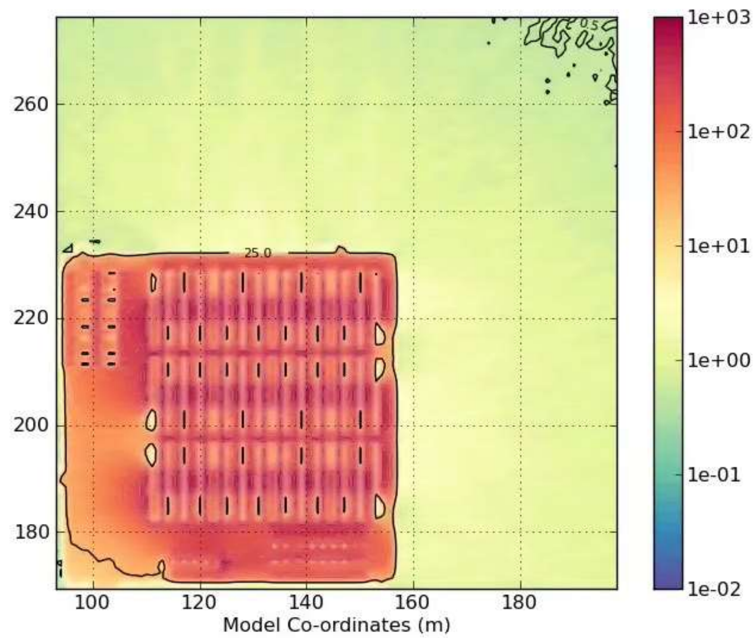

Figure 30: SG Case 1 + RWC Case 2 Best Estimate Dose Rates (μSv/hr) Around PCSS

5.3.3.2 Concrete Roof Thickness Sensitivity

A sensitivity case of the base cases with an increased roof thickness was performed. The concrete roof thickness was increased from 10 cm to 15 cm. The best estimate dose rates for the roof thickness sensitivity case site dose points are shown in Table 29 and Table 30. Substantial reductions to the dose rates at the considered dose points with the SG does rate being approximately halved.

Table 29: Roof Thickness Sensitivity Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (μSv/hr)					
	PW24	Error	PW26	Error	PW10	Error
DSC Case 1 (SB3/SB4/SB5)	1.91E-02	6.8%	9.92E-03	2.3%	2.29E-01	3.2%
SG Case 1	1.02E-02	3.4%	2.48E-02	1.5%	1.88E-01	4.7%
SG Case 2	5.10E-03	3.4%	1.24E-02	1.5%	9.40E-02	4.7%
SG Case 3	2.55E-03	3.4%	6.19E-03	1.5%	4.70E-02	4.7%
RWC-EF Case 1	6.44E-05	6.5%	1.91E-04	3.4%	5.56E-03	7.9%
RWC-PT Case 1	1.33E-04	13.5%	1.53E-04	4.5%	1.60E-03	11.4%
RWC-EF Case 2	1.29E-04	6.5%	3.83E-04	3.4%	1.12E-02	7.9%
RWC-PT Case 2	1.33E-04	13.5%	1.53E-04	4.5%	1.60E-03	11.4%
RWC Case 1 + SG Case 1	**2.95E-02**	**4.6%**	**3.50E-02**	**1.2%**	**4.24E-01**	**2.7%**
RWC Case 2 + SG Case 1	**2.96E-02**	**4.6%**	**3.52E-02**	**1.2%**	**4.30E-01**	**2.7%**
RWC Case 1 + SG Case 2	**2.44E-02**	**5.5%**	**2.26E-02**	**1.9%**	**3.30E-01**	**3.4%**
RWC Case 2 + SG Case 2	**2.45E-02**	**5.5%**	**2.28E-02**	**1.9%**	**3.36E-01**	**3.4%**
RWC Case 1 + SG Case 3	**2.18E-02**	**6.2%**	**1.65E-02**	**2.7%**	**2.83E-01**	**4.0%**
RWC Case 2 + SG Case 3	**2.19E-02**	**6.1%**	**1.66E-02**	**2.6%**	**2.89E-01**	**4.0%**

Table 30: Roof Thickness Sensitivity Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 1 (SB3/SB4/SB5)	1.54E-05	2.9%	2.56E-04	2.6%	1.69E-03	2.0%	4.03E-03	1.6%	1.04E-02	2.6%
SG Case 1	2.35E-06	10.0%	3.57E-05	5.8%	3.11E-04	4.0%	1.08E-03	7.0%	3.37E-03	3.6%
SG Case 2	1.17E-06	10.0%	1.79E-05	5.8%	1.55E-04	4.0%	5.41E-04	7.0%	1.68E-03	3.6%
SG Case 3	5.87E-07	10.0%	8.93E-06	5.8%	7.77E-05	4.0%	2.71E-04	7.0%	8.42E-04	3.6%
RWC-EF Case 1	1.64E-08	22.6%	7.86E-07	29.6%	2.15E-06	11.5%	6.48E-06	11.9%	2.02E-05	7.7%
RWC-PT Case 1	7.67E-08	14.4%	1.33E-06	12.5%	6.08E-06	11.6%	1.26E-05	8.4%	3.35E-05	8.1%
RWC-EF Case 2	3.30E-08	22.6%	1.58E-06	29.6%	4.33E-06	11.5%	1.30E-05	11.9%	4.05E-05	7.7%
RWC-PT Case 2	7.67E-08	14.4%	1.33E-06	12.5%	6.08E-06	11.6%	1.26E-05	8.4%	3.35E-05	8.1%
RWC Case 1 + SG Case 1	**1.79E-05**	**2.8%**	**2.94E-04**	**2.4%**	**2.00E-03**	**1.8%**	**5.13E-03**	**1.9%**	**1.38E-02**	**2.1%**
RWC Case 2 + SG Case 1	**1.79E-05**	**2.8%**	**2.95E-04**	**2.4%**	**2.01E-03**	**1.8%**	**5.13E-03**	**1.9%**	**1.38E-02**	**2.1%**
RWC Case 1 + SG Case 2	**1.67E-05**	**3.0%**	**2.76E-04**	**2.5%**	**1.85E-03**	**2.0%**	**4.59E-03**	**2.1%**	**1.21E-02**	**2.4%**
RWC Case 2 + SG Case 2	**1.67E-05**	**3.0%**	**2.77E-04**	**2.5%**	**1.85E-03**	**2.0%**	**4.59E-03**	**2.1%**	**1.22E-02**	**2.4%**
RWC Case 1 + SG Case 3	**1.61E-05**	**3.1%**	**2.67E-04**	**2.6%**	**1.77E-03**	**2.0%**	**4.32E-03**	**2.3%**	**1.13E-02**	**2.6%**
RWC Case 2 + SG Case 3	**1.61E-05**	**3.1%**	**2.68E-04**	**2.6%**	**1.77E-03**	**2.0%**	**4.32E-03**	**2.3%**	**1.13E-02**	**2.6%**

The best estimate dose rates are summarized in Table 31. Increasing the roof concrete thickness from 10 cm to 15 cm results in all 6 cases meeting the dose point acceptance criteria without any additional shielding (interior walls or roll-up doors). However, the increased roof thickness had marginal impact on the PCSS perimeter dose rates.

Table 31: Roof Thickness Sensitivity Case Best Estimate + 2σ Dose Rates

Dose Point	Dose Rate (µSv/hr)							
	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
RWC Case 1 + SG Case 1	3.22E-02	3.59E-02	1.89E-05	3.08E-04	2.08E-03	5.32E-03	1.44E-02	4.47E-01
RWC Case 2 + SG Case 1	3.22E-02	3.61E-02	1.89E-05	3.09E-04	2.08E-03	5.33E-03	1.44E-02	4.53E-01
RWC Case 1 + SG Case 2	2.71E-02	2.35E-02	1.77E-05	2.90E-04	1.92E-03	4.78E-03	1.27E-02	3.53E-01
RWC Case 2 + SG Case 2	2.72E-02	2.37E-02	1.77E-05	2.91E-04	1.92E-03	4.79E-03	1.28E-02	3.59E-01
RWC Case 1 + SG Case 3	2.45E-02	1.73E-02	1.71E-05	2.81E-04	1.84E-03	4.51E-03	1.19E-02	3.06E-01
RWC Case 2 + SG Case 3	2.46E-02	1.75E-02	1.72E-05	2.82E-04	1.85E-03	4.52E-03	1.19E-02	3.12E-01

5.3.3.3 SGs Scenario 1 – Final Placement Year 2032

The previous SG cases 1, 2 and 3 assumed dose rates of 40 mrem/h, 20 mrem/h and 10 mrem/h at 1 m from the SG. This updated SG scenario considers the decay time between reactor shutdown and placement within the PCSS. The initial source strength is based on gamma spectroscopy survey information. The single SG dose rates decayed per placement year are shown in Table 32.

Table 32: Single SG Decayed Dose Rates at Placement Year – Scenario 1 (PCSS full in 2032)

SG	Placement Year	Shutdown Date	Transfer to PCSS Date	Total time between Shutdown and Placement Year (y)	Dose Rate at Placement Year (mrem/h)
U5	May-28	Oct-26	May-28	1.58	7.47
U5	Jun-29	Oct-26	May-28	2.67	6.46
U6	Jun-29	Jan-27	Jun-29	2.41	8.70
U5	Sep-30	Oct-26	May-28	3.92	5.47
U6	Sep-30	Jan-27	Jun-29	3.67	7.37
U7	Sep-30	Oct-26	Sep-30	3.92	6.64
U5	Feb-32	Oct-26	May-28	5.34	4.44
U6	Feb-32	Jan-27	Jun-29	5.08	5.98
U7	Feb-32	Oct-26	Sep-30	5.34	5.41
U8	Feb-32	Jan-27	Feb-32	5.08	5.98

The best estimate dose rates at the site dose points for the combinations with the Scenario 1 SGs, the DSC and RWC cases, and the PCSS 10 cm and 15 cm roof shielding are shown in the tables below[5].

[5] The RWCs and SGs contributions for these configurations were calculated in MCNP models considering the full SB5. Therefore, a lower dose rate shadow can be seen around the positions where the full SB5 DSCs would be. Since this does not significantly impact the land and water-based dose points results and they are superseded by the final PCSS layout runs, no updates were made for these cases at this time.

Table 33: Dose Rate (µSv/h, BE) per Placement Year – 10 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 1

Dose Point	PW24	Error	PW26	Error	PW10	Error
Case 1 DSC Total (SB3/SB4/SB5)	1.91E-02	6.8%	9.92E-03	2.3%	2.29E-01	3.2%
DSC Case 1 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 10cm Total	1.75E-02	6.3%	1.21E-02	1.7%	2.16E-01	2.9%
DSC Case 1 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 10cm Total	1.91E-02	6.0%	1.51E-02	1.5%	2.39E-01	2.8%
DSC Case 1 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 10cm Total	1.97E-02	5.8%	1.62E-02	1.4%	2.55E-01	2.7%
DSC Case 1 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 10cm Total	2.01E-02	5.7%	1.67E-02	1.4%	2.68E-01	2.7%
DSC Case 1 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 10cm Total	1.84E-02	6.1%	1.38E-02	1.6%	2.36E-01	2.8%
DSC Case 1 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 10cm Total	2.01E-02	5.7%	1.69E-02	1.4%	2.60E-01	2.7%
DSC Case 1 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 10cm Total	2.07E-02	5.6%	1.80E-02	1.3%	2.75E-01	2.6%
DSC Case 1 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 10cm Total	2.11E-02	5.5%	1.85E-02	1.3%	2.88E-01	2.6%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Case 1 DSC Total (SB3/SB4/SB5)	1.54E-05	2.9%	2.56E-04	2.6%	1.69E-03	2.0%	4.03E-03	1.6%	1.04E-02	2.6%
DSC Case 1 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 10cm Total	1.34E-05	2.9%	2.22E-04	2.5%	1.47E-03	2.0%	3.53E-03	1.5%	9.23E-03	2.5%
DSC Case 1 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 10cm Total	1.41E-05	2.8%	2.34E-04	2.5%	1.54E-03	1.9%	3.75E-03	1.5%	9.84E-03	2.4%
DSC Case 1 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 10cm Total	1.44E-05	2.9%	2.37E-04	2.5%	1.58E-03	1.9%	3.82E-03	1.5%	1.01E-02	2.4%
DSC Case 1 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 10cm Total	1.45E-05	2.8%	2.38E-04	2.4%	1.59E-03	1.9%	3.85E-03	1.5%	1.02E-02	2.3%
DSC Case 1 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 10cm Total	1.37E-05	2.9%	2.28E-04	2.5%	1.49E-03	1.9%	3.64E-03	1.5%	9.52E-03	2.4%
DSC Case 1 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 10cm Total	1.44E-05	2.9%	2.40E-04	2.5%	1.57E-03	1.9%	3.86E-03	1.5%	1.01E-02	2.4%
DSC Case 1 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 10cm Total	1.47E-05	2.9%	2.42E-04	2.4%	1.60E-03	1.9%	3.93E-03	1.5%	1.04E-02	2.3%
DSC Case 1 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 10cm Total	1.48E-05	2.9%	2.44E-04	2.4%	1.62E-03	1.9%	3.96E-03	1.4%	1.05E-02	2.3%

Table 34: Dose Rate (µSv/h, BE) per Placement Year – 15 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 1

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 1 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 15cm Total	1.69E-02	6.5%	1.03E-02	2.0%	2.07E-01	3.0%
DSC Case 1 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 15cm Total	1.79E-02	6.3%	1.20E-02	1.8%	2.23E-01	2.9%
DSC Case 1 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 15cm Total	1.83E-02	6.2%	1.26E-02	1.8%	2.29E-01	2.9%
DSC Case 1 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 15cm Total	1.85E-02	6.2%	1.28E-02	1.7%	2.37E-01	3.0%
DSC Case 1 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 15cm Total	1.69E-02	6.5%	1.04E-02	2.0%	2.12E-01	3.0%
DSC Case 1 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 15cm Total	1.80E-02	6.3%	1.22E-02	1.8%	2.28E-01	2.9%
DSC Case 1 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 15cm Total	1.84E-02	6.2%	1.28E-02	1.7%	2.34E-01	2.8%
DSC Case 1 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 15cm Total	1.85E-02	6.2%	1.30E-02	1.7%	2.42E-01	2.9%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 1 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 15cm Total	1.33E-05	2.9%	2.21E-04	2.5%	1.45E-03	2.0%	3.49E-03	1.5%	9.03E-03	2.5%
DSC Case 1 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 15cm Total	1.38E-05	2.9%	2.30E-04	2.5%	1.51E-03	2.0%	3.64E-03	1.5%	9.47E-03	2.5%
DSC Case 1 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 15cm Total	1.39E-05	2.8%	2.31E-04	2.5%	1.53E-03	2.0%	3.68E-03	1.5%	9.63E-03	2.5%
DSC Case 1 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 15cm Total	1.39E-05	2.8%	2.32E-04	2.5%	1.53E-03	2.0%	3.70E-03	1.5%	9.70E-03	2.4%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 1 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 15cm Total	1.33E-05	2.9%	2.21E-04	2.5%	1.46E-03	2.0%	3.49E-03	1.5%	9.05E-03	2.5%
DSC Case 1 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 15cm Total	1.38E-05	2.9%	2.31E-04	2.5%	1.52E-03	2.0%	3.65E-03	1.5%	9.49E-03	2.5%
DSC Case 1 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 15cm Total	1.39E-05	2.8%	2.32E-04	2.5%	1.53E-03	2.0%	3.69E-03	1.5%	9.65E-03	2.5%
DSC Case 1 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 15cm Total	1.40E-05	2.8%	2.33E-04	2.5%	1.54E-03	2.0%	3.71E-03	1.5%	9.72E-03	2.4%

Table 35: Dose Rate (µSv/h, BE+2σ) per Placement Year – 10 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 1

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	5.00E-02	5.00E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	5.00E-01
DSC Case 1 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 10cm Total	1.97E-02	1.25E-02	1.42E-05	2.34E-04	1.52E-03	3.64E-03	9.68E-03	2.29E-01
DSC Case 1 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 10cm Total	2.14E-02	1.56E-02	1.49E-05	2.46E-04	1.60E-03	3.86E-03	1.03E-02	2.53E-01
DSC Case 1 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 10cm Total	2.20E-02	1.67E-02	1.52E-05	2.48E-04	1.64E-03	3.93E-03	1.06E-02	2.68E-01
DSC Case 1 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 10cm Total	2.24E-02	1.71E-02	1.54E-05	2.50E-04	1.65E-03	3.96E-03	1.07E-02	2.82E-01
DSC Case 1 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 10cm Total	2.06E-02	1.43E-02	1.45E-05	2.39E-04	1.55E-03	3.75E-03	9.98E-03	2.49E-01
DSC Case 1 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 10cm Total	2.24E-02	1.74E-02	1.52E-05	2.52E-04	1.63E-03	3.97E-03	1.06E-02	2.74E-01
DSC Case 1 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 10cm Total	2.30E-02	1.85E-02	1.55E-05	2.54E-04	1.66E-03	4.04E-03	1.09E-02	2.90E-01
DSC Case 1 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 10cm Total	2.34E-02	1.89E-02	1.57E-05	2.56E-04	1.68E-03	4.08E-03	1.10E-02	3.04E-01

Table 36: Dose Rate (µSv/h, BE+2σ) per Placement Year – 15 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 1

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
DSC Case 1 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 15cm Total	1.91E-02	1.07E-02	1.40E-05	2.32E-04	1.51E-03	3.60E-03	9.49E-03	2.19E-01
DSC Case 1 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 15cm Total	2.02E-02	1.25E-02	1.46E-05	2.42E-04	1.57E-03	3.75E-03	9.94E-03	2.36E-01
DSC Case 1 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 15cm Total	2.06E-02	1.31E-02	1.47E-05	2.43E-04	1.59E-03	3.79E-03	1.01E-02	2.42E-01
DSC Case 1 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 15cm Total	2.07E-02	1.33E-02	1.47E-05	2.44E-04	1.59E-03	3.81E-03	1.02E-02	2.52E-01
DSC Case 1 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 15cm Total	1.91E-02	1.09E-02	1.40E-05	2.33E-04	1.51E-03	3.60E-03	9.50E-03	2.24E-01
DSC Case 1 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 15cm Total	2.03E-02	1.26E-02	1.46E-05	2.42E-04	1.58E-03	3.76E-03	9.96E-03	2.41E-01
DSC Case 1 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 15cm Total	2.06E-02	1.32E-02	1.47E-05	2.44E-04	1.59E-03	3.80E-03	1.01E-02	2.47E-01
DSC Case 1 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 15cm Total	2.08E-02	1.34E-02	1.48E-05	2.45E-04	1.60E-03	3.82E-03	1.02E-02	2.57E-01

Table 37: Dose Rate (µSv/h, BE) per Placement Year – 10 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 1

Dose Point	PW24	Error	PW26	Error	PW10	Error
Case 2 DSC Total (SB/SB4 from PV209 and SB5 updated layout)	4.02E-03	2.9%	3.07E-03	2.2%	1.89E-01	3.7%
DSC Case 2 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 10cm Total	4.69E-03	2.3%	6.30E-03	1.5%	1.82E-01	3.3%
DSC Case 2 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 10cm Total	5.89E-03	2.1%	9.13E-03	1.3%	2.04E-01	3.2%
DSC Case 2 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 10cm Total	6.53E-03	1.9%	1.02E-02	1.2%	2.20E-01	3.0%
DSC Case 2 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 10cm Total	6.88E-03	1.8%	1.07E-02	1.1%	2.33E-01	3.0%

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 2 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 10cm Total	5.63E-03	3.4%	8.01E-03	1.4%	2.02E-01	3.1%
DSC Case 2 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 10cm Total	6.87E-03	3.0%	1.09E-02	1.3%	2.25E-01	3.0%
DSC Case 2 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 10cm Total	7.50E-03	2.7%	1.20E-02	1.1%	2.40E-01	2.9%
DSC Case 2 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 10cm Total	7.86E-03	2.6%	1.24E-02	1.1%	2.53E-01	2.9%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Case 2 DSC Total (SB/SB4 from PV209 and SB5 updated layout)	1.31E-05	3.3%	1.92E-04	3.2%	9.68E-04	2.4%	1.88E-03	1.5%	3.64E-03	2.7%
DSC Case 2 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 10cm Total	1.14E-05	3.2%	1.68E-04	3.1%	8.58E-04	2.3%	1.71E-03	1.5%	3.49E-03	2.4%
DSC Case 2 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 10cm Total	1.20E-05	3.2%	1.78E-04	3.1%	9.16E-04	2.3%	1.87E-03	1.4%	3.92E-03	2.3%
DSC Case 2 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 10cm Total	1.23E-05	3.3%	1.80E-04	3.0%	9.47E-04	2.3%	1.93E-03	1.4%	4.15E-03	2.2%
DSC Case 2 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 10cm Total	1.25E-05	3.2%	1.82E-04	3.0%	9.62E-04	2.2%	1.97E-03	1.3%	4.28E-03	2.1%
DSC Case 2 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 10cm Total	1.12E-05	3.4%	1.74E-04	3.1%	8.86E-04	2.3%	1.82E-03	1.5%	3.78E-03	2.5%
DSC Case 2 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 10cm Total	1.72E-05	2.3%	1.84E-04	3.0%	9.45E-04	2.2%	1.98E-03	1.5%	4.22E-03	2.3%
DSC Case 2 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 10cm Total	1.16E-05	3.6%	1.86E-04	3.0%	9.76E-04	2.2%	2.04E-03	1.4%	4.45E-03	2.3%
DSC Case 2 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 10cm Total	1.28E-05	3.2%	1.88E-04	3.0%	9.91E-04	2.2%	2.08E-03	1.3%	4.58E-03	2.2%

Table 38: Dose Rate (µSv/h, BE) per Placement Year – 15 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 1

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 2 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 15cm Total	4.08E-03	2.6%	4.47E-03	1.9%	1.73E-01	3.5%
DSC Case 2 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 15cm Total	4.75E-03	2.4%	6.03E-03	1.6%	1.88E-01	3.3%
DSC Case 2 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 15cm Total	5.09E-03	2.3%	6.63E-03	1.7%	1.94E-01	3.3%
DSC Case 2 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 15cm Total	5.25E-03	2.2%	6.83E-03	1.5%	2.02E-01	3.4%
DSC Case 2 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 15cm Total	4.13E-03	2.5%	4.64E-03	1.8%	1.78E-01	3.4%
DSC Case 2 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 15cm Total	4.81E-03	2.4%	6.20E-03	1.5%	1.93E-01	3.3%
DSC Case 2 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 15cm Total	5.14E-03	2.3%	6.80E-03	1.6%	1.99E-01	3.2%
DSC Case 2 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 15cm Total	5.31E-03	2.2%	7.00E-03	1.4%	2.07E-01	3.3%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 2 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 15cm Total	1.13E-05	3.3%	1.66E-04	3.2%	8.46E-04	2.4%	1.67E-03	1.5%	3.29E-03	2.6%
DSC Case 2 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 15cm Total	1.17E-05	3.2%	1.74E-04	3.1%	8.87E-04	2.3%	1.76E-03	1.4%	3.55E-03	2.5%
DSC Case 2 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 15cm Total	1.18E-05	3.2%	1.75E-04	3.1%	8.98E-04	2.3%	1.80E-03	1.4%	3.70E-03	2.5%
DSC Case 2 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 15cm Total	1.19E-05	3.2%	1.76E-04	3.1%	9.05E-04	2.3%	1.82E-03	1.4%	3.77E-03	2.4%
DSC Case 2 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 15cm Total	1.13E-05	3.3%	1.67E-04	3.2%	8.48E-04	2.4%	1.67E-03	1.5%	3.31E-03	2.5%
DSC Case 2 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 15cm Total	1.18E-05	3.2%	1.74E-04	3.1%	8.89E-04	2.3%	1.77E-03	1.4%	3.57E-03	2.5%
DSC Case 2 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 15cm Total	1.19E-05	3.2%	1.76E-04	3.1%	9.00E-04	2.3%	1.80E-03	1.4%	3.72E-03	2.5%
DSC Case 2 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 15cm Total	1.19E-05	3.2%	1.77E-04	3.1%	9.07E-04	2.3%	1.82E-03	1.4%	3.79E-03	2.4%

Table 39: Dose Rate (µSv/h, BE+2σ) per Placement Year – 10 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 1

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	5.00E-02	5.00E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.94E-01
DSC Case 2 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 10cm Total	4.91E-03	6.49E-03	1.22E-05	1.78E-04	8.98E-04	1.76E-03	3.66E-03	1.94E-01
DSC Case 2 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 10cm Total	6.14E-03	9.37E-03	1.28E-05	1.89E-04	9.58E-04	1.92E-03	4.10E-03	2.17E-01
DSC Case 2 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 10cm Total	6.78E-03	1.05E-02	1.32E-05	1.91E-04	9.90E-04	1.99E-03	4.34E-03	2.33E-01
DSC Case 2 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 10cm Total	7.14E-03	1.09E-02	1.33E-05	1.93E-04	1.00E-03	2.02E-03	4.46E-03	2.47E-01
DSC Case 2 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 10cm Total	6.01E-03	8.23E-03	1.20E-05	1.84E-04	9.26E-04	1.87E-03	3.97E-03	2.15E-01
DSC Case 2 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 10cm Total	7.27E-03	1.12E-02	1.79E-05	1.95E-04	9.87E-04	2.04E-03	4.42E-03	2.39E-01
DSC Case 2 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 10cm Total	7.91E-03	1.23E-02	1.24E-05	1.97E-04	1.02E-03	2.10E-03	4.66E-03	2.54E-01
DSC Case 2 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 10cm Total	8.27E-03	1.27E-02	1.36E-05	1.99E-04	1.03E-03	2.13E-03	4.78E-03	2.68E-01

Table 40: Dose Rate (µSv/h, BE+2σ) per Placement Year – 15 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 1

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	5.00E-02	5.00E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	5.00E-01
DSC Case 2 + RWC Case 1 +2028 - Scenario 1 SGs - Roof 15cm Total	4.29E-03	4.64E-03	1.20E-05	1.77E-04	8.87E-04	1.72E-03	3.46E-03	1.85E-01
DSC Case 2 + RWC Case 1 +2029 - Scenario 1 SGs - Roof 15cm Total	4.98E-03	6.22E-03	1.25E-05	1.85E-04	9.29E-04	1.81E-03	3.72E-03	2.01E-01
DSC Case 2 + RWC Case 1 +2030 - Scenario 1 SGs - Roof 15cm Total	5.32E-03	6.85E-03	1.26E-05	1.86E-04	9.40E-04	1.85E-03	3.88E-03	2.07E-01
DSC Case 2 + RWC Case 1 +2032 - Scenario 1 SGs - Roof 15cm Total	5.48E-03	7.03E-03	1.27E-05	1.87E-04	9.47E-04	1.87E-03	3.95E-03	2.16E-01
DSC Case 2 + RWC Case 2 +2028 - Scenario 1 SGs - Roof 15cm Total	4.34E-03	4.81E-03	1.20E-05	1.78E-04	8.88E-04	1.72E-03	3.48E-03	1.90E-01
DSC Case 2 + RWC Case 2 +2029 - Scenario 1 SGs - Roof 15cm Total	5.04E-03	6.39E-03	1.25E-05	1.85E-04	9.31E-04	1.82E-03	3.74E-03	2.06E-01
DSC Case 2 + RWC Case 2 +2030 - Scenario 1 SGs - Roof 15cm Total	5.38E-03	7.02E-03	1.26E-05	1.87E-04	9.42E-04	1.86E-03	3.90E-03	2.12E-01
DSC Case 2 + RWC Case 2 +2032 - Scenario 1 SGs - Roof 15cm Total	5.54E-03	7.20E-03	1.27E-05	1.88E-04	9.49E-04	1.87E-03	3.97E-03	2.21E-01

The placement year with the highest dose rates is 2032 for all cases in all dose points. The dose rates in all dose points are below the acceptance criteria for both 10 cm and 15 cm PCSS roof shielding, considering the dose rate from the DSCs, RWCs, and SGs. Below are dose rate maps around PCSS considering the contributions from RWCs, SGs (rescaled to 0.88 of Scenario 2), and DSCs.

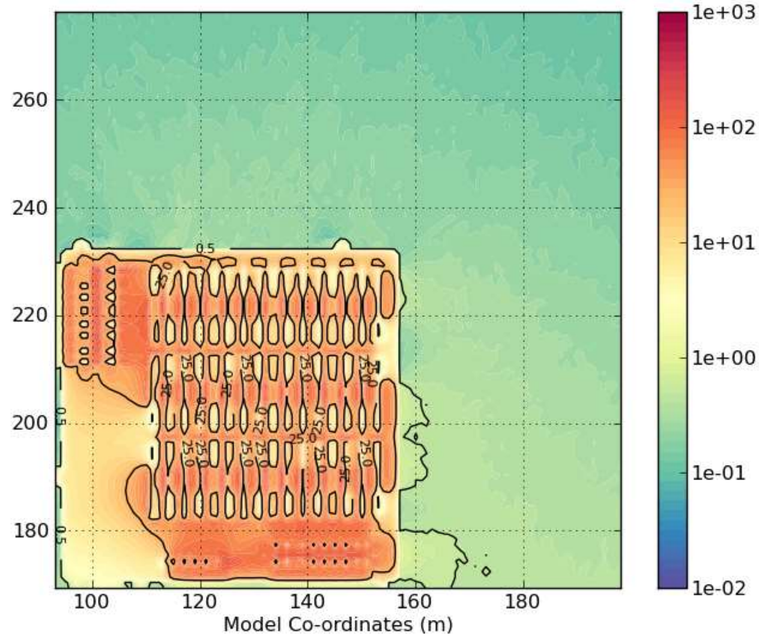

Figure 31: SG 2032 Scenario 1 + RWC Case 1 + DSC Case 1 – Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

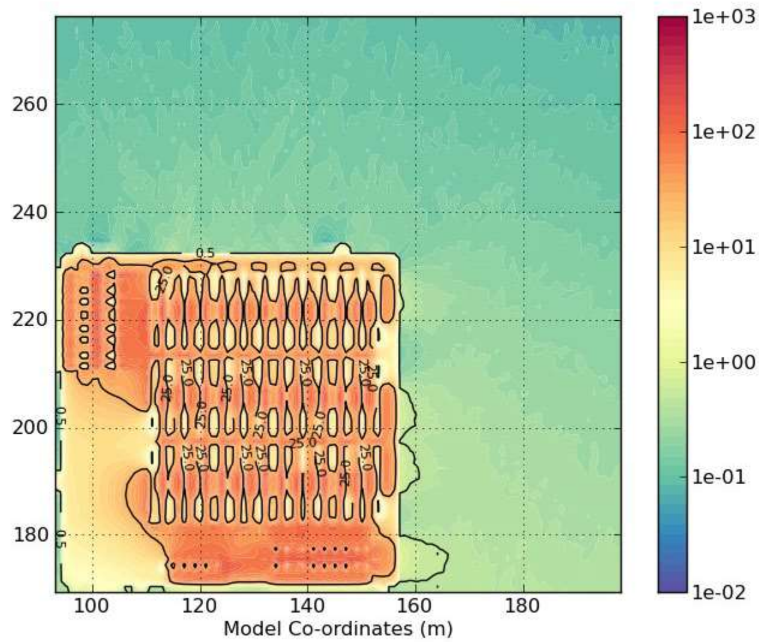

Figure 32: SG 2032 Scenario 1 + RWC Case 1 + DSC Case 1 – Roof 15cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

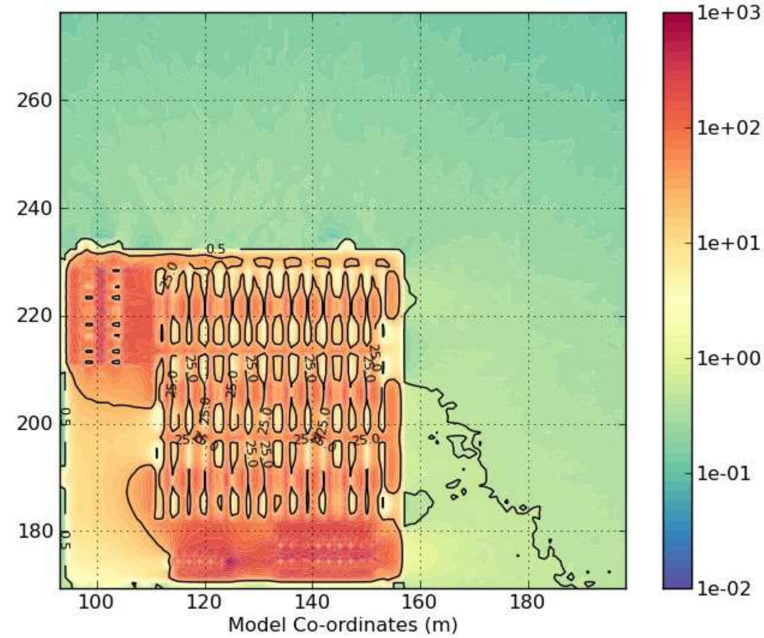

Figure 33: SG 2032 Scenario 1 + RWC Case 2 + DSC Case 1 – Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

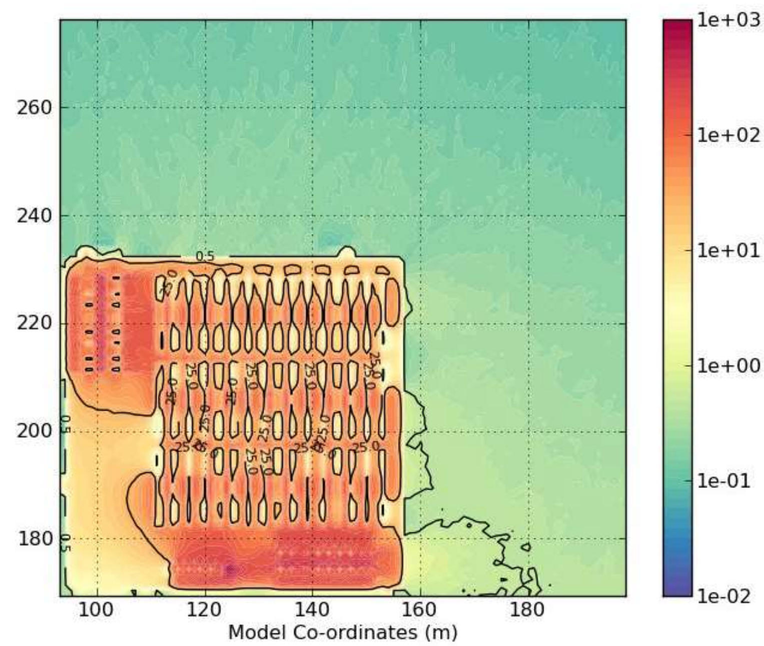

Figure 34: SG 2032 Scenario 1 + RWC Case 2 + DSC Case 1 – Roof 15cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

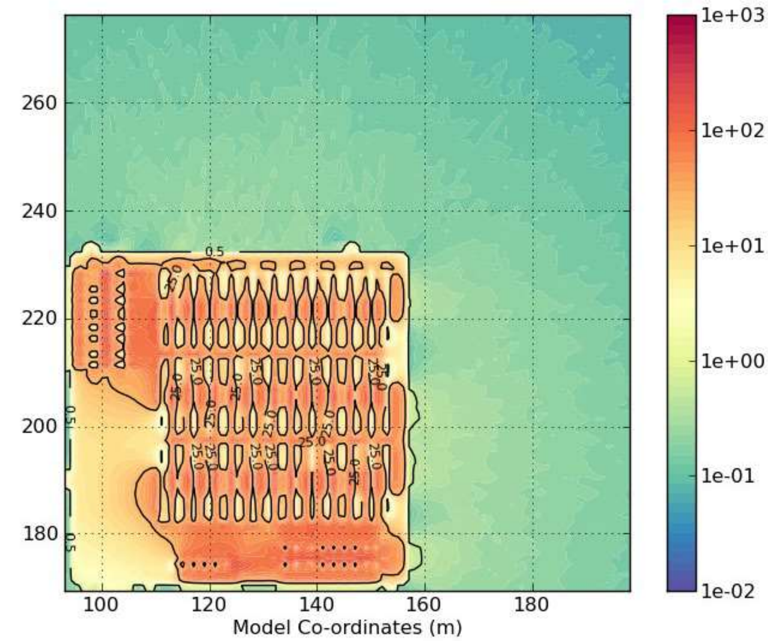

Figure 35: SG 2032 Scenario 1 + RWC Case 1 + DSC Case 2 – Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

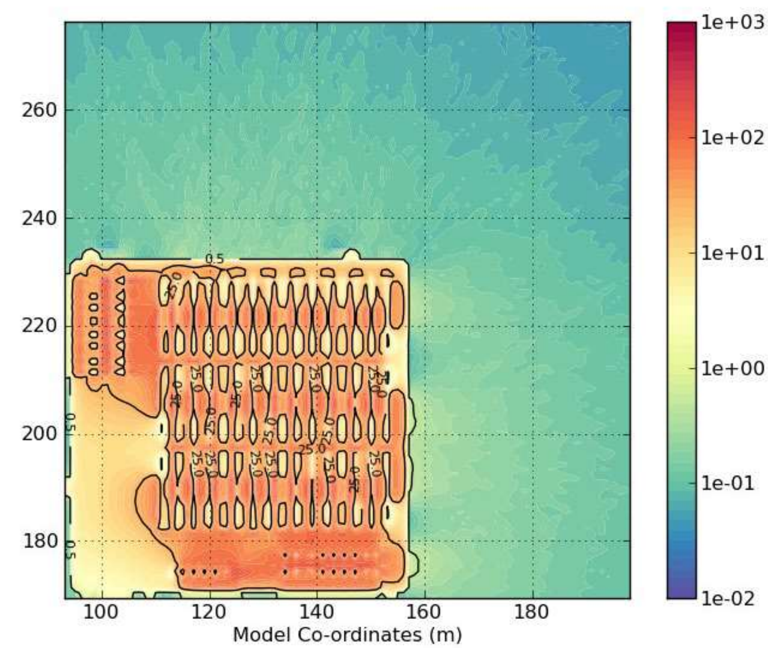

Figure 36: SG 2032 Scenario 1 + RWC Case 1 + DSC Case 2 – Roof 15cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

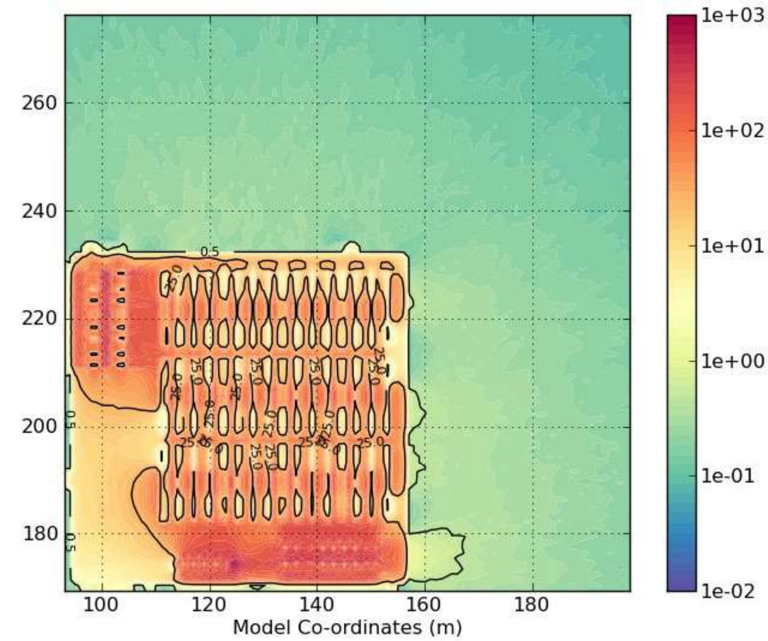

Figure 37: SG 2032 Scenario 1 + RWC Case 2 + DSC Case 2 – Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

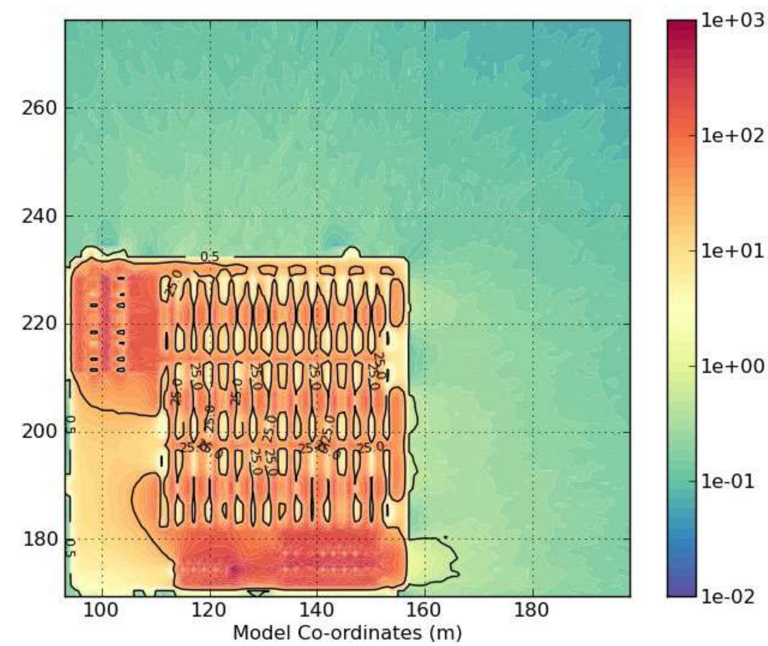

Figure 38: SG 2032 Scenario 1 + RWC Case 2 + DSC Case 2 – Roof 15cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

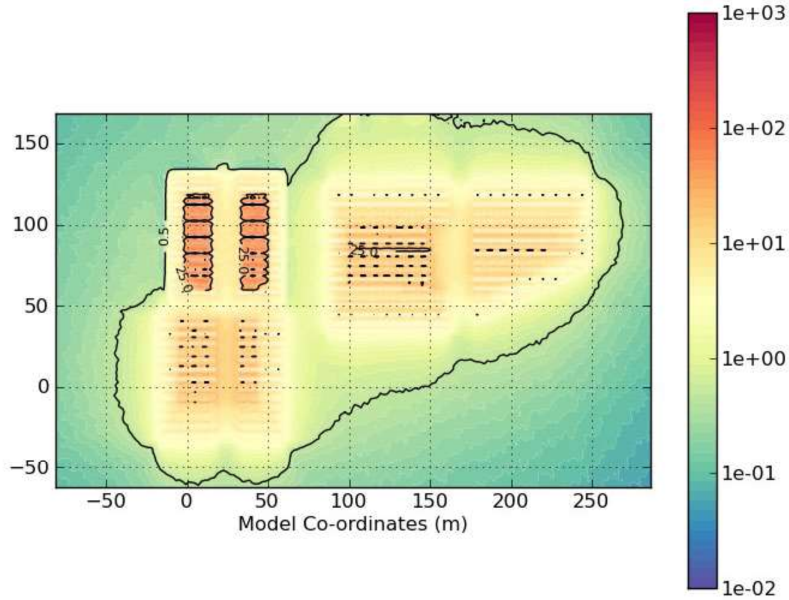

Figure 39: SG 2032 Scenario 1 + RWC Case 1 + DSC Case 1 – PCSS Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around DSCs

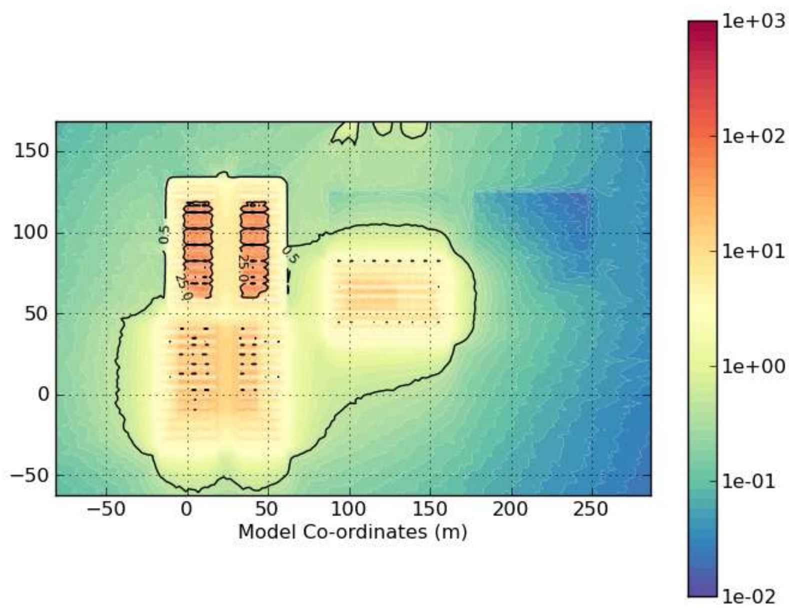

Figure 40: SG 2032 Scenario 1 + RWC Case 1 + DSC Case 2 – PCSS Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around DSCs

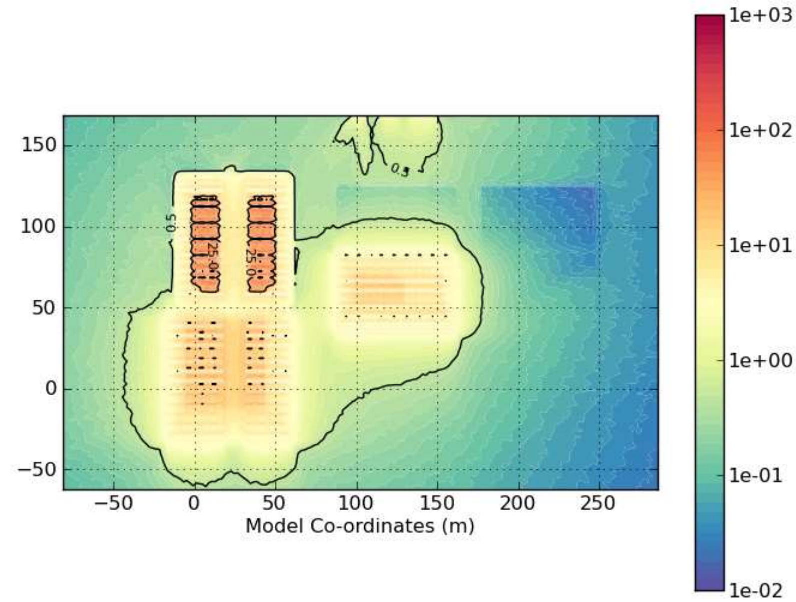

Figure 41: SG 2032 Scenario 1 + RWC Case 2 + DSC Case 2 – PCSS Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around DSCs

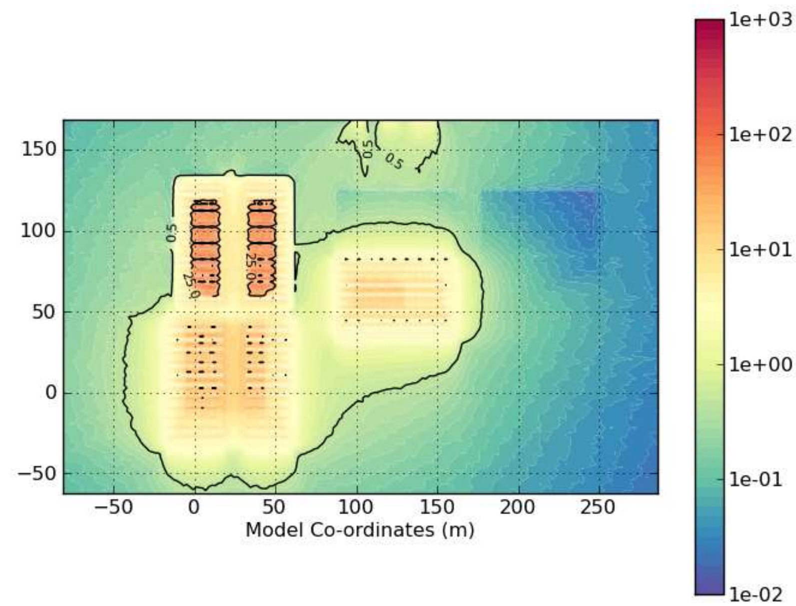

Figure 42: SG 2032 Scenario 1 + RWC Case 2 + DSC Case 2 – PCSS Roof 15cm – Best Estimate Dose Rates (μSv/hr) Around DSCs

5.3.3.4 SGs Scenario 2 – Final Placement Year 2031

This scenario considers that the final placement year of the SGs in PCSS is 2031, considering the decay between each unit shutdown and movement date to PCSS. The single SG dose rates decayed per placement year are shown in Table 41.

Table 41: Single SG Decayed Dose Rates at Placement Year – Scenario 2 (PCSS full in 2031)

SG	Placement Year	Shutdown Date	Transfer to PCSS Date	Total time between Shutdown and Placement Year (y)	Dose Rate at Placement Year (mrem/h)
U5	May-27	Oct-26	May-27	0.58	8.81
U5	Jun-28	Oct-26	May-27	1.67	7.38
U6	Jun-28	Jan-27	Jun-28	1.42	9.95
U5	Sep-29	Oct-26	May-27	2.92	6.25
U6	Sep-29	Jan-27	Jun-28	2.67	8.41
U7	Sep-29	Oct-26	Sep-29	2.92	7.56
U5	Feb-31	Oct-26	May-27	4.34	5.07
U6	Feb-31	Jan-27	Jun-28	4.08	6.82
U7	Feb-31	Oct-26	Sep-29	4.34	6.16
U8	Feb-31	Jan-27	Feb-31	4.08	6.82

The best estimate dose rates at the site dose points for the combinations with the Scenario 1 SGs, the DSC and RWC cases, and the PCSS 10 cm and 15 cm roof shielding are shown in the tables below[6].

[6] The RWCs and SGs contributions for these configurations were calculated in MCNP models considering the full SB5. Therefore, a lower dose rate shadow can be seen around the positions where the full SB5 DSCs would be. Since this does not significantly impact the land and water-based dose points results and they are superseded by the final PCSS layout runs, no updates were made for these cases at this time.

Table 42: Dose Rate (µSv/h, BE) per Placement Year – 10 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 2

Dose Point	PW24	Error	PW26	Error	PW10	Error
Case 1 DSC Total (SB3/SB4/SB5)	1.91E-02	6.8%	9.92E-03	2.3%	2.29E-01	3.2%
DSC Case 1 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 10cm Total	2.06E-02	6.3%	1.43E-02	1.7%	2.55E-01	2.9%
DSC Case 1 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 10cm Total	2.18E-02	6.0%	1.73E-02	1.5%	2.74E-01	2.8%
DSC Case 1 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 10cm Total	2.25E-02	5.8%	1.85E-02	1.4%	2.91E-01	2.7%
DSC Case 1 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 10cm Total	2.29E-02	5.7%	1.90E-02	1.4%	3.05E-01	2.7%
DSC Case 1 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 10cm Total	2.17E-02	6.1%	1.63E-02	1.6%	2.79E-01	2.8%
DSC Case 1 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 10cm Total	2.29E-02	5.7%	1.93E-02	1.4%	2.97E-01	2.7%
DSC Case 1 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 10cm Total	2.36E-02	5.6%	2.06E-02	1.3%	3.14E-01	2.6%
DSC Case 1 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 10cm Total	2.40E-02	5.5%	2.11E-02	1.3%	3.29E-01	2.6%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Case 1 DSC Total (SB3/SB4/SB5)	1.54E-05	2.9%	2.56E-04	2.6%	1.69E-03	2.0%	4.03E-03	1.6%	1.04E-02	2.6%
DSC Case 1 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 10cm Total	1.58E-05	2.9%	2.62E-04	2.5%	1.73E-03	2.0%	4.17E-03	1.5%	1.09E-02	2.5%
DSC Case 1 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 10cm Total	1.61E-05	2.8%	2.68E-04	2.5%	1.76E-03	1.9%	4.28E-03	1.5%	1.13E-02	2.4%
DSC Case 1 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 10cm Total	1.64E-05	2.9%	2.70E-04	2.5%	1.80E-03	1.9%	4.35E-03	1.5%	1.15E-02	2.4%
DSC Case 1 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 10cm Total	1.66E-05	2.8%	2.72E-04	2.4%	1.82E-03	1.9%	4.39E-03	1.5%	1.17E-02	2.3%
DSC Case 1 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 10cm Total	1.62E-05	2.9%	2.69E-04	2.5%	1.76E-03	1.9%	4.30E-03	1.5%	1.12E-02	2.4%
DSC Case 1 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 10cm Total	1.64E-05	2.9%	2.75E-04	2.5%	1.80E-03	1.9%	4.41E-03	1.5%	1.16E-02	2.4%
DSC Case 1 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 10cm Total	1.68E-05	2.9%	2.77E-04	2.4%	1.83E-03	1.9%	4.48E-03	1.5%	1.18E-02	2.3%
DSC Case 1 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 10cm Total	1.69E-05	2.9%	2.78E-04	2.4%	1.85E-03	1.9%	4.52E-03	1.4%	1.20E-02	2.3%

Table 43: Dose Rate (µSv/h, BE) per Placement Year – 15 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 2

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 1 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 15cm Total	1.99E-02	6.5%	1.21E-02	2.0%	2.44E-01	3.0%
DSC Case 1 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 15cm Total	2.05E-02	6.3%	1.37E-02	1.8%	2.55E-01	2.9%
DSC Case 1 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 15cm Total	2.09E-02	6.2%	1.44E-02	1.8%	2.62E-01	2.9%
DSC Case 1 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 15cm Total	2.11E-02	6.2%	1.46E-02	1.7%	2.71E-01	3.0%
DSC Case 1 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 15cm Total	2.00E-02	6.5%	1.23E-02	2.0%	2.50E-01	3.0%
DSC Case 1 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 15cm Total	2.06E-02	6.3%	1.39E-02	1.8%	2.61E-01	2.9%
DSC Case 1 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 15cm Total	2.10E-02	6.2%	1.46E-02	1.7%	2.67E-01	2.8%
DSC Case 1 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 15cm Total	2.11E-02	6.2%	1.48E-02	1.7%	2.77E-01	2.9%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 1 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 15cm Total	1.57E-05	2.9%	2.60E-04	2.5%	1.72E-03	2.0%	4.12E-03	1.5%	1.07E-02	2.5%
DSC Case 1 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 15cm Total	1.58E-05	2.9%	2.63E-04	2.5%	1.73E-03	2.0%	4.16E-03	1.5%	1.08E-02	2.5%
DSC Case 1 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 15cm Total	1.59E-05	2.8%	2.64E-04	2.5%	1.74E-03	2.0%	4.20E-03	1.5%	1.10E-02	2.5%
DSC Case 1 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 15cm Total	1.59E-05	2.8%	2.65E-04	2.5%	1.75E-03	2.0%	4.22E-03	1.5%	1.11E-02	2.4%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 1 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 15cm Total	1.57E-05	2.9%	2.61E-04	2.5%	1.72E-03	2.0%	4.12E-03	1.5%	1.07E-02	2.5%
DSC Case 1 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 15cm Total	1.58E-05	2.9%	2.64E-04	2.5%	1.73E-03	2.0%	4.17E-03	1.5%	1.08E-02	2.5%
DSC Case 1 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 15cm Total	1.59E-05	2.8%	2.65E-04	2.5%	1.74E-03	2.0%	4.21E-03	1.5%	1.10E-02	2.5%
DSC Case 1 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 15cm Total	1.59E-05	2.8%	2.66E-04	2.5%	1.75E-03	2.0%	4.23E-03	1.5%	1.11E-02	2.4%

Table 44: Dose Rate (µSv/h, BE+2σ) per Placement Year – 10 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 2

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	5.00E-02	5.00E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	5.00E-01
DSC Case 1 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 10cm Total	2.32E-02	1.48E-02	1.67E-05	2.76E-04	1.80E-03	4.30E-03	1.14E-02	2.70E-01
DSC Case 1 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 10cm Total	2.44E-02	1.78E-02	1.70E-05	2.81E-04	1.83E-03	4.41E-03	1.18E-02	2.89E-01
DSC Case 1 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 10cm Total	2.51E-02	1.91E-02	1.74E-05	2.83E-04	1.87E-03	4.48E-03	1.21E-02	3.06E-01
DSC Case 1 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 10cm Total	2.55E-02	1.96E-02	1.75E-05	2.85E-04	1.88E-03	4.52E-03	1.22E-02	3.22E-01
DSC Case 1 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 10cm Total	2.44E-02	1.68E-02	1.71E-05	2.82E-04	1.83E-03	4.43E-03	1.18E-02	2.94E-01
DSC Case 1 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 10cm Total	2.56E-02	1.98E-02	1.73E-05	2.88E-04	1.87E-03	4.54E-03	1.21E-02	3.13E-01
DSC Case 1 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 10cm Total	2.63E-02	2.11E-02	1.77E-05	2.90E-04	1.90E-03	4.61E-03	1.24E-02	3.31E-01
DSC Case 1 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 10cm Total	2.67E-02	2.16E-02	1.79E-05	2.92E-04	1.92E-03	4.65E-03	1.25E-02	3.46E-01

Table 45: Dose Rate (µSv/h, BE+2σ) per Placement Year – 15 cm roof (DSCs Case 1 + RWCs + SGs) – Scenario 2

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
DSC Case 1 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 15cm Total	2.25E-02	1.26E-02	1.66E-05	2.74E-04	1.78E-03	4.24E-03	1.12E-02	2.59E-01
DSC Case 1 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 15cm Total	2.31E-02	1.42E-02	1.67E-05	2.76E-04	1.80E-03	4.29E-03	1.14E-02	2.70E-01
DSC Case 1 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 15cm Total	2.35E-02	1.49E-02	1.68E-05	2.77E-04	1.81E-03	4.33E-03	1.15E-02	2.77E-01
DSC Case 1 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 15cm Total	2.37E-02	1.51E-02	1.68E-05	2.78E-04	1.82E-03	4.35E-03	1.16E-02	2.87E-01
DSC Case 1 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 15cm Total	2.26E-02	1.28E-02	1.66E-05	2.74E-04	1.79E-03	4.25E-03	1.12E-02	2.64E-01
DSC Case 1 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 15cm Total	2.32E-02	1.44E-02	1.67E-05	2.77E-04	1.80E-03	4.30E-03	1.14E-02	2.76E-01
DSC Case 1 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 15cm Total	2.36E-02	1.51E-02	1.68E-05	2.78E-04	1.81E-03	4.34E-03	1.16E-02	2.82E-01
DSC Case 1 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 15cm Total	2.37E-02	1.53E-02	1.68E-05	2.79E-04	1.82E-03	4.36E-03	1.16E-02	2.93E-01

Table 46: Dose Rate (µSv/h, BE) per Placement Year – 10 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 2

Dose Point	PW24	Error	PW26	Error	PW10	Error
Case 2 DSC Total (SB/SB4 from PV209 and SB5 updated layout)	4.02E-03	2.9%	3.07E-03	2.2%	1.89E-01	3.7%
DSC Case 2 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 10cm Total	5.53E-03	2.3%	7.43E-03	1.5%	2.15E-01	3.3%
DSC Case 2 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 10cm Total	6.74E-03	2.1%	1.04E-02	1.3%	2.34E-01	3.2%
DSC Case 2 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 10cm Total	7.45E-03	1.9%	1.17E-02	1.2%	2.51E-01	3.0%
DSC Case 2 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 10cm Total	7.85E-03	1.8%	1.22E-02	1.1%	2.65E-01	3.0%
DSC Case 2 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 10cm Total	6.64E-03	3.4%	9.45E-03	1.4%	2.39E-01	3.1%

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 2 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 10cm Total	7.85E-03	3.0%	1.25E-02	1.3%	2.57E-01	3.0%
DSC Case 2 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 10cm Total	8.56E-03	2.7%	1.37E-02	1.1%	2.74E-01	2.9%
DSC Case 2 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 10cm Total	8.97E-03	2.6%	1.42E-02	1.1%	2.89E-01	2.9%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Case 2 DSC Total (SB/SB4 from PV209 and SB5 updated layout)	1.31E-05	3.3%	1.92E-04	3.2%	9.68E-04	2.4%	1.88E-03	1.5%	3.64E-03	2.7%
DSC Case 2 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 10cm Total	1.35E-05	3.2%	1.98E-04	3.1%	1.01E-03	2.3%	2.02E-03	1.5%	4.12E-03	2.4%
DSC Case 2 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 10cm Total	1.37E-05	3.2%	2.04E-04	3.1%	1.05E-03	2.3%	2.13E-03	1.4%	4.49E-03	2.3%
DSC Case 2 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 10cm Total	1.41E-05	3.3%	2.06E-04	3.0%	1.08E-03	2.3%	2.20E-03	1.4%	4.74E-03	2.2%
DSC Case 2 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 10cm Total	1.42E-05	3.2%	2.07E-04	3.0%	1.10E-03	2.2%	2.24E-03	1.3%	4.88E-03	2.1%
DSC Case 2 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 10cm Total	1.32E-05	3.4%	2.05E-04	3.1%	1.04E-03	2.3%	2.15E-03	1.5%	4.46E-03	2.5%
DSC Case 2 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 10cm Total	1.96E-05	2.3%	2.10E-04	3.0%	1.08E-03	2.2%	2.26E-03	1.5%	4.83E-03	2.3%
DSC Case 2 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 10cm Total	1.33E-05	3.6%	2.13E-04	3.0%	1.11E-03	2.2%	2.33E-03	1.4%	5.08E-03	2.3%
DSC Case 2 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 10cm Total	1.46E-05	3.2%	2.14E-04	3.0%	1.13E-03	2.2%	2.37E-03	1.3%	5.22E-03	2.2%

Table 47: Dose Rate (µSv/h, BE) per Placement Year – 15 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 2

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 2 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 15cm Total	4.81E-03	2.6%	5.28E-03	1.9%	2.04E-01	3.5%
DSC Case 2 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 15cm Total	5.43E-03	2.4%	6.89E-03	1.6%	2.15E-01	3.3%
DSC Case 2 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 15cm Total	5.81E-03	2.3%	7.57E-03	1.7%	2.22E-01	3.3%
DSC Case 2 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 15cm Total	5.99E-03	2.2%	7.79E-03	1.5%	2.31E-01	3.4%
DSC Case 2 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 15cm Total	4.87E-03	2.5%	5.47E-03	1.8%	2.10E-01	3.4%
DSC Case 2 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 15cm Total	5.50E-03	2.4%	7.08E-03	1.5%	2.21E-01	3.3%
DSC Case 2 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 15cm Total	5.87E-03	2.3%	7.76E-03	1.6%	2.27E-01	3.2%
DSC Case 2 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 15cm Total	6.06E-03	2.2%	7.99E-03	1.4%	2.37E-01	3.3%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 2 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 15cm Total	1.33E-05	3.3%	1.96E-04	3.2%	9.98E-04	2.4%	1.97E-03	1.5%	3.88E-03	2.6%
DSC Case 2 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 15cm Total	1.34E-05	3.2%	1.99E-04	3.1%	1.01E-03	2.3%	2.01E-03	1.4%	4.06E-03	2.5%
DSC Case 2 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 15cm Total	1.35E-05	3.2%	2.00E-04	3.1%	1.03E-03	2.3%	2.05E-03	1.4%	4.22E-03	2.5%
DSC Case 2 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 15cm Total	1.36E-05	3.2%	2.01E-04	3.1%	1.03E-03	2.3%	2.07E-03	1.4%	4.30E-03	2.4%
DSC Case 2 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 15cm Total	1.33E-05	3.3%	1.97E-04	3.2%	1.00E-03	2.4%	1.97E-03	1.5%	3.90E-03	2.5%
DSC Case 2 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 15cm Total	1.34E-05	3.2%	1.99E-04	3.1%	1.02E-03	2.3%	2.02E-03	1.4%	4.08E-03	2.5%
DSC Case 2 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 15cm Total	1.35E-05	3.2%	2.01E-04	3.1%	1.03E-03	2.3%	2.06E-03	1.4%	4.24E-03	2.5%
DSC Case 2 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 15cm Total	1.36E-05	3.2%	2.02E-04	3.1%	1.04E-03	2.3%	2.08E-03	1.4%	4.32E-03	2.4%

Table 48: Dose Rate (µSv/h, BE+2σ) per Placement Year – 10 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 2

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	5.00E-02	5.00E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	5.00E-01
DSC Case 2 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 10cm Total	5.79E-03	7.65E-03	1.44E-05	2.11E-04	1.06E-03	2.08E-03	4.31E-03	2.29E-01
DSC Case 2 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 10cm Total	7.02E-03	1.07E-02	1.46E-05	2.16E-04	1.10E-03	2.20E-03	4.69E-03	2.48E-01
DSC Case 2 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 10cm Total	7.74E-03	1.20E-02	1.50E-05	2.18E-04	1.13E-03	2.27E-03	4.95E-03	2.66E-01
DSC Case 2 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 10cm Total	8.14E-03	1.25E-02	1.52E-05	2.20E-04	1.15E-03	2.30E-03	5.09E-03	2.81E-01
DSC Case 2 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 10cm Total	7.09E-03	9.71E-03	1.41E-05	2.17E-04	1.09E-03	2.21E-03	4.68E-03	2.54E-01
DSC Case 2 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 10cm Total	8.31E-03	1.28E-02	2.05E-05	2.23E-04	1.13E-03	2.33E-03	5.05E-03	2.73E-01
DSC Case 2 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 10cm Total	9.03E-03	1.40E-02	1.42E-05	2.25E-04	1.16E-03	2.40E-03	5.31E-03	2.90E-01
DSC Case 2 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 10cm Total	9.43E-03	1.45E-02	1.55E-05	2.27E-04	1.18E-03	2.44E-03	5.46E-03	3.06E-01

Table 49: Dose Rate (µSv/h, BE+2σ) per Placement Year – 15 cm roof (DSCs Case 2 + RWCs + SGs) – Scenario 2

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
DSC Case 2 + RWC Case 1 +2027 - Scenario 2 SGs - Roof 15cm Total	5.06E-03	5.47E-03	1.42E-05	2.09E-04	1.05E-03	2.02E-03	4.08E-03	2.18E-01
DSC Case 2 + RWC Case 1 +2028 - Scenario 2 SGs - Roof 15cm Total	5.69E-03	7.11E-03	1.43E-05	2.11E-04	1.06E-03	2.07E-03	4.26E-03	2.29E-01
DSC Case 2 + RWC Case 1 +2029 - Scenario 2 SGs - Roof 15cm Total	6.07E-03	7.82E-03	1.44E-05	2.12E-04	1.07E-03	2.11E-03	4.43E-03	2.36E-01
DSC Case 2 + RWC Case 1 +2031 - Scenario 2 SGs - Roof 15cm Total	6.25E-03	8.02E-03	1.44E-05	2.13E-04	1.08E-03	2.13E-03	4.51E-03	2.47E-01
DSC Case 2 + RWC Case 2 +2027 - Scenario 2 SGs - Roof 15cm Total	5.12E-03	5.67E-03	1.42E-05	2.09E-04	1.05E-03	2.03E-03	4.10E-03	2.24E-01
DSC Case 2 + RWC Case 2 +2028 - Scenario 2 SGs - Roof 15cm Total	5.76E-03	7.30E-03	1.43E-05	2.12E-04	1.06E-03	2.08E-03	4.28E-03	2.35E-01
DSC Case 2 + RWC Case 2 +2029 - Scenario 2 SGs - Roof 15cm Total	6.14E-03	8.01E-03	1.44E-05	2.13E-04	1.07E-03	2.12E-03	4.45E-03	2.42E-01
DSC Case 2 + RWC Case 2 +2031 - Scenario 2 SGs - Roof 15cm Total	6.32E-03	8.22E-03	1.45E-05	2.14E-04	1.08E-03	2.14E-03	4.53E-03	2.52E-01

The placement year with the highest dose rates is 2031 for all cases in all dose points in Scenario 2. The dose rates in all dose points are below the acceptance criteria for both 10 cm and 15 cm PCSS roof shielding, considering the dose rate from the DSCs, RWCs, and SGs. Below are dose rate maps around PCSS considering the contributions from RWCs, SGs, and DSCs.

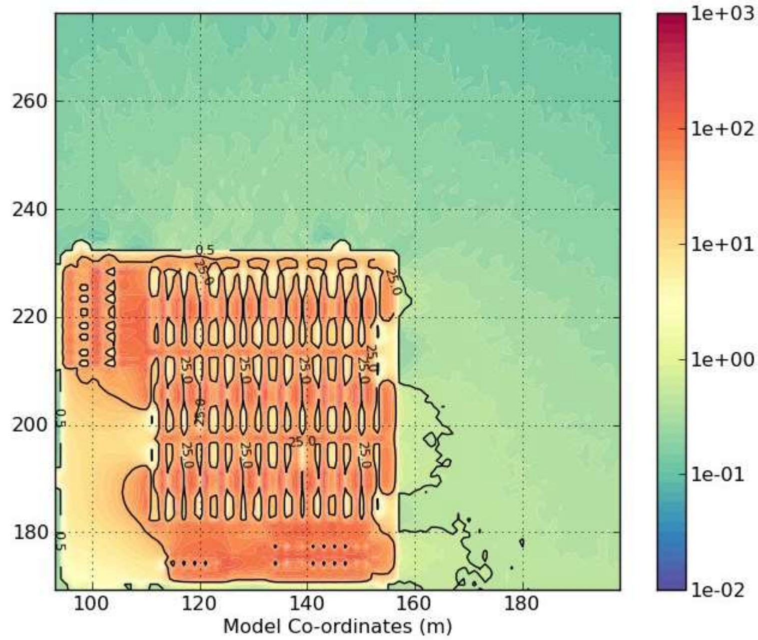

Figure 43: SG 2031 Scenario 2 + RWC Case 1 + DSC Case 1 – Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

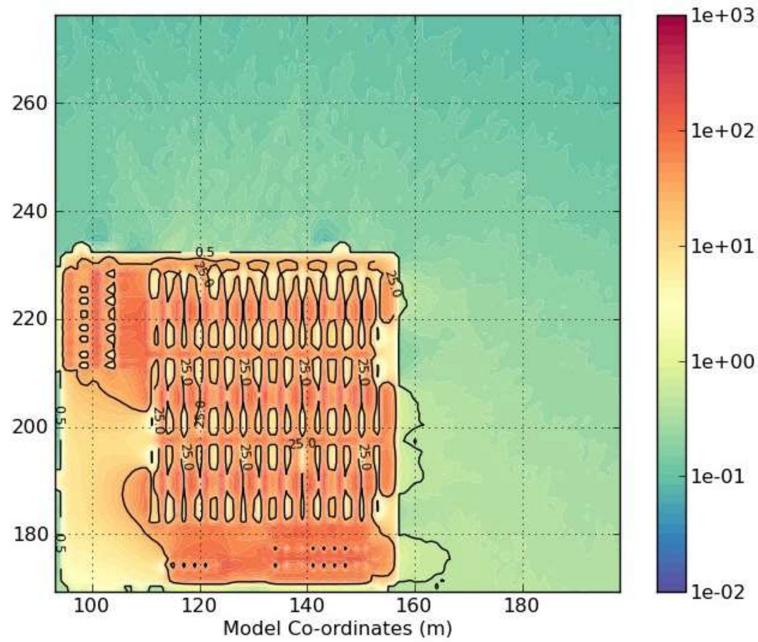

Figure 44: SG 2031 Scenario 2 + RWC Case 1 + DSC Case 1 – Roof 15cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

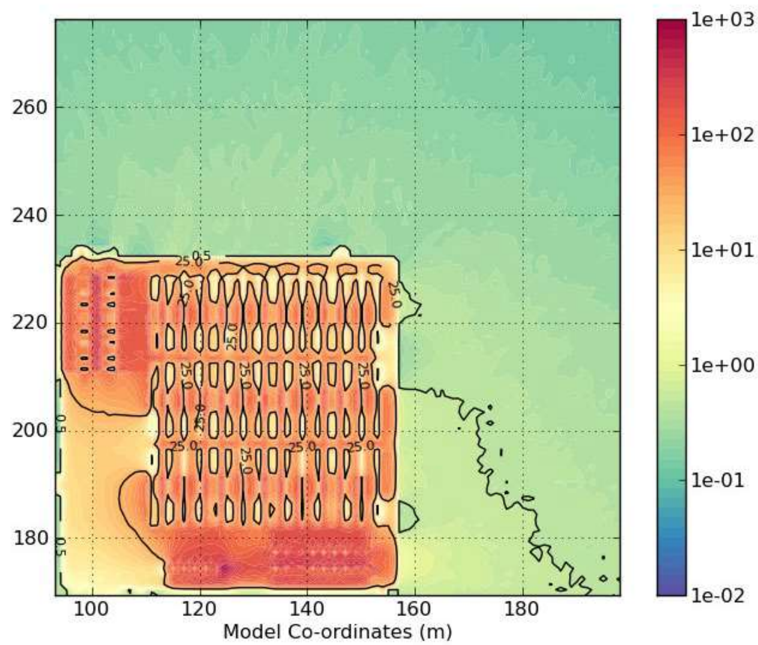

Figure 45: SG 2031 Scenario 2 + RWC Case 2 + DSC Case 1 – Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

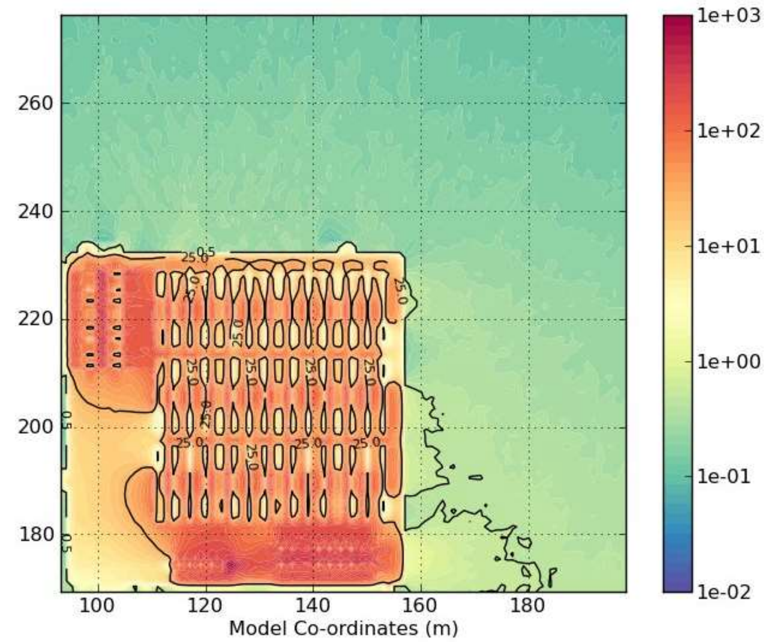

Figure 46: SG 2031 Scenario 2 + RWC Case 2 + DSC Case 1 – Roof 15cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

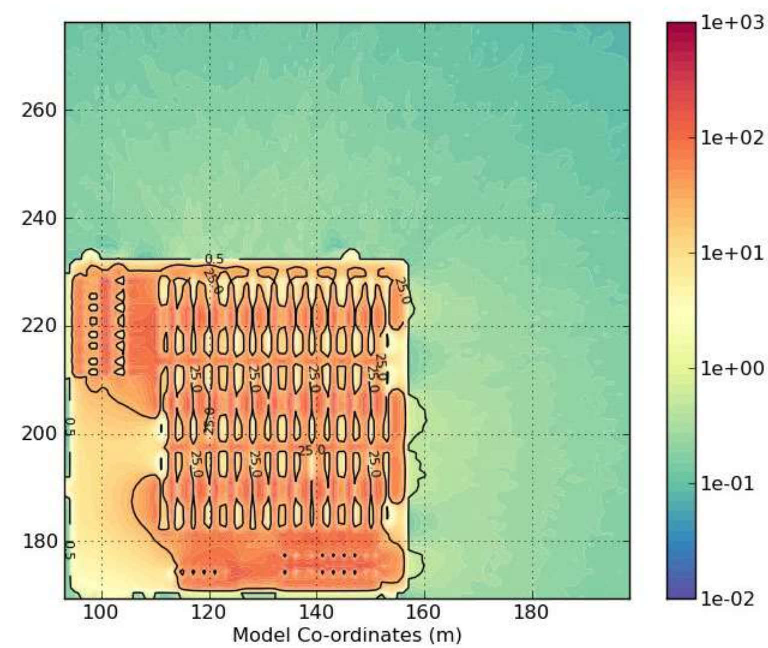

Figure 47: SG 2031 Scenario 2 + RWC Case 1 + DSC Case 2 – Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

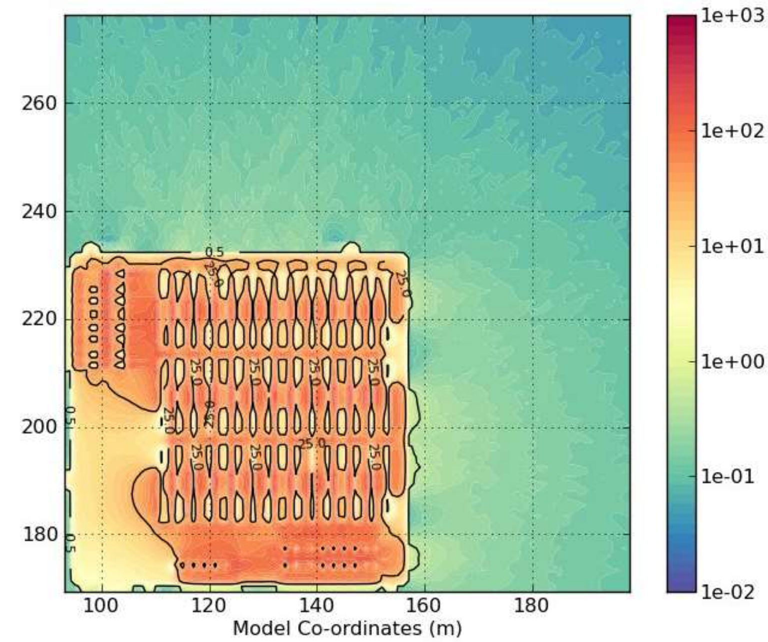

Figure 48: SG 2031 Scenario 2 + RWC Case 1 + DSC Case 2 – Roof 15cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

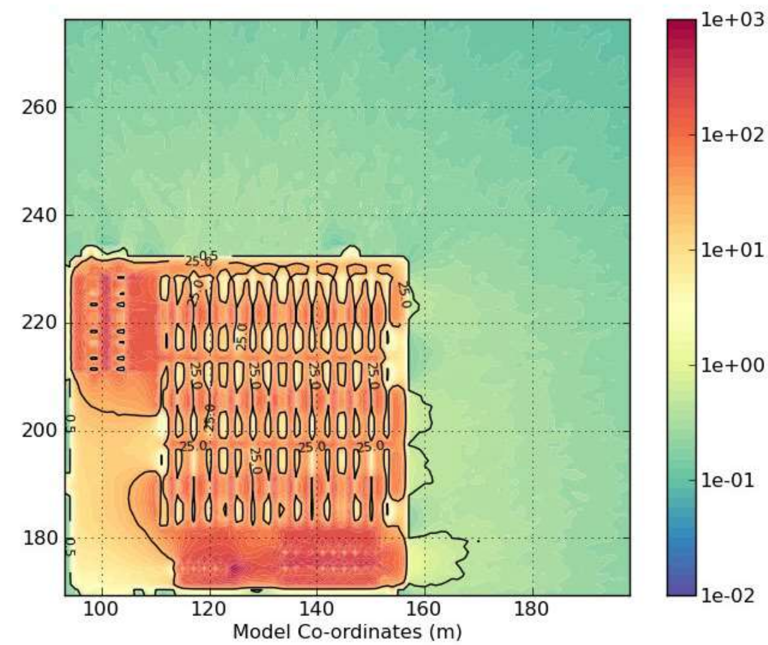

Figure 49: SG 2031 Scenario 2 + RWC Case 2 + DSC Case 2 – Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around PCSS

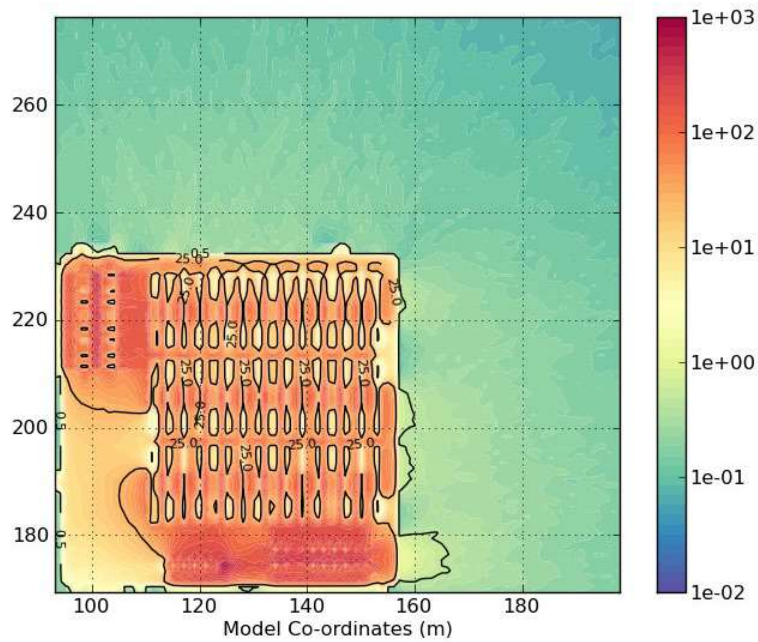

Figure 50: SG 2031 Scenario 2 + RWC Case 2 + DSC Case 2 – Roof 15cm – Best Estimate Dose Rates (μSv/hr) Around PCSS

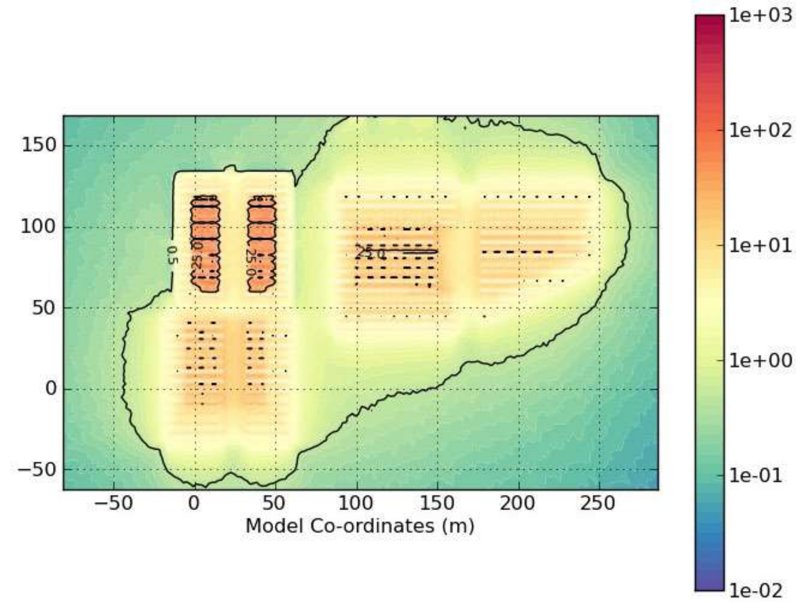

Figure 51: SG 2031 Scenario 2 + RWC Case 1 + DSC Case 1 – PCSS Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around DSCs

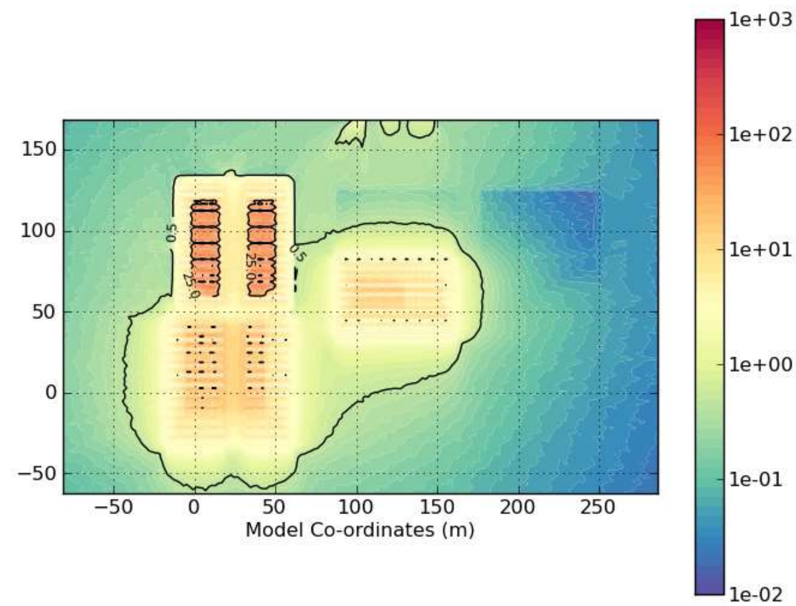

Figure 52: SG 2031 Scenario 2 + RWC Case 1 + DSC Case 2 – PCSS Roof 10cm – Best Estimate Dose Rates (µSv/hr) Around DSCs

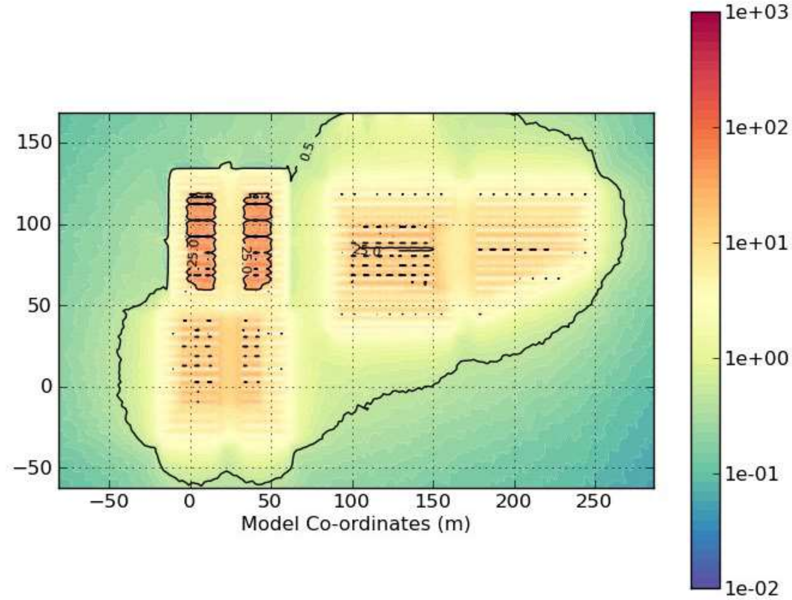

Figure 53: SG 2031 Scenario 2 + RWC Case 2 + DSC Case 1 – PCSS Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around DSCs

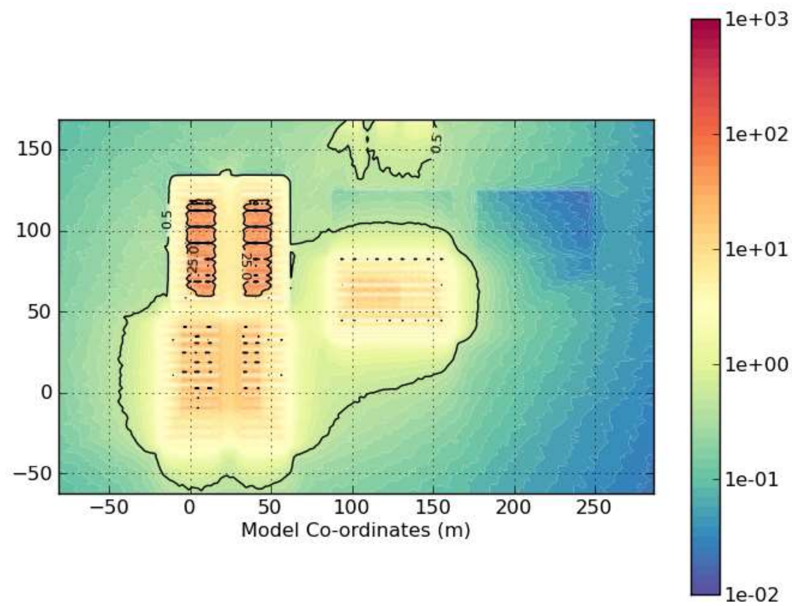

Figure 54: SG 2031 Scenario 2 + RWC Case 2 + DSC Case 2 – PCSS Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around DSCs

5.3.3.5 Additional Wall and Roll-up Door Shielding

The more conservative cases for the SGs (Scenario 2 – final placement year 2031) and RWCs (Case 2) combined with the SB5 updated DSC Case 2 layout (Figure 16), considering the PCSS roof with 10 cm shielding, has areas outside the PCSS walls above the 0.5 μSv/hr acceptance criterion. The areas above criterion were the south wall (near RWCs), south rollup door opening, east wall, west wall (near RWCs), and north wall (near the west opening), these regions are shown in Figure 49 and Figure 54 above, and highlighted in Figure 55.

To estimate the shielding thickness, transmission factors were calculated by dividing the acceptance criteria by the dose rates (BE+2σ) for each part of the outer wall of PCSS from the summed-up mesh tally result. For each region above criteria, transmission curves from Reference [62] were used to determine the required thickness of concrete, steel, and lead.

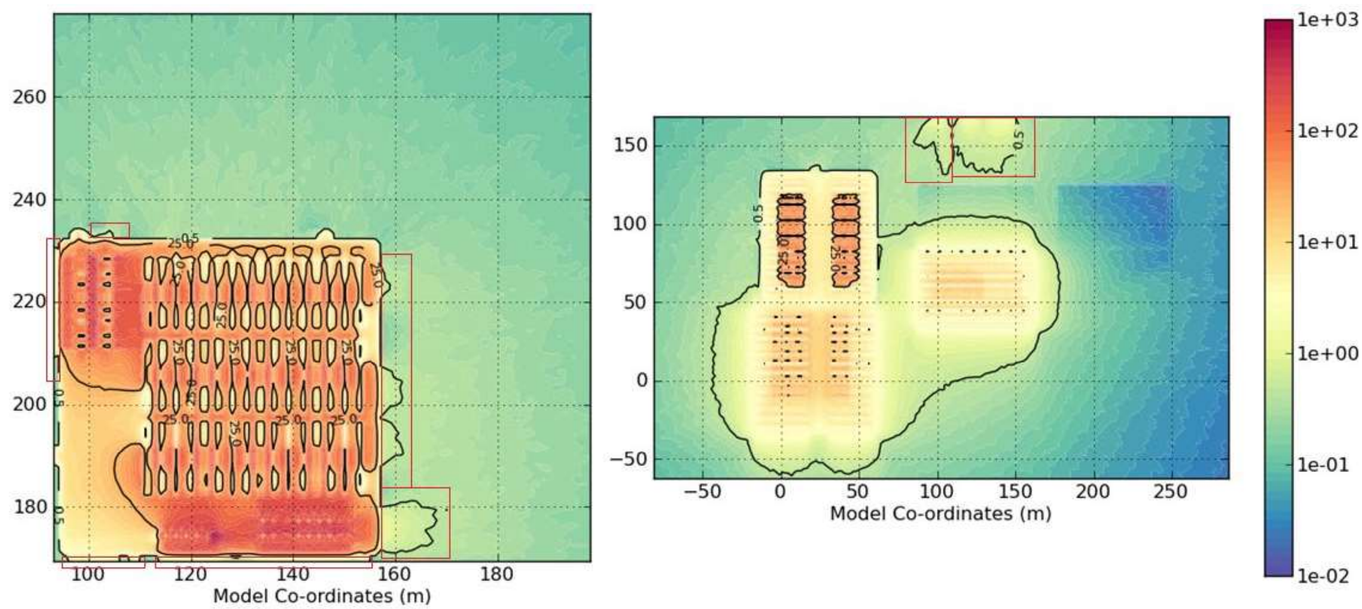

Figure 55: SG Scenario 2 + RWC Case 2 + DSC Case 2 – Roof 10cm – Best Estimate Dose Rates (μSv/hr) without additional shielding (areas above the acceptance criterion highlighted)

Interior concrete shielding walls were calculated at various thicknesses to reduce the dose rates at the PCSS perimeter below the 0.5 μSv/h acceptance criterion. In this case combination, SG Scenario 2 + RWC Case 2 + DSC Case 2 and Roof 10cm, the region with the highest dose rates is the rollup door opening at the south wall, which can be shielded with about 28 cm of concrete, 9 cm of steel, or 5 cm of lead, as shown in Table 50. Adding shielding only to these regions should suffice to bring the dose rates below the acceptance criterion at all walls of the PCSS.

Table 50: PCSS Outer Wall Regions above Criterion and Estimated Shielding Thickness (SG Scenario 2 + RWC Case 2 + DSC Case 2 – Roof 10cm)

PCSS Region	Approximate Maximum Dose (μSv/hr, BE+2σ)	Transmission Factor	Concrete Thickness (cm)	Steel Thickness (cm)	Lead Thickness (cm)
South Wall (Near RWCs)	3.5	1.4E-01	25	8	4
South Wall (Rollup Door)	5.0	1.0E-01	28	9	5
East Wall (Near RWCs)	2.0	2.5E-01	20	6	3
East Wall (Near SGs)	1.0	5.0E-01	7	3	2
West Wall	3.5	1.4E-01	25	8	4
North Wall	1.0	5.0E-01	7	3	2

The estimated shielding results in Table 50 above do not consider decay to the RWCs. Comparing the RWCs with 1y decay and the RWCs from the removal schedule with 620 days of decay (1.7y), based on the CTI Release & Removal schedule from Reference [27], the dose rates for the SG Scenario 2 + RWC Case 2 + DSC case 2 are shown in Table 51. In this case, the region with the highest dose rates is the rollup door opening at the south wall, which can be shielded with about 27 cm of concrete, 8 cm of steel, or 5 cm of lead, as shown in Table 52.

Table 51: Dose Rate (μSv/h, BE+2σ) per Placement Year – 10 cm roof (SG scenario 2 + RWC scenario 2 + DSC case 2)

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	0.05	0.05	0.1	0.1	0.1	0.1	0.1	0.5
DSC Case 2 + RWC Case 2 1y Decay + 2031 - Scenario 2 SGs Total	9.43E-03	1.45E-02	1.55E-05	2.27E-04	1.18E-03	2.44E-03	5.46E-03	3.06E-01
DSC Case 2 + RWC Case 2 1.7y Decay +2031 - Scenario 2 SGs Total	9.28E-03	1.43E-02	1.55E-05	2.26E-04	1.18E-03	2.42E-03	5.41E-03	3.03E-01
Ratio	0.984	0.983	0.997	0.996	0.997	0.994	0.992	0.990

Table 52: PCSS Outer Wall Regions above Criterion and Estimated Shielding Thickness (SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm)

PCSS Region	Approximate Maximum Dose (μSv/hr, BE+2σ)	Transmission Factor	Concrete Thickness (cm)	Steel Thickness (cm)	Lead Thickness (cm)
South Wall (Near RWCs)	2.5	2.0E-01	21	7	4
South Wall (Rollup Door)	4.5	1.1E-01	27	8	5
East Wall (Near RWCs)	1.5	3.3E-01	16	5	3
East Wall (Near SGs)	1.0	5.0E-01	11	3	2
West Wall	2.6	1.9E-01	22	7	4
North Wall	0.9	5.6E-01	9	3	2

A confirmatory MCNP calculation was made with the estimated concrete shielding values considering RWCs with 1.7 years of decay, adding walls to the interior of PCSS in each region above the criteria. The concrete thicknesses and lengths for each region are shown in the MCNP model in Figure 56. With the added concrete shielding from Table 52, the dose rates around the PCSS outer walls are below the criteria, as shown in Figure 57 and Figure 58. The results for the dose rates at the site dose points are shown in Table 55 and Table 56. The dose rates at the site dose points are all below the acceptance criteria.

[redacted]

Figure 56: MCNP Model with Added Concrete Shielding (Length × Thickness) – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2

Table 53: Dose Rate (µSv/h, BE) – Updated PCSS Layout with Added Concrete Shielding (2031 SG Scenario 2 + RWC Scenario 2 + DSC Case 2)

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 2 + RWC Case 2 +2031 Scenario 2 SGs - Roof 10cm	8.93E-03	2.1%	1.44E-02	1.1%	2.86E-01	2.8%
DSC Case 2 + RWC Case 2 1.7y Decay + 2031 - Scenario 2 SGs - Roof 10cm	8.63E-03	2.0%	1.38E-02	1.1%	2.80E-01	2.8%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 2 + RWC Case 2 + 2031 Scenario 2 SGs - Roof 10cm	1.42E-05	2.9%	2.09E-04	3.2%	1.13E-03	2.0%	2.36E-03	1.5%	5.33E-03	2.4%
DSC Case 2 + RWC Case 2 1.7y Decay + 2031 Scenario 2 SGs - Roof 10cm	1.41E-05	2.9%	2.08E-04	3.2%	1.12E-03	2.0%	2.33E-03	1.5%	5.23E-03	2.4%

Table 54: Dose Rate (μSv/h, BE+2σ) – Updated PCSS Layout with Added Concrete Shielding (2031 SG Scenario 2 + RWC Scenario 2 + DSC Case 2)

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
DSC Case 2 + RWC Case 2 + 2031 Scenario 2 SGs - Roof 10cm	9.30E-03	1.48E-02	1.50E-05	2.22E-04	1.17E-03	2.43E-03	5.59E-03	3.02E-01
DSC Case 2 + RWC Case 2 1.7y Decay +2031 Scenario 2 SGs - Roof 10cm	8.97E-03	1.41E-02	1.50E-05	2.21E-04	1.17E-03	2.40E-03	5.48E-03	2.96E-01

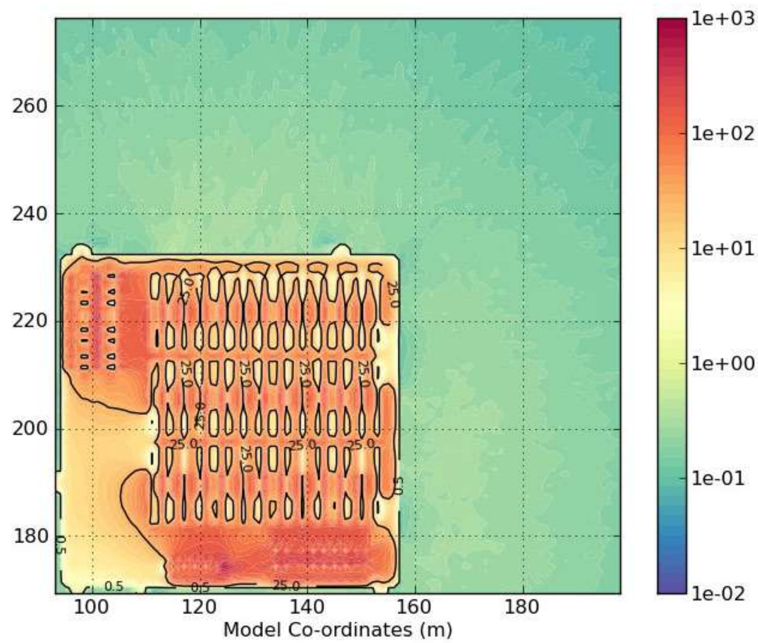

Figure 57: SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around PCSS with Additional Shielding

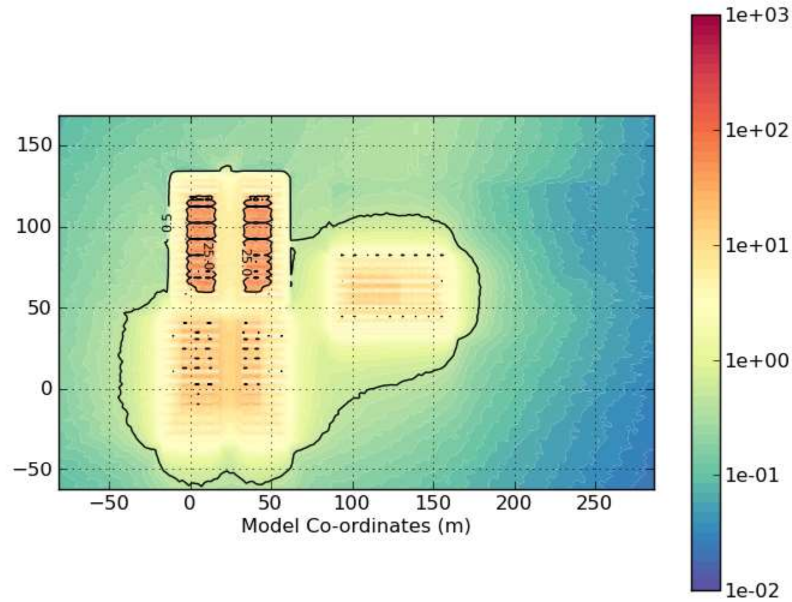

Figure 58: SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – PCSS Roof 10cm – Best Estimate Dose Rates (μSv/hr) Around DSCs with PCSS Additional Shielding

5.3.4 Final PCSS Layout Full Building MCNP Dose Rates

The results for the dose rates at the site dose points are shown in Table 55 and Table 56. The dose rates around the PCSS and around the DSCs with the final PCSS layout are shown in Figure 59 and Figure 60, respectively. The dose rates at the site dose points are all below the acceptance criteria.

Table 55: Dose Rate (μSv/h, BE) – Final PCSS Layout (2031 SG Scenario 2 + RWC scenario 2 + DSC case 2)

Dose Point	PW24	Error	PW26	Error	PW10	Error
DSC Case 2 + RWC Case 2 +2031 Scenario 2 SGs - Roof 10cm	8.97E-03	1.6%	1.43E-02	0.9%	2.78E-01	2.5%
DSC Case 2 + RWC Case 2 1.7y Decay + 2031 - Scenario 2 SGs - Roof 10cm	8.69E-03	1.6%	1.37E-02	0.9%	2.73E-01	2.5%

Dose Point	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
DSC Case 2 + RWC Case 2 + 2031 Scenario 2 SGs - Roof 10cm	1.42E-05	2.9%	2.10E-04	3.2%	1.14E-03	2.0%	2.38E-03	1.4%	5.29E-03	2.2%
DSC Case 2 + RWC Case 2 1.7y Decay + 2031 Scenario 2 SGs - Roof 10cm	1.42E-05	2.9%	2.09E-04	3.2%	1.13E-03	2.0%	2.34E-03	1.4%	5.20E-03	2.2%

Table 56: Dose Rate (µSv/h, BE+2σ) – Final PCSS Layout (2031 SG Scenario 2 + RWC scenario 2 + DSC case 2)

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
DSC Case 2 + RWC Case 2 + 2031 Scenario 2 SGs - Roof 10cm	9.26E-03	1.45E-02	1.51E-05	2.24E-04	1.19E-03	2.44E-03	5.52E-03	2.92E-01
DSC Case 2 + RWC Case 2 1.7y Decay +2031 Scenario 2 SGs - Roof 10cm	8.96E-03	1.39E-02	1.50E-05	2.23E-04	1.18E-03	2.41E-03	5.43E-03	2.87E-01

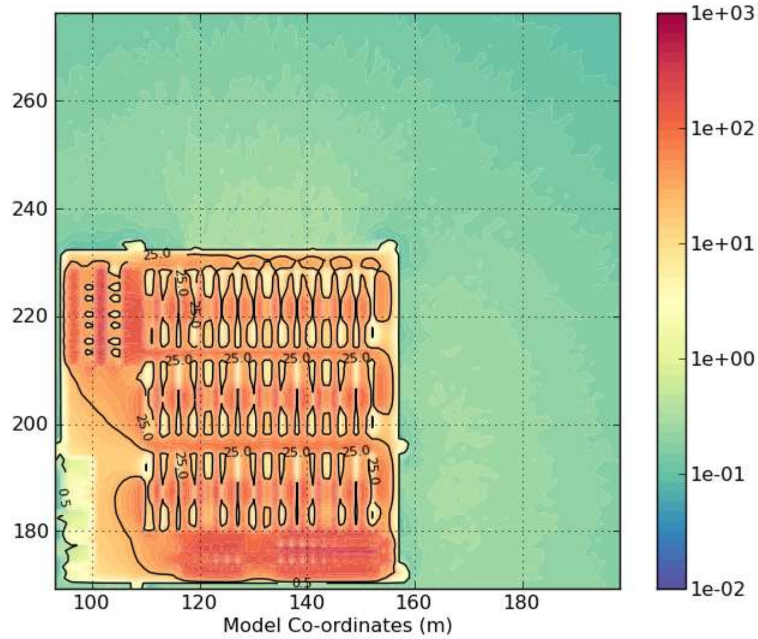

Figure 59: Best Estimate Dose Rates (µSv/hr) Around PCSS with Final PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

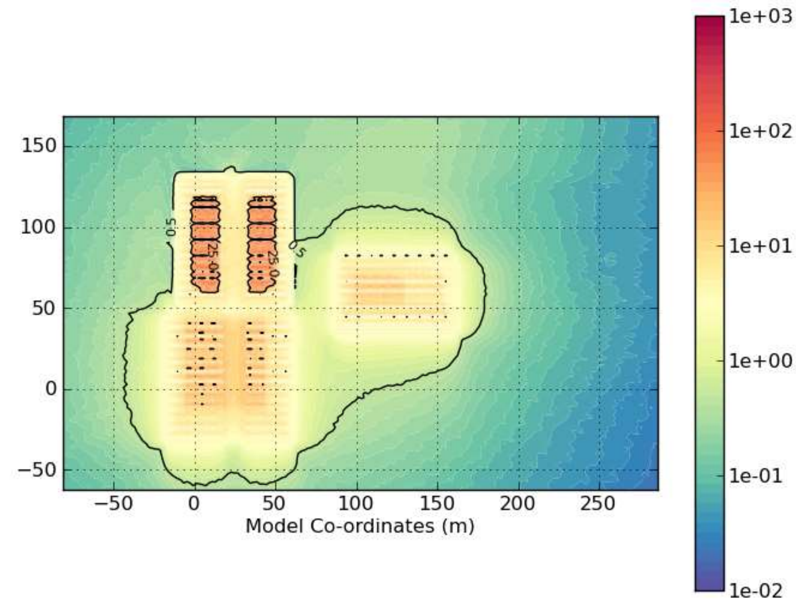

Figure 60: Best Estimate Dose Rates (μSv/hr) Around DSCs with Final PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

Dose rates along the outer walls of the PCSS perimeter were extracted accounting for the contributions of DSCs, SGs, and RWCs, which are shown in Figure 61. The dose rates were taken up to 25 cm away from the walls. This shows that the dose rates were below 0.5 μSv/hr along the whole PCSS perimeter, except for the door openings, which are shielded by the labyrinth walls. The dose rates at door openings were found to be above 0.5 μSv/hr. So, to confirm the dose rates along the labyrinth walls are below 0.5 μSv/hr, the dose rates along the outer position of the labyrinth walls were also extracted for the east and west walls, as shown in Figure 62 and Figure 63. These results show that the dose rates are well below 0.5 μSv/hr along the outer labyrinth walls.

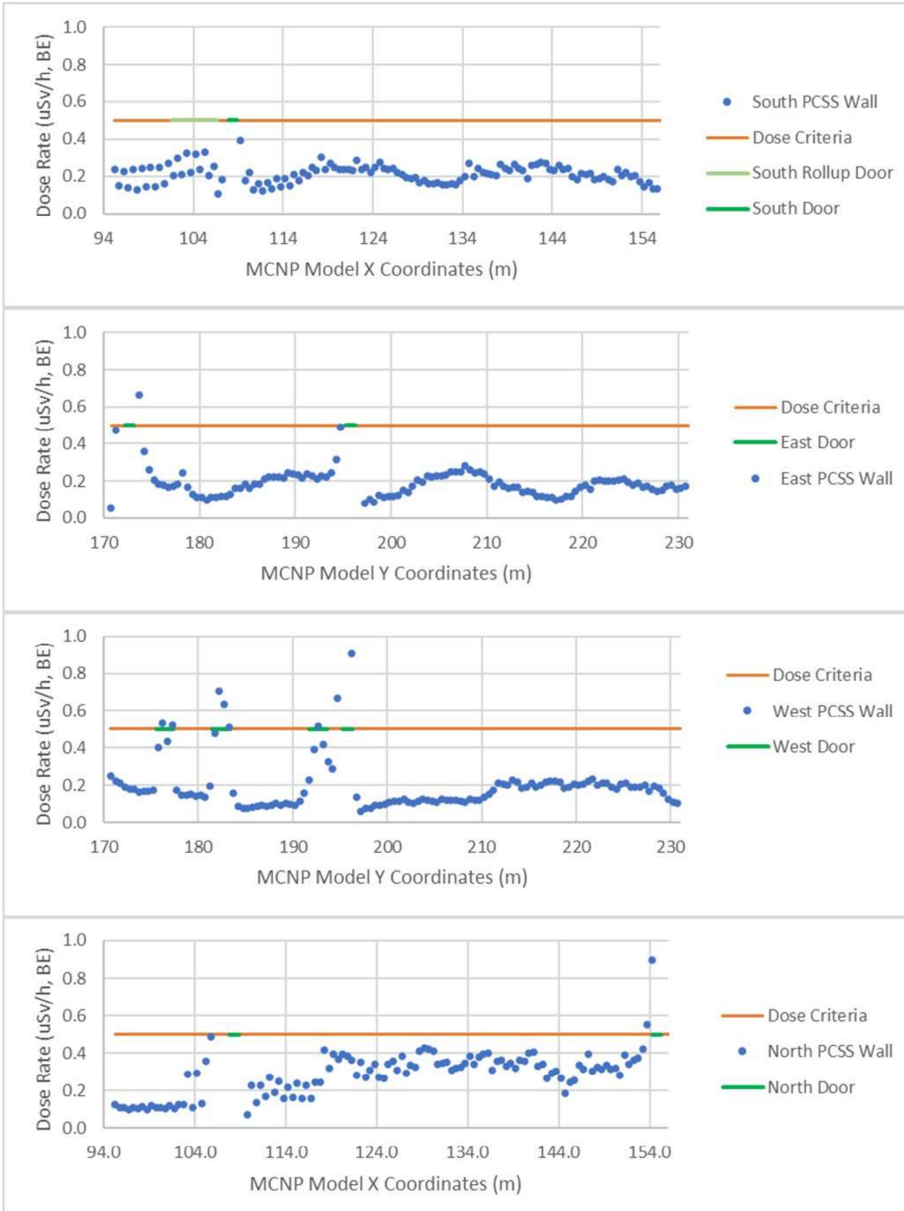

Figure 61: Best Estimate Dose Rates (μSv/hr) Along the PCSS Perimeter – Final PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

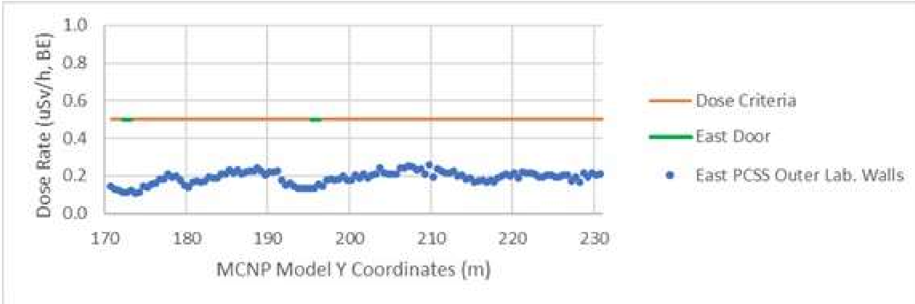

Figure 62: Best Estimate Dose Rates (μSv/hr) Along the East Labyrinth Walls Perimeter – Updated PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

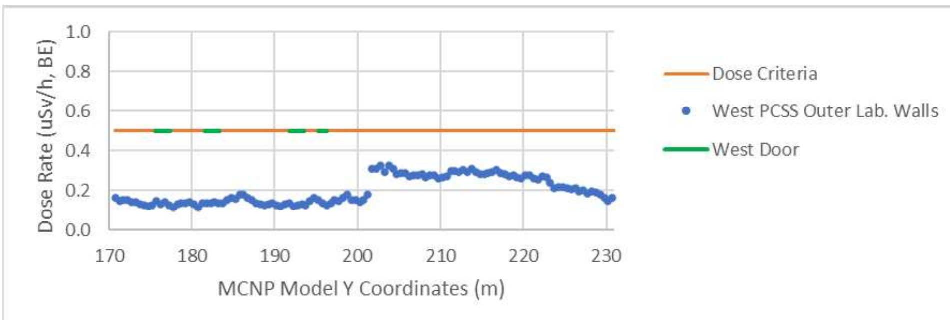

Figure 63: Best Estimate Dose Rates (μSv/hr) Along the West Labyrinth Walls Perimeter – Final PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

The dose rates along the SB3–SB5 fence lines were also extracted. The fence distances were taken from Reference [63] and their positions were adjusted to match the translation applied to the MCNP model. The dose rates were extracted between points A–I, as shown in Figure 64. The dose rates between each point are shown in Figure 65. A dose rate map showing the SB3–SB5 fence dose rates is shown in Figure 66. This shows that some regions along the fences are above 0.5 μSv/hr. Occupational doses arising from UFDS operations are managed under the Radiation Protection Program and are expected to be well below regulatory dose limits.

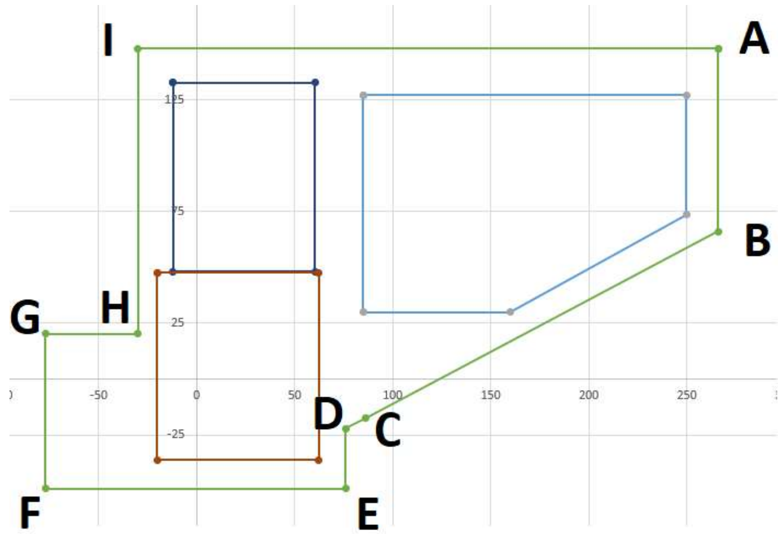

Figure 64: SB3–SB5 Fence Points in the MCNP Model Coordinates

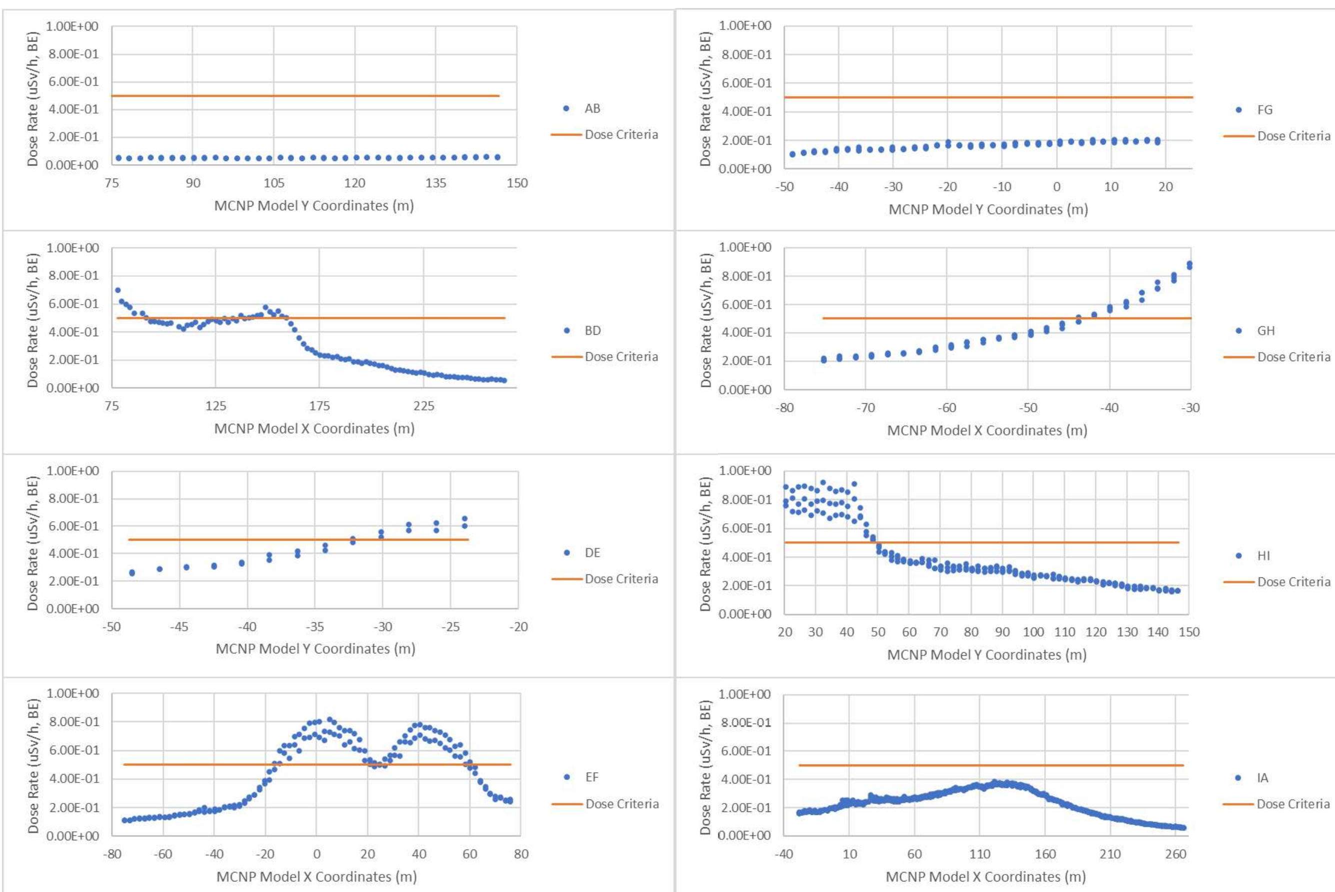

Figure 65: Best Estimate Dose Rates (μSv/hr) Between Each SB3–SB5 Fence Line Point – Final PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

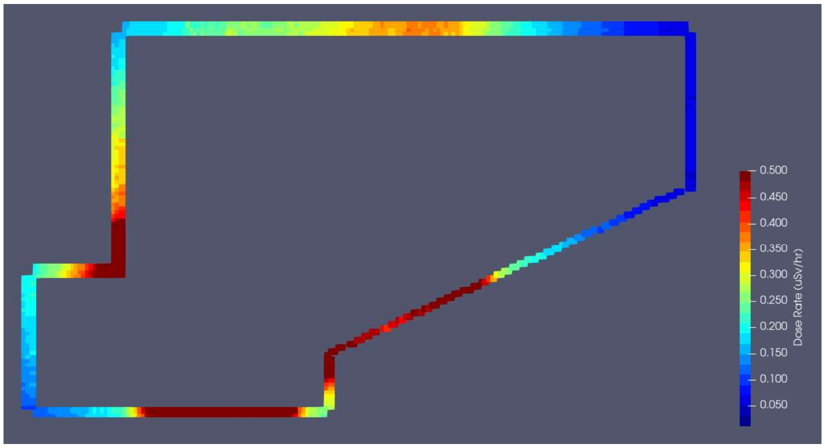

Figure 66: Best Estimate Dose Rates (µSv/hr) Along the SB3–SB5 Fence Lines[7] – Final PCSS Layout and Additional Shielding – SG Scenario 2 + RWC Case 2 Decayed 1.7 years + DSC Case 2 – Roof 10cm

5.3.5 PCSS Neutron Dose Rates

As documented in Reference [28], the calculated neutron contact dose rates around a single RWC were 356.3, 396.8, 251, and 253.5 µSv/h at the short, long, top, and bottom sides of the RWC, respectively, and 69.7, 92.4, 55.8, and 56.2 µSv/h at 1 meter. Considering a full-building calculation with 60 RWC-PT/CT placed at the final layout PCSS, described in Section 3.1.2.4, the neutron dose rates meet the land and water-based dose point limits. This is also true when adding the gamma dose contribution from all wastes stored in PCSS and DSCs in the Storage Buildings (SB3–SB5). However, neutron dose rates reach approximately 0.7 µSv/h along the south wall of the PCSS and 1.0 µSv/h on the east wall by the personnel door labyrinth wall. Therefore, additional neutron shielding will be used to reduce dose rates and meet the acceptance criteria.

The dose rates with various thicknesses of BPE shielding with a 5% boron concentration around the RWC-PT/CTs were assessed in Reference [28]. It was determined that 2-inch BPE shielding along the south, east, and west sides and 3-inch BPE shielding at the top of the RWC-PT/CT group was required. The total dose rates with this shielding meet all land and water-based dose point limits, as shown in Table 57, and are below 0.5 µSv/h along the PCSS perimeter. OPG will pursue the addition of temporary neutron shielding. It should be noted that these results are conservative as the waste will have 4-5 years decay by the time the building is full, and the dose rates are expected to be lower than presented here, as discussed in Section 3.1.2.5.

Table 57: PWMF Dose Rates (µSv/h, BE+2σ) with BPE Shielding Around RWC-PT/CTs

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10
Acceptance Criteria	5.00E-02	5.00E-02	1.00E-01	1.00E-01	1.00E-01	1.00E-01	1.00E-01	5.00E-01
Neutron	1.60E-03	3.29E-03	2.19E-07	4.59E-06	2.73E-05	9.63E-05	3.31E-04	2.00E-02
Secondary Gamma	8.59E-05	2.32E-04	1.19E-06	2.68E-06	1.60E-05	1.88E-05	5.62E-05	8.72E-04
Gamma	8.96E-03	1.39E-02	1.50E-05	2.23E-04	1.18E-03	2.41E-03	5.43E-03	2.87E-01
Total	1.07E-02	1.75E-02	1.64E-05	2.30E-04	1.22E-03	2.53E-03	5.81E-03	3.08E-01

[7] This contour plot should be used for informational purposes only.

5.3.6 Recommendations

Initial Full Building MCNP Dose Rates:
As per the MCNP results shown above in Section 5.3.2, the only cases that were below the acceptance criteria for all dose points were the sensitivity cases that used SG dose rates of 10 mrem/h at 1 m and had a shielded roof on the PCSS. All other cases were over the dose acceptance criteria for at least one dose point. As the PCSS moves further into detailed design, the following recommendations should be considered for any future MCNP analysis:

- Refine source terms for all PCSS waste using more realistic values based on surveys.
- Credit any decay time in the derivation of source terms for each waste type.
- Re-evaluate the fence distances around the PCSS.
- Re-evaluate the layout of waste within the PCSS, and use older less radioactive waste to shield newer waste that has had less decay time wherever possible.

Updated Full Building MCNP Dose Rates:
As per the MCNP results shown above in Section 5.3.3, only the base case was not below the acceptance criteria for all dose points. The concrete roof thickness sensitivity case still had significant dose rates at the PCSS perimeter. Considering the sensitivity cases for the SGs that credit unit specific survey data (Scenario 1 and Scenario 2), additional shielding is required to reduce the PCSS perimeter dose rates below 0.5 µSv/hr. For SG Scenario 2, RWC Case 2 decayed 1.7 years, and DSC Case 2, the recommended concrete shielding is up to 27 cm at the rollup door opening in the south wall.

Final PCSS Layout Full Building MCNP Dose Rates:
As per the MCNP results with the final PCSS layout shown above in Section 5.3.4, the configuration assessed (SG Scenario 2, RWC Case 2 decayed 1.7 years, and DSC Case 2) demonstrated that the dose rates at the PCSS perimeter meet the limit of 0.5 µSv/hr and all land and water-based receptors meet the required dose rate limits. The dose rates along the SB3–SB5 fence lines showed that some regions are above 0.5 µSv/hr. Occupational doses arising from UFDS operations are managed under the Radiation Protection Program and are expected to be well below regulatory dose limits.

PCSS Neutron Dose Rates:
As per the MCNP results with the neutron dose rates from the final PCSS layout summarized above in Section 5.3.5 and described in detail in Reference [28], when considering both neutron and gamma contributions, the dose rates at certain sections of the PCSS perimeter will exceed 0.5 µSv/h. To meet the dose rate acceptance criteria, 5% boron BPE shielding is required, with 2 inches on three sides and 3 inches on top of the 60 RWC-PT/CTs group. Note that these results are conservative given the short decay used for the waste versus the actual decay when the building is full. OPG will monitor the RWCs prior to storage and will pursue the addition of temporary neutron shielding (either to the PCSS walls or on the RWCs) to meet dose rate acceptance criteria.

6.0 Malfunctions/Accidents Safety Assessment

6.1 Hazard Identification, Screening and Classification of Bounding Accidents

Hazards were identified and screened following the methodology specified in Section 3.2.1 for the following activities:

1. Construction of the PCSS;
2. On-site transfer of RWCs and SGs; and
3. Handling and storage of the RWCs and SGs.

The results are documented in the following subsections. A pre-screening of the identified hazards was performed for on-site transfer and handling and storage in the PCSS. Some events were eliminated during pre-screening if they can be determined to be not applicable without any additional analyses or they have negligible impacts on the safety of the PWMF. Hazards screened in are further assessed as part of the detailed screening analysis as documented in this section. The results of the pre-screening assessment are presented in Appendix A.

6.1.1 Malfunctions/Accidents during Construction of PCSS

Construction of the PCSS will consist of two stages; that is, site preparation and construction. Site preparation activities will include the following activities:

- Site clearing and grading,
- Fencing,
- Establishing a water management system,
- Creating material laydown areas, and
- General preparation for construction activities.

The construction of the PCSS will include the following activities:

- Surveying,
- Excavation,
- Foundations,
- Steel and equipment erection,
- Install building envelope,
- Hook-ups to existing utilities (power, water, sewer, communications), and
- Commissioning.

The malfunctions and accidents associated with site preparation and construction were identified and screened, and preventative and mitigation measures have been suggested. The results are summarized in Table 58 below. In summary, with the appropriate preventative and mitigation measures in place, the malfunctions/accidents associated with site preparation and construction of the PCSS will be prevented and the consequences, should those events occur, will be minimized and controlled.

Table 58: Malfunctions/Accidents during Site Preparation and Construction

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Fire	The following fire accidents could occur: • Combustion of waste generated during site clearing, such as grass and trees; • Combustion of construction materials; • Fire at a temporary facility or equipment fire; • Fire during a vehicle accident; and • Fire during welding and cutting.	Fire will be limited to a local area. Emergency preparedness program, including fire extinguishers or other equipment, will be in place. This will minimize the consequences of a fire accident, should it occur.
Vehicle accidents	The following vehicle accidents could occur: • Collision with other vehicles, equipment, temporary buildings, or wildlife; and • Turnover of transportation vehicles such as haulage trucks or front-end loaders.	Safety programs for contractors will include safe driving procedures. All applicable transportation regulations will be followed in the movement of vehicles. Traffic control and speed limits will be in place. All of these will minimize the occurrence of vehicle accidents.
Electrical accidents	Electrical accidents, such as an electrical short circuit or electrical shock, could occur resulting from: • Misuse or poor maintenance of electrical equipment; • Damage to electrical equipment as a result of other project-related activities; • Staff access to live electrical equipment without authorization; and • Severe weather conditions, such as lightning.	Procedures will be in place to ensure the health and safety of workers and equipment, including proper maintenance of electrical equipment, Lock-out or tag out procedure, use of qualified workers and work permits. This will prevent the occurrence of electrical accidents.
Structural instability	Structural instability-related accidents could include: • Toppling of soil and waste rock piles; • Collapse or rolling of stacked pipes; • Collapse of scaffold, elevated plate form and ladder; • Heavy equipment crashes; and • Collapse of buildings under construction.	Safe work code of practice will be followed, including appropriate housekeeping and pipe handling work instruction. All activities will be carried out within a regulatory environment and conforming to design and construction protocols. This will minimize the occurrence of structural instability events.

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Material handling accidents/ equipment failure	Material handling accidents/equipment failure could occur, including: • Material dropping from scaffold or elevated platform, or failure of crane or other lifting equipment; • Loss of control of mobile equipment/equipment collision; • Uncontrolled loading impacting equipment or personnel; • Material rolling or sliding; and • Utility damage (for example, water line, communication system) due to unexpected ground disturbance	Stringent safety requirements or procedures will be followed. For example, cranes will have a significant safety factor in terms of lifting capability. All applicable regulatory requirements related to safe rigging and hoisting will be met. An experienced contractor with a proven safety record in undertaking heavy lifts will be used, where applicable.
Spill of fuel, lubricants, oils and chemicals used for construction such as cement, paints, solvents or sealants.	Spill of these materials could take place. The scenarios include: • During a vehicle accident, tanker truck or gas tank of the vehicle is damaged and liquids (gasoline, diesel or liquid chemicals) in the tank spill. • The integrity of the on-site liquid storage equipment (tanks) is damaged as a result of extreme weather conditions or mechanical failure causing chemicals, lubricants and oil contained in the equipment to spill into the environment. • Spills could occur as a result of operational errors such as the leak of diesel fuel from a tanker truck or a storage tank while refueling equipment or vehicles.	Spill contingency plans as part of environmental management plan for the preparation and construction work should be in place. This will ensure prompt spill containment and clean-up. Given that the amount of spill could be limited, the effects would be minor or negligible after appropriate clean-up.

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Occupational accidents	The following occupational accidents could occur, including: • Falls of workers from scaffold, ladder or elevated work locations, such as building under construction; • Slips, trips or falls on uneven or wet or icy surface; • Injury during welding and cutting or during material handling; • Extreme weather-related injury such as frostbite or heat exhaustion/stroke; • Accidents related to moving/rotating machinery or other equipment or tools; • Machinery-related accidents during the operation of drill, dozer or other equipment or accidents related to the use of hand tools; and • Injury due to falling objects, including from collapse of buildings.	Contractors will have extensive programs, policies and procedures to prevent occupational accidents. For example, workers will be properly trained prior to the execution of the work assigned. All activities will be carried out within a regulatory environment and conforming to design and construction protocols. This will minimize the potential of occupational injuries.
Explosion/ detonation	Explosions could occur because of: • Inadvertent detonation of explosive used during construction; and • Explosion of pressurized cylinder/tank.	All operations associated with materials that are potentially explosive will be carried out within a regulatory environment and conforming to design and construction protocols. This will minimize the potential of explosion.
Exposure to substances hazardous to health	Workers could be exposed to substances hazardous to health including toxic or controlled substances used during site preparation and construction.	Workplace Hazardous Materials Information System (WHMIS) will be in place. Workers will be properly trained for the use of these materials. Personal protective equipment will also help minimize the consequence of exposure to substances hazardous to health.

6.1.2 Malfunctions/Accidents during On-site Transfer of RWC and SG

The proposed route for transferring RWC and SG from PNGS to PCSS is illustrated in Figure 67. The malfunction and accidents during on-site transfer of RWC and SG was assessed below.

Note: The green line shows the transfer route assessed before and the red dotted line represents the new portion of the route for the transfer of SGs and RWCs to the PCSS.

Figure 67: Proposed Transfer Route for Transferring RWC and SG to PCSS

6.1.2.1 Drop of RWC or SG due to On-site Vehicle Accidents

The SGs could be transported to the PCSS on a Self-Propelled Modular Transporter (SPMT) or equivalent transfer vehicle. It is assumed that a maximum of twelve SGs will be transferred from the PNGS to the PCSS per year given there will be only one reactor refurbished at a time.

For RWCs, they are expected to be transported individually to the PCSS on a flatbed trailer or equivalent transfer vehicle, with tie-downs applied. It is assumed that a maximum of 25 RWCs will be transferred from the PNGS to the PCSS per year.

On-site transfer will not be conducted during poor weather conditions and the transfer vehicle will travel at a low rate of speed to ensure that the risk due to an on-site vehicle accident is minimized. However, there remains the risk that unforeseen conditions may lead to a collision that causes the transfer vehicle or RWC/SG being transferred to topple and results in the drop of the RWC/SG. Therefore, this event was screened in.

6.1.2.2 Transporter Operator Health-Related Emergency

The transporter operator could have a health-related emergency and lose consciousness during the transfer. However, the transporter operator is normally escorted by at least one additional individual. This second person could intervene to stop the transporter in such an event. Furthermore, the transporter operates at the low speed. Even if operator illness were to result in the transporter leaving the road, a release of radioactivity from a RWC or packed SG is not expected, taking into account the design of the RWC or SG package. . For the worst-case scenario that the transporter toppled over, the radiological consequences would be bounded by the event of RWC or SG drop discussed in Section 6.1.2.1. Therefore, this event was screened out.

6.1.2.3 Fire

The route for transferring RWC and SG from PNGS to the PCSS is illustrated in Figure 67. It is similar to the route assessed in previous work [64] with the exception of the route represented in red dotted line in Figure 67. The potential for an accident due to a fire along the transfer route has been considered. The fire sources directly along the transfer route could include the P-10 gas cylinders outside of the Auxiliary Security Building within the Protected Area and invasive phragmites stands inside the ditches. Recommendations have been made to reduce the fire hazard such as relocation of the cylinder. The portion of transfer route which has not been specifically assessed (red dotted line in Figure 67) only extends less than 200 meters beyond the route which has been assessed. Some photos were recently taken along this portion of the transfer route (Appendix C). Based on the review of these photos, there are no additional fire sources identified along this portion of the transfer route.

The combustible materials originating from the transporter itself, including the diesel fuel in the tank, engine lubricating oil and hydraulic oil, could represent a fire hazard. However, it is expected that such a fire would be of short duration as a result of the fire detection and suppression systems in the transporter design and the expected response of the Pickering NGS Emergency Response Team (ERT).

RWCs will be constructed of non-combustible materials and the waste stored inside them is mostly non-combustible. All SG penetrations and openings will be welded with thick steel plates prior to transport to ensure all internal source term is contained. Furthermore, the outer surface of the RWCs and SGs will be decontaminated prior to transfer. Therefore, release of radioactive materials from RWCs and SGs due to a fire accident was screened out.

6.1.2.4 Adverse Road/Weather Conditions

Similar to the current practice, it is expected that procedural controls will be in place to prohibit on-site transfer under poor road/weather conditions or until potentially slippery conditions can be mitigated with appropriate measures such as sanding or salting of the transfer route. Even if the transporter were to lose traction on a slippery surface resulting in the vehicle leaving the road, a release of radioactivity from a RWC or SG is not expected given the robust design of a RWC or packed SG, which is intended to withstand transportation accident loads. For the worst-case scenario, the radiological consequences would be bounded by the event of RWC or SG drop. Therefore, this event was screened out.

6.1.2.5 Soil Failures/Slope Instability

In the event the on-site transfer of a RWC or SG takes longer than expected as a result of adverse road conditions due to soil failure or slope instability, a release of radioactivity from a RWC or SG is not expected given the robust design of a RWC or packed SG. For the worst scenario, the radiological consequences would be bounded by the event of RWC or SG drop. Therefore, this event was screened out.

6.1.2.6 Earthquake

The Pickering B Design Basis Earthquake (DBE) is defined as an earthquake with a peak ground acceleration (PGA) of 0.05 g and a frequency of reoccurrence once in 1000 years, using the 84th percentile seismic hazard curve for the Pickering site [65].

Since the transporter with a RWC or SG is not on the road 100 percent of the time, the combined occurrence of a DBE and the transporter being on the road simultaneously can be determined based on the following assumptions:

- A maximum of 25 RWCs and 12 SGs are transferred each year between the station and the PWMF PCSS given there is only one reactor being refurbished at a time.
- The greatest distance the transporter needs to travel between the station and the PCSS is less than 1 km.
- The transporter is conservatively assumed to take a longer time during transfer and be on the road for 1 hour to increase time-at-risk.

The frequency of a DBE occurring at a time when a SG or RWC is being transferred is:

$$(12+25)\,\frac{transfers}{year} \times \frac{1\ hour}{8760\ hours\ per\ year} \times (1\ \times 10^{-3}\ events\ per\ year)$$
$$= 4.22\ \times 10^{-6}\ events\ per\ year$$

The event frequency is greater than the cut-off frequency of 10^{-6} events per year, therefore this hazard cannot be screened out based on frequency.

If the earthquake occurs during the on-site transfer of a RWC or SG from the Station to the PCSS, the RWC or SG will not topple over due to the forces from the DBE if the seismic design requirement for SG and RWC is similar to that for DSC, for which the required horizontal and vertical PGA is 0.12 g [66], higher than the postulated Pickering B DBE with the peak PGA of 0.05 g. If the seismic design requirement does not meet this criterion, toppling over is likely. In addition, the transporter could topple over during the earthquake event which could affect the RWCs or SGs being transferred. However, this is bounded by the RWC or SG drop event. Therefore, this event was screened out.

6.1.2.7 Tornado

A tornado is a rotating thunderstorm with a vortex of air extending downward from a thundercloud, which normally occurs in unstable atmospheric conditions when warm moist air comes into contact with cold air. The Design Basis Tornado (DBT) has not been addressed for PNGS [67], thus, the DBT defined for the Darlington nuclear site [68] as defined as follows, was considered in this work:

- Rotational wind speed of 322 km/h,
- Translational wind speed of 96 km/h,
- Pressure drop of 9.6 kPa,
- Rate of pressure drop of 5.6 kPa/s and
- Radius of maximum rotational wind speed of 46 m.

These parameters are considered to be large enough to envelope any credible tornadoes in southern Ontario [68]. Based on the PNGS site wind speed frequencies [69], the DBT-definition rotational wind speeds (322 km/h) correspond to a mean frequency of 3.13×10^{-6} events per year. Therefore, the frequency of a tornado occurring at a time when a RWC or SG is being transferred is:

$$(12+25)\ \frac{transfers}{year} \times \frac{1\ hour}{8760\ hours\ per\ year} \times (3.13\ \times 10^{-6}\ events\ per\ year)$$
$$= 1.32\ \times 10^{-8}\ events\ per\ year$$

This value is significantly below the cut-off frequency of 10^{-6} per year, therefore this event was screened out.

6.1.2.8 Thunderstorms/Lightning

Thunderstorms can potentially involve lightning striking a SG or RWC on the transporter during on-site transfer. The effects of a lightning strike will increase the temperature of the affected SG or RWC and might result in an increased release of loose contamination from inside the packages; the packages will be cleaned of surface contamination prior to transport.

The impact of a lightning strike on the nuclear waste containers including RWC has been assessed [70]. In an unlikely event of a direct lightning strike to the RWCs during transfer, arcing will occur between the vehicle and the ground, dissipating the lightning energy. It was concluded that the shielding of the RWC will not be compromised and the containment will not be breached. The conclusion is also applied to SGs being transported.

However, the lightning may be hazardous for the driver or the electrical/electronic components of the vehicle. Even if operator incapacitation were to result in the transporter leaving the road, a release of radioactivity from a RWC or a SG is not expected given the design of the RWC or SG. For the worst-case scenario that the transporter toppled over, the dose consequences from this postulated scenario would be bounded by the RWC or SG drop event. Therefore, this event was screened out.

6.1.2.9 Flooding

The only possibility for flooding at the Pickering site would be as a result of extreme local meteorological events. However, procedures will be in place to require that RWCs or SGs not be transferred during anticipated extremely adverse weather conditions. In addition, sufficient warning time should be available for site staff to prevent this scenario from occurring. For example, a station wide Public Address (PA) announcement will alert staff of heavy rain, electrical storm, or flooding advisory, at a 4-hour frequency until the severe weather advisory has ended [71].

If in an unlikely event, transport of a RWC or SG during an extreme rainfall were to occur, extensive flooding would likely affect the operation of the transporter. However, based on the study for the Darlington site which is applicable to Pickering site, the direct on-site rainfall (Probable Maximum Precipitation or PMP) would result in floodwater to a depth of approximately 20-30 cm [72], which would not be high enough to reach the platform of the transporter. Furthermore, there would be no detrimental effect on the RWCs as they are designed to have sealed containment envelope that prevent the ingress of water [73]. As such, the temporary flooding water would not enter the RWCs or SGs and result in any concern from the radiological safety perspective. Therefore, this event has been screened out.

6.1.2.10 Explosions along the Transfer Route

There are several potential sources of explosion along the transfer route of the RWCs or SGs from the station to PCSS. Therefore, the impact of an explosion along the transfer route must be assessed.

Explosion hazards along the onsite transfer route of the DSCs from the Phase I processing building to the Phase II storage building 4 have been assessed [74]. The following explosion hazard scenarios have been considered:

- Acetylene cylinder detonation
- Propane storage tank Boiling Liquid Expanding Vapour Explosion (BLEVE)
- Vapour cloud explosion (VCE) due to a propane storage tank rupture.

The combined explosion hazard frequency has been determined to be 5.2×10^{-8} per year, assuming about 1000 DSC shipments per year [74]. As shown in Figure 67, the RWC or SG transfer route from the Station to PCSS is partially overlapped with the transfer route of the DSCs which were assessed. Given the total RWC and SG shipment rate will be 37 per year, much less than that for DSCs, it is expected that the explosion hazard frequency will be lower than 5.2×10^{-8} per year, less than the cut-off frequency of 10^{-6}. Furthermore, based on the review of photos which were taken recently (see Appendix C, no additional explosion sources have been identified for the portion of the RWC/SG transfer route which has not been assessed before. Therefore, the explosion hazard was screened out based on frequency.

6.1.2.11 Turbine Missile Strike

The RWC or SG transporter travelling from the station to the PCSS could be potentially impacted by a low trajectory turbine missile originating from the accident unit. The frequency of low trajectory turbine missiles impacting nearby structures, systems and components (SSCs) was estimated to be 6×10^{-6} events per year [72].

It is estimated that RWCs and SGs will be transferred at the rate of 25 and 12 per year, respectively. Therefore, the frequency of turbine missiles impacting a SG or a loaded RWC when they are being transferred from PNGS to the PCSS is:

$$(12+25)\,\frac{transfers}{year}\times\frac{1\ hour}{8760\ hours\ per\ year}\times(6\ \times10^{-6}\ events\ per\ year)$$
$$=2.53\ \times10^{-8}\ events\ per\ year$$

The value is below the cut-off frequency of 10^{-6} per year. Therefore, this hazard was screened out.

6.1.2.12 Aircraft Crash

The aircraft crash frequency calculated for the on-site transfer was 2.53×10^{-10} events per year. The detailed calculations are presented in Appendix B. This value is lower than the cut-off frequency of 10^{-6} events per year. Therefore, this was screened out.

6.1.2.13 Toxic Gas Release ‐ Chlorine Originated from Ajax Water Treatment Plant

The Ajax Water Treatment Plant (WTP), which uses chlorine cylinders for water treatment, is located at approximately 4.0 km from the PCSS. The Screening Distance Value (SDV) for chlorine is 4.4 km [72]. A portion of the RWC and SG transfer route and the PCSS are within this distance. Therefore, this hazard cannot be screened out based on distance.

An airborne chlorine leak from the Ajax WTP could have an impact on the transporter operator ability to keep the transporter safely on the road. The consequences will be similar to the scenario described in Section 6.1.2.2. Therefore, this event was screened out.

6.1.2.14 Soil Liquefaction

The PCSS site soil per National Building Code Canada (NBCC) is classified as class C, as per Section 5.4 of Reference [75]. For class C soil classification, liquefaction of the PCSS foundation soils is not likely. Accordingly, no additional mitigation measures are required with respect to soil liquefaction. Therefore, this event was screened out.

6.1.3 Malfunctions/Accidents during Handling and Storage

6.1.3.1 SG Drop during Handling in PCSS

SGs transferred from PNGS will be received, inspected, and moved into the PCSS after surveying and hotspots identification. The SGs will be off-loaded from the SPMT using a hydraulic jacking system or gantry crane system, lowered onto a sliding system and moved to their individual storage location. The total duration of these activities is assumed to be 22 hours per SG taking into account some contingency [55].

The jack and slide system is a simple and safe means for the vertical movement of very heavy loads and an accidental SG drop is not expected during this process. However, a load instability and the drop of the SG from a low height may result when being placed in its final location in the PCSS in the following unlikely events:

- the jacking band or support beams failure;
- hydraulic or mechanical failure of one or more jacks under load, or;
- due to unstable jacks, not positioned on a level surface.

An SG drop assessment has been carried out [76] and it was concluded that a short drop may cause some damage resulting in potential for radiological release, although the steam generator is a robust package with openings covered with thick plates welded in place. Therefore, this event is screened in for further assessment.

6.1.3.2 RWC Drop during Handling in PCSS

The RWCs might be handled in the PCSS using a heavy forklift. The RWC-PTs, RWC-CTIs and the RWC-EFs may be stacked three high. The event of a RWC drop could occur during handling due to forklift hydraulic system failure and Forklift fork structural failure. The worst scenario could be the drop of an RWC from a 4-meter height onto a reinforced concrete surface.

For RWC-EF, the analysis has shown that some drop orientations resulted in larger gaps and longer gap time during impact [77]. However, it was concluded that these gaps are not sufficiently big to provide a line of sight to the RWC contents or to release any bulk contents. Only a minor amount of fines or dust could be released during such an event.

For RWC-PT/CT/CTI, the analysis has shown that the bolts did not fail due to excessive plastic strain, and gaps between the RWC main body and the shielding panels existed only briefly during the impact and they were very small [78]. It was concluded that the lid and shielding panels of the RWC remain sufficiently attached to the main body, preventing spilling of any bulk contents. Only minor amounts of swarf, fines, or dust will be released as a result of the drop.

The frequency of RWC drop was calculated as 1.6×10^{-5} events/year (6.33×10^{-7} failures/hour x 25 hours/year), taking into account the following information:

- Duration of placing one RWC to its storage location is conservatively assessed at 1 hour;
- Forklift hydraulic system failure is 5.83×10^{-7} per hour and Forklift fork structural failure is 5×10^{-8} per hour, for a total of 6.33×10^{-7} failures per hour [79]
- 25 RWCs will be moved to PCSS in a year.

If rearrangement of RWCs in PCSS is required, the frequency of the event is higher. Given this value is greater than the 10^{-6} cut-off frequency, this event is screened in for further assessment.

A handling accident involving dropping an RWC onto another RWC is also credible if the operator fails to keep the load in balance and the container tilts and drops back onto the RWC below. However, due to the low lift height relative to the lower level RWC, the hazard of dropping an RWC onto another RWC is bounded by drop of an RWC from 4 meters onto the concrete floor. Therefore, this event is screened out.

6.1.3.3 Collision with RWC or Other structures in the PCSS

RWC handling accident due to operator error using the forklift could result in a lifted RWC colliding with another RWC or other structure. However, the consequence of this scenario is bounded by that of the RWC drop since the impact of an RWC drop is expected to be higher compared to the scenario when the forklift collides with another structure within the PCSS. Therefore, this event is screened out.

6.1.3.4 Seal Failure during Storage

The lid/seal of the SG or RWC must fail for a radiological release to occur. However, all SG penetrations and openings will be welded with thick steel plates. Also, the RWC assembly has been designed to maintain its structural, containment, and shielding integrity with no significant degradation for a long design life. Therefore, it is highly unlikely that there would be any sealing failure leading to radiological consequences during their storage at PCSS.

In the unlikely event that the lid/seal of a SG or RWC fails, only gaseous components evolved from the solid crud/deposit materials in the SG or RWC, if any, would be released to the environment. This postulated release would occur over a long period of time, which would allow for dispersion. Therefore, the worker and public dose would be bounded by the acute release due to the SG or RWC drop accident. As such, this event was screened out.

6.1.3.5 PCSS Fire

A fire hazard assessment has been conducted for similar facilities where RWCs and SGs are stored [56].

For Retube Component Storage Building (RCSB), large diesel-powered forklift trucks periodically located in the unloading area of the building present a credible ignition source. A pool fire resulting from leakage of the forklift truck fuel tank and subsequent hydraulic oil spill was determined to be the bounding fire hazard in the building. However, the evaluations concluded that the fire originating from a heavy-duty forklift truck will not affect the building.

Furthermore, the RWCs were constructed of non-combustible materials and the waste stored inside them is mostly noncombustible. Given the large thermal inertia of RWCs, any fires in the RCSB would take a long time, allowing time for manual suppression, before any overheating could be expected that may result in a release. Therefore, the fire hazard is screened out.

Similarly, the SGSB houses non-combustible waste which will not sustain a fire. The building is considered a low fire hazard as it does not contain any significant quantity of combustible content. The bounding fire hazard will be a pool fire resulting from a transport vehicle diesel fuel leakage/spill.

The fire evaluation concluded that the roof steel structure of SGSB will be impacted by the high temperatures; however, manual activation of the suppression system and the intervention of the Emergency Response Team will prevent the building from collapsing. Furthermore, the outer surface of the SGs has been de-contaminated prior to storage and all source term is located within the SGs. All SG penetrations and openings are welded with thick steel plates to ensure all internal source term is contained. Therefore, the evaluation concluded that even without any suppression or response from the Emergency Response Team, the generator casings would not fail, and the source term remains contained. As such, the fire accident was screened out.

The PCSS will be built similar to RCSB and SGSB discussed above and house a minimal amount of combustible material. The items stored within PCSS, SG packages and RWCs, are large, sealed concrete and steel containers with large thermal inertia. Therefore, it is expected that the conclusions of the FHA for the similar storage facilities apply to PCSS, which can be further confirmed by the FHA for the PCSS when it is available. As such, the fire accident was screened out.

6.1.3.6 Earthquake

For the purposes of the safety assessment, it was conservatively assumed that for the postulated earthquake scenario, the PCSS at its capacity in terms of waste storage could suffer extensive damage and collapse. All RWCs and SGs stored within the PCSS were affected and were considered material at risk. Airborne releases could occur following the breach of RWCs or SGs. Therefore, this event was screened in.

6.1.3.7 Tornado

Similar to the earthquake event, it is conservatively assumed for the purpose of safety assessment that the PCSS is not expected to withstand the forces from a DBT and the collapse of the PCSS may lead to the toppling of the stacked RWCs. The damage to the packages will be similar to the events described in Section 6.1.3.6. Therefore, this event was screened in.

6.1.3.8 Thunderstorms/Lightning

Thunderstorms can potentially involve lightning striking the PCSS. However, the PCSS will be designed to be equipped with appropriate grounding provisions. As such, its structural integrity, appropriate shielding and containment function will be maintained for severe atmospheric conditions, such as lightning. Therefore, this event was screened out.

6.1.3.9 Flooding

Water entry into the PWMF storage buildings originating from a PMP event is possible. However, the outer surface of SGs or RWCs have been decontaminated prior to the storage. In addition, the SG and RWC are sealed tight enough to prevent water from entering even if the water level was high enough to partially submerge a portion of the SG or RWC. For these reasons, PMP flooding does not represent radiological safety concern. Therefore, this event was screened out.

6.1.3.10 Turbine Missile Strike

According to Reference [72], the most significant missile is a large fragment of Disc 3 from a low-pressure turbine. However, the PCSS is located approximately 600 m northeast of Unit 8. The building is separated not only by the distance from the Unit 8 turbine, but also is shielded by various buildings located between the two facilities. Therefore, this hazard was screened out.

6.1.3.11 Explosion

As discussed in Section 6.1.2.10,explosion hazard exists along the RWC and SG transfer route. Based on the assessment [80], the peak side-on overpressure at the distance of 100 m from the sources of the explosion is no more than 7 kPa. As the PCSS is located at least 200 m away from these explosion sources and there are other facilities between the PCSS and these sources, the impact of the explosion on the PCSS can be screened out given the estimated overpressure level at the PCSS will be less than 6.9 kPa, the criterion specified by the US NRC [81]. Furthermore, the maximum thermal radiation due to propane fireball is expected to be less than 18 kW/m^2, less than the potential impact criteria of 35 kW/m^2.

6.1.3.12 Aircraft Crash

The cumulative aircraft crash frequency calculated for the Used Fuel Dry Storage Area (Phase I and Phase II), RCS Area and PCSS for RWCs is 9.78×10^{-7} events per year. For PCSS for SGs, the crash frequency is 8.64 $x10^{-8}$ events per year. The detailed calculations are presented in Appendix B. These values are lower than the cut-off frequency of 10^{-6} events per year. Therefore, this was screened out.

6.1.4 Summary of Malfunctions/Accidents Associated with Construction, Transfer, Handling and Storage

Based on the screening performed in Section 6.1.1 to 6.1.3, the following events were screened in for further assessment:

- Vehicle accident during the on-site transfer from PNGS to the PCSS (Section 6.1.2.1)
- Failure of handling equipment when the package being handled in the PCSS (Section 6.1.3.1 and 6.1.3.2)
- Earthquake resulting in PCSS collapse (Section 6.1.3.6)

Both vehicle accident during the on-site transfer and the failure of handling equipment when the package being handled in the PCSS could result in the drop of a SG or a RWC to the ground which was considered a DBA based on its frequency discussed in the previous sections. The earthquake event could result in the collapse of the PCSS which affects all RWCs and SGs stored in the PCSS. During these events, the SGs or RWCs could be partially damaged, resulting in a small amount of radioactive materials being released from the damaged SGs or RWCs to the environment. The workers in the nearby area and the public in the vicinity of the PNGS site could be affected. The detailed assessments of these events and the consequences are carried out and the results are documented in the following sections.

6.2 Radiological Releases

6.2.1 Radiological Releases due to SG Drop

The specific activities of Co-60 in SGs from Pickering B, based on gamma spectroscopy results, are presented in Table 59 [82]. Taking into account the total area of SG tubes of 1.83E+07 cm^2 [83], the highest Co-60 activity per SG in Pickering B is [redacted]. Compared with the data from other sources as listed in Table 60, the highest Co-60 activity per SG is [redacted]. Therefore, the radionuclide inventory per SG presented in Table 4-9 of [37] represents the bounding inventory of an SG. This is a conservative approach since the reduction of radionuclide inventory due to decay was not credited and the highest Co-60 activity per SG was used as the scaling factor. This inventory data as listed in Table 61 was then used in the dose assessment.

Table 59: Specific Activity of Co-60 in Pickering B SGs [82]

[redacted]

Table 60: Co-60 Inventory in Steam Generator [based on Table A-17 of [37]

[redacted]

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[8] It is assumed here that the activity is uniformly distributed across the SG.
[9] As shown in table below, this corresponds to SG in Darlington.

[redacted]

Table 61: Bounding radionuclide Activity in Steam Generator (Table 4-9 of [37])

[redacted]

[redacted]

* For Cs-137 and Sr-90, their daughter's activity, Ba-137m and Y-90 respectively, is included.

Steam generators are reasonably robust containers and will survive a short drop with only some damage. Using the guideline given in the IAEA Safety Guide TS-G.1.1 for similar packages, the fraction of steam generator deposit that will be released from the container is assigned to be 1E-02 [55]. The $ARF * RF$ from this event was assumed to be 1.0E-04 which is the same as the value assigned to the suspension of powder due to debris impact. Therefore, a total release fraction of 1E-06 of the steam generator inventory, as summarized in Table 62, is applied to the SG drop scenario. Note the release fraction of 1E-06 applies to all radionuclides considered with the exception of C-14 and tritium. For C-14, it is assumed that all C-14 has been converted to carbon dioxide and is completely released. For tritium, the airborne release fraction is set to 2.7%, consistent with the SG drop scenario in the WWMF safety assessment report [55] [84].

Table 62: Parameters used to Calculate Activity Release from SG

Parameter	Values	Note
Fraction to calculate MAR	1.0E-02	See discussion above
DR	1	Assumed value, conservative
ARF*RF	1.0E-04	See discussion above
LPF	1	Assumed value, conservative
Total Release Fraction	• C-14: 1 • Tritium (HTO): 2.7E-02 • Other radionuclides: 1.0E-06	See discussion above

Accordingly, the radionuclide releases following a SG drop scenario were calculated and the results are listed in Table 63. In the dose assessment as discussed in Section 6.2.3, it was assumed that the duration of the release is one hour.

Table 63: Activity Released from SG due to SG Drop

[redacted]

6.2.2 Radiological Releases due to RWC Drop

For the safety assessment, the radionuclide activities given in Table 5-9 of Reference [37] were selected as the limiting inventory for a RWC[10]. This is a conservative approach since the reduction of radionuclide inventory due to decay is not credited. The radionuclide inventory of the RWC is listed in Table 64. In the dose assessment as discussed in Section 6.3.2, it is assumed that the release duration is one hour.

Table 64: Bounding Radionuclide Activity in RWC

[redacted]

[10] Pickering specific RWC inventory is not available. Therefore, Table 5-9 of Reference [32], which was derived based on the historical data from different CANDU reactors as discussed in Reference [32], represented the bounding RWC inventory and was used in this work.

[redacted]

Retube wastes consist of cuttings of fuel channel components (PTs, CTs), CTIs and EFs. The potential source of airborne releases would come from the metal dust from the cuttings. An experimental study of fine particle (< 850 μm) distribution during volume reduction of PTs indicates that the less than 0.01% of the volume-reduced PTs became fine particles [85]. For conservatism, 0.02% of the base metal and 100% of the oxide deposits in RWCs were assumed to be in the form of fine particles which have the potential to be released to air.

The RWCs are assumed to be reasonably robust containers and will survive a short drop with only some damage. Using the guideline given in the IAEA Safety Guide TS-G.1.1 for similar packages, the fraction of RWC content that will be released from the container is assigned to be 1E-02. The bounding value of 1E-04 for suspension of powder due to debris impact was applied. Therefore, a total release fraction of up to 1E-06 of the RWC fine particles or surface deposit inventory is applied for RWC drop scenario. These parameters are summarized in Table 65. Similar to the SG drop event, the release fraction of 1E-06 applies to all radionuclides considered with the exception of C-14 and tritium. For C-14, all C-14 is assumed to have been converted to carbon dioxide and all of it is released. For tritium, the airborne release fraction is set to 5.4E-06 for base metal and 2.7% for oxide deposit [55] [84] .

Table 65: Parameters used to Calculate Activity Release from RWC

Parameter	Values	Note
Fraction to calculate MAR	Base metal: 2.0E-06	See discussion above.
	Oxide deposit: 1.0E-02	
DR	1	Assumed value, conservative
ARF*RF	1.0E-04	See discussion above
LPF	1	Assumed value, conservative
Total Release Fraction	Base metal: • C-14: 1 • Tritium (HTO): 5.4E-06 • Other radionuclides: 2.0E-10	See discussion above
	Oxide deposit: • C-14: 1 • Tritium (HTO): 2.7E-02 • Other radionuclides: 1.0E-06	

Accordingly, the radionuclide releases following a RWC drop scenario were calculated based on the equation in Section 3.2.2 and the results are listed in Table 66.

Table 66: Radiological Releases from the RWC due to RWC Drop

[redacted]

[redacted]

6.2.3 Radiological Releases due to Earthquake

As discussed in Section, 6.1.3, for the earthquake event, the PCSS was assumed to collapse. All RWCs and SGs stored in the PCSS were assumed to be affected, resulting in airborne releases. For the purposes of the dose assessment, it was assumed that the following amounts of RWCs and SGs were stored in the PCSS when the earthquake event occurred:

- SG: 48
- RWC-PT: 32
- RWC-CT: 28
- RWC-CTI:16
- RWC-EF: 64

The airborne emissions were estimated based on the same approach used for RWC/SG drop event. The results are summarized in Table 67.

Table 67: Radiological Releases from PCSS resulting from Earthquake Event

[redacted]

[redacted]

6.3 Doses to Public and Workers from the Postulated Malfunctions/Accidents

6.3.1 Doses to Public from the Postulated Malfunctions/Accidents

Radioactivity release resulting from the drop of a SG or a RWC was analyzed in Sections 6.2.1 and 6.2.2. On this basis, doses to the public resulting from these events were calculated following the methodology specified in Section 3.2.3. The inputs for dose calculation including assumptions are consistent with those summarized in Appendix B of the previous work [3][11]. The results are presented in Table 68 to Table 72. From the tables, the highest dose to public resulting from SG or RWC drop event is 1.6 μSv due to the drop of a RWC-PT, which is less

[11] The only exception is the meteorological data used for ADDAM analysis. As discussed in Section 3.2.3, the five-year data for the period of 2017 to 2021 was used.

than the acceptance criterion of 1 mSv. The critical group is an adult from the hypothetical group located at landside (east) of Pickering nuclear site exclusion boundary.

Radioactivity release resulting from the earthquake event was analyzed in Section 6.2.3. The dose consequence is presented in Table 73. The highest dose to public is 80 µSv, also less than the acceptance criterion of 1 mSv. The critical group is the same as that for the RWC drop event.

The doses were generally converged with the exception of a few locations such as B_N, B_WSW-Lake and B_NNW. These locations were not converged even with a high bin number (5000) for approximating cumulative frequency distribution. Increasing the number of bins is expected to lower the non-converged doses so the reported doses are conservative.

Table 68: Doses to Public due to SG Drop

Receptors	95^{th} Individual Effective Dose (µSv)*	
	Adult	Infant
B_N	5.1E-05	7.5E-05
B_NNE	4.2E-02	3.1E-02
B_NE	1.4E-01	1.1E-01
B_ENE	2.2E-01	1.6E-01
B_E	3.2E-01	2.4E-01
B_ESE-Lake	9.9E-02	7.2E-02
B_SE-Lake	6.6E-02	4.9E-02
B_SSE-Lake	3.6E-02	2.7E-02
B_S-Lake	4.6E-02	3.7E-02
B_SSW-Lake	3.5E-02	2.9E-02
B_SW-Lake	1.7E-02	1.3E-02
B_WSW-Lake	6.4E-05	7.0E-05
B_W-Lake	1.1E-02	8.5E-03
B_WNW	1.3E-02	9.4E-03
B_NW	5.7E-05	3.5E-05
B_NNW	5.8E-05	5.2E-05
IND	4.6E-02	3.4E-02
Fisher	4.5E-02	3.6E-02
Beach	2.2E-02	1.6E-02
UR_WNW	1.0E-02	7.6E-03
UR_NW	4.2E-05	2.7E-05
UR_NNW	3.3E-05	2.1E-05
C2	7.9E-03	5.8E-03
Dairy Farm, NNE	1.1E-03	8.5E-04
Farm, NE	2.7E-03	2.0E-03

Table 69: Doses to Public due to RWC-PT Drop

Receptors	95th Individual Effective Dose (μSv)	
	Adult	Infant
B_N	1.6E-03	1.6E-03
B_NNE	2.1E-01	2.2E-01
B_NE	7.3E-01	7.4E-01
B_ENE	1.1E+00	1.1E+00
B_E	1.6E+00	1.6E+00
B_ESE-Lake	5.0E-01	5.0E-01
B_SE-Lake	3.6E-01	3.6E-01
B_SSE-Lake	2.1E-01	2.1E-01
B_S-Lake	3.8E-01	3.9E-01
B_SSW-Lake	3.3E-01	3.4E-01
B_SW-Lake	1.0E-01	1.0E-01
B_WSW-Lake	1.5E-03	1.6E-03
B_W-Lake	5.3E-02	5.5E-02
B_WNW	6.1E-02	6.2E-02
B_NW	6.7E-04	7.0E-04
B_NNW	1.1E-03	1.2E-03
IND	2.3E-01	2.4E-01
Fisher	3.7E-01	3.8E-01
Beach	1.0E-01	1.0E-01
UR_WNW	4.8E-02	4.9E-02
UR_NW	5.1E-04	5.3E-04
UR_NNW	6.8E-04	7.0E-04
C2	4.0E-02	4.1E-02
Dairy Farm, NNE	6.3E-03	6.3E-03
Farm, NE	1.6E-02	1.6E-02

Table 70: Doses to Public due to RWC-CT Drop

Receptors	95th Individual Effective Dose (μSv)	
	Adult	Infant
B_N	4.6E-04	4.6E-04
B_NNE	6.2E-02	6.3E-02
B_NE	2.1E-01	2.1E-01
B_ENE	3.1E-01	3.2E-01
B_E	4.6E-01	4.5E-01
B_ESE-Lake	1.4E-01	1.4E-01
B_SE-Lake	1.0E-01	1.0E-01
B_SSE-Lake	6.1E-02	6.1E-02
B_S-Lake	1.1E-01	1.1E-01

Receptors	95th Individual Effective Dose (μSv)	
	Adult	Infant
B_SSW-Lake	1.0E-01	1.0E-01
B_SW-Lake	2.9E-02	2.9E-02
B_WSW-Lake	4.72E-04	4.83E-04
B_W-Lake	1.5E-02	1.6E-02
B_WNW	1.7E-02	1.8E-02
B_NW	3.7E-04	3.7E-04
B_NNW	1.9E-04	1.9E-04
IND	6.7E-02	6.8E-02
Fisher	1.1E-01	1.1E-01
Beach	2.9E-02	2.9E-02
UR_WNW	1.4E-02	1.4E-02
UR_NW	2.8E-04	2.8E-04
UR_NNW	1.2E-04	1.1E-04
C2	1.2E-02	1.2E-02
Dairy Farm, NNE	1.8E-03	1.8E-03
Farm, NE	4.7E-03	4.7E-03

Table 71: Doses to Public due to RWC-CTI Drop

Receptors	95th Individual Effective Dose (μSv)	
	Adult	Infant
B_N	1.1E-05	1.1E-05
B_NNE	1.6E-03	1.6E-03
B_NE	5.3E-03	5.4E-03
B_ENE	7.9E-03	8.0E-03
B_E	1.14E-02	1.14E-02
B_ESE-Lake	3.6E-03	3.6E-03
B_SE-Lake	2.6E-03	2.6E-03
B_SSE-Lake	1.5E-03	1.5E-03
B_S-Lake	2.8E-03	2.8E-03
B_SSW-Lake	2.5E-03	2.5E-03
B_SW-Lake	7.3E-04	7.3E-04
B_WSW-Lake	1.16E-05	1.19E-05
B_W-Lake	3.8E-04	4.0E-04
B_WNW	4.3E-04	4.5E-04
B_NW	5.1E-06	5.1E-06
B_NNW	8.6E-06	8.6E-06
IND	1.7E-03	1.7E-03
Fisher	2.8E-03	2.8E-03

Receptors	95th Individual Effective Dose (µSv)	
	Adult	Infant
Beach	7.2E-04	7.3E-04
UR_WNW	3.5E-04	3.5E-04
UR_NW	7.5E-06	3.9E-06
UR_NNW	5.2E-06	5.4E-06
C2	2.9E-04	2.9E-04
Dairy Farm, NNE	4.6E-05	4.6E-05
Farm, NE	1.2E-04	1.2E-04

Table 72: Doses to Public due to RWC-EF Drop

Receptors	95th Individual Effective Dose (µSv)	
	Adult	Infant
B_N	1.7E-06	2.2E-06
B_NNE	6.6E-04	8.4E-04
B_NE	2.3E-03	2.9E-03
B_ENE	3.5E-03	4.4E-03
B_E	5.0E-03	6.2E-03
B_ESE-Lake	1.6E-03	2.0E-03
B_SE-Lake	1.1E-03	1.3E-03
B_SSE-Lake	6.0E-04	7.5E-04
B_S-Lake	8.4E-04	1.0E-03
B_SSW-Lake	6.8E-04	8.0E-04
B_SW-Lake	2.9E-04	3.6E-04
B_WSW-Lake	1.61E-06	2.03E-06
B_W-Lake	1.9E-04	2.4E-04
B_WNW	2.1E-04	2.6E-04
B_NW	8.6E-07	1.3E-06
B_NNW	8.3E-07	1.2E-06
IND	7.3E-04	9.0E-04
Fisher	8.2E-04	9.9E-04
Beach	3.5E-04	4.4E-04
UR_WNW	1.7E-04	2.1E-04
UR_NW	6.6E-07	9.7E-07
UR_NNW	5.1E-07	7.4E-07
C2	1.3E-04	1.7E-04
Dairy Farm, NNE	1.9E-05	2.4E-05
Farm, NE	4.6E-05	5.8E-05

Table 73: Doses to Public due to Earthquake Event

Receptors	95 Percentile Dose (μSv)	
	Adult	Infant
B_N	7.7E-02	7.3E-02
B_NNE	1.1E+01	1.0E+01
B_NE	3.6E+01	3.5E+01
B_ENE	5.5E+01	5.2E+01
B_E	8.0E+01	7.6E+01
B_ESE-Lake	2.5E+01	2.4E+01
B_SE-Lake	1.8E+01	1.7E+01
B_SSE-Lake	1.0E+01	9.8E+00
B_S-Lake	1.8E+01	1.8E+01
B_SSW-Lake	1.6E+01	1.5E+01
B_SW-Lake	5.0E+00	4.8E+00
B_WSW-Lake	7.5E-02	7.3E-02
B_W-Lake	2.7E+00	2.6E+00
B_WNW	3.1E+00	3.0E+00
B_NW	3.7E-02	4.1E-02
B_NNW	2.7E-02	2.8E-02
IND	1.2E+01	1.1E+01
Fisher	1.8E+01	1.7E+01
Beach	5.1E+00	4.9E+00
UR_WNW	2.4E+00	2.3E+00
UR_NW	2.8E-02	3.4E-02
UR_NNW	1.6E-02	1.7E-02
C2	2.0E+00	1.9E+00
Dairy Farm, NNE	3.1E-01	3.0E-01
Farm, NE	7.8E-01	7.5E-01

6.3.2 Doses to Workers from Postulated Malfunctions/Accidents

Radioactivity release resulting from the drop of a SG or a RWC was analyzed in Section 6.2. on this basis doses to worker resulting from these events were calculated following the methodology specified in Section 3.2.4. The inputs for dose calculation including assumptions are consistent with those summarized in Appendix B of the previous work [3], which has inputs from References [86], [87], [88], [89], and [90]. The results are presented in Table 74. From the table, the highest dose to individual worker is 5.0 mSv due to the drop of a RWC-PT, which is less than the acceptance criterion of 50 mSv.

Table 74: Doses to Workers due to the Drop of SG or RWC

Event	Doses to Workers (mSv)
Drop of SG	1.0

Event	Doses to Workers (mSv)
Drop of RWC-PT	5.0
Drop of RWC-CT	1.5
Drop of RWC-CTI	0.04
Drop of RWC-EF	0.007

For the earthquake event, the PCSS was assumed to collapse. All RWCs and SGs stored in the PCSS were assumed to be damaged, resulting in airborne releases. Assuming the PWMF workers are able to evacuate, the dose consequence to the worker would be similar to the dose calculated for members of the public.

6.3.3 Summary of Dose Assessment for the Malfunctions and Accidents

The dose consequences resulting from the postulated malfunctions and accidents during on-site transfer, handling and storage of the RWCs and SGs in the PCSS are summarized in Table 75 and Table 76, respectively. As discussed in Sections 6.3.1 and 6.3.2, the doses to public and workers are all less than the dose acceptance criteria.

Note that no radioactive materials are involved during site preparation and construction of the PCSS. Therefore, there are no dose consequences resulting from the postulated malfunctions and accidents during that stage. As such, they are not presented in this section.

Table 75: Postulated Malfunction or Accidents during On-site Transfer of RWCs and SGs

Malfunction or Accident	Potential for occurrence (event /year)	Credible event (Y/N) -See Note 1	Classification (see Note 3)	Potential maximum dose to public (mSv)	Potential maximum occupational dose (mSv)
RWC/SG drop during on-site vehicle accident	See Note 2	Y	See Note 2	1.6E-03	5.0
Vehicle operator health-related emergency	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Fire	See Note 2	Y	See Note 2	0	0
Adverse road/weather conditions	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Soil Failures/Slope Instability	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Earthquake	4.22 E-06	Y	DEC	<1.6E-03	<5.0
Tornado	1.32E-08	N	---	---	---

Malfunction or Accident	Potential for occurrence (event /year)	Credible event (Y/N) -See Note 1	Classification (see Note 3)	Potential maximum dose to public (mSv)	Potential maximum occupational dose (mSv)
Thunderstorms /lightning	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Flooding	See Note 2	Y	See Note 2	0	0
Explosions along the transfer route	<5.2E-08	N	---	---	---
Turbine Missile Strike	2.53E-08	N	---	---	---
Aircraft crash	2.53E-10	N	---	---	---
Toxic Gas Release	See Note 2	Y	See Note 2	<1.6E-03	<5.0

Notes:

1. The term credible is used for those events with the frequency of occurrence higher than 1E-06 events per year.
2. The hazard frequency was not calculated for this scenario. The event is considered credible based on its nature or if it is bounded by a credible event. The classification of DEC was assigned to such event for conservatism.
3. As per REGDOC 2.4.4 [33], the following classification was considered for applicability:
    - AOO: an event with a likelihood of occurrence greater than 10^{-2} per year
    - DBA: an event with a likelihood of occurrence less than 10^{-2} per year and greater than 10^{-5} per year
    - DEC: an event with a likelihood of occurrence less than 10^{-5} per year and greater than 10^{-6} per year

Table 76: Postulated Malfunction or Accidents during Handling and Storage in PCSS

Malfunction or Accident	Potential for occurrence (event/year)	Credible event (Y/N)	Classification (see Note 5)	Potential maximum dose to public (mSv)	Potential maximum occupational dose (mSv)
RWC/SG drop during handling in PCSS	>1.6E-05	Y	DBA	1.6E-03	5.0
Collision with RWC or other structures in the PCSS	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Seal failure during storage	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Fire	See Note 2	Y	See Note 2	0	0
Earthquake	See Note 2	Y	See Note 2	8.0E-02	8.0E-02[4]
Tornado	See Note 2	Y	See Note 2	<8.0E-02	<8.0E-02[4]
Thunderstorms/lightning	See Note 2	Y	See Note 2	0	0
Flooding	See Note 2	Y	See Note 2	0	0

Malfunction or Accident	Potential for occurrence (event/year)	Credible event (Y/N)	Classification (see Note 5)	Potential maximum dose to public (mSv)	Potential maximum occupational dose (mSv)
Turbine missile strike	See Note 2	Y	See Note 2	0	0
Explosion	See Note 2	Y	See Note 2	0	0
Aircraft crash	9.87E-07 (See Note 3)	N	---	---	---

Notes:

1. The term credible is used for those events with the frequency of occurrence higher than 1E-06 events per year.
2. The hazard frequency was not calculated for this scenario. The event is considered credible based on its nature or if it is bounded by a credible event. The classification of DEC was assigned to such event for conservatism.
3. The calculated cumulative frequency of occurrence considers the Phase I, Phase II sites (SB3, SB4, SB5 and the portion of PCSS for RWCs) and DSM storage area together.
4. For worker dose during the earthquake, refer to the discussion in Section 6.3.2.
5. As per REGDOC 2.4.4 [33], the following classification was considered for applicability:
   - AOO: an event with a likelihood of occurrence greater than 10^{-2} per year
   - DBA: an event with a likelihood of occurrence less than 10^{-2} per year and greater than 10^{-5} per year
   - DEC: an event with a likelihood of occurrence less than 10^{-5} per year and greater than 10^{-6} per year

7.0 ALARA Assessment

The estimated collective doses and maximum individual doses from handling and emplacing of one SG, one RWC-PT/CT/CTI and one RWC-EF exclusive of surrounding waste packages corresponding to maximum package external dose rates at 1 m of 10 mrem/hr appear in Table 77.

There are 60 RWC-PT/CTs, 16 RWC-CTIs, 64-RWC-EFs and 48 SGs. The overall collective doses are 16.5, 3.7, 17.7, and 182.6 person-mSv, respectively, for a total collective dose of 221 person-mSv.

The ALARA assessment considers solely the emplacement activities. The results indicate that both the OPG ECL for a NEW of 1,000 mrem/yr (10 mSv/yr) as well as the regulatory limit for a NEW of 5,000 mrem/yr (50 mSv/yr) require that emplacement of RWCs and SGs in the PCSS would require that the task be divided among several workers. In particular, different work crews should be used for each of the following tasks:

(i) Reception and Emplacement of the RWCs in the PCSS.

(ii) Reception and Emplacement of the SGs on saddles in the PCSS;

A relatively simple method for reducing doses for emplacement activities would be the use of temporary shielding. Shielding blankets could be placed over the waste packages during transfer activities. Temporary shielding walls could also be erected within the PCSS to reduce doses from waste already emplaced whilst new waste is being brought in.

It would prove prudent to investigate whether further efficiencies in work activities could result in lower exposure times. To this end, the use of mock-up trials and/or the investigation of alternative waste package transfer methodologies should be considered.

Additionally, during receipt and storage of Bruce Unit 6 SGs and most recently Bruce Unit 6/Unit 3 RWC (including correction estimates for low levels of neutrons), the actual dose incurred for each respective campaign was found to have low individual maximum and collective doses which were well below estimates in the respective ALARA assessments. OPG provides the following Electronic Personal Dosimeter (EPD) results for these respective campaigns:

- Receipt & Placement of Bruce Unit 6 MCR Steam Generators: 0.68 mSv (Highest Individual Dose) and 3.39 person-mSv collective dose.

- Bruce Unit 6 MCR RWC Receipt/Unload/Store: 0.55 mSv (Estimated Highest Effective Dose including neutron estimate for campaign) and 2.47 person-mSv collective dose.

- Bruce Unit 3 MCR RWC Receipt/Unload/Store: 0.30 mSv (Estimated Highest Individual Effective Dose including neutron estimate for campaign) and 1.32 person-mSv collective.

Table 77: Handling and Emplacement of Single RWCs and SGs

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
1.1	Preparation for RWC-PT/CTs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	60	4.98	5.65E-02	5.65E-02
1.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	RWC-PT/CT@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
1.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
1.4		Start-up 40T Forklift, adjust forks, place sleeves on forks and move close to RWC-PT/CT package. Assume after every shift.	PCSS	Exit Door	1.14E-02	0.083	1	60	4.98	5.65E-02	5.65E-02
1.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	60	4.98	5.65E-02	1.13E-01

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
1.6		OPG Supervision	PCSS	Exit Door	1.14E-02	8	1	60	480.00	5.45E+00	5.45E+00
		Total							**495.69**		**5.73E+00**
1.7	Receive 60 RWC-PT/CTs outside PCSS	Receive, inspect RWC-PT/CTs, confirm dose rates	Outside, South side of PCSS	RWC-PT/CT@1 m	1.00E-01	0.25	1	60	15.00	1.50E+00	1.50E+00
1.8		Remove tie-downs for 60 RWC-PT/CTs	Outside, South side of PCSS	RWC on contact	1.39E-01	0.25	2	60	15.00	2.09E+00	4.17E+00
1.9		Perform contamination scan of forklift and personnel prior to exit from PCSS	Inside South side of PCSS	PCSS	1.14E-02	0.083	2	60	4.98	5.65E-02	1.13E-01
1.10		Align Forklift and remove RWC from flatbed	Outside, South side of PCSS	RWC-PT/CT@1 m	1.00E-01	0.083	2	60	4.98	4.98E-01	9.96E-01
		Total							**39.96**		**6.78E+00**
1.11	Emplace 60 RWC-PT/CTs in designated location inside PCSS	Move RWC-PT/CT package to inside PCSS and place in appropriate location/layer.	inside PCSS among RWCs	RWC-PT/CT@1 m	1.00E-01	0.25	2	60	15.00	1.50E+00	3.00E+00
1.12		Record/verify RWC-PT/CT ID, location & dose rates	inside PCSS among RWCs	RWC-PT/CT@1 m	1.00E-01	0.083	2	60	4.98	4.98E-01	9.96E-01
		Total							**19.98**		**3.99E+00**

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
2.1	Preparation for RWC-CTIs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	16	1.33	1.51E-02	1.51E-02
2.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	RWC-CTI@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
2.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
2.4		Start-up 40T Forklift, adjust forks, place sleeves on forks and move close to RWC-CTI package. Assume after every shift.	PCSS	Exit Door	1.14E-02	0.083	1	16	1.33	1.51E-02	1.51E-02
2.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	16	1.33	1.51E-02	3.02E-02
2.6		OPG Supervision	PCSS	Exit Door	1.14E-02	2	1	16	32.00	3.63E-01	3.63E-01
		Total							**36.73**		**4.79E-01**
2.7	Receive 16 RWC-CTIs outside PCSS	Receive, inspect RWC-CTIs, confirm dose rates	Outside, South side of PCSS	RWC-CTI@1 m	1.00E-01	0.25	1	16	4.00	4.00E-01	4.00E-01

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
2.8		Remove tie-downs for 16 RWC-CTIs	Outside, South side of PCSS	RWC on contact	1.78E-01	0.25	2	16	4.00	7.10E-01	1.42E+00
2.9		Perform contamination scan of forklift and personnel prior to exit from PCSS	Inside South side of PCSS	PCSS	1.14E-02	0.083	2	16	1.33	1.51E-02	3.02E-02
2.10		Align Forklift and remove RWC from flatbed	Outside, South side of PCSS	RWC-CTI@1 m	1.00E-01	0.083	2	16	1.33	1.33E-01	2.66E-01
		Total							**10.66**		**2.12E+00**
2.11	Emplace 16 RWC-CTIs in designated location inside PCSS	Move RWC-CTI package to inside PCSS and place in appropriate location/layer.	inside PCSS among RWCs	RWC-CTI@1 m	1.00E-01	0.25	2	16	4.00	4.00E-01	8.00E-01
2.12		Record/verify RWC-CTI ID, location & dose rates	inside PCSS among RWCs	RWC-CTI@1 m	1.00E-01	0.083	2	16	1.33	1.33E-01	2.66E-01
		Total							**5.33**		**1.07E+00**
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
3.1	Preparation for RWC-EFs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	64	5.31	6.03E-02	6.03E-02

Estimated Doses for Placement of RWCs and SGs in the PCSS

Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
3.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	RWC-EF@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
3.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
3.4		Start-up 40T Forklift, adjust forks, place sleeves on forks and move close to RWC-EF package. Assume after every shift.	PCSS	Exit Door	1.14E-02	0.083	1	64	5.31	6.03E-02	6.03E-02
3.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	64	5.31	6.03E-02	1.21E-01
3.6		OPG Supervision	PCSS	Exit Door	1.14E-02	8	1	64	512.00	5.81E+00	5.81E+00
		Total							**528.69**		**6.11E+00**
3.7	Receive 64 RWC-EFs outside PCSS	Receive, inspect RWC-EFs, confirm dose rates	Outside, South side of PCSS	RWC-EF@1 m	1.00E-01	0.25	1	64	16.00	1.60E+00	1.60E+00
3.8		Remove tie-downs for 64 RWC-EFs	Outside, South side of PCSS	RWC on contact	1.43E-01	0.25	2	64	16.00	2.28E+00	4.57E+00
3.9		Perform contamination scan of forklift and personnel	Inside South side of PCSS	PCSS	1.14E-02	0.083	2	64	5.31	6.03E-02	1.21E-01

Estimated Doses for Placement of RWCs and SGs in the PCSS

Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
		prior to exit from PCSS									
3.10		Align Forklift and remove RWC from flatbed	Outside, South side of PCSS	RWC-EF@1 m	1.00E-01	0.083	2	64	5.31	5.31E-01	1.06E+00
		Total							**42.62**		**7.35E+00**
3.11	Emplace 64 RWC-EFs in designated location inside PCSS	Move RWC-EF package to inside PCSS and place in appropriate location/layer.	inside PCSS among RWCs	RWC-EF@1 m	1.00E-01	0.25	2	64	16.00	1.60E+00	3.20E+00
3.12		Record/verify RWC-EF ID, location & dose rates	inside PCSS among RWCs	RWC-EF@1 m	1.00E-01	0.083	2	64	5.31	5.31E-01	1.06E+00
		Total							**21.31**		**4.26E+00**
6.1	Preparation for RWC-SGs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	48	3.98	4.52E-02	4.52E-02
6.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	SG@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
6.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
6.4		Start-up 40T Forklift, adjust forks, place sleeves on	PCSS	Exit Door	1.14E-02	0.083	1	48	3.98	4.52E-02	4.52E-02

Estimated Doses for Placement of RWCs and SGs in the PCSS

Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
		forks and move close to RWC-SG package. Assume after every shift.									
6.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	48	3.98	4.52E-02	9.05E-02
6.6		OPG Supervision	PCSS	Exit Door	1.14E-02	15	1	48	720.00	8.18E+00	8.18E+00
		Total							**732.70**		**8.41E+00**
6.7	Emplacement of SGs in west bay of PCSS	Set up the rigging required (jack and slide system) (inside building)	PCSS	PCSS S Walls @1m	1.14E-02	2.5	6	1	2.5	2.84E-02	1.70E-01
6.8		Receive, inspect and place SG in the PCSS	PCSS	SG @30cm side	1.61E-01	0.5	3	48	24	3.86E+00	1.16E+01
6.9			PCSS	SG @1m side	1.00E-01	2	3	48	96	9.60E+00	2.88E+01
6.10			PCSS	SG @5m side	2.82E-02	4	3	48	192	5.41E+00	1.62E+01
6.11		Position SG in the storage location	PCSS	U5 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.12			PCSS	U6 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.13			PCSS	U7 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.14			PCSS	U8 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.15			PCSS	U5 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01
6.16			PCSS	U6 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01

Estimated Doses for Placement of RWCs and SGs in the PCSS

Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
6.17			PCSS	U7 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01
6.18			PCSS	U8 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01
6.19			PCSS	SG @5m side	2.82E-02	4	3	48	192	5.41E+00	1.62E+01
6.20		Supervision	PCSS	SG @5m side	2.82E-02	44	4	1	44	1.24E+00	4.96E+00
		Total							**862.5**		**1.74E+02**
Total Collective Dose											**2.21E+02**
Maximum Individual Dose - assumes 1 worker does each task apart from supervision										**9.60E+00**	

8.0 Conclusions

This report documents the safety assessments that were performed to support the construction of the PCSS on the PWMF site. These safety assessments included a normal operations safety assessment, malfunction/accident safety assessment, and an ALARA assessment.

In the normal operations safety assessment, doses to workers and the public for normal operation of the PWMF were assessed. It was concluded that doses to the public due to chronic emissions from the PWMF were significantly less than the dose acceptance criterion. However, dose to workers and the public due to direct gamma radiation could potentially exceed the dose limit based on the shielding analysis which was conducted based on the current design.

The full building MCNP dose rate calculations with the initial layout resulted in dose rates that broadly exceeded the targets. Recommendations were made based on those results, which led to a revision of the initial configuration. Therefore, additional configurations were evaluated considering the updated PCSS layout. As a result of this revision, only the base case did not meet the acceptance criteria for all dose points. While the other cases met the acceptance criteria for all dose points, some portions of the PCSS perimeter still had dose rates above 0.5 μSv/hr. One case was selected by OPG for the calculation of additional shielding needed to reduce the PCSS perimeter dose rates. This was calculated for the configuration with SG Scenario 2, RWC Case 2 decayed 1.7 years, and DSC Case 2, and the recommended concrete shielding is up to 27 cm at the rollup door opening in the south wall. From these results, a final PCSS layout was defined and the dose rates for this configuration were assessed. The results for the final PCSS layout demonstrated that the dose rates at the PCSS perimeter meet the limit of 0.5 μSv/hr and all land and water-based receptors meet the required dose rate limits. The dose rates along the SB3–SB5 fence lines showed that some regions are above 0.5 μSv/hr. Occupational doses arising from UFDS operations are managed under the Radiation Protection Program and are expected to be well below regulatory dose limits. The neutron hazards associated with the RWC-PT/CTs that will be stored in the PCSS were assessed and it showed that when considering both neutron and gamma contributions, the dose rates at certain sections of the PCSS perimeter may exceed 0.5 μSv/h. Additional neutron shielding was assessed and it was demonstrated that the combined neutron and gamma dose rates on the perimeter of the PCSS and at land/water based receptors would all meet acceptance criteria.

In the malfunction/accident safety assessment, hazards were identified and screened for the construction of the PCSS, on-site transfers, handling and storage of the RWCs and SGs. On this basis, the bounding event was identified to be the drop of a SG or a RWC and the radiological consequences of the event were assessed. It was concluded that the doses to worker and public resulting from the event were less than the dose acceptance criteria. The consequence of the earthquake event was also assessed and the estimated doses for all receptors considered were less than the dose acceptance criterion as well.

The ALARA assessment showed that for the emplacement of 60 RWC-PT/CTs, 16 RWC-CTIs, 64-RWC-EFs and 48 SGs, the overall collective doses are 16.5, 3.7, 17.7, and 182.6 person-mSv, respectively, for a total collective dose of 221 person-mSv. In order to stay below the OPG ECL for a NEW of 1,000 mrem/yr (10 mSv/yr) the emplacement tasks should be divided among multiple workers. Temporary shielding could also be used to reduce dose rates to workers during emplacement activities.

9.0 References

[1] Ontario Power Generation, "Pickering Waste Management Facility – Safety Report," 92896-SR-01320-10002 R006, November 2018.

[2] Ontario Power Generation, "Guideline For Safety Assessment In Support Of Safety Report Update For OPG Waste Facilities," W-REP-01320-00014 R001, June 2022.

[3] Ontario Power Generation, "NSS-P Safety Assessment Update," 92896-REP-01320-00015, November 2022.

[4] Ontario Power Generation, "Reference Nuclear Waste Shielding Analysis Methodology for Heavily Shielded Containers," W-REP-03200-00002 R03, April 2022.

[5] Ontario Power Generation, "Radiological Assessment of Lower Aged Fuel in PWMF SB3 Including Conceptual SB5," 92896-REP-01320-00013 R00, April 2021.

[6] Ontario Power Generation, "Pickering Nuclear Generating Station Conceptual Radioactive Waste Container-End Fitting Shielding Analysis," 92896-REP-79146-00001 R000, July 2023.

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Appendix A: Hazard Pre-Screening

A.1 Hazard Pre-screening

The pre-screening of hazards associated with PCSS safety analysis as presented below was conducted based on the previous work [A-1] and was updated to take into account the project specific aspects, such as the location and design of the PCSS, and the characteristics of the packages (SG or RWC) to be transferred and stored.

Category	Hazard	Screening Status	Rationale
H-EXT External Hazards – Human Induced			
Mobile Sources			
H-EXT-1	Aircraft Impact	IN	This hazard is expected to cause significant damage to the PCSS and may lead to a radiological release.
H-EXT-2 Rail Transportation Hazards			
H-EXT-2.1	Train Crash	OUT	The screening distance for train derailment is estimated to be 80 m (3-rail-car length) from the crash [A-2]. The CN Rail main line runs north of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3] Therefore, this hazard can be screened out based on the distance from the PWMF.
H-EXT-2.2	Cold Toxic Gas Release	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site, [A-3]. Table 3-1 of Reference [A-2]shows the SDV for Cold Toxic Gases. SDV for Ammonia, Hydrochloric Acid and Hydrogen Fluoride releases is 0.9 km and 1.4 km, respectively. This means that these toxic materials can be screened out based on distance. SDV for Chlorine, Sulphuric Acid and Sulphur Dioxide is 4.4 km. This hazard can be screened out based on frequency (8.81E-07) (refer to Table 3-9 of Reference [A-3]).
H-EXT-2.3	Hot Toxic Gas Release	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. Table 3-2 of Reference [A-2]shows that the maximum SDV is 2.3 km (sulphur dioxide) for hot toxic gases. Therefore, this hazard can be screened out based on the distance from the PWMF.

Category	Hazard	Screening Status	Rationale
H-EXT-2.4	BLEVE – Missile Damage	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site, [A-3]. The BLEVE SDV is estimated to be 1600 m [A-2]. Therefore, the BLEVE hazard from rail derailment can be screened out based on the distance from the PWMF.
H-EXT-2.5	BLEVE – Blast Wave	OUT	The blast waves associated with a BLEVE are localized and not as strong as a Vapour Cloud Explosion (VCE) [A-2]. Since this hazard is bounded by the VCE hazard, it is not included in the screening analysis.
H-EXT-2.6	VCE	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The Vapour Cloud Explosion SDV is estimated to be 460 m [A-2]. Therefore, this hazard can be screened out based on the distance from the PWMF.
H-EXT-2.7	Explosions of Rail Car Containing Explosive	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The SDV is estimated to be 700 m [A-2]. Therefore, this hazard can be screened out based on the distance from the PWMF.
H-EXT-3 Road Transportation Hazards			
H-EXT-3.1	Cold Toxic Gas Release, such as: ammonia, hydrochloric acid and hydrogen fluoride, hot toxic gases, BLEVEs, VCEs, and Explosions	OUT	As major roads/highways are slightly further away from the plant than the railway, these offsite road transportation accidents can be screened out based on distance [A-2].
H-EXT-3.2	Cold Toxic Gas Release e.g., Chlorine; Sulphuric Acid, Sulphur Dioxide	OUT	Only 10% of these chemicals are transported on Highway 401 compared to the CN rail line traffic [A-2]. This hazard can be screened out based on frequency (8.81E-08), referring to Table 3-11 of Reference [A-3].
H-EXT-4 Ship Accidents			

Category	Hazard	Screening Status	Rationale
H-EXT-4.1	Small Vessels	OUT	Boats/small vessels are not permitted to dock on the shore near the PWMF. The accidents associated with small vessels are not expected to have an impact on the PWMF. Therefore, this hazard can be screened out.
H-EXT-4.2	Large Vessels	OUT	The normal shipping lanes in Lake Ontario are 10 kilometres away from the shoreline in the vicinity of the plant [A-2]. In addition, there are no commercial wharfs around the Pickering area [A-3]. Therefore, this hazard can be screened out based on the distance from the PWMF.
Fixed Sources			
H-EXT-5	Nearby Nuclear Event	OUT	An accident at the Pickering A, Pickering B or Darlington NGS, resulting in significant releases would progress slowly enough to ensure notification to PWMF personnel such that the required actions could be taken. Any anticipated dose from the PWMF as a result of a significant event at either Pickering A or Pickering B, would be bounded by the dose received from the station itself. Therefore, this hazard can be screened out.
H-EXT-6 Toxic Gas Release			
H-EXT-6.1	Toxic Gas Release – Chlorine originated from Ajax Water Treatment Plant	IN	The Ajax Water Treatment Plant is situated near the Ajax Waterfront Park and uses chlorine cylinders for water treatment. The SDV for Chlorine is 4.4 km [A-2]. The Ajax Water Treatment facility is located approximately 4.0 km from the PCSS. This hazard cannot be screened out based on distance, it will be further evaluated.
H-EXT-6.2	Toxic Gas Release - Chlorine originated from the Duffin Creek Water Pollution Control Plant	OUT	The Duffin Creek Water Pollution Control Plant which uses chlorine for pollution control is located in Pickering at 1.0 km from the PCSS. Due to its proximity, it may be able to release sufficient chlorine to impair the SG/RWC transporter operator. Since the SDV for chlorine is 4.4 km, this hazard cannot be screened out based on distance. However, the annual frequency of a chlorine leak from a fixed storage tank is 2.86E-07 (refer to Table 3-12 of Reference [A-3]), which is below the cutoff frequency of 10E-6, this hazard can be screened out based on frequency.
H-EXT-7	BLEVE	OUT	External fixed sources of BLEVEs have been identified within a radius of 5 km of PNGS [A-3] and it was concluded that none of the sites were within the

Category	Hazard	Screening Status	Rationale
			SDV, which is 1600 m for BLEVE [A-2]. Therefore, this hazard can be screened out based on distance.
Other Sources			
H-EXT-8	Missiles from Military Activity	OUT	This is considered a malevolent act; therefore, it is out of scope per Reference [A-2]
H-EXT-9	Orbital Debris Crashes	OUT	Orbital debris can cause serious damage to the SGs and RWCs. There is no SDV for this hazard type [A-2]. However, based on the annual frequency analysis, this hazard can be screened out for UFDS facilities and DSC on-site transfer due to low frequency [A-5][A-6]. Similarly, this hazard can be screened out for the PCSS based on similar building size and transport route.
N-EXT External Hazards – Natural			
N-EXT-1	Earthquakes	IN	The ground motion associated with this event may exceed the design capacity of the PWMF facility. Earthquake could also affect the RWCs or SGs if they are being transported when the earthquake occurs. This hazard has the potential to lead to a radiological release, and therefore it cannot be screened out.
N-EXT-2 Soil Failures			
N-EXT-2.1	Slope Instability	IN	The PNGS site complies with the specific clauses of the Canadian Foundation Engineering Manual and the National Building Code of Canada (NBCC) ([A-2] and [A-3]). However, potential slope failures/soil instability will impact the onsite transfer of SGs and RWCs. This hazard will be further evaluated.
N-EXT-2.2	Subsidence	OUT	The PNGS site is not situated in a geographical area where subsidence can occur ([A-2] and [A-3]). Therefore, this hazard can be screened out.
N-EXT-2.3	Swelling Clay	OUT	The foundations of PNGS are not on clay layers [A-2]. Therefore, this hazard can be screened out.
N-EXT-2.4	Soil Frost	OUT	This hazard is primarily relevant to the integrity of buried piping [A-2]. This hazard is not anticipated to impact the transfer or storage of the SGs and RWCs and is therefore not applicable to the present assessment.
N-EXT-3 Flooding			

Category	Hazard	Screening Status	Rationale
N-EXT-3.1	Flooding Due to Runoff	IN	A PMP event has the potential to cause damage to the PWMF SSCs and could result in radiological release. Therefore, flooding has been screened in for transportation and storage.
N-EXT-3.2	Flooding Due to River	OUT	Main river courses are located at a distance greater than 2 km from the western (Rouge River and the Petticoat Creek) and eastern (Duffin's Creek) boundary of the PNGS site [A-3]. Based on distance, the potential for these rivers to represent a potential flood hazard to the PWMF site is screened out. Krosno Creek is located immediately to the west of the PNGS and is prone to flooding. Based on Flood Plain Mapping from the Toronto and Region Conservation Authority (TRCA), water surface elevations for Krosno Creek are in the range from 76.26 m (at Liverpool Road) to 77.22 m (at Sandy Beach Road). Ground elevations between the PNGS and the flood zone are approximately 3.6 m and 5.1 m, respectively, above the Regional Flood elevation at these locations, Appendix F of Reference [A-3]. An assessment has been conducted as part of the Fukushima follow-up and it was determined that Krosno Creek would maintain at minimum approximately 2.7 m of freeboard from a potential spill during the flooding due to a PMP event. Based on this, the potential for flooding from this river can be screened out.
N-EXT-3.3	Flooding Due to Waves	OUT	Unlike DSMs which are stored outside, the RWCs and SGs are stored within the PCSS which is away from the shore. As such, flooding due to waves will not directly affect RWCs and SGs. Therefore, this hazard can be screened out.
N-EXT-3.4	Flooding Due to Seiche	OUT	Section 4.4.4 of Reference [A-3]notes that the site requires protection for water surge of up to 0.75 m, as the highest modeled water level at Darlington resulting from surge or seiche is about 0.75 m. The 100-year maximum lake level is 75.6 m [A-3], so the possible maximum level is 76.35m. However, the average shoreline near PNGS is 77 m. This hazard can be screened out.
N-EXT-3.5	Flooding Due to Tsunami	OUT	A tsunami in Lake Ontario is an improbable event, with no associated flood hazard potential [A-2]. Furthermore, the Great Lakes are in a geologically stable, mid-continental region, where the probability of occurrence of earthquakes large enough to generate tsunamis is negligible [A-3]. Therefore, this hazard can be screened out.
N-EXT-3.6	Flooding Due to Sudden	OUT	No large lakes and no man-made water retaining structures creating reservoirs are located within the drainage areas in the vicinity of the PNGS that could influence flooding [A-3]. For this reason, this hazard can be screened out.

Category	Hazard	Screening Status	Rationale
	Releases of Water from Natural or Artificial Storage		
N-EXT-3.7	Flooding Due to Rapid Melting of Snow and Large Blocks of Ice	OUT	Rapid melting of snow and large blocks of ice accumulated on the buildings' rooftop and at site as the temperature rises above the freezing point (late winter/early spring) can cause flooding. However, the event is slow developing [A-3], providing enough time for operational personnel to ensure all PWMF facility are in a safe state. Therefore, this hazard can be screened out.
N-EXT-3.8	Flooding Due to Other Causes	OUT	Other causes of flooding may include underwater landslides and lake ice. Lake Ontario shorelines as a whole are not susceptible to shore slope failure or landslide [A-3]; lake ice can be also screened out as a flood hazard as ice structures are not expected to create or worsen any coastal flood hazard at Pickering [A-3]. Therefore, this hazard has been screened out.
N-EXT-4 Meteorological – Extremes			
N-EXT-4.1	Temperature (extreme high/ extreme low)	OUT	Extreme temperatures are predictable allowing time for operational staff to ensure all PWMF facilities are in a safe state. Procedures are in place to prohibit transfer under poor or slippery road conditions [A-6]. Therefore, this hazard can be screened out.
N-EXT-4.2	Snowpack	OUT	Snowpack and subsequent 48-hour winter PMP would occur gradually, allowing time for the removal of snow for affected structures. The procedures will be developed that waste transfer activities should not be performed during snow-covered conditions and are bounded by a transporter failure incident [A-6]. Therefore, this hazard can be screened out.
N-EXT-4.3	Freezing Rain	OUT	The impact of freezing rain is bounded by the impact of external flood, ice-storms and snowpack. Similar to the current practice, procedures will be developed to prohibit transfer under poor or slippery road conditions. Even if the on-site transfer of SG and RWC takes longer than expected as result of adverse road conditions, the radiological consequence is not expected given the robust design of a RWC or packed SG. Therefore, this hazard can be screened out.
N-EXT-4.4	Extreme Water Temperature	OUT	Operation of the PWMF does not depend on the use of lake water. There is no interaction between the transfer of the RWCs and SGs and the lake water temperature. This event is screened out.

Category	Hazard	Screening Status	Rationale
N-EXT-4.5	Avalanches	OUT	The PNGS is not situated in a mountainous region with large slopes which would lead to an avalanche. This event is screened out.
N-EXT-4.6	Lightning	IN	The effects of a lightning strike will increase the temperature of the affected SG or RWC and might result in an increased release of loose contamination from inside the packages; the packages will be cleaned of surface contamination prior to transport. Therefore, this event is screened in.
N-EXT-4.7	Hurricanes	OUT	Tornadoes are more frequent in the region of concern and the impact of a tornado is considered bounding for high-winds category of hazard. Therefore, the wind speeds from tornadoes are considered a bounding hazard.
N-EXT-4.8	Tornadoes	IN	This hazard is expected to cause significant damage to the PWMF and will impact transport and may lead to radiological release. As per [A-8], the tornado occurrence rate in the Pickering site is 3.13E-06 events per year. This hazard requires further evaluation.
N-EXT-4.9	Sandstorms	OUT	Sandstorms are typically associated with deserts. In the vicinity of the PWMF there are no large sand-bodies, therefore sandstorms are not a credible potential external hazard for Ontario [A-3]
N-EXT-4.10	Ice Storms	OUT	The PCSS conforms to NBCC requirements ([A-2][A-3]) which account for loading due to ice and snow. Waste transfer activities should not be performed under severe weather conditions such as ice storms. Therefore, this hazard can be screened out.
N-EXT-4.11	Frazil Ice	OUT	Operation of the PWMF does not depend on the use of the lake water. There is no interaction between transport and the lake. Therefore, this hazard can be screened out.
N-EXT-4.12	Low Lake Level/Drought	OUT	Operation of the PWMF does not depend on the use of the lake water. Therefore, this hazard can be screened out.
N-EXT-4.13	Meteorites	OUT	Similar to the orbital debris hazard, this hazard cannot be screened out based on qualitative screening. However, based on the annual frequencies of this hazard ([A-5][A-6]), this hazard can be screened out for UFDS facilities and DSC on-site transfer due to low frequency. Similarly, this hazard can be screened out for the PCSS based on similar building size and transport route.
N-EXT-4.14	Geomagnetic storm	OUT	Geomagnetic storm events will impact the power distribution system equipment and may cause loss of off-site power [A-3]. This hazard does not have an impact on the PCSS; therefore, it can be screened out.

Category	Hazard	Screening Status	Rationale
N-EXT-5 Other Hazards			
N-EXT-5.1	Forest Fire	OUT	There is no heavily forested area within 3 km of the site [A-6]. The SDV for this hazard is 1 km [A-2]. Therefore, this hazard can be screened out.
N-EXT-5.2	Corrosion from Salt Water	OUT	This hazard is not applicable in the Great Lakes area [A-2]; therefore, this hazard can be screened out.
N-EXT-5.3	Animals	OUT	This hazard does not have any impact on the PWMF site or on-site transfer [A-6].
H-INT Internal Hazards			
H-INT-1	Turbine Generated Missiles	IN	The SG or RWC transfer route from the Station to the PCSS is in the proximity of the stations' powerhouses. A missile may have an impact on the transfer, handing or storage of the SGs or RWCs.
H-INT-2	Other Mechanically Generated Missile Sources	OUT	PWMF facility: As the Heat Transport pump missiles are assumed incapable of penetrating the RB wall; there is no impact to the PWMF facility. The effects of missiles from other pumps and valves are assumed bounded by turbine missiles. During on-site transfer: Similar to DSC on-site transfer, missile sources originating from hydrogen cylinder/trailers/ stationary tank set, compressed gas bottle storage facility and oil storage tank along the SG or RWC onsite transfer route were screened out based on frequency (Section 5.6.1, 5.6.2, 5.6.3 and 5.6.4 of Reference [A-6]). A transportation accident causing mechanical damage and leading to a pressure vessel burst is bounded by tornado missiles.
H-INT-3	Acetylene Decomposition Explosion Missile	OUT	The effects of this hazard would be bounded by that of tornado generated missiles.
H-INT-4	Missiles Generated by a Hydrogen Explosion at the Tritium Removal Facility	OUT	This hazard is associated with the tritium removal facility at Darlington and not applicable for the Pickering site [A-9].
H-INT-5	Control Rod Ejection Missiles	OUT	This hazard is not applicable due to the design of a CANDU reactor [A-9].

Category	Hazard	Screening Status	Rationale
H-INT-6	Explosions within the PWMF Facility and along the on-site transfer route	IN	No explosive materials will be stored in the PCSS. However, there are potential sources of explosions along the SG/RWC transfer route that may lead to radiological releases.
H-INT-7 Release of Toxic, Radioactive or Corrosive Gases and Liquids from On-Site Storage			
H-INT-7.1	Acute Inhalation Toxicity	Out	It is expected that no acutely toxic materials will be stored in the PCSS. Therefore, this hazard can be screened out.
H-INT-7.2	Corrosion	OUT	It is expected that no corrosive materials will be stored in the processing building. Therefore, this hazard can be screened out.
H-INT-7.3	Oxidizing/Reactive Chemicals	OUT	There is no oxygen gas stored at the PWMF facility. This hazard is screened out.
H-INT-7.4	Asphyxiants	OUT	There will not be any significant quantities of asphyxiating gas (argon and helium) stored in the PCSS. Therefore, this hazard can be screened out.
H-INT-7.5	Release of Stored Energy	OUT	Catastrophic failure of pressure vessels is excluded from consideration. There are no other sources of significant stored energy, such as high-pressure piping, associated with the PWMF.
H-INT-8 Transportation			
H-INT-8.1	Vehicle Impacts – Onsite Vehicle Movements	IN	Vehicle accident during onsite transfer of SGs/RWCs have the potential to lead to radiological release. The accident could consist of a collision resulting in a drop of the RWC or SG, or the transporter leaving the road due to transporter operator health-related emergency. Therefore, this hazard is screened in.
H-INT-8.2	Collision Impacts Within PCSS	IN	Collision with other vehicles/structures within the PCSS has the potential to lead to radiological release. Therefore, this hazard is screened in.
H-INT-8.3	Toxic and/or Dangerous Goods - Onsite Vehicle Movements	OUT	This hazard is bounded by vehicle accidents involving radiological waste.
H-INT-8.4	BLEVE – Blast Wave	IN	The blast waves associated with a BLEVE could occur along the SG/RWC transfer route from PNGS to PCSS. Therefore, this hazard is screened in.
H-INT-8.5	Vapour Cloud Explosion	IN	There are propane storage tanks along the SG/RWC transfer route from PNGS to PCSS, which could result in VCE. Therefore, this hazard is screened in.

Category	Hazard	Screening Status	Rationale
H-INT-8.6	Fire	IN	Fires along the transfer route or originating from combustible materials on the transporter can lead to damage of transporter and packages being transported and potential release of radioactivity.
H-INT-9	Collapsed Structures	OUT	This hazard is bounded by earthquakes.
H-INT-10	Fire – Toxic Effects Only	OUT	The effects of this hazard are bounded by fire.
H-INT-11	Dropped or impacting loads	IN	The dropping of SGs/RWCs during handling can lead to radioactive release. This applies to transport and handling in the PCSS.
H-INT-12	Electromagnetic Interference (EMI) and Radio-Frequency Interference (RFI)	OUT	Proper design ensures that EMI and RFI are not a potential hazard to safety. The Pickering B Hazard Screening report [A-3] states that this hazard was accounted for in the design of the PNGS B. The same design requirements would be expected to be applicable to the PWMF.
H-INT-13	Seal Failure	IN	The failure of lid/seal of the SG or RWC could potentially result in the radiological release.
H-INT-14	Fire within the PCSS	IN	Fire within the PCSS can lead to damage of RWCs and SGs stored and potential release of radioactivity.
H-INT-15	Extended loss of AC power (ELAP)	OUT	An ELAP is a loss of all off-site and on-site AC power sources for an unknown period of time. It could be a significant challenge for the long-term cooling of the reactor core and the spent fuel storage pool. Given that only RWCs and SGs will be stored within the PCSS and that cooling is not specifically required for the safe storage of RWCs and SGs and any operation within the PCSS could be held when an ELAP occurs, the radiological impact of an ELAP on the safe operation of the PCSS is negligible. Therefore, this hazard can be screened out.

A.2 References

[A-1] Ontario Power Generation, "PWMF Safety Assessment Update", 92896-REP-01320-00015, November 2022.

[A-2] Ontario Power Generation, "OPG Probabilistic Safety Assessment (PSA) Guide – External Hazards Screening," N-GUID-03611-10001 Vol. 8, R005, November 2018.

[A-3] Ontario Power Generation, "Hazard Screening Analysis – Pickering B", NK30-REP-03611- 00008 R002, December 2021.

[A-4] Ontario Power Generation, "Dry Storage Module (DSM) Storage Facility Safety Assessment", 90387, December 1990.

[A-5] Ontario Power Generation, "Hazard Screening Analysis – Pickering Used Fuel Dry Storage", P-REP-03611-00009, R000, September 2017.

[A-6] Ontario Power Generation, "Hazards Analysis of the Existing Dry Storage Container Transport Route at Pickering Site", 92896-REP-00120-00005 R000, July 2013.

[A-7] Ontario Power Generation, "Pickering Waste Management Facility Campus Plan", 92896-REP- 03460-00001 R005, November 2014.

[A-8] Ontario Power Generation, "Pickering NGS "B" High Wind Probabilistic Safety Assessment", NK30-REP-03611-00020-R002, July 2017.

[A-9] Ontario Power Generation, "OPG Probabilistic Safety Assessment (PSA) Guide – Internal Hazards Screening", N-GUID-03611-10001, Vol. 9, R003 December 2018.

Appendix B: Aircraft Crash Frequency Calculations

This Appendix presents the aircraft crash frequency calculations for the PWMF site. The calculations were based on the Appendix B of Reference [B-1], including the calculation of the effective area of the target and multiplying that by the aircraft crash rate.

The effective target area A_{eff} is calculated as

$$A_{eff} = A_f + A_s$$

where

$$A_f = (WS + R) * H * \cot\Phi + (2 * \cdot L^* \cdot W^* \cdot WS)/R + L^* \cdot W$$
$$A_s = (WS+R) * S$$

Where

A_f = effective fly-in area;
A_s = effective ski area;
WS = aircraft wingspan;
R = length of the diagonal of the facility;
H = facility height;
cotΦ = mean of the cotangent of the aircraft impact angle;
L = length of facility;
W = width of facility; and
S = aircraft skid distance

The values for the aircraft wingspan, mean of the cotangent of the aircraft impact angle and aircraft skid distance were taken from Tables B-16, B-17 and B-18 from Reference [B-2], respectively. The aircraft crash rates for the PNGS site were taken from Table 3-2 of Reference [B-3]. Airports located in a radius of about 35 kilometers from the PNGS were considered in the airfield crash rate calculations.

For the SG transfer vehicle (SPMT), the size (L, W, H) is from page 18 of Reference [B-4]. The size of the RWC transfer vehicles was conservatively considered to be the same as the size of the SPMT. For PCSS, the dimensions of the building were based on References [B-5].

The results of aircraft crash frequency calculations for the PWMF site, taking into the results of [B-6] and [B-7], are presented in Table B-1.

Table B-1: Aircraft Crash Frequency Calculations

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	**Helicopters**	**Small Transport**	**Large Transport**	**Military Combat**	
Wingspan	WS, ft	73	50	59	98	110	
Skid distance	S, ft	60	0	1440	1440	447	
Impact angle cotangent	cotΦ	8.2	0.58	10.2	10.2	10.4	
Crash rate	km^{-2} yr^{-1}	5.10E-06	3.60E-07	9.30E-07	1.20E-06	6.60E-08	
DSC On-Site Transfer with Liftking Transporter							
Transporter Length	L, ft		27.83	27.83	27.83	27.83	
Transporter Width	W, ft		10.88	10.88	10.88	10.88	
Diagonal of Transporter	R, ft		29.88	29.88	29.88	29.88	
Transporter Height	H, ft		15.52	15.52	15.52	15.52	
Effective fly area	Af. ft^2		2,034.72	15,569.24	22,533.58	25,110.67	
Effective skid area	As, ft^2		0.00	127,990.26	184,150.26	62,527.31	
Total Area	Aeff, ft^2		2,034.72	143,559.50	206,683.84	87,637.98	
	Aeff, km^2		0.00019	0.013	0.019	0.008	
Probability of a loaded transporter on-site	yr^{-1}		0.017	0.017	0.017	0.017	
Crash Frequency	yr^{-1}		1.17E-12	2.12E-10	3.95E-10	9.20E-12	**6.17E-10**
Phase I (processing building and storage buildings SB 1 and SB 2)							
Facility Length	L, ft		342.00	342.00	342.00	342.00	
Facility Width	W, ft		312.00	312.00	312.00	312.00	
Diagonal of Facility	R, ft		462.93	462.93	462.93	462.93	

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Facility Height	H, ft		45.00	45.00	45.00	45.00	
Effective fly area	Af. ft^2		121,800.28	352,129.37	388,008.98	404,205.27	
Effective skid area	As, ft^2		0.00	751,585.13	807,745.13	256,101.55	
Total Area	Aeff, ft^2		121,800.28	1,103,714.50	1,195,754.11	660,306.82	
	Aeff, km^2		0.011	0.103	0.111	0.061	
Crash Frequency	yr^{-1}		4.07E-09	9.54E-08	1.33E-07	4.05E-09	**2.37E-07**
DSM/RCS Area							
Facility Length	L, ft	196.00	196.00	196.00	196.00	196.00	
Facility Width	W, ft	136.80	136.80	136.80	136.80	136.80	
Diagonal of Facility	R, ft	239.02	239.02	239.02	239.02	239.02	
Facility Height	H, ft	16.07	16.07	16.07	16.07	16.07	
Effective fly area	Af. ft^2	84,306.88	40,724.47	88,899.39	104,041.95	109,822.95	
Effective skid area	As, ft^2	18,721.16	0.00	429,147.83	485,307.83	156,011.64	
Total Area	Aeff, ft^2	103,028.04	40,724.47	518,047.22	589,349.78	265,834.59	
	Aeff, km^2	0.010	0.004	0.048	0.055	0.025	
Crash Frequency	yr^{-1}	4.88E-08	1.36E-09	4.48E-08	6.57E-08	1.63E-09	**1.62E-07**
Phase II - DSC Storage Buildings SB3, SB4 and SB5							
Facility Length	L, ft		891.08	891.08	891.08	891.08	
Facility Width	W, ft		553.75	553.75	553.75	553.75	
Diagonal of Facility	R, ft		1049.13	1049.13	1049.13	1049.13	
Facility Height	H, ft		33.19	33.19	33.19	33.19	
Effective fly area	Af. ft^2		369,189.50	731,629.83	781,518.39	804,562.77	
Effective skid area	As, ft^2		0.00	1,595,705.38	1,651,865.38	518,130.54	
Total Area	Aeff, ft^2		369,189.50	2,327,335.21	2,433,383.77	1,322,693.32	
	Aeff, km^2		0.034	0.216	0.226	0.123	

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Crash Frequency	yr-1		1.23E-08	2.01E-07	2.71E-07	8.11E-09	**4.93E-07**
PCSS for RWCs							
Facility Length	L, ft	167.00	167.00	167.00	167.00	167.00	
Facility Width	W, ft	157.00	157.00	157.00	157.00	157.00	
Diagonal of Facility	R, ft	229.21	229.21	229.21	229.21	229.21	
Facility Height	H, ft	26.24	26.24	26.24	26.24	26.24	
Effective fly area*	Af. ft^2	51351.05	18331.67	55806.12	65486.37	69355.00	
Effective skid area*	As, ft^2	9066.35	0.00	207512.42	235592.42	75813.81	
Total Area	Aeff, ft^2	60417.40	18331.67	263318.53	301078.79	145168.82	
	Aeff, km^2	0.006	0.002	0.024	0.028	0.013	
Crash Frequency	yr^{-1}	2.86E-08	6.13E-10	2.28E-08	3.36E-08	8.90E-10	**8.64E-08**
Cumulative Frequency for Used Fuel Dry Storage Area (Phase I and Phase II), RCS Area and PCSS for RWCs							**9.78E-07**
PCSS for SGs							
Facility Length	L, ft	167.00	167.00	167.00	167.00	167.00	
Facility Width	W, ft	157.00	157.00	157.00	157.00	157.00	
Diagonal of Facility	R, ft	229.21	229.21	229.21	229.21	229.21	
Facility Height	H, ft	26.24	26.24	26.24	26.24	26.24	
Effective fly area*	Af. ft^2	51351.05	18331.67	55806.12	65486.37	69355.00	
Effective skid area*	As, ft^2	9066.35	0.00	207512.42	235592.42	75813.81	
Total Area	Aeff, ft^2	60417.40	18331.67	263318.53	301078.79	145168.82	
	Aeff, km^2	0.006	0.002	0.024	0.028	0.013	
Crash Frequency	yr^{-1}	2.86E-08	6.13E-10	2.28E-08	3.36E-08	8.90E-10	**8.64E-08**
RWC/SG On-Site Transfer							
Transporter Length	L, ft	60.27	60.27	60.27	60.27	60.27	

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Transporter Width	W, ft	13.00	13.00	13.00	13.00	13.00	
Diagonal of Transporter	R, ft	61.66	61.66	61.66	61.66	61.66	
Transporter Height	H, ft	15.75	15.75	15.75	15.75	15.75	
Effective fly area	Af. ft^2	20,029.67	3,074.26	21,666.42	28,922.98	31,696.48	
Effective skid area	As, ft^2	8,079.37	0.00	173,744.76	229,904.76	76,730.27	
Total Area	Aeff, ft^2	28,109.04	3,074.26	195,411.19	258,827.74	108,426.75	
	Aeff, km^2	0.00261	0.00029	0.018	0.024	0.010	
Probability of a loaded transporter on-site	yr^{-1}	0.004	0.004	0.004	0.004	0.004	
Crash Frequency	yr^{-1}	5.63E-11	4.34E-13	7.13E-11	1.22E-10	2.81E-12	**2.53E-10**

Note: *Based on the arrangement of RWCs and SGs in the PCSS, it is conservatively assumed that 50% of the PCSS is occupied by RWCs. Only this potion of the PCSS was taken into account the calculation of cumulative crash frequency for safety containers. The crash frequency for the rest of the building used for the storage of SGs was calculated separately.

B.1 References

[B-1] US Department of Transportation, “Accident Analysis for Aircraft Crash into Hazardous Facilities”, DOE-STD-3014-2006, Reaffirmed May 2006

[B-2] OPG, Ontario Power Generation Used Fuel Dray Storage Container Design Requirement, 00104-DR-79171-10000 R03, June 2011

[B-3] OPG, “Hazard Screening Analysis – Pickering B”, NK30-REP-03611-00008 R002, December 2021.

[B-4] Mammoet, “Old Steam Generator Offloading and Laydown Procedure”, W -01098-PLAN-79137-00013 R000, 2007.

[B-5] OPG. Email from Shelaney L. To Eric H. Re PCSS Layout, PV209/RE/0009 R00, July 27, 2023.

[B-6] OPG, "NSS-P Safety Assessment Update," 92896-REP-01320-00015 R00, November 2022.

[B-7] OPG, “Radiological Assessment of Lower Aged Fuel in PWMF SB3 including Conceptual SB5”, 92896-REP-01320-00013 R00, April 2021.

Appendix C: Photos along the Portion of the Transfer Route

Figure C: Picture Showing the Locations where Photos were Taken along the Transfer Rout)

Figure C-1: Photo Taken at East Complex Warehouse Cross-Walk (Approximate 50m North of Intersection).

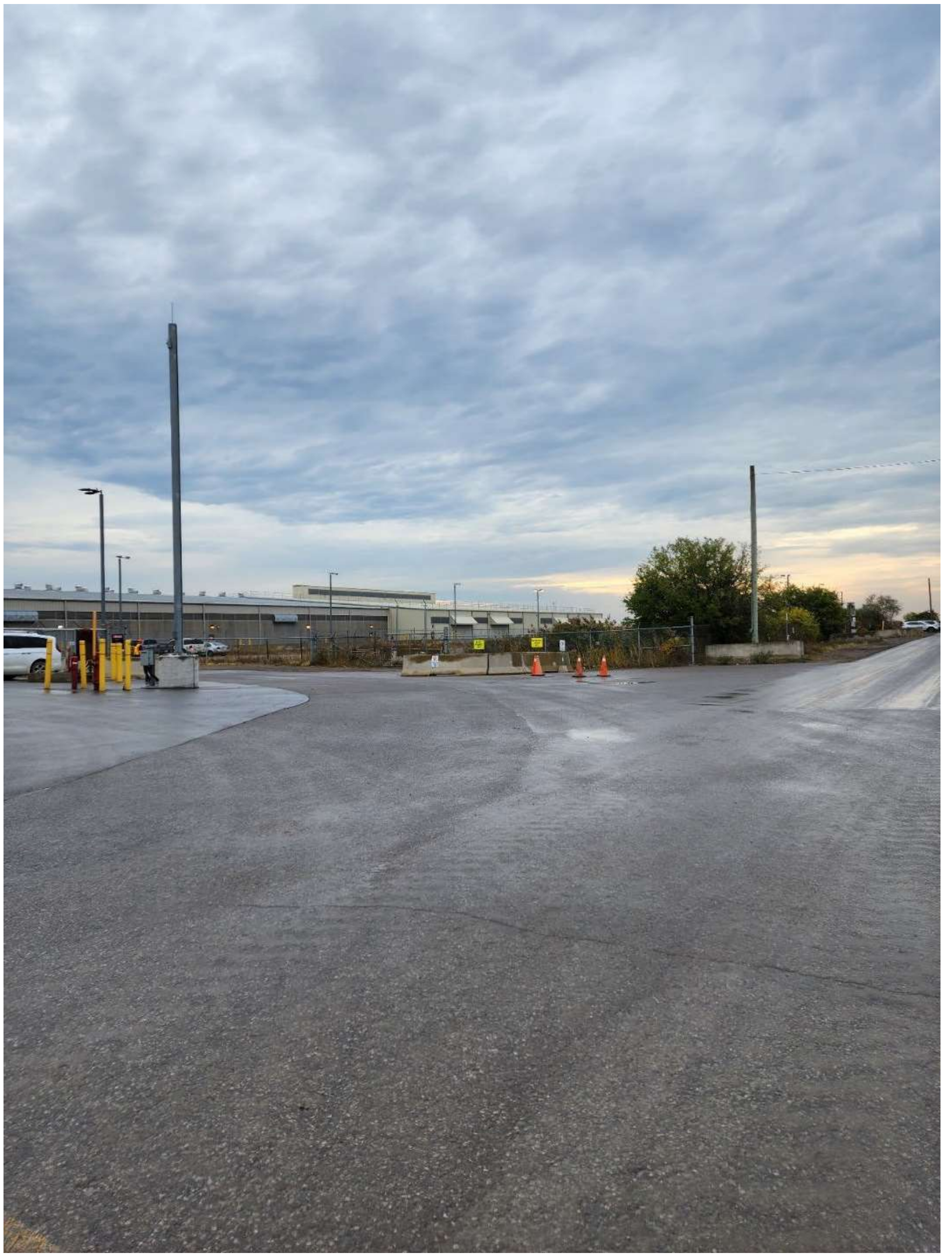

Figure C-2: Photo Taken At the Southwest Corner of East Complex Warehouse (Looking Southeast towards Entrance to PWMF Building).

Figure C-3: Photo Taken At the Southwest Corner of East Complex Warehouse (Looking East along the Route)

Figure C-4: Photo Taken At the Southeast Corner of East Complex Warehouse (Looking West towards PNGS).

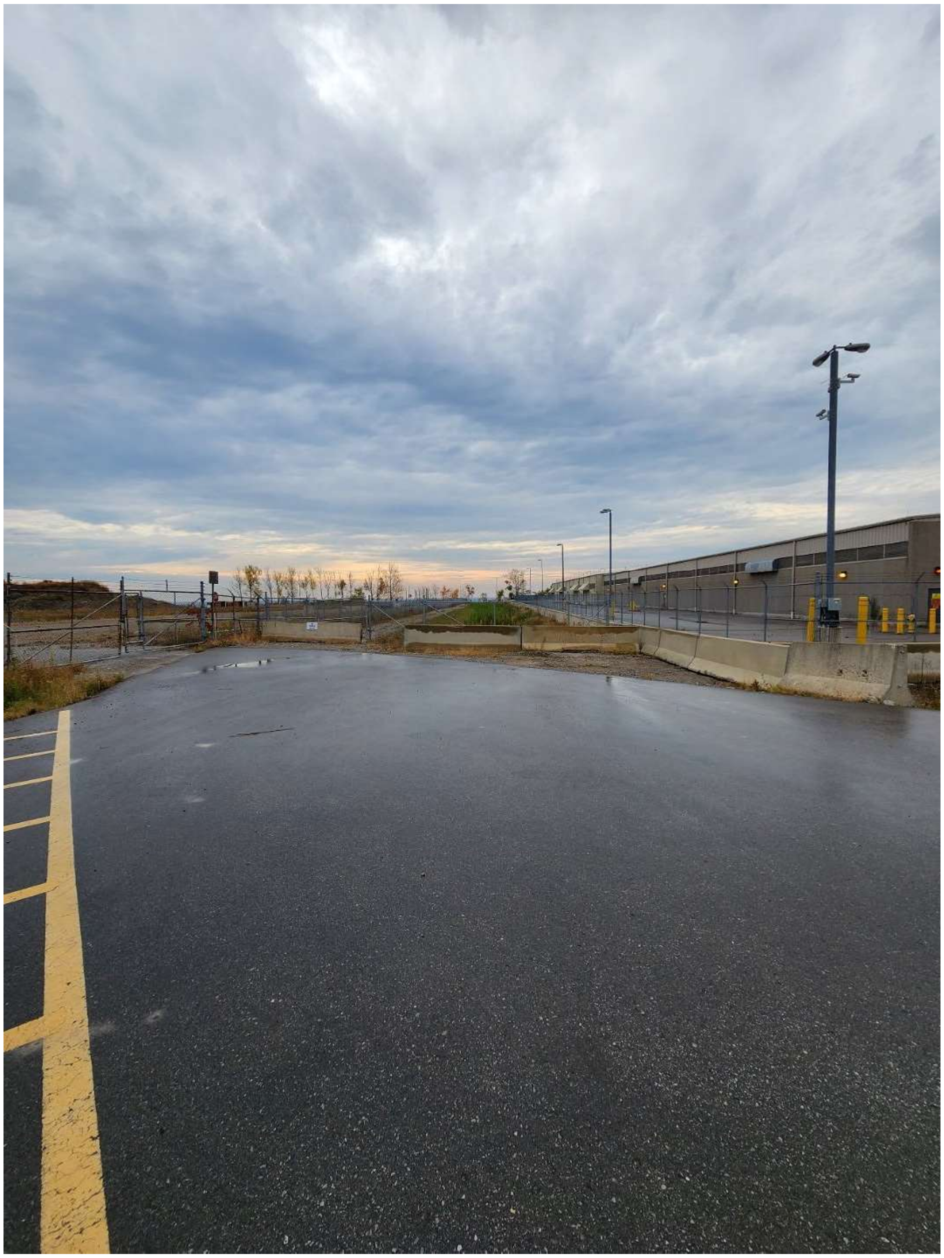

Figure C-5: Photo Taken At the Midpoint of Curved Section of Route (Looking South) .

Figure C-6: Photo Taken At Eastern End of Route (Looking West).

Figure C-7: Photo Taken At Eastern End of Route (Looking Northeast through the Fence)
Note: PCSS will be built in this area.

Appendix D: Materials used in MCNP Modeling

D.1 Single Container MCNP Models

D.1.1 RWC-PT

For the RWC-PT concept, the container material is simply listed as carbon steel [8]. As the type of carbon steel was not specified, a carbon steel used in the previous full building MCNP model of the PWMF site [5], ASTM A516 Grade 70, was used to allow for easy integration of the new containers into the full building model in the Stage 2 calculation. The PT/CT coupons were treated as 100% zirconium, as this is a thick-walled container and photons are being modelled, it is not necessary to include the exact composition of the PT/CTs. The density of the homogenized PT/CT coupons was determined by taking the assumed mass of 3192 kg of coupons per container provided in Reference [8] and dividing it by the container internal volume of 1.78 m^3 to get a density of 1.79 g/cm^3. The composition of the materials used in the RWC-PT model is shown in Table D-1.

Table D-1: Material Composition of RWC-PT Components

Material	Density (g/cm^3)	Composition (wgt %)
Carbon Steel (ASTM A516 Grade 70)	7.85	C: 0.27% Si: 0.4% P: 0.025% S: 0.025% Mn: 1.2% Fe: 98.08%
Homogenized PT Coupons	1.79	Zr: 100%

D.1.2 RWC-EF

The material specification for the RWC-EF model was left unchanged from those used in the previous shielding analysis for the conceptual design of the RWC-EF [6]. The composition of the container and the End Fitting assemblies is shown in Table D-2 and Table D-3.

Table D-2: Material Composition of RWC-EF Container [6]

RWC-EF Component	Material Specification
External Bolt	ASTM A352 LC3
Fork Lift Pocket Support	A36 Carbon Steel
Internal Shield Plates and Plenum	A36 Carbon Steel
Lid	ASTM A516 Gr. 60
Body	ASTM A516 Gr.60

Table D-3: Material Composition of End Fitting Assemblies [6]

IEFs component	Material Specification
EF body	SS Type 403
Liner Tube	SA268 TP410
Fuel Adapter, Flow Tube, Shield Plug Body	SS Type 410
Wear Ring, Casing, Spider/Safety Stem and Latch	ASTM A564 SS630
Inboard Journal Ring	UNS T30102 AISI Type D2
Outboard Bearing Sleeve	UNS T30102 AISI Type A2
EF Shielding Sleeve	ASTM A519 Gr. 1025 Carbon Steel

D.1.3 Steam Generators

For the Steam Generator models, the materials were taken from the drawing of the SG [10] to the extent possible.

Table D-4: Material Composition of SG Components

Component	Material	Density (g/cm^3)	Composition (wgt %)
Outer Shell	Carbon Steel – ASTM A516 Grade 70	7.85	C: 0.27% Si: 0.4% P: 0.025% S: 0.025% Mn: 1.2% Fe: 98.08%
Homogenized u-tube bundle	Nickel-Copper – ASTM B163 [91]	Material: 8.8 g/cm^3 Component[12]: 1.0399 g/cm^3	C: 0.3% S: 0.024% Si: 0.5%

[12] Homogenized u-tube bundle density was set to 11.82% of the material density to account for the hollow tubes in the bundle. This ratio is consistent with the previous modelling of the WWMF SGs in Reference [9].

			Mn: 2% Fe: 2.5% Ni: 66.676% Cu: 28%
Tubesheet[13]	Carbon Steel Forgings for Piping – ASTM SA105 [92]	Material: 7.86 g/cm^3 Component[14]: 0.929 g/cm^3	C: 0.35% Mn: 0.60% P: 0.035% S: 0.04% Cu: 0.40% Ni: 0.40% Cr: 0.30% Mo: 0.12% V: 0.08% Fe: 97.675%

D.2 Full Building PCSS MCNP Model

The materials used were largely the same as the previously developed model for the PWMF in Reference [5]. A new material was added to represent the rockwool insulation of the industrial roof of the PCSS. This material definition was taken from the shielding analysis of the RWSB at the DWMF [12].

The materials for the RWCs and SGs were incorporated into the model, using the same definitions as described above. The only exception is that the air inside the RWC-EF used when creating the surface source used a slightly different density and definition of air, which was replaced with the same air definition as the rest of the model. The assumed composition of the materials used in the modelling of the PCSS are shown in Table D-5.

[13] Carbon Steel Forgings for Piping - ASTM SA105 from reference [76] contains 0.1 to 0.33% of silicon. However, for a gamma calculation, the omission of a very small amount of silicon in the Tubesheet, which is not part of the source material, is acceptable and hence the composition was not corrected.
[14] The tubesheet density was set to 11.82% of the material density to account for the hollow tubes. This ratio is consistent with the previous modelling of the WWMF SGs in Reference [9].

Table D-5: Composition of PCSS Materials

Material	Density (g/cm³)	Element	Weight %	Reference
Concrete (shielding panels, floor)	2.35	H	0.56	Same as existing model in [5], first described in [16]
		O	49.83	
		Na	1.71	
		Mg	0.24	
		Al	4.56	
		Si	31.58	
		S	0.12	
		K	1.92	
		Ca	8.26	
		Fe	1.22	
Steel (A516 Grade 70, industrial roof cladding)	7.85	C	0.27	
		Si	0.4	
		P	0.025	
		S	0.025	
		Mn	1.2	
		Fe	98.08	
Rockwool Insulation (industrial roof insulation)	0.1	O	41.72	[12]
		Na	1.699	
		Al	3.45	
		Si	24.74	
		P	0.0655	
		K	1.303	
		Ca	21.64	
		Ti	0.306	
		Mn	0.0465	
		Fe	1.82	

ENCLOSURE 2

OPG Letter, K. Aggarwal to C. Salmon, "Pickering Waste Management Facility – Pickering Component Storage Structure, Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment Commission Member Document".

CD# 92896-CORR-00531-01606 P

Predictive Environmental Risk Assessment for Pickering Component Storage Structure

92896-REP-07701-00019 R002

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Predictive Environmental Risk Assessment for Pickering Component Storage Structure

92896-REP-07701-00019 R002 (LOF)

2024-11-25

Proprietary

Accepted by: Cammie Cheng

Cammie Cheng
Director, Nuclear Environment

Ecometrix | Environmental INTELLIGENCE

PREDICTIVE ENVIRONMENTAL RISK ASSESSMENT FOR PICKERING COMPONENT STORAGE STRUCTURE

92896-REP-07701-00019 R002 (LOF)

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92896-REP-07701-00019 R002 (LOF)

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Project Principal, Reviewer, and Approver

Revision Number	Date	Comments
R000	19-Oct-2023	Initial Issue of report.
R001	15-Nov-2023	Revision of Section 6.1.4.1 and Section 6.1.4.2 to remove text referring to a 1% increase in vehicle traffic.
R002	22-Nov-2024	Report updated to address CNSC comments on R001. Specific updates include: • A summary of the predicted effects of decommissioning (Section 4.2.4), • Discussion on uncertainties associated with models and data used (Sections 6.5 and 7.5), • Assessment for the effects of dewatering (Section 5.2.3) and • Assessment updated with the dose rates consistent with 92896-REP-01320-00019 R000, *"Pickering Component Storage Structure Safety Assessment*" (Sections 6.2, 6.4.1, 7.2, 7.4.1)

LAND ACKNOWLEDGMENT

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.

PNGS is within the territory of the Gunshot Treaty 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.

ALDERVILLE FIRST NATION · BEAUSOLEIL FIRST NATION · CURVE LAKE FIRST NATION · GEORGINA ISLAND FIRST NATION · HIAWATHA FIRST NATION · SCUGOG ISLAND FIRST NATION · RAMA FIRST NATION

EXECUTIVE SUMMARY

Ontario Power Generation (OPG), plans to construct the Pickering Component Storage Structure (PCSS) for the storage of low and intermediate level waste, including components such as steam generators, pressure and calandria tubes, calandria tube inserts as well as end fittings.

Since this would be a new activity for the Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF) within Pickering Nuclear (PN) site, not covered under the current NSS-PWMF operating licence, a licence amendment to the existing NSS-PWMF operating licence will be required. A predictive environmental risk assessment (PERA) is prepared to be a supporting document to the licence amendment application. The PERA presented in this document meets the requirements outlined in CSA N288.6-22 (CSA, 2022) and REGDOC 2.9.1 (CNSC, 2020).

The PERA will supplement the existing PN environmental risk assessment (ERA) (Ecometrix, 2023a) which has so far not considered the potential for effects from the PCSS.

The potential interactions of the PCSS Project with various environmental components during all phases of the Project were evaluated qualitatively. Based on the qualitative assessment of Project-Environment interactions, the following assessment areas were identified as the focus of the quantitative assessment in the PERA.

- Emissions of dust (total suspended particulates) and particulate matter (PM_{10}, $PM_{2.5}$) to air during site preparation and construction.
- Elevated noise levels during site preparation and construction.
- Gamma radiation from the PCSS during operation.

Human Health Risk Assessment

The screening assessment of air quality and noise indicated that all predicted air concentrations and noise levels are expected to be below their limits; therefore, no further quantitative assessment is required.

The human health risk assessment evaluated the impact on human health of gamma radiation from the PCSS. For exposure of human receptors to gamma radiation from the PCSS, the potential dose to the Sport Fisher, located at the outfall, was evaluated. The estimated dose for the Sport Fisher is 4.89E-03 µSv/a. Considering the existing facilities on the PN site, the 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 1000 µSv/a.

Overall, since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential groups to gamma radiation from the PCSS.

Ecological Risk Assessment

The screening assessment of air quality indicated that all predicted air concentrations are expected to be below their limits; therefore, no further quantitative assessment is required. While no specific noise level thresholds exist for ecological receptors, noise levels are expected to be elevated temporarily only during site preparation and construction. Most wildlife in the area are already accustomed to noise levels associated with an urban environment (i.e., noise from traffic on local roads and highway 401 and from other nearby industrial and commercial activities). Therefore, no further quantitative assessment is required.

The ecological risk assessment evaluated the impact on ecological health of 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 fenceline. All predicted doses are lower than the 2.4 mGy/d radiation benchmark for terrestrial biota. Therefore, it was concluded that there are likely no adverse radiological effects to the ecological receptors.

The dose also remains well below the radiation benchmark (at 3% of the terrestrial dose benchmark or less) if the maximum dose from the PCSS is combined with the dose to ecological receptors from being exposed to radionuclides through other existing PN operations.

Mitigation Measures and Environmental Monitoring Program

OPG will obtain all required environmental approvals and permits for the Project and will follow typical construction best practices including implementation of an Environmental Management Plan and a Stormwater Management Plan.

OPG's Environmental Policy requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001 Environmental Management System Standard. During site preparation, construction and operation of the PCSS, OPG's EMS will continue to require the assessment of environmental risks associated with the facility's activities, and to ensure that these activities are conducted such that any adverse impact on the natural environment is as low as reasonably achievable (ALARA).

Thermoluminescent dosimeters (TLDs) will be installed around the PCSS to monitor ambient dose rates during operation, and confirm that gamma dose rates remain below the dose rate target of 0.5 µGy/hr. TLD measurements will be summarized in the quarterly reports for the NSS-PWMF.

Based on the results of the PERA, no need for additional mitigation as a result of the PCSS was identified.

Overall, the PCSS will not result in any unacceptable risks to human and ecological receptors residing in the vicinity of the PN site. OPG maintains a comprehensive Environmental Monitoring

Program that provides data to confirm that all facilities on the PN site, including the future PCSS, operate in a manner that is protective of human and ecological receptors residing in the surrounding area.

LIST OF ACRONYMS

Acronym	Definition
AAQC	Ambient Air Quality Criteria
ALARA	As Low As Reasonably Achievable
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CNSC	Canadian Nuclear Safety Commission
CO	Carbon Monoxide
COPC	Contaminant of Potential Concern
CSA	Canadian Standards Association
EMP	Environmental Monitoring Program
ERA	Environmental Risk Assessment
HHRA	Human Health Risk Assessment
ISO	International Organization for Standardization
L&ILW	Low and Intermediate Level Waste
MECP	Ontario Ministry of Environment, Conservation and Parks
NOx	Nitrogen Oxides
NSS-DWMF	Nuclear Sustainability Services – Darlington Waste Management Facility
NSS-PWMF	Nuclear Sustainability Services – Pickering Waste Management Facility
OPG	Ontario Power Generation
PCSS	Pickering Component Storage Structure
PERA	Predictive Environmental Risk Assessment
PM	Particulate Matter
PN	Pickering Nuclear
PNGS	Pickering Nuclear Generating Station
QA	Quality Assurance
RWC	Retube Waste Containers
RWSB	Retube Waste Storage Building
SO_2	Sulfur Dioxide
TLD	Thermoluminescent Dosimeters
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
UCLM	Upper Confidence Limit on the Mean
WSP	Water Supply Plant

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1.0 Introduction

Ontario Power Generation (OPG) plans to construct and operate the Pickering Component Storage Structure (PCSS) for the storage of low and intermediate level waste, including components such as steam generators, pressure and calandria tubes, calandria tube inserts as well as end fittings.

Since this would be a new activity for the Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF) within Pickering Nuclear (PN), not covered under the current NSS-PWMF operating licence, a licence amendment to the existing NSS-PWMF operating licence will be required. In order to obtain the licence amendment, it will be necessary to demonstrate to the Canadian Nuclear Safety Commission (CNSC) that construction and operation of the PCSS will have no adverse significant environmental impact.

Accordingly, a predictive environmental risk assessment (PERA) has been prepared to be a supporting document to the licence amendment application. The PERA presented in this document meets the requirements outlined in CSA N288.6-22 (CSA, 2022) and REGDOC 2.9.1 (CNSC, 2020). Clause 11.1 of CSA N288.6-22 and Section 4.1.1 of REGDOC 2.9.1 version 1.2 identify the need for a revised predictive environmental risk assessment when there is a proposed major facility change. From OPG's perspective, construction and operation of the PCSS is considered a proposed major facility change that would trigger a predictive environmental risk assessment. The PERA is intended to supplement the existing PN environmental risk assessment (ERA) (Ecometrix, 2023a) and to support any future ERAs and/or PERAs that will be completed for PN, as applicable.

1.1 Indigenous Engagement

OPG recognizes that while the assessment of effects from the PCSS project has been satisfied from the Western scientific perspective, it may not fully address the impact on Indigenous inherent and treaty rights as they are understood today. OPG endeavors to continue to work with Indigenous nations and communities to develop more fulsome and ongoing engagement. OPG is sharing this PERA report with Indigenous nations and communities for feedback.

2.0 Objectives and Scope

The objective of this assessment is to predict any potential risk posed by contaminants and physical stressors in the environment associated with the construction and operation of the PCSS.

The scope of the assessment includes consideration of project activities and their interactions with the environment, screening level identification of activities with potential for environmental effects, and prediction of effects from those activities.

The construction activities associated with building the structure will be considered at a screening level, but as further discussed below under project-environment interactions (**Section 5.0**), no environmental impacts from construction are expected. Accordingly, the scope of this assessment will be focused thereafter on the facility operation. Consistent with CSA N288.6:22 (CSA, 2022), the scope of this assessment only considers normal operation of the PCSS and does not assess potential effects associated with accidents.

Furthermore, there is currently only a conceptual decommissioning plan for the PCSS after its operational life. A general discussion of the predicted effects of decommissioning is provided in **Section 4.2.4**. The existing Preliminary Decommissioning Plan for the NSS-PWMF will be updated to include decommissioning planning for the PCSS.

The predicted effects from the PCSS will be compared to existing effects related to the current PN operations as described in the existing PN ERA (Ecometrix, 2023a).

The need for mitigation measures, or for environmental monitoring related to operation of the PCSS, will be considered based on the predicted effects of the operation.

Cumulative effects due to the operation of the PCSS will be evaluated, along with a comparison against baseline conditions in the existing PN ERA (Ecometrix, 2023a).

3.0 Structure of the Assessment

The PERA is carried out in accordance with ERA guidance as per CSA N288.6-22 (CSA, 2022) and CNSC REGDOC 2.9.1 (CNSC, 2020). The steps in the assessment are illustrated at a high level in **Figure 3-1**.

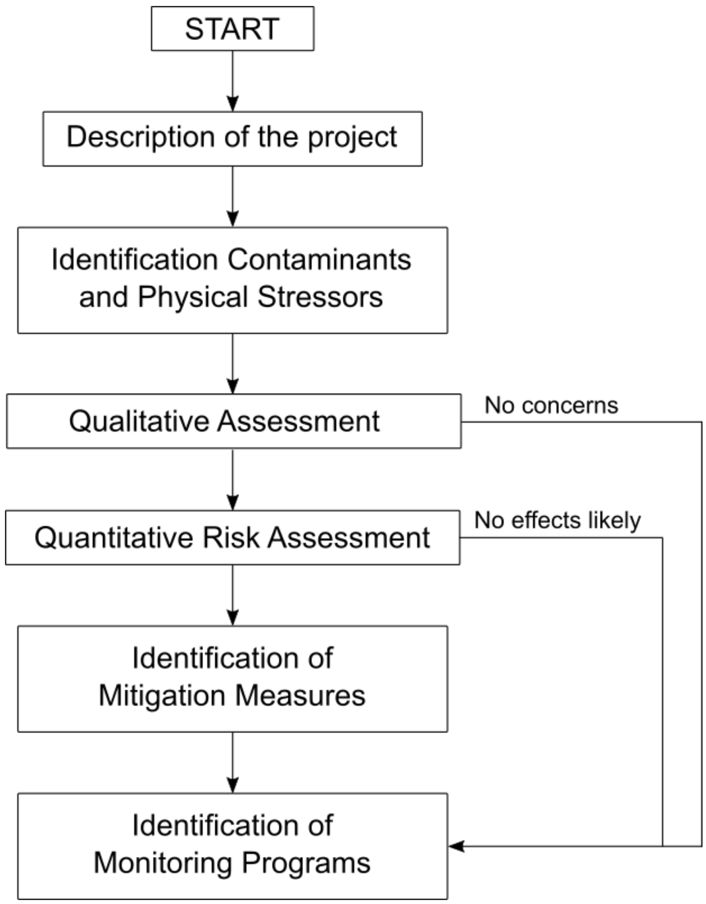


Figure 3-1: Steps in the Predictive Environmental Risk Assessment

A qualitative assessment of potential for environmental effects related to project activities (i.e. of potential project-environment interactions) identifies activities that require a quantitative predictive assessment.

The quantitative risk assessment in **Figure 3-1** includes consideration of risk to both human receptors (HHRA) and ecological receptors (EcoRA). These are two components of ERA as described by CSA N288.6-22 (CSA, 2022).

The mitigation measures mentioned in **Figure 3-1** refer to environmental protection measures associated with the project, which include measures to monitor and/or control emissions, as described in CNSC REGDOC 2.9.1 on Environmental Protection (CNSC, 2020).

The monitoring programs mentioned in **Figure 3-1** refer to the environmental monitoring programs (EMP). Any additions to the existing EMP that may be needed in relation to the operation of the PCSS will be described.

The following sections of this report address the structure outlined in **Figure 3-1**, including:

Section 4.0 Description of the Project (including contaminants of potential concern)

Section 5.0 Potential Project-Environment Interactions, Qualitative Assessment, and Plan for Quantitative Assessment

Section 6.0 Predictive Human Health Risk Assessment

Section 7.0 Predictive Ecological Risk Assessment

Section 8.0 Cumulative Effects Assessment

Section 9.0 Environmental Management

Section 10.0 Quality Assurance

Section 11.0 Conclusions and Recommendations

4.0 Description of the Project

4.1 Project Overview

The Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF), formerly the Pickering Waste Management Facility (PWMF), sits within the Pickering Nuclear (PN) site to the east of the Pickering Nuclear Generating Station (PNGS). The PN site is located in the Province of Ontario, in the Regional Municipality of Durham, 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 at latitude 43° 49′ N and longitude 79° 04′ W. The site location and vicinity are shown in **Figure 4-1**. The PN site is owned and operated by Ontario Power Generation (OPG).

The NSS-PWMF has been in service since 1994 and is comprised of two (2) sites. The NSS-PWMF Phase I site is located southeast of PN Unit 8, adjacent to the east side of the station security fence, and contains two used fuel dry storage buildings and a Retube Component Storage area. The NSS-PWMF Phase II site is located approximately 500 m north-east of the power generating facilities in the East Complex, with its own distinct "protected area" (OPG, 2018).

The proposed PCSS will be located adjacent to the northern boundary of the NSS-PWMF Phase II site within the Pickering Site East Complex as shown in **Figure 4-2**. However, ownership and operation of the PCSS will fall under the NSS-PWMF. The PCSS will be used for the storage of low and intermediate level waste from potential refurbishment and/or decommissioning storage requirements, including components such as steam generators, pressure and calandria tubes, calandria tube inserts, and end fittings. Based on the expected waste streams that will be produced, the PCSS is expected to have an area of approximately 26,000 ft^2. The structure will be shielded with concrete walls and enclosed with a roof.

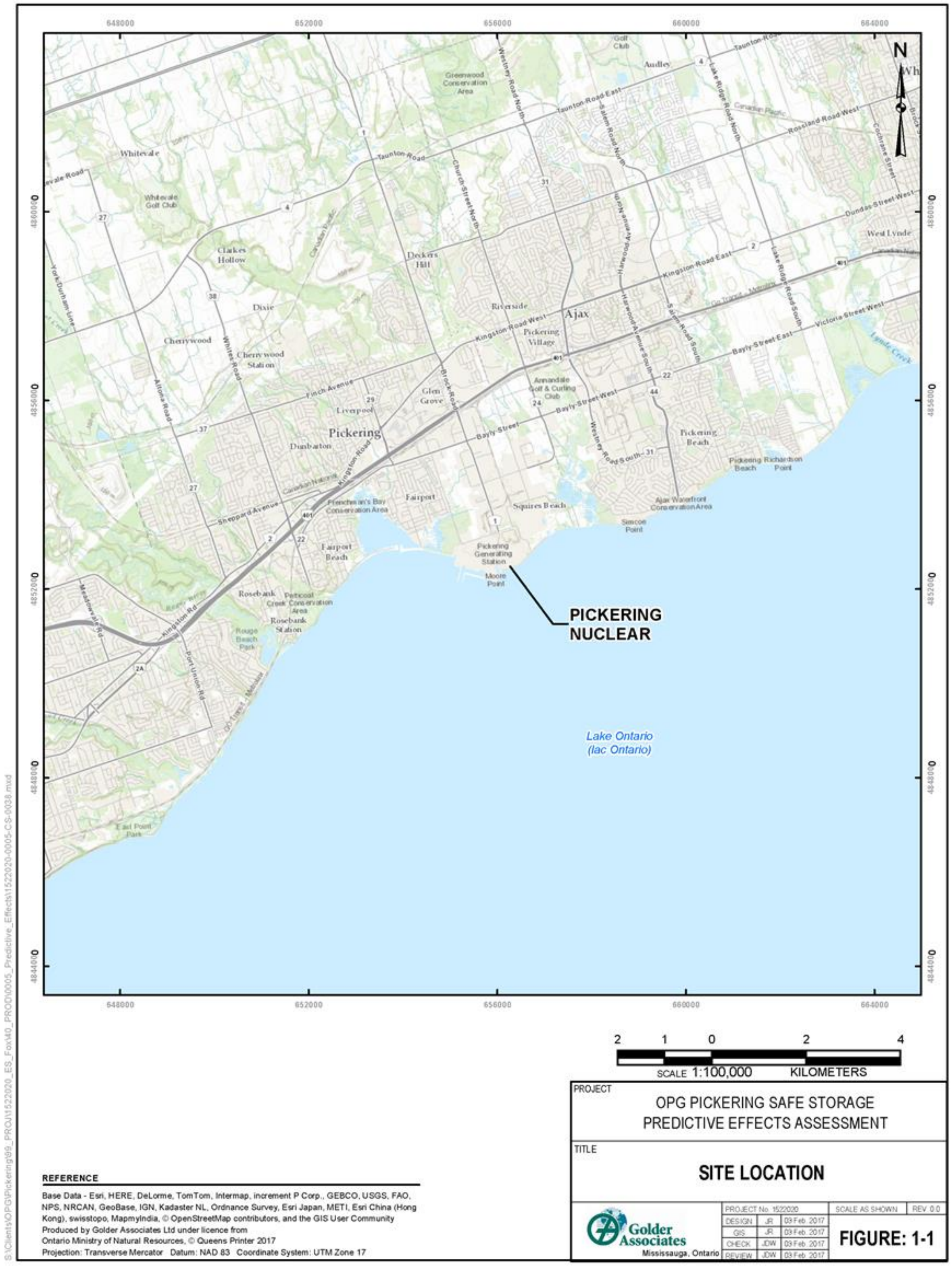


Figure 4-1: PN Site Location and Vicinity

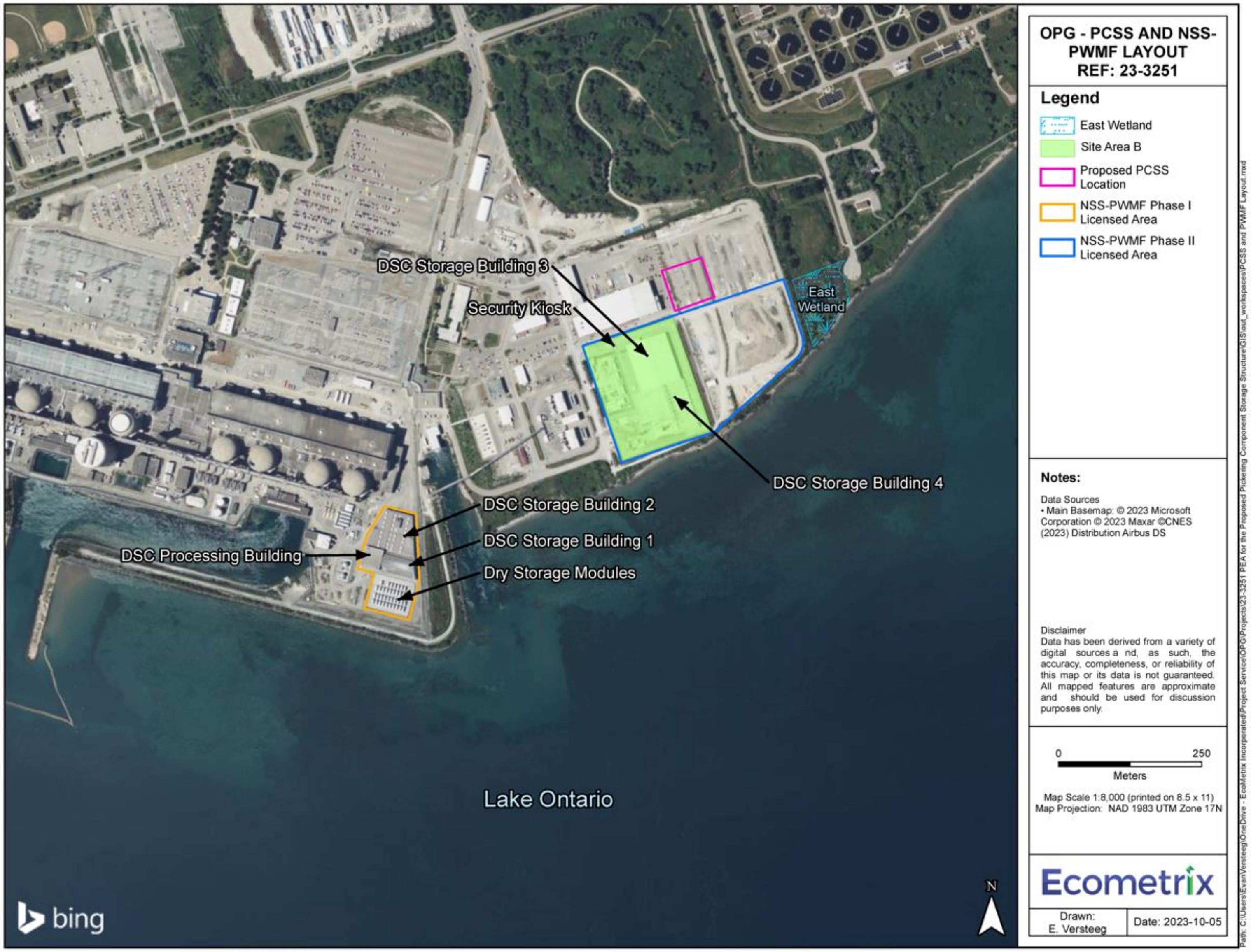


Figure 4-2: PCSS and NSS-PWMF Layout

4.2 Project Activities

Three main phases are associated with the Project and include:

- **Site Preparation:** This phase includes all activities associated with preparing the Project area for construction of the PCSS. Activities may include clearing the site, excavation, grading, and installation of utilities.
- **Construction:** This phase includes all activities associated with constructing the PCSS immediately following site preparation and up to the transfer of wastes to the new structure.
- **Operation and Maintenance:** This phase includes all activities associated with normal operation of the PCSS, and includes accepting and storing wastes and performing regular inspections and maintenance activities.
- **Decommissioning:** This phase includes all activities associated with decommissioning of the PCSS, and will include preparation of the detailed decommissioning plans and site decommissioning and restoration.

4.2.1 Site Preparation Phase Works and Activities

Site preparation involves preparation of the site for future construction activities. All site preparation activities are assumed to be completed at approximately the same time before construction of the PCSS begins. For the purposes of this PERA, the following site preparation activities are assumed to occur during pre-construction.

4.2.1.1 Site Clearing and Maintenance of Cleared Areas

Currently, the area of the proposed PCSS (shown on **Figure 4-2**) is being used as a laydown area where tools, materials and other equipment are being temporarily stored. The area is sparsely vegetated, but small patches of shrubbery and plants may need to be removed using conventional equipment including shovels, chainsaws or excavators. Cleared vegetation may be transported off-site for disposal or may remain on the PN site. Following clearing, the area will be maintained to ensure new vegetation does not repopulate the area and that the area remains clear of debris.

4.2.1.2 Excavation

During site preparation, the area will be excavated and levelled as required to establish appropriate grading for future construction of the PCSS. Excavation will take place using conventional equipment such as excavators and bulldozers. Where possible, excavated soil may be used as fill material. Otherwise, soil and other excavated materials may either be stored for future use at the PN site or be disposed of off-site in accordance with applicable regulations.

4.2.1.3 Grading and Compaction

Grading and compaction will be required on the overall site and in the area where backfilling of the structure's foundation has occurred. Conventional construction equipment such as graders and vibratory rollers will be used. Where possible, site grading will direct surface runoff to the existing drainage infrastructure using industry best management practices for erosion and sediment control.

4.2.1.4 Installation of Utilities

Utilities connected to the new PCSS will include electricity, communication services, and fire water supply. The structure will not have any personal services (i.e. washrooms, office, lunch room, etc.)

4.2.1.5 Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel

During the site preparation phase, construction materials, equipment and trailers will be transported and stored within the PCSS area. This will increase the amount of vehicle traffic (passenger vehicles, heavy construction machinery) moving to and within the Project area. A spill management plan will be in place within the construction island as a result of these activities.

4.2.1.6 Vehicle and Equipment Operation, Maintenance and Refueling

Refuelling by a refuelling truck and maintenance of construction equipment and vehicles will occur on an as-needed basis within the PCSS construction island. A spill management plan will be in place within the construction island as a result of these activities.

4.2.1.7 Stormwater Management and Drainage

The stormwater management system collects, transports, and discharges precipitation that falls onto the NSS-PWMF site. During site preparation, measures will be put in place to minimize the impact of site runoff. These temporary measures may include ditching, sediment basins, berms and hay bales to reduce sediment loadings in runoff. As noted, site grading should direct surface runoff to the existing drainage infrastructure where possible. 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.

4.2.2 Construction Phase Works and Activities

The construction phase involves the construction of the new PCSS. For the purposes of this PERA, the following activities are assumed to occur during construction.

4.2.2.1 PCSS Construction

Construction activities and materials will be similar to those used for conventional industrial buildings. Once the PCSS is constructed, the area surrounding the structure will be paved over.

4.2.2.2 Construction Waste Management

Construction activities are expected to produce negligible quantities of conventional construction waste and no radioactive waste. Potential waste streams include gravel, wood, domestic refuse, and potentially small quantities of metal and concrete. On-site waste management and off-site disposal will be the responsibility of the construction contractor selected by OPG.

4.2.2.3 Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel

During the construction phase, construction materials, equipment, and trailers will continue to be transported and stored within the PCSS area. This will increase the amount of vehicle traffic (passenger vehicles, heavy construction machinery) moving in, out and within the PCSS area.

4.2.2.4 Vehicle and Equipment Operation, Maintenance and Refueling

Refuelling by a refuelling truck and maintenance of construction equipment and vehicles will occur on an as-needed basis within the PCSS area in areas designated for such activities.

4.2.2.5 Stormwater Management and Drainage

Stormwater management during construction will be the same as during site preparation. OPG will employ best practices for stormwater management that would meet Ontario MECP requirements and industrial sewage works rules.

4.2.3 Operation and Maintenance Phase Works and Activities

The operation and maintenance phase is assumed to commence once construction is complete. The operation of the NSS-PWMF is governed by the Waste Facility Operating Licence (CNSC, 2018) and OPG policies and procedures covering all aspects of the waste management systems and structures. The PCSS will be incorporated into the existing NSS-PWMF operating policies and procedures.

4.2.3.1 Transfer of Waste to the PCSS

The PCSS is proposed to store L&ILW associated with the possible PNGS refurbishment project and possibly future PNGS decommissioning activities. The waste streams that would require storage at the PCSS include intact steam generators (SGs), pressure tubes and calandria tubes, calandria tube inserts and end fittings. These materials will be processed (e.g. volume reduced, packaged, etc.) within the PNGS before transfer to the PCSS for secure storage.

4.2.3.2 Operation of the PCSS

Storage of wastes at the PCSS will occur in accordance with approved OPG policies and practices. Radiological monitoring consistent with existing OPG procedures and protocols for other waste buildings within the NSS-PWMF will occur at the PCSS once radiological wastes are received.

The PCSS will require regular inspection and maintenance; maintenance is anticipated to consist largely of lamp replacement for overhead lights, roof inspections and routine scheduled maintenance of mechanical components (e.g., fans, service doors, fire protection systems).

Radioactive contamination is not expected in the PCSS under normal operation. Waste packages must be surveyed and be free of loose external contamination before leaving the Protected Area boundary of the PNGS. Based on knowledge of existing waste buildings, it is expected that negligible quantities of LLW, such as contaminated wipes, floor sweepings, rags and cleaning materials may be produced in the PCSS during operation and maintenance. These wastes will be managed according to approved OPG policies and practices.

Operation and maintenance of the PCSS will require minimal use of potentially hazardous substances. Small quantities of non-radioactive domestic waste typical of a commercial/industrial facility (e.g., cleaning solutions) may be produced during operation and maintenance of the facility.

4.2.3.3 Stormwater Management and Drainage

The infiltration capacity of the NSS-PWMF area may be decreased by the PCSS due to vegetation clearing, grading and compaction, and the paving of surfaces. This may result in an increase in peak flows. To the extent possible, grading will be designed to direct surface runoff towards existing drainage infrastructure. All site grading and other stormwater management activities will be undertaken during the site preparation phase. OPG will employ best practices for stormwater management that would meet Ontario MECP requirements and industrial sewage works rules.

4.2.4 Predicted Effects of Decommissioning

There is currently only a conceptual decommissioning plan for the PCSS after its operational life. The existing Preliminary Decommissioning Plan for the NSS-PWMF will be updated to include decommissioning planning for the PCSS.

At a high level, once the PCSS ceases storing low and intermediate level waste, including components such as steam generators, pressure and calandria tubes, calandria tube inserts as well as end fittings, all waste will be transferred to a licensed long-term waste management facility. No hazardous materials will be used in the construction of the PCSS. Additionally, the PCSS is not expected to become contaminated during operation since the waste will be enclosed within waste packages. As such, interactions with the environment during decommissioning are expected to be minimal and are not discussed further.

5.0 Potential Project-Environment Interactions, Qualitative Assessment

5.1 Potential Project Environment Interactions

The PCSS has the potential to affect various components of the environment, including the surface water environment, atmospheric environment (air quality and noise), the soil and shallow groundwater (by transfer from air to soil porewater), the terrestrial environment (plants and animals) and human health (workers and members of the public). Based on the description of Project activities (**Section 4.2**) the potential for impact on components of the environment is evaluated qualitatively in this section at a screening level, to identify interactions that warrant further quantitative assessment (see **Table 5-1**).

Workers during site preparation, construction, and operations and maintenance will be working under the existing OPG Radiation Protection Program, and the existing Health and Safety Management Systems. Normal work planning procedures will be followed, and worker doses will be monitored as usual. As such, worker health from the PCSS is not considered further in the PERA.

Table 5-1: Identification of Project-Environment Interactions

Project Activities	Atmospheric Environment (air and noise)	Surface Water Environment (quality and quantity)	Groundwater (quality and quantity)	Geology (Soils)	Radiation and Radioactivity	Terrestrial Environment	Aquatic Environment	Human Health (public)
Site Preparation								
Site Clearing and Maintenance of Cleared Areas	✓	O	O	O	-	✓	O	✓
Excavation (and Storage)	✓	O	O	O	-	✓	O	✓
Grading and Compaction	✓	O	O	O	-	✓	O	✓
Installation of Utilities	✓	-	O	O	-	✓	-	✓
Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel	✓	O	O	O	-	✓	O	✓
Vehicle and Equipment Operation, Maintenance and Refueling	✓	O	O	O	-	✓	O	✓
Stormwater Management and Drainage	-	O	O	O	-	O	O	O
Construction								
PCSS Construction	✓	O	O	O	-	✓	O	✓
Construction Waste Management	✓	O	O	O	-	✓	O	✓
Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel	✓	O	O	O	-	✓	O	✓
Vehicle and Equipment Operation, Maintenance and Fueling	✓	O	O	O	-	✓	O	✓

Project Activities	Atmospheric Environment (air and noise)	Surface Water Environment (quality and quantity)	Groundwater (quality and quantity)	Geology (Soils)	Radiation and Radioactivity	Terrestrial Environment	Aquatic Environment	Human Health (public)
Stormwater Management and Drainage	-	O	O	O	-	O	O	O
Operation and Maintenance								
Transfer of Waste to the PCSS	O	O	O	O	✓	✓	O	✓
Operation of the PCSS	-	-	-	-	✓	✓	-	✓
Stormwater Management and Drainage	-	O	O	-	-	-	O	O

Note:
✓ Indicates direct interaction with the environmental component. Further quantitative assessment required.
O Indicates negligible interaction with the environmental component. No further quantitative assessment required.
'-' Indicates no interaction with the environmental component. No assessment required.

5.2 Qualitative Assessment of Project-Environment Interactions

Table 5-1 summarizes the potential interactions of the Project with various environmental components either as direct or negligible interactions. The following section details these interactions and assesses the risk qualitatively or identifies that the interaction is assessed further quantitatively in **Sections 6.0**, **7.0** and **8.0**.

5.2.1 Atmospheric Environment (Air Quality and Noise)

The atmospheric environment consists of the air surrounding the Project area within which air pollutants and elevated noise levels may be experienced by on-site and off-Site humans or ecological receptors. All phases of the Project are expected to interact with the atmospheric environment.

5.2.1.1 Air Quality

5.2.1.1.1 Radiological Emissions

No radiological air emissions are expected during any phase of the Project. No radiological materials are associated with site preparation and construction. During operation and maintenance of the PCSS, radiological wastes will be contained and stored in the PCSS, and as a result, no radiological emissions are expected during normal operations. Thus, radiological emissions to the atmosphere are considered negligible and are not assessed further in the PERA. Gamma radiation from the PCSS is discussed in **Section 5.2.5**.

5.2.1.1.2 Non-Radiological Emissions

Site preparation and construction are expected to involve the use of both light equipment (e.g., chainsaws) and heavy equipment (e.g., bulldozers, dump trucks, pick-up trucks) that could release non-radiological air emissions (e.g., exhaust emissions) into the atmosphere. Excavation, grading, installation of buried utilities and other sub-surface activities that disrupt the soil surface may contribute to particulate matter (PM) and dust in the air.

OPG will follow typical construction best practices including implementation of an Environmental Management Plan. The construction Environmental Management Plan will include protocols for dust suppression during site preparation and construction to reduce the release of particulates and dust into the atmosphere. The on-site storage of excess soils may also contribute to particulate and dust emissions and may also be subject to dust suppression protocols as required. During construction, building and construction waste materials (e.g., concrete) may also contribute particulates and dust to the atmosphere. Other chemicals including fuel (gasoline or diesel), oils, paints, solvents and cleaners may release volatile compounds into the atmosphere during use or accidental spills. However, the quantity and frequency of these releases is considered negligible as these chemicals will be securely stored, and spills would be managed following site-specific procedures and existing OPG spill management protocol.

Once operation of the PCSS begins, there would be exhaust emissions from vehicles during the transfer of waste materials. Vehicle traffic associated with PCSS operation may be similar to or slightly higher than that associated with current NSS-PWMF operations, but the increased vehicle emissions due to the slightly increased traffic volumes would overall be considered negligible.

Considering the above interactions, non-radiological air pollutants (e.g., particulate matter, dust, exhaust emissions) may impact the atmospheric environment during site preparation and construction, and will be quantitatively assessed in the PERA.

5.2.1.2 Noise

During site preparation and construction, elevated levels of noise may be produced. Both light equipment (e.g., chainsaws, power tools) and heavy equipment (e.g., bulldozers, dump trucks, pick-up trucks) produce loud sounds and vibrations during their operation. In addition, loud banging sounds typical of an active construction site are expected during site preparation and construction.

During operation and maintenance, noise may be produced by trucks transferring waste materials to the PCSS. Vehicle traffic associated with PCSS operation may be similar to or slightly higher than that associated with current NSS-PWMF operations but would overall be considered negligible.

OPG will follow typical construction best practices including implementation of an Environmental Management Plan.

Considering the above interactions, elevated levels of noise during site preparation and construction only may impact the atmospheric environment and will be quantitatively assessed in the PERA.

5.2.2 Surface Water Environment and Aquatic Environment

The surface water environment at PN with respect to the PCSS is described as surface runoff and drainage features on the property, which ultimately drain into Lake Ontario. The aquatic environment at PN with respect to the PCSS is Lake Ontario. A construction Environmental Management Plan will be in place with mitigation measures to minimize adverse impacts to the environment. For example, excavations are expected to be shored or sloped until stable to ensure that any surface water runoff is directed to a sump pit where it will be collected and removed by a sump pump and will subsequently be properly managed and controlled to meet the regulatory requirements. Excavations, stockpiling or backfilling activities will also be rescheduled or suspended to limit work completed during days of heavy rainfall or adverse weather conditions that could impact soil or surface water quality.

Any impacts from the transportation and storage of various components as well as vehicle and equipment operations involved in site preparation, construction and operations may indirectly impact surface water. However, surface water quality entering the surface drainage features will not likely be impacted, due to the implementation of OPG's existing spill management protocols, which outlines the framework to manage spills, ensuring the implementation of spill prevention, preparedness, clean-up and remediation processes. Potential impacts due to a spill event investigation and associated corrective actions are not considered in this document.

During all Project phases there is no source of contaminants (radiological or non-radiological) that would result in impacts to surface water or sediment. Water would be managed and monitored according to the approved Environmental Compliance Approval for the PN site.

During site preparation and construction surface runoff and drainage will be directed towards surface drainage infrastructure (i.e., new ditches and sewers that connect to the existing stormwater infrastructure).

Sediment may have the potential to impact the surface drainage infrastructure, drainage to Lake Ontario and therefore the aquatic environment. A Stormwater Management Plan will be developed to provide the plans for mitigating erosion and sediment transport during site preparation and construction. Additionally, it is expected that the PCSS Project will utilize construction best practices to mitigate the amount of sedimentation created within the Project area and apply the appropriate control measures to achieve the required contaminant removal efficiency for total suspended solids (TSS) prior to the release of water into the surface water environment. Additional control measures such as diversion ditching, silt fencing, and straw bale barriers will also be used in areas where existing systems or typical control measures do not fully address potential sedimentation issues related to this Project.

A separate Stormwater Management Plan will be developed for the operation and maintenance phase post construction. The assessment of 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. As such, no change to existing channel forming flows, flood risk, or erosion potential will be expected during operation and maintenance of the PCSS. Additionally, any shoreline work for potential 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.

Considering the above commitments and mitigation measures, no further quantitative assessment is included as part of this PERA. Further detail on mitigations will be developed through the design of the stormwater management system. Therefore, impacts to the surface water environment (through surface water quality) and to the aquatic environment as a result of surface water runoff from the PCSS Project are considered to be adequately managed and will not be assessed further in the PERA.

5.2.3 Groundwater (Quality and Quantity)

Overall, during site preparation, construction, operation and maintenance, any exposed soil can result in constituents in soil, surface water and precipitation infiltrating downwards towards the groundwater table instead of being diverted to surface drainage. Soils interacting with surface water (site drainage) can infiltrate into the water table and impact groundwater quality. However, groundwater quality is not expected to be impacted as a result of these activities as any potential spills will be managed following site-specific procedures and existing OPG spill management protocol. Potential impacts due to a spill event investigation and associated corrective actions are not considered in this document.

A geotechnical investigation conducted in Fall 2024 for the proposed PCSS characterized the prevailing subsurface soil and groundwater conditions to provide geotechnical engineering design recommendations (Englobe, 2024). The geotechnical investigation identified that groundwater conditions are likely to require dewatering during excavation of caissons for the foundations of the PCSS.

Any dewatering will only be done with necessary permissions following 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). Based on the estimated hydraulic conductivity estimate of 1×10^{-9} m/s provided by Englobe (2024), dewatering rates will be much lower than 50,000 L/d. The water table will be temporarily lowered in a very local area around the caissons.

Therefore, based on the current understanding of the dewatering, impacts to the groundwater quality and quantity as a result of the PCSS Project will be negligible, and will not be assessed further in the PERA.

5.2.4 Geology (Soils)

Overall, during site preparation, construction, operation and maintenance, any exposed soil can be impacted due to excavations, or the storage, transportation or handling and maintenance of various components related to different phases of the PCSS. Soil and other excavated materials may either be stored for future use at the PN site or be removed off-site in accordance with applicable regulations.

Soil quality is not expected to be impacted as a result of these activities as any potential spills will be managed following site-specific procedures and existing OPG spill management protocol. Potential impacts due to a spill event investigation and associated corrective actions are not considered in this document.

A construction Environmental Management Plan will also be in place with some mitigation measures. For example, excavations are expected to be shored or sloped until stable to ensure any surface water runoff is directed to a sump pit where it will be collected and removed by a sump pump where it will subsequently be properly managed and controlled to meet the regulatory requirements. Also, excavations, stockpiling or backfilling activities will also be rescheduled or suspended to limit work completed during days of heavy rainfall or adverse weather conditions that could impact soil or groundwater quality.

Therefore, impacts to the soil quality as a result of the PCSS Project will be negligible, and will not be assessed further in the PERA.

5.2.5 Radiation and Radioactivity

Increased radiation or radioactivity levels in the environment are not expected during site preparation and construction as these phases do not involve the use of radioactive materials or the modification of facilities that use radioactive materials.

During the operation and maintenance phase, no radioactivity will be released to air or water as all radionuclides are expected to be contained in waste storage containers within the PCSS (**Section 5.2.1.1.1**).

There will be gamma radiation fields emitted during the transfer of waste storage containers and once waste is stored in the PCSS during operation. The design of the PCSS will provide some shielding in the walls, which will be verified upon the completion of the structure design. The effects of direct gamma radiation from operation of the PCSS are assessed conservatively by assuming the full complement of loaded waste storage containers and minimal shielding.

Therefore, gamma radiation fields from the transfer and storage of waste containers at the PCSS during the operation and maintenance phase can impact humans and terrestrial organisms and is therefore considered further for the quantitative assessment.

5.2.6 Terrestrial Environment

The terrestrial environment considers the various terrestrial habitats within and immediately surrounding the PCSS site and the diverse groups of plants and animals that rely on those habitats for survival, including federally and provincially-protected Species at Risk (SAR). Although the PCSS site is highly disturbed and is not considered to contain significant terrestrial habitat, some plant and animal species adapted to urban and disturbed environments may reside within the PCSS site. Interactions between the Project and the terrestrial environment are expected to occur as a result of either direct disturbance of the ground (e.g., excavation) or through the release of air pollutants and noise/vibration from the atmospheric environment.

The PCSS will be constructed within the existing PN site, which consists of numerous buildings, parking lots, paved and gravel areas, and outdoor laydown areas where equipment and materials are stored. There is no significant vegetation within the proposed PCSS site. Vegetation that does exist is sparse and is consistent with rugged vegetation typical of a highly-disrupted, developed environment (e.g., weeds, grasses, small shrubs). These small pockets of vegetation will be removed during site preparation to clear the area for paving and the PCSS structure itself. Denser vegetation consisting of cultural meadows containing species tolerant of poor soil conditions exist to the north and east of the site. Pockets of mineral cultural woodlands containing younger treed communities and mineral cultural thickets are interspersed within the surrounding meadows. Small mineral shallow marshes exist dotted around the PN site to the north, east and west of the proposed PCSS location (Beacon, 2023). To the south, along Lake Ontario, there also exist pockets of meadows, thickets and open shoreline where vegetation is generally sparse. Off-site vegetated areas surrounding the PN site are fragmented by roads, public trails and other infrastructure (Beacon, 2023). Soil organisms that live within the subsurface may be impacted during site preparation as the landscape is drastically altered and disturbed by excavation and grading. Small mammals and birds are likely present in the proposed PCSS area, and may use the area for shelter or to hunt and scavenge for prey and food. These mammals and birds will be disrupted during site preparation and construction, but are expected to return during normal operations when construction has ceased.

During all phases of the Project, there is the potential for vehicle collisions with wildlife that may result in injuries or road mortalities. Wildlife surrounding the PCSS may be impacted by air emissions (e.g., vehicle exhausts, dust) and loud noises and vibrations during site preparation and construction. During operation and maintenance, wildlife may be exposed to direct gamma radiation fields from the PCSS where waste materials are stored.

During site preparation and construction, various measures outlined in the construction Environmental Management Plan will be followed to minimize impacts to the terrestrial environment and local wildlife. The Environmental Management Plan identifies best practices relating to air and water management, noise control, contaminated and excess soil management, and general wildlife management. Safe driving best practices will be used to avoid vehicle collisions with wildlife.

Since direct interactions between Project activities and the atmospheric environment were identified for the site preparation and construction phases, the subsequent effects on the terrestrial environment will be quantitatively assessed for these phases. In addition, a quantitative assessment of radiation exposures near the PCSS during the operation and management phase will be completed for terrestrial wildlife.

5.2.7 Human Health (Public)

During site preparation and construction, OPG staff will be working under the existing OPG Health and Safety Management Systems. Similarly, on-site contractors are expected to work in accordance with their own health and safety programs and procedures. Once operation of the PCSS begins, OPG staff will be working under the existing OPG Radiation Protection Program. For these reasons, the assessment of potential Project effects to on-site workers are not considered part of this PERA.

Members of the general public will not have direct access to the PCSS as the entire PN site is enclosed by perimeter fencing and is continuously protected by security personnel. However, off-site human receptors at the perimeter of the PN site may be impacted by Project activities. This is primarily expected to be due to loud noises and vibrations associated with site preparation and construction. Human receptors may come into contact with airborne dust at the PN perimeter. As noted in **Section 5.2.1.1.2**, dust suppression techniques used during site preparation and construction is expected to reduce the amount of dust emissions released to the atmosphere. Human receptors at the PN site boundary may be exposed to air constituents associated with engine emissions during site preparation and construction. During operation and maintenance, the general public in close proximity to the eastern boundary of the PN site may be exposed to direct gamma radiation fields emitted from the PCSS.

Since direct interactions between Project activities and the atmospheric environment were identified, the subsequent effects on human health (e.g., dust, engine emissions, noise) will also be quantitatively assessed for the site preparation and construction phases. In addition, a quantitative assessment of direct gamma radiation exposures to the general public at the PN site boundary from the PCSS during the operation and maintenance phase will be completed.

5.2.8 Identification of Contaminants of Potential Concern and Physical Stressors

The environmental stressors investigated further in this PERA include air emissions, noise and radiation.

It is expected that air emissions are released during the site preparation and construction phase that are largely related to engine emissions from construction activities involving both light and heavy equipment. It is expected that the contaminants of potential concern (COPCs) include sulfur dioxide (SO_2), nitrogen oxide compounds (NO_x), carbon monoxide (CO), dust (i.e., total suspended particulates) and particulate matter at 2.5 µm and 10 µm ($PM_{2.5}$ and PM_{10}). Noise is also a potential stressor to human and terrestrial biota associated with the use of light and heavy equipment operations during site preparation and construction of the PCSS.

Finally, gamma radiation fields associated with the storage of radiological wastes can act as a potential stressor to both human and terrestrial biota from the PCSS.

5.3 Quantitative Assessment of Project-Environment Interactions

As previously noted, **Table 5-1** summarizes the potential interactions of the Project with various environmental components either as direct, indirect or negligible interactions. Direct interactions identified in **Table 5-1** and further characterized in **Section 5.2** will be assessed quantitatively in **Sections 6.0** and **7.0.** Additionally, **Section 8.0** will quantitatively assess potential cumulative effects between the PCSS and the existing PN site.

Section 6.0 will quantitatively assess potential risks to human health from air pollutants, dust and noise emissions produced during site preparation and construction of the PCSS, and from gamma radiation released from the PCSS during operation and maintenance.

Similarly, **Section 7.0** will quantitatively assess potential risks to ecological (terrestrial) receptors from air pollutants, dust and noise emissions produced during site preparation and construction of the PCSS, and from gamma radiation fields from the PCSS during operation and maintenance.

5.4 Climate Change Considerations

There is uncertainty related to interactions of climate change with this Project. Changes in climate have the potential to affect meteorological parameters that influence dispersion over the long term (i.e., the life of the Project). This may influence deposition rates and subsequent environmental media concentrations. Considering site preparation and construction activities are anticipated to last for a short duration (less than one to two years), the impact of climate change on meteorological conditions is minimal.

Likely increased frequency and severity of extreme weather events over the coming decades due to climate change may affect the Project. Changes in climate during the lifetime of the Project may result in increased precipitation which would result in additional runoff. Additionally, extreme precipitation events are expected to increase over time. The design of the water management infrastructure would include additional capacity to accommodate climate change, as applicable. Additionally, the Project will be designed using engineering best practices which will account for considerations of extreme weather events. OPG's existing Emergency Management Program addresses actions to be taken to respond to emergencies which would include extreme weather events.

Overall, considering the limited interactions of the Project with the environment, and the existing measures (e.g., Emergency Management Program, consideration of extreme weather events in infrastructure design) to mitigate interactions between the environment and the Project, the impacts of climate change on the Project are considered negligible.

6.0 Predictive Human Health Risk Assessment

6.1 Problem Formulation

The problem formulation provides the objectives, goals, framework and methodology for the risk assessment and consists of identifying the relevant components for the HHRA. These components include the human receptors that may be potentially present in or around the PN Site; the chemical and radiological contaminants 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 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.

The 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 operation and maintenance of the PCSS, 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 HHRA. The focus of the HHRA is on off-site members of the public.

6.1.2 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 the “critical group”. Potential critical groups are defined through site specific surveys and their doses are calculated in the OPG Annual Environmental Monitoring Program (EMP) Reports.

Consistent with the potential critical groups identified in the EMP (OPG, 2023) and in the PN ERA (Ecometrix, 2023a), the six 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).

- 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.

Indigenous communities were considered in the selection of receptors for the HHRA. Information from engagement with Indigenous communities, councils and organizations gathered during preparation of the PN U5-8 Refurbishment Environmental Assessment (EA) (SENES, 2007) did not indicate their use of lands, water or resources for traditional purposes within the Local Study Area (defined for the PN U5-8 Refurbishment EA as extending approximately 10 km from PN). However, it is possible that individuals may carry out these activities in a limited fashion as these activities would be restricted by the urbanization, population density, and preponderance of private land in the area. Through engagement with Indigenous communities, OPG continues to seek to learn about how the lands and waters in the area around PN are being used. Based on OPG’s current understanding, it was judged that any influence from PN on the health of Indigenous communities was likely to be bounded by the assessment for potential critical groups located much closer to PN who consume foods local to PN as part of their diet. For example, the farm receptors obtain a large fraction of their fruits, vegetables and animal produce locally, with the nearest location at 6 km from PN. While there may be dietary differences such as more wild game in the Indigenous diet, and more farm produce in the farm diet, both groups will have high local food intake fractions, and overall dietary intakes will be similar. Likewise, the Sport Fishers are assumed to obtain their entire fish diet from the PN outfall. It is expected that Indigenous communities would receive doses that are equal to or lower than those received by these potential critical groups.

Since the majority of the potential critical groups are located greater than 1 km from the PN Site, their exposure to releases from the PCSS site during all Project phases is limited. Of the six potential critical groups, the Sport Fisher is expected to conservatively represent interactions with the PCSS due to their proximity to the site, approximately 0.5 km south of the PN Site at the outfall. The exposure location of this critical receptor group is shown in **Figure 6-1**.

In summary, the Sport Fisher (representative of receptors that are in close proximity to the site boundary) is the human receptor group assessed in this HHRA.

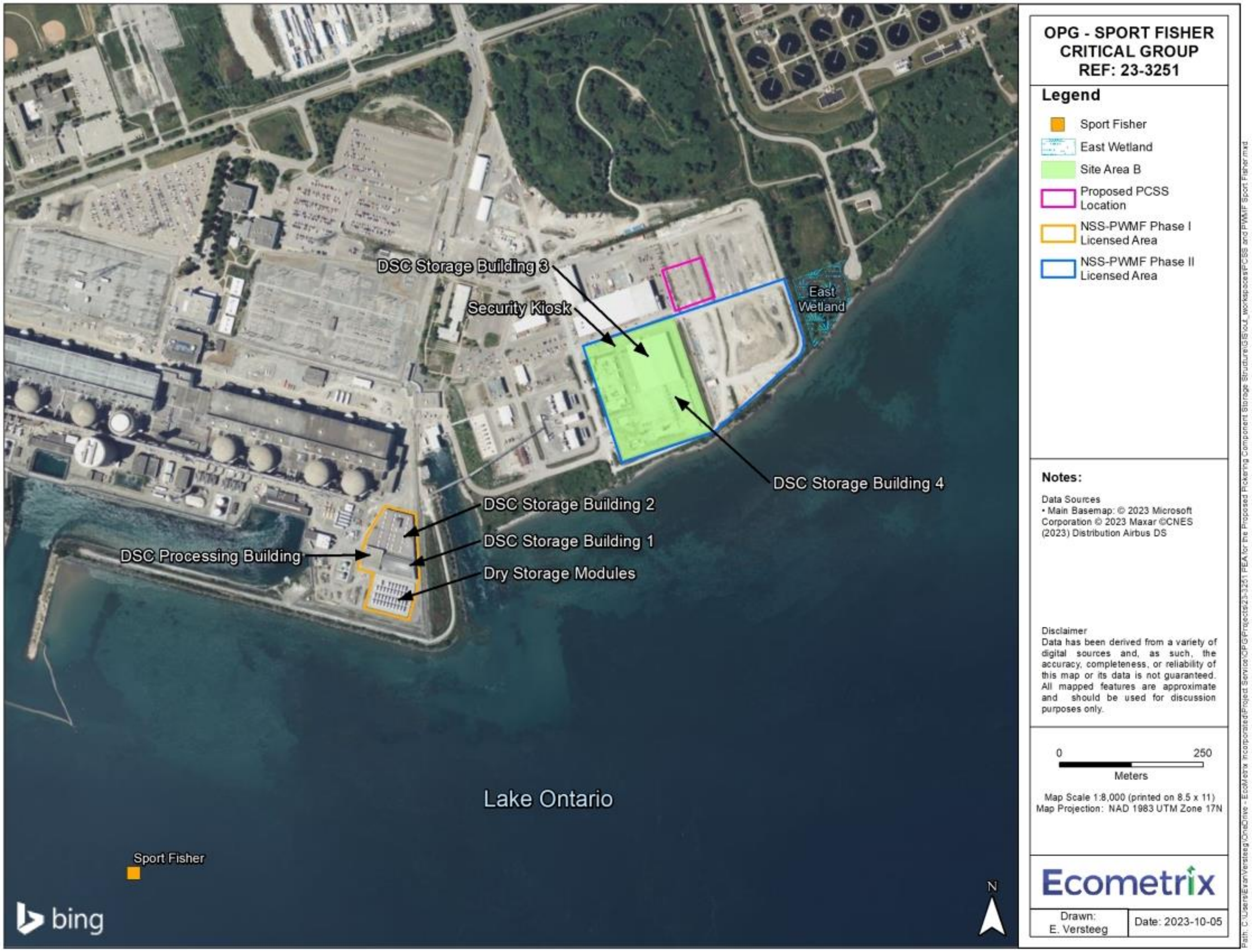


Figure 6-1: Location of Human Receptor – Sport Fisher

6.1.3 Human Health Exposure Pathways and Conceptual Model

As discussed in **Section 5.2**, direct interactions of PCSS with the atmospheric environment were identified. Additionally, human receptors will be exposed to direct gamma radiation from the PCSS. **Table 6-1** summarizes the human health exposure pathways from the PCSS for the human receptors identified for the site.

Table 6-1: Human Health Exposure Pathways

Receptor Group	Environmental Media	Exposure Pathway
Sport Fisher	Air	Radiation immersion (external exposure)
		Noise – noise levels
		Inhalation of particulates and contaminants

6.1.4 Screening Assessment

6.1.4.1 Atmospheric Environment (Air Quality and Emissions)

Air quality around the PN site is dominated by emissions released throughout the Greater Toronto Area and the United States and is typical of the general air quality in Southern Ontario along the Windsor-Quebec corridor. Substances that can produce smog or acid rain dominate air quality impacts and include carbon monoxide, nitrogen oxides, sulfur dioxide, total suspended particulates (TSP), inhalable particulates (PM_{10}) and respirable particulates ($PM_{2.5}$). Ontario's MECP measures air quality at several locations between Toronto and Oshawa. The PN site itself does not significantly contribute to chemical air quality emissions at a regional level (OPG, 2003).

Air quality at the proposed PCSS is expected to be comparable to the current and historic air quality of the local region (i.e., City of Pickering), except for a brief period during site preparation and construction where project activities are expected to contribute higher levels of dust (TSP) and particulates (PM_{10} and $PM_{2.5}$) to the atmosphere.

The screening of air quality COPCs against ambient air quality criteria/standards in this PERA report is consistent with the methodology used in the 2003 PWMF Phase II EA. The PWMF Phase II project involved the construction of a new storage building to increase storage capacity at the PWMF (now the NSS-PWMF) as the PWMF Phase I storage capacity became insufficient over time (OPG, 2003). Air quality modelling conducted as part of the PWMF Phase II expansion is considered bounding of the PCSS project, as the PWMF Phase II project was greater in scope and involved the site preparation of a larger area and the construction of multiple storage buildings.

The concentration of COPCs in air were compared against Ontario MECP's Ambient Air Quality Criteria (AAQCs) and Canadian Ambient Air Quality Standards (CAAQS) from the Canadian Council of Ministers of the Environment (CCME) to determine whether measured and modelled concentrations of atmospheric COPCs could pose a risk to human receptors over the lifetime of the PCSS project. Concentrations were directly compared to guidelines with the same averaging periods. The AAQCs with averaging times of 24 hours or longer are considered protective of chronic health effects and have been selected for use in this PERA. The air quality guidelines used are shown in **Table 6-2**.

Table 6-2: Air Quality Guidelines

Parameter	AAQC	Averaging Time	CAAQS	Averaging Time
Carbon monoxide	13 ppm	8-Hour	NA	NA
Nitrogen dioxide	100 ppb	24-Hour	17 ppb [a, b]	Annual
Sulfur dioxide	4 ppb	Annual	5 ppb [a, b]	Annual
$PM_{2.5}$	27 µg/m^3 [(a)]	24-Hour	27 µg/m^3 [a]	24-Hour
PM_{10}	50 µg/m^3	24-Hour	NA	NA
Total suspended particulates (TSP)	120 µg/m^3	24-Hour	NA	NA

Notes:
[a] 2020 target
[b] Represents the average over a single calendar year of all 1-hour average concentrations
AAQC – Ontario MECP Ambient Air Quality Criteria (MECP, 2020)
CAAQS – Canadian Ambient Air Quality Standard (MECP, 2019)
Averaging Time - Averaging times for ambient air quality criteria protective against chronic effects are generally 24 hours or longer
µg/m^3 – micrograms per cubic metre of air
ppm - parts per million
ppb – parts per billion
NA – Not available

Consistent with the 2003 PWMF Phase II EA, the overall PN site, inclusive of the NSS-PWMF, is not considered to significantly contribute nitrogen oxides (NOx) or sulfur dioxide (SO_2) to the atmosphere (OPG, 2003). Thus, local air quality measurements of these specific parameters are considered bounding of any air concentrations arising from site preparation, construction and operation of the PCSS. Local air quality measurements were obtained for the last three (3) available years (2018 to 2020) from the Ontario MECP's "Air Quality in Ontario" reports (MECP, 2022, 2023a, 2023b). Air quality data was assessed from the Toronto East and Toronto West monitoring stations (west of the PN site) and the Oshawa station (east of the PN site). The annual average and annual 90th-percentiles for air concentrations of NO_2, SO_2 and CO are shown in **Table 6-3**.

Average annual 1-hour concentrations of NO_2 ranged from 3.50 – 3.79 ppb in Oshawa and 8.41 – 10.55 ppb in Toronto East between 2018 to 2020. Annual 90th-percentile 1-hour concentrations ranged between 7.7 – 8.3 ppb in Oshawa and 17.8 – 21.8 ppb in Toronto East. No exceedances of the annual CAAQS were recorded at the Toronto East and Oshawa stations based on the annual average 1-hour concentrations.

SO_2 and CO are not monitored at every station – the closest station to the PN site where these parameters are measured is the Toronto North monitoring station, approximately 32 km west of the PN site. Between 2018 to 2020, average annual 1-hour concentrations of SO_2 ranged between 0.15 – 0.26 ppb at the Toronto North station, while annual 90th-percentile 1-hour concentrations ranged between 0.3 – 0.5 ppb. The annual average 1-hour concentrations of SO_2 met the CAAQS of 5 ppb (annual averaging period) and the AAQC of 4 ppb (annual averaging period). During the same sampling period, maximum 8-hour annual concentrations of CO ranged between 0.62 – 0.84 ppm, meeting the 8-hour CO AAQC of 13 ppm.

Table 6-3: Select Monitored Concentrations of NO_2, SO_2 and CO at the Toronto East, Toronto North, and Oshawa Monitoring Stations, 2018 – 2020

Parameter	Units	Station	Year	Annual Average 1-hour Concentration	Annual 90th-percentile 1-hour Concentration	AAQC	CAAQS
NO_2	ppb	Toronto East	2018	10.55	21.8	NA	17
		Toronto East	2019	10.24	21.6	NA	17
		Toronto East	2020	8.41	17.8	NA	17
		Oshawa	2018	3.79	8.3	NA	17
		Oshawa	2019	3.50	8.0	NA	17
		Oshawa	2020	3.61	7.7	NA	17
SO_2	ppb	Toronto North	2018	0.26	0.5	4	5
		Toronto North	2019	0.15	0.3	4	5
		Toronto North	2020	0.15	0.4	4	5
CO [a]	ppm	Toronto North	2018	0.62 (8-hour max)	NA	13	NA
		Toronto North	2019	0.71 (8-hour max)	NA	13	NA
		Toronto North	2020	0.84 (8-hour max)	NA	13	NA

Notes:

[a] Carbon monoxide data are 8-hour maximums

AAQC – Ambient Air Quality Criteria

CAAQS – Canadian Ambient Air Quality Standards

Based on expected release of dust and particulates during site preparation and construction activities, the 2003 PWMF Phase II environmental assessment predicted incremental 24-hour air concentrations at two locations (Site Area B and East Wetland) of the PWMF Phase II site (refer to **Figure 4-2** in **Section 4.1** for the locations of Site Area B, the East Wetland and the PCSS). Predicted incremental 24-hour concentrations were added to background 24-hour concentrations of TSP, PM_{10} and $PM_{2.5}$ and compared against 24-hour ambient air quality criteria (**Table 6-4**).

Site Area B is considered representative of the PCSS due to the close proximity of the two sites, and the East Wetland is similarly representative of a receptor at the boundary of the PN site.

Table 6-4: Estimated Total Airborne Dust and Particulates at the Site Area B and East Wetland Boundary During Site Preparation and Construction Compared with AAQC Guidelines

Parameter	Background 24-Hour Concentration (µg/m³) [a]		Predicted Incremental 24-Hour Concentration (µg/m³)	Incremental + Background (90th-Percentile) 24-Hour Concentration (µg/m³)	24-Hour Air Quality Criteria (AAQC)
	Average	90th-Percentile			
Site Area B					
Total Suspended Particulates (TSP)	42	75	7.4	82.4	120
PM_{10}	18	35	2.1	37.1	50
$PM_{2.5}$	11.5	23	0.44	23.4	27
East Wetland					
Total Suspended Particulates (TSP)	42	75	5.3	80.3	120
PM_{10}	18	35	1.3	36.3	50
$PM_{2.5}$	11.5	23	0.41	23.4	27

Notes:

[a] Background concentrations for TSP, PM_{10} and $PM_{2.5}$ were taken from the 2003 PWMF Phase II environmental assessment. These values represent average and 90th-percentile 24-hour concentrations.

Results presented in **Table 6-4** demonstrate that maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ 24-hour concentrations could reach 7.4 µg/m³, 2.1 µg/m³ and 0.44 µg/m³ at Site Area B, respectively. At the East Wetland, the maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ 24-hour concentrations were modelled to reach 5.3 µg/m³, 1.3 µg/m³ and 0.41 µg/m³, respectively. These predicted incremental increases assume reasonable dust suppression measures are used on dry days (i.e., road and surface watering).

The total 24-hour concentrations for TSP, PM_{10} and $PM_{2.5}$ (incremental increases plus 90th-percentile background) are all below the applicable ambient air quality criteria at both modelled locations. Any increases in dust and particulate emissions are expected to be short-term and below the applicable AAQC/CAAQS limits.

The modelling is conservative as it assumed that site preparation and construction activities expected to generate the most intense amounts of dust and particulates would all occur at the same time over a three-month period. It is more likely that site preparation and construction activities would occur more infrequently over a phased construction schedule. Furthermore, the modelled predictions assumed that these project activities would occur at the same time as the worst-case meteorological conditions, which is similarly unlikely to occur over the modelled three-month construction schedule.

Construction traffic was not considered in the air quality modelling as it is expected that the increase in traffic and vehicle emissions would be negligible (OPG, 2003). The emissions released by a small number of construction vehicles (e.g., backhoes, graders, dump trucks) would be negligible compared to the number of vehicles that currently service the thousands of employees working at the PN site. Relatedly, no off-site impacts to air quality are expected from the negligible increase in construction-related traffic emissions.

Based on the assessment above, no impacts to human health are expected from air emissions of dusts, particulates, or other air pollutants associated with vehicle exhausts including NO_x, SO_2 or CO. Thus, project-related atmospheric emissions as they relate to human health are not assessed further in this PERA report.

6.1.4.2 Atmospheric Environment (Noise)

Site preparation and construction activities are expected to result in increased noise levels. Consistent with **Section 6.1.4.1**, the 2003 PWMF Phase II environmental assessment was considered applicable for the PCSS project. The 2003 PWMF Phase II environmental assessment assumed that equipment and vehicles would utilize noise control devices, be maintained in proper working condition, and that noise emissions from such equipment would be compliant with regulatory noise guidelines. These assumptions are similarly applicable to the PCSS project.

Background noise at the PCSS is assumed to be similar to the overall PN site. The 2022 PN ERA reported an L_{Aeq} (1-hr) of 54 dBA and L_{A90} (1-hr) of 50 dBA at noise monitoring station NM-2 during daytime hours (07:00 – 19:00). The L_{Aeq} (1-hr) represents the average sound energy in A-weighted decibels (dBA) measured over a 1-hour period; the L_{A90} (1-hr) represents the sound energy (in dBA) exceeded for 90% of the measurement period (i.e., 54 minutes of the 1-hour measurement period). As the L_{A90} describes the noise level exceeded for 90% of the measurement period, it is a more representative measure of background sound levels. This monitoring station is considered representative of daytime background noise levels experienced by a receptor adjacent to the walking trail at the eastern boundary of the PN site.

Similar to the air quality assessment, the 2003 PWMF Phase II environmental assessment predicted noise levels at Site Area B and the East Wetland. The maximum sound level experienced by a receptor at Site Area B exposed to worst-case construction activities was modelled to be 55 dBA. Maximum predicted noise levels at the East Wetland due to construction activities was modelled to be 64 dBA.

The MECP does not have prescribed noise and vibration limits from construction activity. Health Canada recommends that project-related noises do not exceed 75 dBA; above this level, noise is likely to cause sleep disturbance or disturb vulnerable populations (HC, 2017). Both PN baseline and modelled noise levels associated with PCSS construction do not exceed this 75 dBA threshold.

Site preparation and construction activities are expected to be relatively short in duration, and will occur in phases over the course of the overall construction schedule. Work will also be limited to daytime hours when background sound levels are generally higher. As previously noted, the increase in vehicle traffic associated with site preparation and construction is expected to be negligible compared to baseline traffic levels. Therefore, noise effects from a small incremental increase in construction traffic is considered negligible compared to the overall PN site.

Based on the assessment above, no human health effects are expected to occur as a result of sound emissions associated with site preparation and construction of the PCSS. No further assessment of project-related noise as it relates to human health is required in this PERA report.

6.1.4.3 Radiation

The Sport Fisher is the only potential critical group where gamma radiation fields from the NSS-PWMF would likely be measurable. This was confirmed in the 2022 PN ERA (Ecometrix, 2023a) based on a 2017 study. 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 PWMF, the air kerma rate was estimated to be negligible. Therefore, the Sport Fisher is expected to experience external exposure to gamma radiation due to the proximity to the PCSS.

The dose rates outside of the PCSS are estimated based on the PCSS Safety Assessment (Kinectrics, 2024). Based on existing radiation safety requirements for the NSS-PWMF, it is expected that the dose rate outside of the PCSS will be below the target of 0.5 μSv/h and below 100 μSv/a at the PN site boundary. The radiation dose to the Sport Fisher is quantified and considered further in the exposure assessment below (**Section 6.2**),

6.1.5 Summary

The screening assessment of air quality and noise indicated that all predicted air concentrations and noise levels are expected to be below their limits; therefore, no further quantitative assessment is required.

Therefore, based on the Problem Formulation, the focus of the exposure assessment is on exposure of the Sport Fisher to gamma radiation from the PCSS.

6.2 Exposure Assessment

In the exposure assessment, the exposure of human receptors to radiological COPCs is quantified in terms of radiation dose.

The dose estimates for normal operations from the PCSS Safety Assessment (Kinectrics, 2024) were used to quantify predicted dose to the Sport Fisher. The location from the PCSS Safety Assessment that would be most relevant to human health receptors for exposure to external gamma radiation is location LS03 – this is the closest location to the Sport Fisher (see **Figure 6-2** below). The most conservative scenario from the PCSS Safety Assessment was retained which assumes the least amount of building shielding and a higher dose rate for the Retube Waste Containers (RWCs) compared to the other sensitivity scenarios. The dose rate at LS03 for the conservative scenario is predicted to be 5.58E-05 µSv/h. This dose rate is considered a best estimate which includes the addition of 2σ (2 standard deviations) to account for code uncertainty.

The Sport Fisher is assumed to reside at the outfall (0.5 km south of the PN site) 1% of the time per year or 87.6 hours per year, which is consistent with the assumptions for the Sport Fisher in the PN ERA (Ecometrix, 2023a). Assuming the Sport Fisher is exposed to a predicted dose rate of 5.58E-05 µSv/h for 87.6 hours (1% occupancy), the predicted total annual dose to the Sport Fisher from the PCSS is 4.89E-03 µSv/a. The dose estimate for the Sport Fisher is conservative, as the Sport Fisher is located farther away than LS03, but provides a reasonable estimate of dose. The dose rates are summarized in **Table 6-5**.

Table 6-5: Predicted Dose Rate for Human Receptors from the PCSS

Receptor	Predicted Annual Dose from PCSS (µSv/a)
Sport Fisher[(a)]	4.89E-03

Notes:

(a) The dose to the Sport Fisher is based on an occupancy at the Outfall of 1% or 87.6 hours per year, and is consistent with assumptions in OPG's EMP.

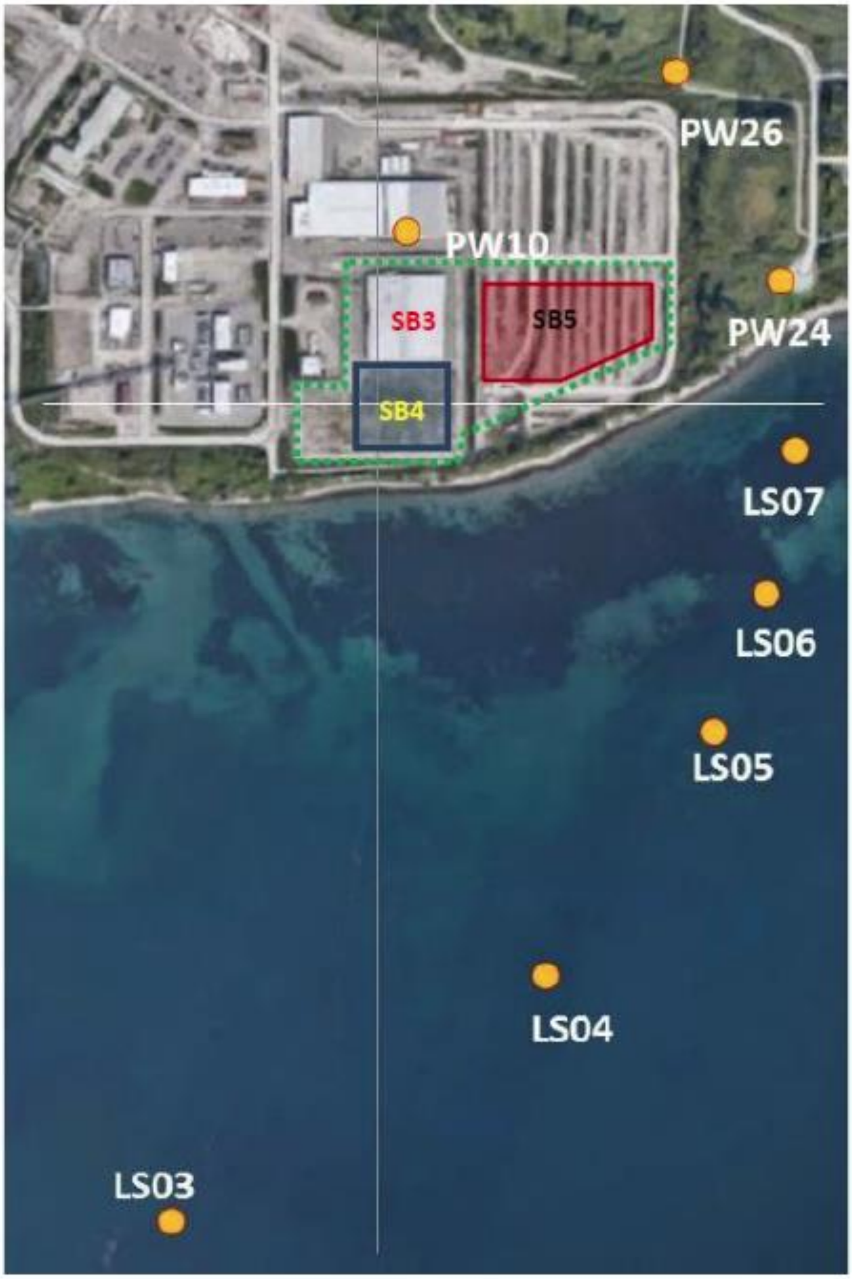


Figure 6-2: Dose Point Locations for PCSS Safety Assessment (Kinectrics, 2024)

6.3 Hazard Assessment

6.3.1 Radiation Public Dose Limit

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 (Nuclear Safety and Control Act, 1997). 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 and higher doses are considered unacceptable.

6.4 Risk Characterization

6.4.1 Radiation

The public dose estimate for the Sport Fisher is 4.89E-03 µSv/a. This dose estimate represents 0.0005% of the regulatory public dose limit (1000 µSv/a) for the Sport Fisher. Since the Sport Fisher is expected to receive the highest dose from PCSS, the demonstration that the Sport Fisher is protected implies that other potential critical groups near the PN site are also protected.

Since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential critical groups to gamma radiation from the PCSS.

6.5 Discussion on Uncertainty

The data used in the predictive HHRA were concluded to be of adequate quality to support the objectives of the PERA. Since this assessment is predictive, the main sources of uncertainty in the PERA are related to model uncertainty.

The air model used in the 2003 PWMF Phase II Expansion EA was considered bounding of the PCSS project, as the PWMF Phase II project was greater in scope and involved the site preparation of a larger area and the construction of multiple storage buildings, compared to the PCSS.

More specifically, the air model used in the 2003 PWMF Phase II Expansion EA was the US EPA ISC3 Dispersion Model with meteorological data from the PN meteorological station. The model was conservative in that it assumed the maximum activity occurred at the same time as the worst-case meteorological conditions. In reality, the maximum site preparation and construction activities will only occur for a short duration; therefore, the combination with worst case meteorological conditions is unlikely.

The meteorological data used in the 2003 PWMF Phase II Expansion EA were based on wind data from the PN meteorological station from 1991 to 1998. The wind rose from the EA is shown below (**Figure 6-3**). The prevailing wind direction from 1991 to 1998 was from the northwesterly quarter occurring approximately 41% of the time, from the south-south-west wind sector approximately 10%, and from the east approximately 7.5% of the time.

The 2022 PN ERA (Ecometrix, 2023a) provides a wind rose from the 2016 to 2020 period from the PN meteorological station. The wind rose from the PN ERA is shown below (**Figure 6-4**). The prevailing winds for the 2016 to 2020 period were also from the northwesterly sector and the southwesterly sector. The prevailing winds are from the northwest approximately 8.9% of the time, north-northwest 8.2% of the time, from the southwest 8.3% of the time, and from the north approximately 8.6% of the time. While there are some changes to the wind rose since the EA, the overall wind rose shapes are similar. Notwithstanding any small differences in wind, the results are still expected to be conservative.

The air quality modelling utilized from the 2003 EA was for Site B and the East Wetland - in the ENE and E wind sector. The wind rose for those wind sectors from the 1991-1998 period is consistent with the updated wind rose for 2016-2020. Overall, based on limited changes to meteorological conditions over time, and the conservatism in the 2003 modelling, the atmospheric modelling from the 2003 PWMF Phase II Expansion EA is still considered appropriate.

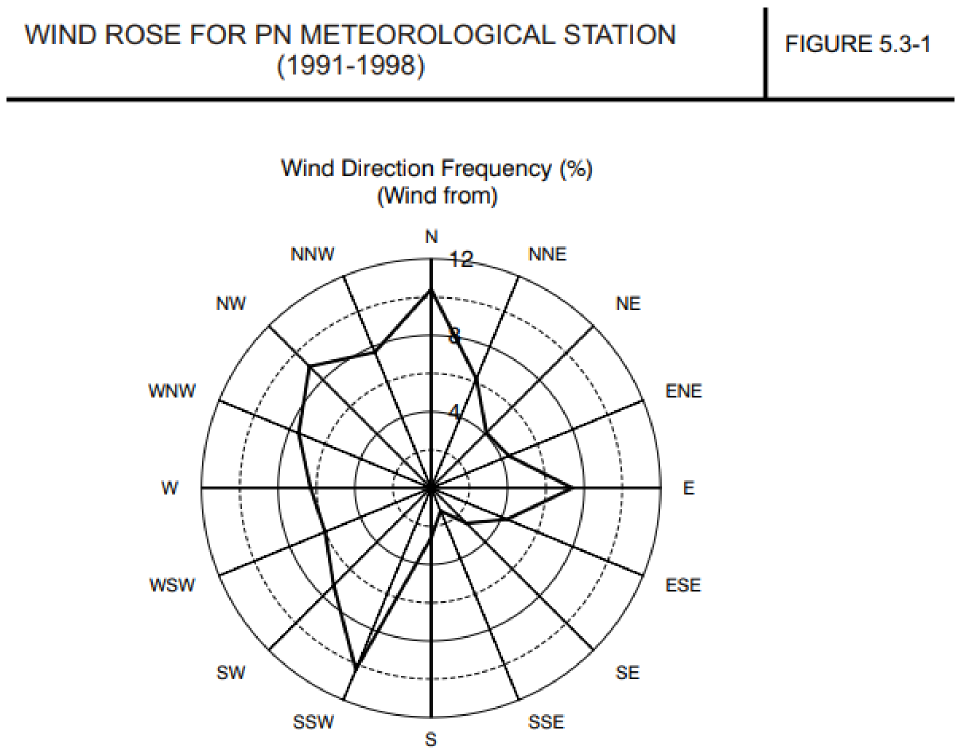
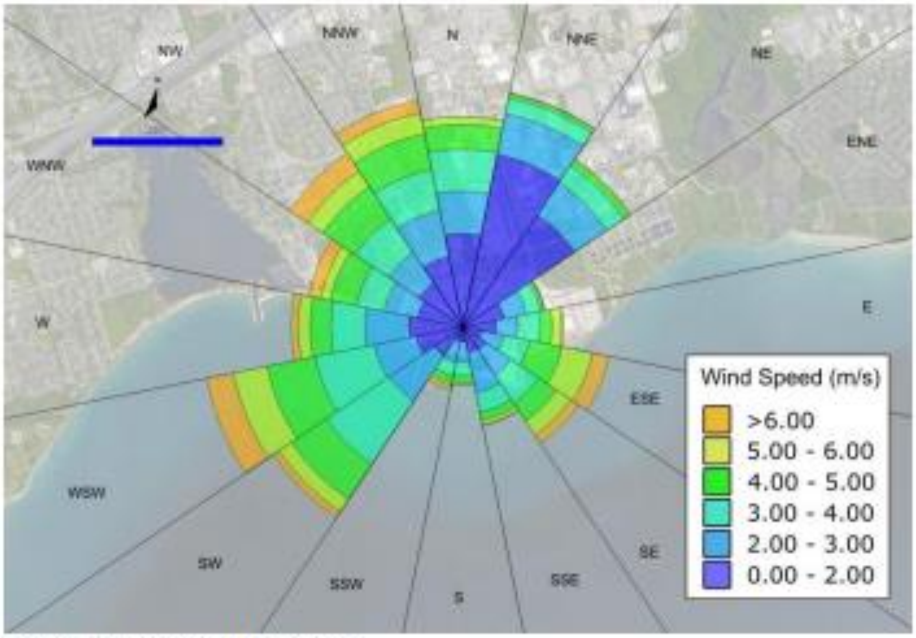


Figure 6-3: 1991-1998 Annual Average Wind Rose for PN Meteorological 10-m Tower (OPG, 2003)



Note: Direction is where wind blows from

Figure 6-4: 2016-2020 Annual Average Wind Rose for PN Meteorological 10-m Tower (Ecometrix, 2023a)

For the radiation dose assessment, the Monte Carlo N-Particle Transport Code was used in the PCSS Safety Assessment for the dose estimates from the PCSS. These dose estimates are conservative in that they include the addition of 2σ (2 standard deviations) to account for code uncertainty (Kinectrics, 2024).

7.0 Predictive Ecological Risk Assessment

7.1 Problem Formulation

7.1.1 Receptor Selection and Characterization

As discussed in **Section 5.2**, the environmental stressors investigated further in this PERA include air emissions, noise and radiation.

The terrestrial ecological receptors outlined below represent receptors considered in this predictive ecological risk assessment. As it is impractical to assess potential effects on all species of biota at the PN site, a select group of representative species are chosen. These organisms are selected because they are known to exist on the site, represent major taxonomic/ecological groups, represent major pathways of exposure, have ecological significance, or have important intrinsic or economic value. These potential receptors were also considered in the 2022 PN ERA for the PN site (Ecometrix, 2023a). The rationale for receptor selection is described in detail in the PN ERA. The protection of the selected receptors should provide reasonable assurance that all species within the ecosystem are protected.

- Terrestrial Plants:
    - Chokecherry
    - New England Aster
    - Eastern Hemlock
    - Red Ash
    - Sandbar Willow
    - Pine/Grass
- Terrestrial Invertebrates:
    - Earthworms
- Terrestrial Birds:
    - Red-winged Blackbird
    - Red-tailed Hawk
- Terrestrial Mammals:
    - Red Fox
    - Meadow Vole
    - White-tailed Deer

7.1.2 Ecological Receptor Exposure Pathways and Conceptual Site Model

As discussed in **Section 5.2**, direct interactions of the PCSS with the atmospheric environment were identified. Additionally, ecological receptors will be exposed to gamma radiation from the PCSS. **Table 7-1** summarizes the ecological exposure pathways and conceptual site model from interactions with the PCSS for the ecological receptors identified for the site.

Exposure pathways consider the various routes by which radionuclides and/or chemicals may enter the body of the receptor, or for radionuclides, may exert effects from outside the body.

Exposures to environmental media may be primary (i.e., by contact) or secondary (i.e., via constituent transport through the food chain).

Considering the sources of COPCs to the environment are from the air pathway, the main exposure pathway is through inhalation of dust and particulate matter and exposure to noise during the site preparation and construction phase as well as exposure to external gamma radiation from operation of the PCSS. As such, only terrestrial receptors from the PN ERA are assessed.

Table 7-1: Ecological Conceptual Site Model

Category	Ecological Receptor	Exposure Pathway
Terrestrial Plants	Chokecherry	Uptake of COPCs sourced from Air Radiation Immersion
	New England Aster	
	Eastern Hemlock	
	Red Ash	
	Sandbar Willow	
	Pine/Grass	
Terrestrial Invertebrates	Earthworms	No complete pathways[(a)]
Terrestrial Birds	Red-winged Blackbird	Noise Inhalation Radiation Immersion
	Red-tailed Hawk	
Terrestrial Mammals	Red Fox	Noise Inhalation Radiation Immersion
	Meadow Vole	
	White-tailed Deer	

Note:
(a) As earthworms live in the soil, they would have limited exposure to air, noise and gamma radiation fields.

7.1.3 Screening Assessment

7.1.3.1 Atmospheric Environment (Air Quality and Emissions)

Ecological receptors can be exposed to air emissions as a result of site preparation and construction activities for the PCSS. Terrestrial birds and mammals can come into direct contact with COPCs released into the air through inhalation.

Air quality at the proposed PCSS is expected to be comparable to the current and historic air quality of the local region (i.e., City of Pickering), except for a brief period during site preparation and construction where project activities are expected to contribute marginally higher levels of dust (TSP) and particulates (PM_{10} and $PM_{2.5}$) to the atmosphere.

Similar to **Section 6.1.4.1**, the screening of air quality COPCs against ambient air quality criteria/standards in this PERA report is consistent with the methodology used in the 2003 PWMF Phase II EA. Air quality modelling conducted as part of the PWMF Phase II expansion is considered bounding of the PCSS project, as the PWMF Phase II project was greater in scope and involved the site preparation of a larger area and the construction of multiple storage buildings.

Air quality parameters were compared against Ontario MECP's Ambient Air Quality Criteria (AAQCs) as AAQCs are developed to be protective of health and the environment, and are therefore appropriate screening guidelines for ecological receptors (MECP, 2020). The list of ambient air quality guidelines is available in **Table 6-2**. The annual air quality data and the comparison with air quality guidelines can be found in **Table 6-3**, both in **Section 6.1.4.1**.

Based on expected releases of dust and particulates during site preparation and construction activities, the 2003 PWMF Phase II environmental assessment predicted air concentrations at two locations (Site Area B and East Wetland) of the PWMF Phase II site (**Figure 4-2**). Predicted incremental concentrations were added to background concentrations of TSP, PM_{10} and $PM_{2.5}$ and compared against AAQCs.

Site Area B is considered representative of on-site terrestrial receptors at the PCSS due to the close proximity of the two sites. The East Wetland is considered representative of off-site terrestrial receptors at the boundary of the PN site.

Results presented in **Table 6-4** in **Section 6.1.4.1** demonstrate that maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ concentrations could reach 7.4 $\mu g/m^3$, 2.1 $\mu g/m^3$ and 0.44 $\mu g/m^3$ at Site Area B, respectively. At the East Wetland, the maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ concentrations were modelled to reach 5.3 $\mu g/m^3$, 1.3 $\mu g/m^3$ and 0.41 $\mu g/m^3$, respectively. These predicted incremental increases assume reasonable dust suppression measures are used on dry days (i.e., road and surface watering).

The total concentrations for TSP, PM_{10} and $PM_{2.5}$ (incremental increases plus 90th-percentile background) are all below the applicable AAQCs at both modelled locations. Any increases in dust and particulate emissions are expected to be short-term and below the applicable AAQCs.

The modelling assumed that site preparation and construction activities expected to generate the most intense amounts of dust and particulates would all occur at the same time over a three-month period. It is more likely that site preparation and construction activities would occur more infrequently over a phased construction schedule. Furthermore, the modelled predictions assumed that these project activities would occur at the same time as the worst-case meteorological conditions, which is similarly unlikely to occur over the assumed three-month construction schedule.

Construction traffic was not considered in the air quality modelling as it is expected that the increase in traffic and vehicle emissions would be negligible (OPG, 2003). The emissions released by a small number of construction vehicles (e.g., backhoes, graders, dump trucks) would be negligible compared to the number of vehicles that currently service the thousands of employees working at the PN site. Relatedly, no impacts to off-site receptors are expected from the negligible increase in construction-related traffic emissions.

Based on the assessment above, no impacts to terrestrial receptors are expected from air emissions of dust, particulates, or other air pollutants associated with vehicle exhausts including NO_x, SO_2 or CO. Thus, project-related atmospheric emissions and the potential impact to ecological receptors are not assessed further in this PERA report.

7.1.3.2 Atmospheric Environment (Noise)

Noise levels due to site preparation and construction of the PCSS may potentially cause disturbance to wildlife. Consistent with **Section 6.1.4.2**, noise modelling conducted for the 2003 PWMF Phase II environmental assessment was considered applicable for the PCSS project.

In the 2003 PWMF Phase II environmental assessment, the maximum sound level experienced by a receptor at Site Area B exposed to worst-case construction activities was modelled to be 55 dBA over an assumed three-month construction period. Maximum predicted noise levels at the East Wetland (representative of off-site terrestrial receptors) due to construction activities was modelled to be 64 dBA.

There are no specific noise level thresholds for ecological receptors within regulatory documents. However, considering that noise levels are expected to be temporarily elevated for a maximum of three (3) months during site preparation and construction, it is expected that some wildlife (e.g., small mammals, birds) may be occasionally disturbed due to elevated noise levels; however, most wildlife in the area are likely already accustomed to noise levels associated with an urban environment. This is consistent with assumptions made for the Pickering B Environmental Assessment Terrestrial Environment Technical scope document (Golder, 2007). Noise levels from the PCSS during operations and maintenance are expected to be negligible compared to the noise levels from the rest of the PN site.

Assuming site preparation and construction equipment are adequately maintained and are compliant with regulatory noise limits, construction activities are not expected to result in long-term effects on terrestrial receptors. Site preparation and construction activities are expected to be relatively short in duration, and will occur in phases over the course of the overall construction schedule. Work will also be limited to daytime hours when sound levels are higher than nighttime hours to prevent the disruption of nocturnal wildlife. As previously noted, the increase in vehicle traffic associated with site preparation and construction is expected to be negligible compared to baseline traffic levels. Therefore, noise effects from a small incremental increase in construction traffic is considered negligible compared to the overall PN site.

Based on the assessment above, given the mitigation measures in place and the temporary nature of the elevated noise levels due to site preparation and construction, noise is not expected to result in adverse risks to terrestrial receptors and is not assessed further in this PERA.

7.1.3.3 Radiation

Ecological receptors in proximity to the PCSS will experience external exposure to direct gamma radiation due to the proximity to the PCSS. The radiation dose to the terrestrial plant, bird and mammal receptors is quantified and considered further in the exposure assessment below.

7.1.4 Summary

The screening assessment of air quality indicated that all predicted air concentrations are expected to be below their limits; therefore, no further quantitative assessment is required. While no specific noise level thresholds exist for ecological receptors, noise levels are expected to be elevated temporarily during site preparation and construction, although most wildlife in the area are likely already accustomed to noise levels associated with an urban environment.

Therefore, based on the Problem Formulation, the focus of the exposure assessment is on exposure of the terrestrial receptors to gamma radiation from the PCSS.

7.2 Exposure Assessment

The assessment of external exposure of terrestrial receptors to gamma radiation from the PCSS is based on the dose estimates for normal operations from the PCSS Safety Assessment (Kinectrics, 2024).

The location from the PCSS Safety Assessment that would be most relevant to ecological receptors for exposure to external gamma radiation is location PW10 which is adjacent to the PCSS (see **Figure 6-2**). As indicated in **Section 6.2**, the most conservative scenario from the PCSS Safety Assessment was retained which assumes the least amount of building shielding and assumes a higher dose rate for the RWCs than the other sensitivity scenarios (Kinectrics, 2024).

The dose rate at PW10 is predicted to be 2.39 μSv/h. This dose rate is considered a best estimate which includes the addition of 2σ (2 standard deviations) to account for code uncertainty.

It is difficult to translate the human effective dose to a whole body absorbed dose for various wildlife species due to a variety of different body geometries and a lack of species-specific tissue depth measurements and radiation weighting factors; however, it has been assumed that the whole-body effective dose for humans (μSv/h) is equivalent to the whole body absorbed dose for wildlife (µGy/h), as human tissue and wildlife tissue, for the purpose of estimating absorbed dose, are practically equivalent.

The dose rate for ecological receptors in close proximity (directly adjacent) to the PCSS could be up to 0.057 mGy/d based on the dose rate of 2.39 µGy/hr. The dose rate to any ecological receptor at the closest PN property boundary would be much lower than 2.39 µGy/h (0.057 mGy/d).

The above assessment is conservative as it assumes the ecological receptor is always located at the PCSS (24 hours per day, 365 days per year) and does not incorporate an occupancy factor based on the fraction of time a receptor is likely to be in close proximity to the PCSS.

7.3 Effects Assessment

7.3.1 Radiation Dose Benchmarks

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 PCSS assessment of effects on aquatic biota and terrestrial biota, respectively, as recommended in the CSA N288.6-22 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.

Only the terrestrial benchmark of 2.4 mGy/d was specifically used to assess radiation dose to terrestrial receptors at the PCSS. Aquatic receptors were not assessed for the PCSS as no Project-related interactions with the aquatic environment are expected (**Section 5.2.2**). However, for assessment of cumulative effects in **Section 8.2**, terrestrial and aquatic receptors were considered; therefore, the relevant terrestrial and aquatic dose benchmarks were applied to the receptors evaluated.

7.4 Risk Characterization

7.4.1 Radiation

The maximum dose rate to any ecological receptors residing in close proximity to the PCSS could be up to 0.057 mGy/d, lower than the 2.4 mGy/d radiation benchmark for terrestrial biota. The maximum dose rate to any off-site ecological receptors residing at the closest boundary of the PN site would be lower, and also below the 2.4 mGy/d radiation benchmark for terrestrial biota.

Since the dose estimates are a small fraction of the terrestrial dose benchmark, no discernable health effects to terrestrial biota are anticipated due to exposure to radiation from the PCSS.

Additionally, with respect to species at risk, since there were no exceedances of any dose benchmarks for the ecological receptors evaluated, individual species at risk would also be considered protected.

7.5 Discussion on Uncertainty

The data used in the predictive EcoRA were concluded to be of adequate quality to support the objectives of the PERA. Since this assessment is predictive, the main sources of uncertainty in the PERA are related to model uncertainty.

The air model used in the 2003 PWMF Phase II Expansion EA (OPG, 2003) was considered bounding of the PCSS project, as the PWMF Phase II project was greater in scope and involved the site preparation of a larger area and the construction of multiple storage buildings, compared to the PCSS. The meteorological conditions in 2003 PWMF Phase II Expansion EA compared to current conditions were considered similar as discussed in detail in **Section 6.5**; therefore, the results of the previous air model were considered applicable and bounding for the PCSS.

For the radiation dose assessment, as discussed in **Section 6.5,** the Monte Carlo N-Particle Transport Code was used in the PCSS Safety Assessment for the dose estimates from the PCSS. These dose estimates are conservative in that they include the addition of 2σ (2 standard deviations) to account for code uncertainty (Kinectrics, 2024).

8.0 Cumulative Effects Assessment

In order to ensure radiation releases from the PN site meet radiation safety limits for humans and ecological radiation benchmarks for wildlife, the combined radiation dose from current PN operations (PNGS and NSS-PWMF) must be considered together with the potential radiation release from the future operation of the PCSS.

The Predictive Effects Assessment (PEA) for PN Safe Storage (Ecometrix, 2023b; Golder and Ecometrix, 2017) was not considered in the cumulative effects assessment as the maximum dose from existing conditions on the PN Site would be bounding of the receptors exposed to the PCSS during PN Safe Storage. Emissions from PNGS are not expected to occur at the same time as the predicted doses during PN Safe Storage.

8.1 Human Health

The 2022 PN ERA calculated total doses received by the Sport Fisher from PN and NSS-PWMF operations (Ecometrix, 2023a). As indicated in **Section 6.1.4.3**, based on distance from the facility, the Sport Fisher is the only human receptor likely to receive measurable dose from the PCSS.

The combined radiation dose for the Sport Fisher is presented in **Table 8-1** below. The total dose received by the Sport Fisher from current PN operations (PNGS and NSS-PWMF) and the PCSS was estimated to be 0.57 µSv/a. The cumulative dose is well below the public dose limit for radiation protection of 1 mSv/a. As the total cumulative dose is only a small fraction (0.06%) of the public dose limit and natural background radiation exposure, no health effects are expected within the general public.

Table 8-1: Cumulative Radiation Dose to the Sport Fisher from PN and PCSS

Receptor	Units	Max Dose from PNGS [a]	Max Dose from NSS-PWMF [a]	Predicted Max Dose from PCSS[b]	Total Max Dose
Sport Fisher	µSv/a	0.5	0.063	0.0049	0.57

Notes:

[a] Total radiation dose estimates for the Sport Fisher receptor from the PNGS (Ecometrix, 2023a)

[b] Predicted max dose from PCSS is based on the PCSS Safety Assessment (Kinectrics, 2024) adjusted to a 1% occupancy for the Sport Fisher.

µSv/a – microSievert per year

8.2 Ecological Health

The 2022 PN ERA also calculated total maximum and UCLM doses received by various terrestrial and aquatic receptors from PN operations. No cumulative effects assessment was done for aquatic receptors in the Outfall and Frenchman's Bay, as radiation releases from the PCSS to the aquatic environment are considered negligible. The combined radiation doses received by ecological receptors are presented in **Table 8-2** below. The maximum combined radiation dose in the terrestrial environment would be 7.28E-02 mGy/d for the red fox. All total maximum and UCLM doses received by terrestrial receptors from both PN and the PCSS were well below (3% or less) the terrestrial radiation benchmark of 2.4 mGy/d. No discernable health effects to terrestrial biota are anticipated due to radiation from PN and the PCSS.

Table 8-2: Cumulative Radiation Dose to Ecological Receptors from PN and PCSS

Location	Receptor	Units	Max Dose from PNGS [a]	UCLM Dose from PN [a]	Max Dose from NSS-PWMF [a]	Max Dose from PCSS	Total Max Dose [b]	Total UCLM Dose [c]	Dose Benchmark	% of Dose Benchmark (Max)	% of Dose Benchmark (UCLM)
Outfall (*Aquatic and Riparian*)	Benthic Fish	mGy/d	2.38E-02	1.49E-03	NA	NA	2.38E-02	1.49E-03	9.6	0.2%	0.02%
	Pelagic Fish	mGy/d	1.56E-02	9.76E-04	NA	NA	1.56E-02	9.76E-04	9.6	0.2%	0.01%
	Benthic Invertebrate	mGy/d	3.82E-02	2.38E-03	NA	NA	3.82E-02	2.38E-03	9.6	0.4%	0.02%
	Ring-Billed Gull	mGy/d	2.79E-02	3.76E-03	NA	NA	2.79E-02	3.76E-03	2.4	1.2%	0.2%
PN Site (*Terrestrial*)	Earthworm	mGy/d	9.07E-04	3.52E-04	NA	NA	9.07E-04	3.52E-04	2.4	0.04%	0.01%
	Grass/Shrub	mGy/d	1.08E-03	5.07E-04	1.2E-02	5.74E-02	7.04E-02	6.99E-02	2.4	2.9%	2.9%
	Pine	mGy/d	9.26E-04	3.55E-04	1.2E-02	5.74E-02	7.03E-02	6.97E-02	2.4	2.9%	2.9%
	Red-winged Blackbird	mGy/d	8.56E-04	3.08E-04	1.2E-02	5.74E-02	7.02E-02	6.97E-02	2.4	2.9%	2.9%
	Red-tailed Hawk	mGy/d	8.30E-04	2.73E-04	1.2E-02	5.74E-02	7.02E-02	6.96E-02	2.4	2.9%	2.9%
	Red Fox	mGy/d	3.46E-03	1.58E-03	1.2E-02	5.74E-02	7.28E-02	7.09E-02	2.4	3.0%	3.0%
	Meadow Vole	mGy/d	8.48E-04	2.94E-04	1.2E-02	5.74E-02	7.02E-02	6.97E-02	2.4	2.9%	2.9%
	White-tailed Deer	mGy/d	8.42E-04	2.62E-04	1.2E-02	5.74E-02	7.02E-02	6.96E-02	2.4	2.9%	2.9%
Frenchman's Bay (*Aquatic and Riparian*)	White Sucker	mGy/d	5.05E-03	4.21E-03	NA	NA	5.05E-03	4.21E-03	9.6	0.1%	0.04%
	Lake Trout	mGy/d	5.03E-03	4.21E-03	NA	NA	5.03E-03	4.21E-03	9.6	0.1%	0.04%
	Frog	mGy/d	3.70E-03	2.87E-03	NA	NA	3.70E-03	2.87E-03	9.6	0.04%	0.03%
	Aquatic Plant	mGy/d	2.13E-03	1.26E-03	NA	NA	2.13E-03	1.26E-03	9.6	0.02%	0.01%
	Benthic Invertebrate	mGy/d	1.85E-03	9.88E-04	NA	NA	1.85E-03	9.88E-04	9.6	0.02%	0.01%
	Bufflehead	mGy/d	7.54E-03	4.06E-03	NA	NA	7.54E-03	4.06E-03	2.4	0.3%	0.2%
	Common Tern	mGy/d	7.58E-03	5.90E-03	NA	NA	7.58E-03	5.90E-03	2.4	0.3%	0.2%
	Trumpeter Swan	mGy/d	3.94E-03	2.26E-03	NA	NA	3.94E-03	2.26E-03	2.4	0.2%	0.1%
	Ring-Billed Gull	mGy/d	1.31E-02	8.09E-03	NA	NA	1.31E-02	8.09E-03	2.4	0.5%	0.3%
	Muskrat	mGy/d	3.09E-03	1.70E-03	NA	NA	3.09E-03	1.70E-03	2.4	0.1%	0.1%

Notes:

Project-related effects from the PCSS and effects from the existing NSS-PWMF are considered negligible for aquatic ecological receptors in the Outfall or Frenchman's Bay, thus no cumulative effects assessment is required.

[a] Total radiation dose estimates for ecological biota at the PNGS (Ecometrix, 2023a)

[b] For terrestrial ecological receptors, total max dose is the sum of the max PN dose, the max NSS-PWMF dose (terrestrial and aquatic/riparian) and max PCSS dose (terrestrial only)

[c] For terrestrial ecological receptors, total UCLM dose is the sum of the PN UCLM dose, the max NSS-PWMF dose (terrestrial and aquatic/riparian) and max PCSS dose (terrestrial only)

UCLM – Upper confidence limit on the mean

mGy/d – milligray per day

NA – Radiation dose to the aquatic/riparian environment is considered negligible

9.0 Environmental Management

9.1 Environmental Management System

OPG's Environmental Policy requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001 Environmental Management System Standard. The EMS provides the structure and processes to ensure implementation and follow-up on the environmental programs needed to comply with the Environmental Policy. As part of OPG's EMS, environmental performance targets, including reportable spills and environmental compliance, are reviewed annually to ensure that opportunities for continuous improvement are identified and implemented. The programs include OPG's approach to ensure compliance with applicable statutory and regulatory requirements.

During construction and operation of the PCSS, OPG's EMS will continue to require the assessment of environmental risks associated with the facility's activities, and to ensure that these activities are conducted such that any adverse impact on the natural environment is as low as reasonably achievable. Additionally, OPG will obtain all required environmental approvals and permits for the Project.

The specific mitigation and emission monitoring measures implemented as part of the PCSS operation are discussed in **Section 9.2**.

9.2 Emission Monitoring and Control

During site preparation and construction OPG will follow the Environmental Management Plan for construction of the PCSS. The Environmental Management Plan will outline the site-specific measures that will be followed to ensure compliance with federal, provincial and municipal legislations, mitigation of potential environmental impacts, and pollution prevention. OPG and its contractors will employ best practices for environmental management which will be outlined in the Environmental Management Plan.

Once the PCSS is operational, additional thermoluminescent dosimeters (TLDs) will be installed around the PCSS to monitor ambient dose rates. The purpose is to ensure that gamma dose rates adjacent to the PCSS remain below the dose rate target of 0.5 µGy/hr. TLD measurements will be summarized in the quarterly reports for the NSS-PWMF.

9.3 Environmental Monitoring Programs

Environmental monitoring at the PN site has been conducted for many years and the environmental performance is reported to the CNSC on a regular basis.

The existing 2022 PN ERA (Ecometrix, 2023a) was developed in accordance with CSA N288.6 to assess the potential risk posed by the existing operation on human and non-human biota. This PERA for the PCSS, estimated the effects of contaminants on the existing environment resulting from the proposed PCSS to be constructed at the NSS-PWMF. The outcome of the ERA, whether baseline or predictive, is to provide risk-based recommendations, either for the EMP or for environmental control measures. The EMP, in turn provides environmental data for the ERA, and may confirm the effectiveness of control measures. Emission controls for the PCSS are identified in **Section 9.2**, Emission Monitoring and Control.

Project activities during site preparation may result in excess soil that will then need to be managed according to MECP's Management of Excess Soil Guideline. A soil sampling program prior to site preparation activities to characterize soil quality in the PCSS area is recommended prior to site preparation.

Based on the results of the PERA, no additional environmental monitoring as a result of the PCSS has been identified.

10.0 Quality Assurance

All data utilized in this PERA provided by OPG were previously verified by OPG or other contract personnel and provided to Ecometrix for use in the assessment.

All EMP data used in the assessment has been verified by OPG, as described in the Quality Assurance (QA) and Quality Control section of the 2022 PN ERA (Ecometrix, 2023a). The EMP has its own QA program that encompasses activities such as sample collection, laboratory analysis, laboratory quality control, and external laboratory comparison. The station chemistry laboratory also has its own QA program and samples sent to be analyzed externally utilize accredited laboratories.

Throughout the planning and preparation of the PERA, all Ecometrix 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, transcription in the report, 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 a paper trail of review comments and dispositions.

11.0 Conclusions and Recommendations

The potential interactions of the PCSS Project with various environmental components during all phases of the Project were evaluated qualitatively. Based on the qualitative assessment of Project-Environment interactions, the following assessment areas were identified as the focus of the quantitative assessment in the PERA.

- Emissions of dust (TSP) and particulate matter (PM_{10}, $PM_{2.5}$) to air during site preparation and construction.
- Elevated noise levels during site preparation and construction.
- Gamma radiation from the PCSS during operation.

11.1 HHRA

The screening assessment of air quality and noise indicated that all predicted air concentrations and noise levels are expected to be below their regulatory limits; therefore, no further quantitative assessment is required.

For exposure of human receptors to gamma radiation from the PCSS, the potential dose to the Sport Fisher was evaluated. The estimated dose for the Sport Fisher is 4.89E-03 µSv/a. Considering the existing facilities on the PN site, the dose to the Sport Fisher could be up to 0.57 µSv/a. This represents less than 1% of the regulatory public dose limit of 1000 µSv/a.

Overall, since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential critical groups to gamma radiation from the PCSS.

11.2 EcoRA

The screening assessment of air quality indicated that all predicted air concentrations are expected to be below their limits; therefore, no further quantitative assessment is required. While no specific noise level thresholds exist for ecological receptors noise levels are expected to be elevated temporarily during site preparation and construction, and most wildlife in the area are likely already accustomed to noise levels associated with an urban environment. Therefore, no further quantitative assessment is required.

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 fenceline. All predicted doses are lower than the 2.4 mGy/d radiation benchmark for terrestrial biota; therefore, no adverse effects are anticipated.

The dose also remains well below (3% or less) the radiation benchmark if the maximum dose from the PCSS is combined with the dose to ecological receptors from being exposed to radionuclides through other existing PN operations.

11.3 Recommendations

Implementation of an Environmental Management Plan during site preparation and construction activities will help mitigate any potential environmental impacts. The Environmental Management Plan will outline procedures relating to air (dust) and water management, noise control, contaminated and excess soil management, and general wildlife management. OPG and its contractors will employ best practices for environmental management which will be outlined in the Environmental Management Plan.

In addition to the Environmental Management Plan, the following plans or documents are recommended to describe mitigations that will prevent or manage impacts to human health and/or terrestrial/aquatic environments:

- A stormwater management plan for site preparation and construction (to provide the plans for mitigating erosion and sediment transport to the surface water environment, and impacts to groundwater from the stormwater management system);
- A stormwater management plan for post development including design requirements;
- Spill management protocol;
- Health and Safety Management Systems for protection of on-site workers and contractors; and
- Radiation Protection Program (during operation).

As indicated in Section 9.2, to quantify ambient dose rates, during the operation phase, TLD monitoring should be performed at the PCSS. Results would be reported quarterly as part of the NSS-PWMF reporting requirements.

No other additional monitoring is considered to be warranted.

12.0 References

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