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Title:
Preliminary Decommissioning Plan - Darlington Waste Management Facility

**Preliminary Decommissioning Plan –
Darlington Waste Management Facility**

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Revision Summary

Revision Number	Date	Comments
R005	December 2021	<ul style="list-style-type: none"> • Entire document: revised to reflect OPG's current planning assumptions, current and future DWMF expansion plans, DWMF Safety Report Revision 3, changed L&ILW DGR with LLW & ILW long-term disposal facility and alignment with latest revision of CSA N294:19 • List of abbreviation updated • Abstract: added reference to SOR/2004-204 and updated licence condition number • Section 1.0: revised text associated with objective of DWMF • Section 2.1: updated Figure 2-1 • Section 2.2: updated to include RWSB and in service date for RWSB as well as in service date for Storage Building #3 and #4, removed Figure 2-4 • Added section 2.2.5 Interfacing Systems and Services • Section 2.3.2.4: updated for consistency with current seismic information • Section 2.3.3.3: updated to include current information from fisheries and Oceans Canada website • Section 2.3.5: updated to align text with DNGS PDP and DWMF SAR. Updated Table 2-1 • Section 2.3.6: changed title of the section to Indigenous Communities and aligned text with current revision of DWMF SAR and latest community relations • Section 2.3.7: updated to include current information on public communication and engagement program • Section 2.3.7.1: new section added to include indigenous community relations program • Section 2.4: updated to include current status of DSCs, in service date for RWSB and in-service dates for DSC Building 4. • Section 3.1: updated to include CEAA is replaced by Impact Assessment Act and included REGDOC 3.2.1 and REGDOC 3.2.2 • Section 3.2: updated to reflect current planning assumptions and included text associated with aging managed program activities to address mitigation strategies • Section 3.6.4: updated to include text "The DWMF site is not expected to become contaminated throughout the DWMF operations" • Section 3.7: updated to include decommissioning experience from Bruce Heavy Water Plant and Spent Solvent Treatment Facility • Section 4.0: updated Table 4-1 to reflect current planning assumptions • Section 4.1: added statement that OPG is responsible for planning, including development of all required documents throughout the life cycle of decommissioning, executing and funding all phases of decommissioning • Section 4.1.3.3: added DOC will perform decontamination and dismantling as well as bring power supply. Changed clean fill to back fill in underline section Dry Storage Container Processing Building • Section 4.1.3.5: updated to reflect planning assumptions regarding long-term waste disposal facility, added statement, all radioactive waste generated during

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		<p>decommissioning will be characterized as per CSA N292 3-14 for compliance with CSA N294:19 requirement, updated financial guarantee period, updated Table 4-2</p> <ul style="list-style-type: none">• Section 4.1.3.6: updated Survey Appendix reference to match with current Appendix related to surveys in CSA N294:19• Section 5.1: updated to reflect current cost estimates• Section 5.2: updated to reflect current financial guarantee period• Section 6: changed CNSC's policy document P 219 reference to REGDOC-2.2.1. updated text to reflect current planning assumptions and removed Table 6-1• Section 7.0: revised text in last paragraph to include CEAA 2012 has been superseded by the Impact Assessment Act• Section 7.1: updated for alignment with DNGS PDP• Section 7.2.1: updated to keep this section generic and removed specific clauses from previous revision of CSA N294-09• Section 7.2.4: updated to reflect current decommissioning dates• Section 12: updated to include indigenous engagement program and REDDOC-3.2.1 and REGDOC-3.2.2• Section 13: updated and added reference as required• Appendix C: updated to reflect current cost estimate• Appendix D: updated to align with CSA N294:19
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Acronyms

Abbreviation	Definition
ALARA	As Low As Reasonably Achievable
APM	Adaptive Phased Management
BHWP	Bruce Heavy Water Plant
CCNS	Centre for Canadian Nuclear Sustainability
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DDP	Detailed Decommissioning Plan
DGR	Deep Geologic Repository
DNGS	Darlington Nuclear Generating Station
DNNP	Darlington New Nuclear Project
DOC	Decommissioning Operations Contractor
DQO	Data Quality Objectives
DSC	Dry Storage Container
DSO	Darlington Storage Overpack
DWMF	Darlington Waste Management Facility
HEPA	High Efficiency Particulate Air
IAEA	International Atomic Energy Agency
IAA	Impact Assessment Act
IAC	Indigenous Advisory Council
IGLD	International Great Lakes Datum
ILW	Intermediate-Level Waste
L&ILW	Low- and Intermediate-Level Waste
LLW	Low-Level Waste
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
OHSA	Occupational Health and Safety Act
ONFA	Ontario Nuclear Funds Agreement
OPG	Ontario Power Generation
PAUT	Phased Array Ultrasonic Testing
PDP	Preliminary Decommissioning Plan
RWC	Retube Waste Container
RWSB	Retube Waste Storage Building
SEIA	Socio-Economic Impact Assessment
SQEP	Suitably Qualified and Experienced Persons
SSTF	Spent Solvent Treatment Facility
TLD	Thermoluminescent dosimeter
TLG	TLG Services, LLC
UFDSB	Used Fuel Dry Storage Building
WWMF	Western Waste Management Facility

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Abstract

This Preliminary Decommissioning Plan (PDP) describes Ontario Power Generation's (OPG's) current plan for decommissioning the Darlington Waste Management Facility (DWMF). It has been prepared in accordance with the requirements of the Class I Nuclear Facilities Regulations (SOR/2000-204 – Clause 3(k) [R-1]) as well as the requirements of the DWMF licence condition handbook (LCH-W4-355.01/2023) [R-2]. It has also been written to meet the requirements of Canadian Nuclear Safety Commission (CNSC) Guide G-219 Decommissioning Planning for Licensed Activities (June 2000) [R-3] and Canadian Standards Association (CSA) N294:19 – Decommissioning of Facilities Containing Nuclear Substances [R-4]. Appendix D of this PDP refers to the specific requirements of CSA N294:19 and the respective sections of the PDP that cover these requirements. With regards to compliance with CNSC Guide G-219 [R-3], this is inferred through the demonstration of compliance with CSA N294:19 [R-4].

This PDP covers decommissioning activities performed after the used fuel and retube waste have been removed from the site and the decision has been made to shut down the DWMF for decommissioning until the site is available for other OPG uses.

The objective is to retire the facility in a manner that ensures the safety of workers, the general public, and the protection of the environment. This PDP includes a schedule and cost estimate based on planning dates.

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1.0 INTRODUCTION

OPG maintains an ongoing program to prepare for the eventual decommissioning of the DWMF, which is located at the Darlington Nuclear Generating Station (DNGS) site in the Municipality of Clarington, Ontario. The objective of the DWMF is to provide safe storage of used fuel from DNGS reactors in Used Fuel Dry Storage Buildings (UFDSB)¹ and intermediate level, retube waste in a Retube Waste Storage Building (RWSB). The DWMF and the Darlington Nuclear site are described in Section 2.0.

Although the DWMF is located on the same site as the DNGS, the life cycle plans of these two facilities are separate from each other. The last unit at DNGS is assumed to be shut down in nominally 2056. The DWMF will remain in operation after the cessation of power production at the DNGS and until the used fuel and retube waste have been removed from the site.

This document outlines the preliminary planning work that has been completed in accordance with the requirements in CNSC Regulatory Guide G-219² [R-3] and CSA Standard N294:19 [R-4]. It is not intended to serve as a detailed plan for the eventual decommissioning of DWMF, but as a foundation/baseline document to demonstrate that the planned decommissioning is feasible with existing technology and provide a basis for estimating the cost of the decommissioning. This PDP includes or references:

- A description of the facility to be decommissioned;
- A description of the decommissioning strategy that will be employed;
- An outline of the work that will be required to complete the decommissioning;
- A discussion of the various waste types and quantities produced;
- A discussion of the decommissioning cost estimate and financial guarantee;
- An outline of the potential environmental and socio-economic impacts of the decommissioning;
- A proposed schedule for the decommissioning work; and
- An outline of the radiological and conventional safety issues involved in the decommissioning.

This document describes the preliminary plan as it exists at the time of writing including any expansions made during the Financial Guarantee applicability timeframe (i.e., 2023-2027). This PDP will be revised periodically to take into account changes in planning assumptions until a Detailed Decommissioning Plan (DDP) is prepared.

¹ UFDSBs are also referred to as Dry Storage Buildings.

² REGDOC-2.11.2, Decommissioning, was published in January 2021 and supersedes G-219. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-2.11.2 in [R-5].

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Decommissioning of the DWMF may begin once the used fuel, retube waste and any hazardous materials have been removed, and the facility has been removed from service. Before decommissioning begins, a DDP will be prepared.

The appropriate methods and technologies available for use at the time of decommissioning will be reviewed and, where applicable, these will be adopted and described in the DDP. Only when the license to perform decommissioning activities has been issued can steps be taken to mobilize the finalized methods and techniques.

Appendix D refers to the specific requirements of CSA N294:19 and the respective sections of the PDP that cover these requirements. With regards to compliance with CNSC Guide G-219 [R-3], this is inferred through the demonstration of compliance with CSA N294:19 [R-4].

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2.0 DESCRIPTION OF THE DARLINGTON WASTE MANAGEMENT FACILITY AND SURROUNDING AREA

2.1 Darlington Nuclear Site

The Darlington Nuclear site is located on the north shore of Lake Ontario, about 70 km east of the City of Toronto, in the Municipality of Clarington in the Regional Municipality of Durham. The DNGS site is comprised of a land parcel of 485 ha plus additional water lot areas extending into Lake Ontario to accommodate station-related structures and features. The centre of the Darlington Nuclear site is approximately at latitude 43° 53' north and longitude 78° 43' west. A map showing the location of the DNGS site within the local area is provided in Figure 2-1 [R-6].

The DNGS site is bounded by the Energy Drive West and Highway 401 to the north and by Lake Ontario to the south. To the west, the site is bounded by Solina Road and agricultural land. The St. Marys Cement Bowmanville plant occupies the land east of the Darlington Nuclear site [R-6].

Convenient access to the DNGS site is afforded by its proximity to the Highway 401 interchanges with Courtice Road, Holt Road and Bowmanville Avenue. Courtice Road (Regional Road 34) is a north-south, two-lane road. Bowmanville Avenue (Regional Road 57) is also north-south, two-lane road and is the main link between the community of Bowmanville and Highway 401. The southern terminus of Holt Road is the main entry to the DNGS site. There is a secondary entry gate (Park Road) on Energy Drive West of Holt Road. Park Road is north south road that leads to Energy Drive. Energy Drive is an east west road that runs parallel to Highway 401 and intersects Holt Road just south of the 401 [R-6].

A Canadian National Railway right-of-way extends east-west across the Darlington Nuclear site. The tracks are fenced and gated across the entire site and access to the southern third of the site is facilitated by overpasses on both Holt and Park Roads [R-6].

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Controlled Area Building Number & Name
112 - Turbine Parts Storage
113 - Field Sales Facility
114 - Drawing Storage Facility
116 - Project Office
118 - Leasehold Garage
124 - Hydro Transformer Substation 052
125 - Steamtrailing Boiler House
126 - Site and Facilities Misc Shop #1
131 - East Warehouse
136 - Flammable Storage Bldg
138 - HNS & HWS Facilities
140 - Warehouse Yard
141 - Maintenance Computer Development Facility
142 - Auxiliary Heating Steam Facility
143 - Lift Station East
203 - Yard Misc Shop
1208 - Hydrogen Trailer
207 - Lift Station West
208 - Refurbishment Project Office
300 - Auxiliary Security Bldg / VSF
302 - Pipe Fab/ Machine Shop
311 - Facilities Vehicle Garage #2
312 - Quonset Bldg
313 - S.S.H. Bldg
329 - Darlington Learning Center (DLC)
330 - ESSB
332 - ESSB Parking Lot
332 - ESSB Parking Lot
333 - ESSB Parking Lot
354 - Executive Parking Lot
355 - MSA Parking Lot
356 - DNMFP Amenity Bldg
357 - Bus Shelter
358 - UFS Sampling Station Bldg
359 - DNMFP Process Bldg
362 - DNMFP Storage Bldg
363 - Used Fuel Dry Storage #2

Protected Area Building Number & Name
01 - Unit 0
1 - Powerhouse
11 - Unit One
12 - Unit Two
13 - Unit Three
14 - Unit Four
CVFS - Containment Filtered Venting System
62 - East FRAA
WF - West FRAA
P1 - Pumphouse One
P2 - Pumphouse Two
P3 - Pumphouse Three
P4 - Pumphouse Four
WTP - Water Treatment Plant
5 - Construction Change Room
6 - Computer Maintenance Bldg
7 - Powerhouse Annex
8 - EPS Fuel Bldg #8
30 - Refuse Waste Processing Bldg
73B - Calibration Shop
14 - Lub Oil Tanks
15 - EPS Bldg
36 - DNMFP Pumphouse/Chlorine Addition Bldg
17 - Chlorinating Water Discharge Structure
38 - EPS #1
39 - EPS #2
32 - EPS Fuel Mgt Bldg
23 - EPS #3
31 - Sheet Metal Shop

Controlled Area Building Number & Name
304 - Refuse Waste Storage Bldg
403 - Contractor Facility
FN02 - OSB Parking
FN02 - OSB Parking
412 - 500
412 - East Parking Lot
414 - Upper & Lower Parking Lot
433 - SSI Cooling Warehouse
435 - Main Security Bldg
432 - Settlement Pond
433 - Hydro Transformer Substation
434 - DNMFP Power Backflow Preventer Check
440 - Rail Siding North
442 - Rail Siding South
443 - MSA Hut
444 - Emergency Equipment Storage Bldg #1
445 - Emergency Equipment Storage Bldg #2
450 - Hydro Transformer Substation D55
FN03 - RFD Lower Parking
FN04 - RFD Upper Parking & Stairway
500 - Soccer Fields
502 - Parking Plaza Trail
504 - SFS Building
508 - Menstruational Trailer
509 - Domestic Water Meter & Valve Station
530 - Radiation Emission Monitor Station #2
531 - Radiation Emission Monitor Station #1
532 - Radiation Kiosk
533 - Covered Walkway
534 - Seismic Monitoring Station
535 - Meter & Backflow Prevention Chamber (Bldg #1)
536 - Meter & Backflow Prevention Chamber (Bldg #2)
A5 - Generator
539 - Temp Trailer Area
538 - Temp Trailer Area

Legend
CGI Ownership
Protected Area
Ongoing / Proposed Projects
2017 Demolition
Future Proposed Demolition
Material Laydown
EMF Hazard
Exclusion Zone
Waterfront Trail
Fitness Loop
DNMP Fence Line

Ongoing / Proposed Projects
30 - BWP Refuse Waste Processing Bldg (2017)
364 - OSB Refuse Waste Storage Bldg (2017)
445 - BME B Emergency Mitigation Equipment (2017)
88 - Bridge Rehabilitation (Both Rd 2017)
96A - Refuse Waste Processing Area (2017)
ZMM - Zebra Mussel Mitigation (2017)
DW - Emergency Service Vehicle (2018)
WTP - Water Treatment Plant (2018)
41 - OSB Storage Bldg (TBD)
UFS01 - Used Fuel Dry Storage #1 (TBD)
UFS04 - Used Fuel Dry Storage #4 (TBD)

Future Proposed Demolition
112 - Turbine Parts Storage (Demo 2023)
126 - Site and Facilities Misc Shop (Demo 2017)
125 - Boiler House / Annex (Demo 2018)
131 - S.S.H. Bldg / DNMFP Lands (Demo 2018)
302 - Pipe Fab / Machine Shop (Demo 2018)
116 - Project Office (Demo 2018)
131 - East Warehouse (Demo 2018)
136 - Flammable Storage Bldg (Demo 2018)
111 - Refuse Waste Storage #2 / DNMFP Lands (Demo TBD)
312 - Quonset Bldg / DNMFP Lands (Demo TBD)

Figure 2-1: Location of the Darlington Nuclear Site

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2.2 Darlington Waste Management Facility

The DWMF is a Class 1B nuclear facility, owned and operated by OPG. The DWMF is located on the Darlington Nuclear site, approximately 460 m east of the DNCS protected area. The DWMF is readily accessible by existing site roads [R-6].

The DWMF currently includes a Dry Storage Container (DSC) Processing Building, RWSB, which was put in service in 2017, and UFDSBs #1 and #2. The DSC Processing Building, Dry Storage Building # 1 and # 2 are surrounded by a security fence and an outer concrete jersey barrier with tie-ins for various site services. The RWSB is located in a separate area, surrounded by its own security fence. The DWMF will be expanded to include two additional UFDSBs (UFDSB #3 expected to be in service by 2023 and UFDSB #4 by 2031³).

Site services provided to the DWMF include: domestic and fire water supply, Class IV electrical power supply, telephone, public announcement and local area network, security, building process and alarms communications, emergency response, sewage treatment, drainage, and storm water management.

The location of the DWMF within the Darlington Nuclear site is shown in Figure 2-2. An aerial photo of the DWMF and surroundings is provided in Figure 2-3.



Figure 2-2: Location of the Darlington Waste Management Facility

³ With the estimated in-service date of 2031 for UFDSB #4, this falls outside of the scope of this PDP. UFDSB #4 is not considered further in any detail in this PDP, but will be incorporated in future revisions, as applicable.

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Figure 2-3: Aerial View of the Darlington Waste Management Facility

The DWMF will have a capacity to store a total of about 2,000 DCSs once all planned DSC Storage Buildings have been built. A list of major systems and components in the DWMF, with a description of their functions, is shown in Appendix A.

Used fuel, with the prescribed minimum cooling period, has been and will continue to be removed from the DNGS irradiated fuel bays and loaded into DSCs. The outer surfaces of the DSCs are decontaminated before being moved to the DSC Processing Building where the DSCs are sealed and prepared for interim storage in a DSC Storage Building.

2.2.1 Dry Storage Containers

The DSC is a rectangular-section container made of a double carbon-steel shell filled with reinforced high-density concrete, see Figure 2-4. The DSC has been designed for above-ground storage and transportability. The design life of the DSCs is at least 50 years. Each DSC has a storage capacity of 384 used fuel bundles. The used fuel in the seal-welded DSCs is stored in an inert helium atmosphere. DSCs inside DSC Storage Building #1 are shown in Figure 2-5.

DSCs will be removed from the DWMF prior to decommissioning and are therefore not described further in this PDP.

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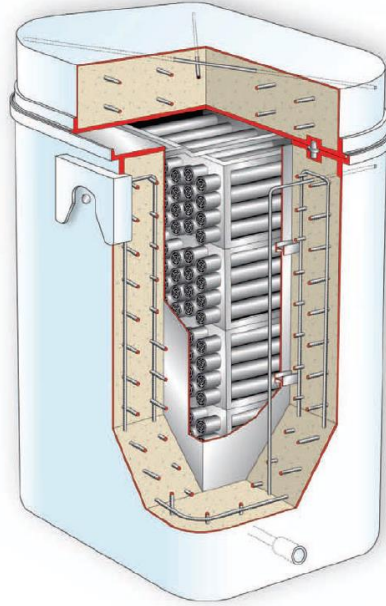


Figure 2-4: Dry Storage Container for Used Fuel



Figure 2-5: Dry Storage Containers in DSC Storage Building #1

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2.2.2 Dry Storage Container Processing Building

The DSC Processing Building was constructed using a steel frame, poured concrete and concrete masonry construction with metal cladding on the exterior, meeting National Building Code requirements for wind and seismic loads. No hazardous materials were used in the construction of the DWMF. It is equipped to receive, inspect and prepare empty new DSCs and to seal weld, leak test and inspect DSCs filled with used fuel from DNGS before they are transferred to a DSC Storage Building.

The 15 m high DSC Processing Building has two storeys. The ground floor includes a truck bay (for receiving the DSC delivery truck and DSC transporter) and accommodates the DSC processing area, weld gas bottles, active waste, inactive drainage, active ventilation and electrical rooms, an operator's room, and a maintenance area including a tool room and stores. The amenities area also covers two floors. The first floor contains rooms for electrical equipment, a mechanical room with active ventilation, and heating ventilation and air conditioning equipment, an operations room, janitor's room, storeroom, washrooms, locker rooms, security area with a security observation post, radiation monitoring area and first aid room. An elevator provides barrier-free access to the second floor which contains general office spaces, an International Atomic Energy Agency (IAEA) equipment room, washrooms, janitor's room, conference room, lunchroom, records room and electrical room. The layout of the DSC Processing Building is shown in Figure 2-6, Figure 2-7 and Figure 2-8.

The main processing area (shown in Figure 2-9) contains a number of dedicated systems for DSC processing, including:

- Lid welding and related systems;
- Welding inspection system;
- Vacuum drying system;
- Helium backfilling system;
- Helium leak detection system; and
- Paint bays (maintenance areas).

The second floor has a storage area and control centres for welding and weld inspection. This floor also contains a maintenance area, air handling equipment, High Efficiency Particulate Air (HEPA) filters and exhaust stack.

The floor surfaces have been treated with surface hardening agents and sealants as required to improve floor durability under heavy wheel loading and to prevent ingress of radioactive contamination while minimizing the slip hazard at variable humidity levels. No loose contamination will be permitted either on the exterior surfaces of DSCs, or on accessible surfaces such as floors in the DSC Processing Building.

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Spot decontamination operations, which may be carried out in the DSC Processing Building, are not expected to generate any liquids. DSC processing involves lid closure by welding, weld inspection, drying, inert gas filling and helium leak testing prior to transport to a DSC Storage Building.

The DSC Processing Building, due to the nature of its operations, stores a variety of consumable materials including non-radioactive, hazardous materials such as compressed gases, paints, etc. Appendix B provides estimated quantities of hazardous materials that are used at the DWMF. The consumable materials are stored in small quantities and are easily removed. The storage locations of the consumable materials are shown in Figure 2-6. There are no laboratory or bulk chemicals stored in the DSC Processing Building.

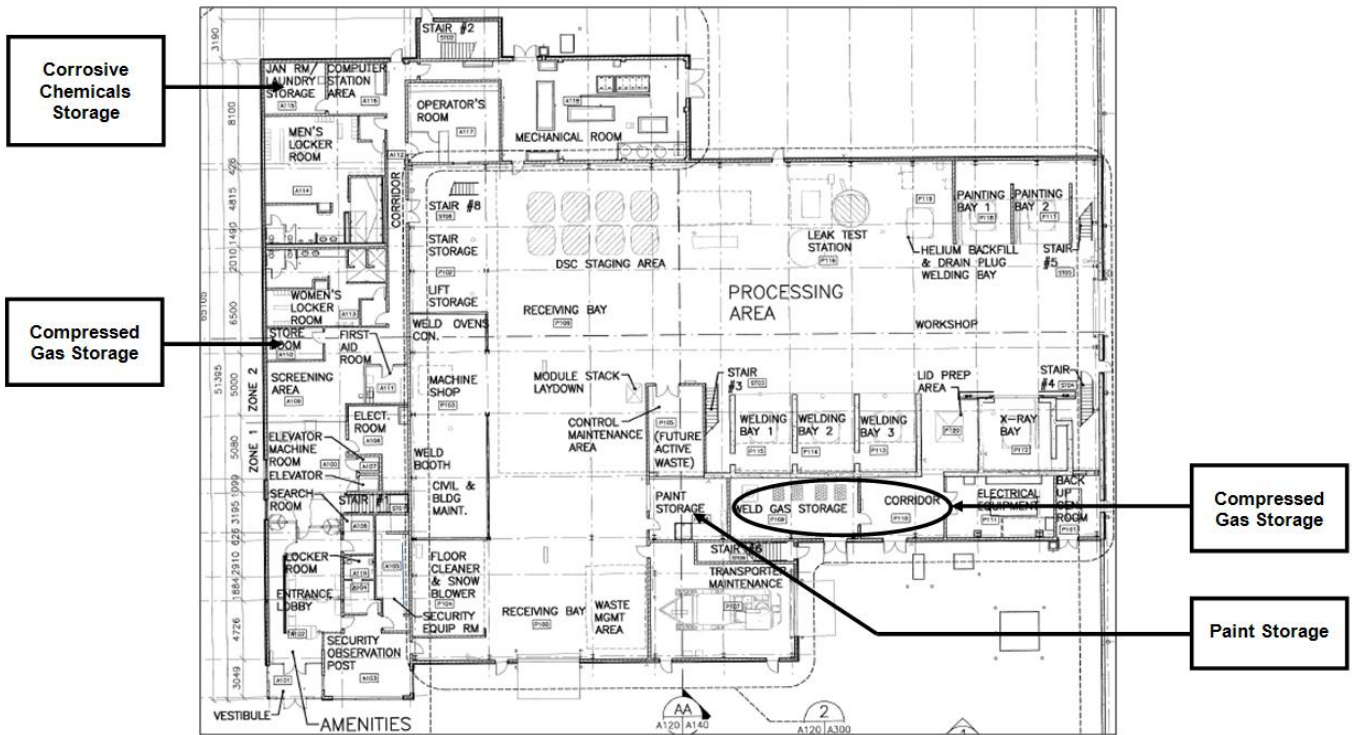


Figure 2-6: Layout of the DSC Processing Building (First Floor)

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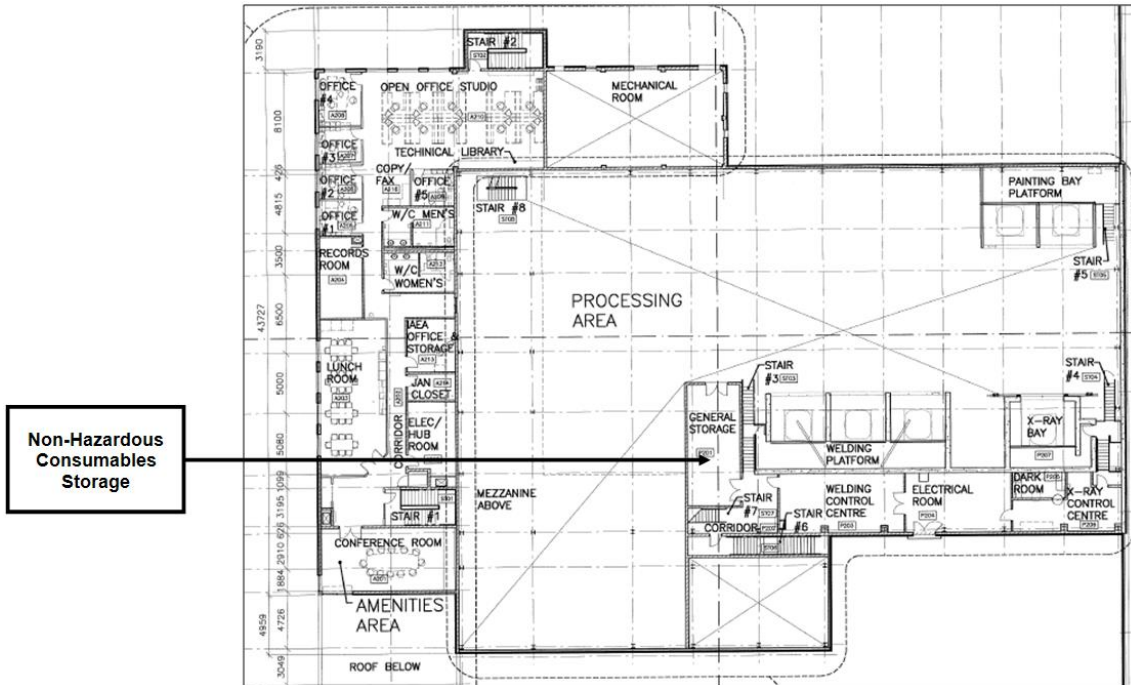


Figure 2-7: Layout of the DSC Processing Building (Second Floor)

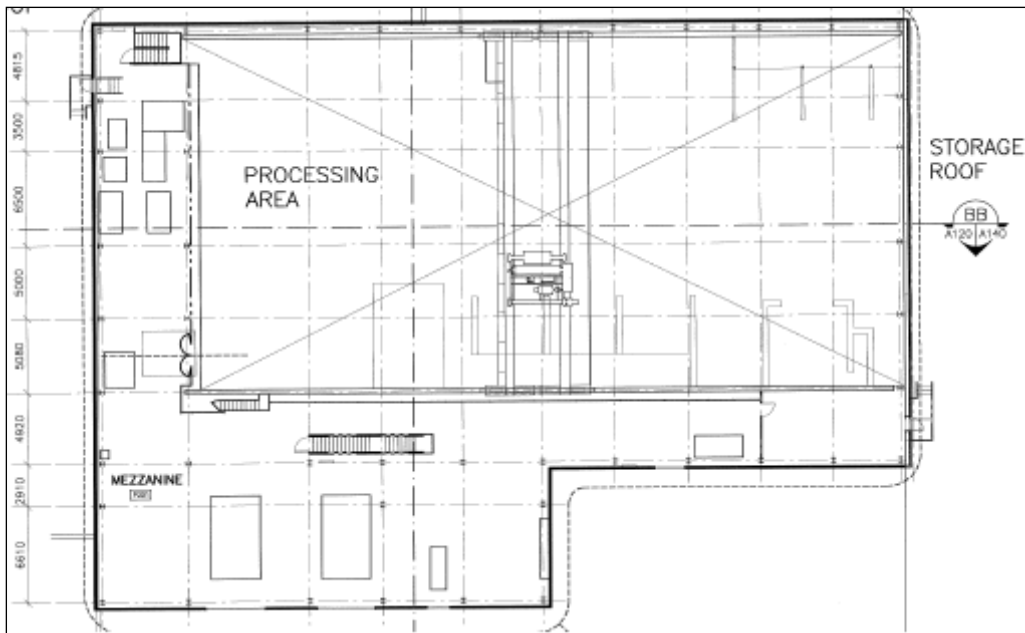


Figure 2-8: Layout of the DSC Processing Building (Mezzanine Floor)



Figure 2-9: Picture of the DSC Processing Building (Interior)

2.2.3 Dry Storage Container Storage Buildings

The DWMF has provision for up to four DSC Storage Buildings of the similar size. Construction of additional DSC Storage Buildings will be staged as additional storage space is required. Each additional DSC Storage Building will have an area of approximately 7000 m² and a nominal storage capacity of 600 DSCs.

DSC Storage Building #1 (see Figure 2-5), is located immediately south of the DSC Processing Building. The layout of DSC Storage Building #1 is shown in Figure 2-10 [R-6]. DSC Storage Building #1 has an approximate area of 5,730 m² and has a nominal storage capacity of 500 DSCs. The walls of this building consist of 254 mm thick and 4.2 m high pre-cast concrete panels. The reinforced concrete floor slabs are designed to accommodate heavy wheel load traffic and the weight of the loaded DSCs. The floors are constructed for long service to retain surface alignment and provide a hard, smooth and durable surface.

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DSC Storage Building #2 is located south of DSC Storage Building #1, see Figure 2-3. The layout of DSC Storage Building #2 is shown in Figure 2-11. It is physically separated from DSC Storage Building #1 by a 15 m space, within the existing DWMF protected area. DSC Storage Building #2 is designed for storage of 500 DSCs and is of a similar construction as DSC Storage Building #1. It consists of pre-cast concrete walls with a thickness of 254 mm (10"). Both DSC Storage Buildings provide shielding necessary to reduce radiation fields from the stored DSCs to 0.5 $\mu\text{Sv/h}$ (0.05 mrem/h) at the DWMF Protected Area fence, and to contribute less than or equal to 10 $\mu\text{Sv/yr}$ (1 mrem/yr) at the Darlington site boundary fence. No hazardous materials, such as asbestos, were used in the construction of either building. Power distribution to DSC Storage Buildings is supplied by the existing DWMF power supplies (Class II, Class III and Class IV). Life safety systems (fire, public address, telephone) are tied into and interface with the existing DWMF systems.

DSC Storage Building #1 and DSC Storage Building # 2 are unheated except for DSC Storage Building #2's janitor's closet, which is equipped with interior heating. Both storage buildings contain minimal services, including: lighting, public address system, telephone and fire detection systems. Safeguards video and surveillance systems are available in DSC Storage Building #1. The buildings are passively ventilated using horizontal louvres in the east and west perimeter walls. The 30 roof-mounted turbine ventilators dissipate decay heat from the stored used fuel. The east and west louvers have manual control capabilities to allow isolation of ventilation during winter and/or severe weather conditions, and to minimize ingress of wind driven snow and rain. The covered louvers are installed at each end of the north and south walls of DSC Storage Building #2 to protect them from snow, ice, and rain penetrating during winter. Inactive floor drains capture water ingress from the ventilation system [R-6].

Storage Building #3 and #4 are planned to come into service nominally in 2023 and 2031 respectively.

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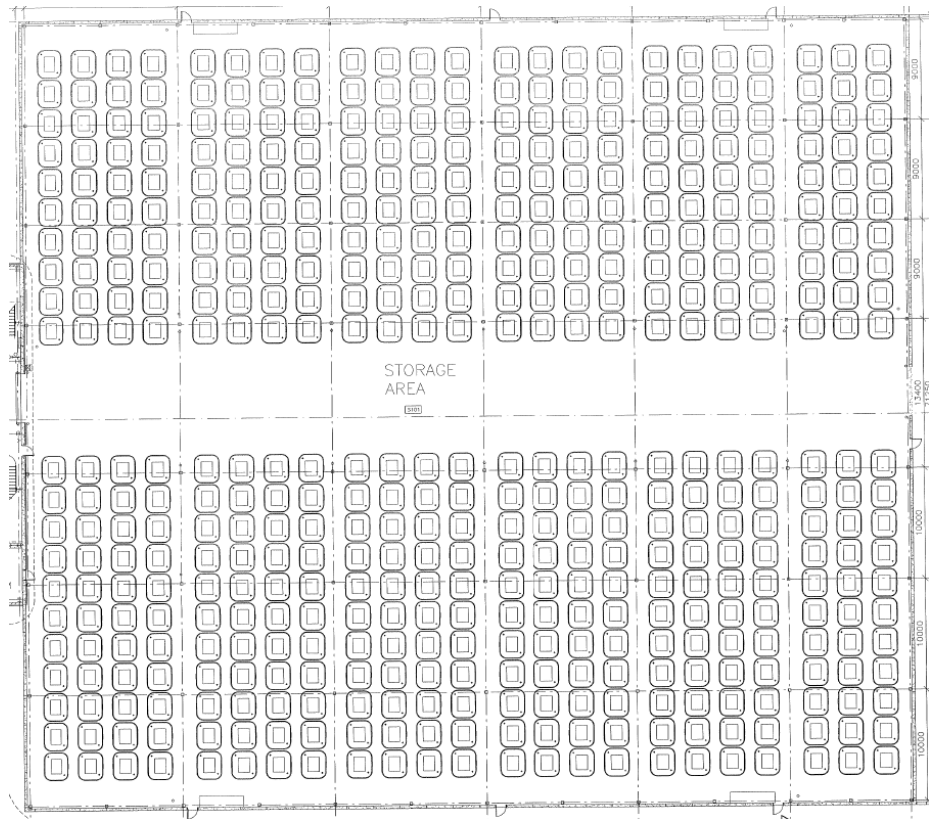


Figure 2-10: Layout of DSC Storage Building #1

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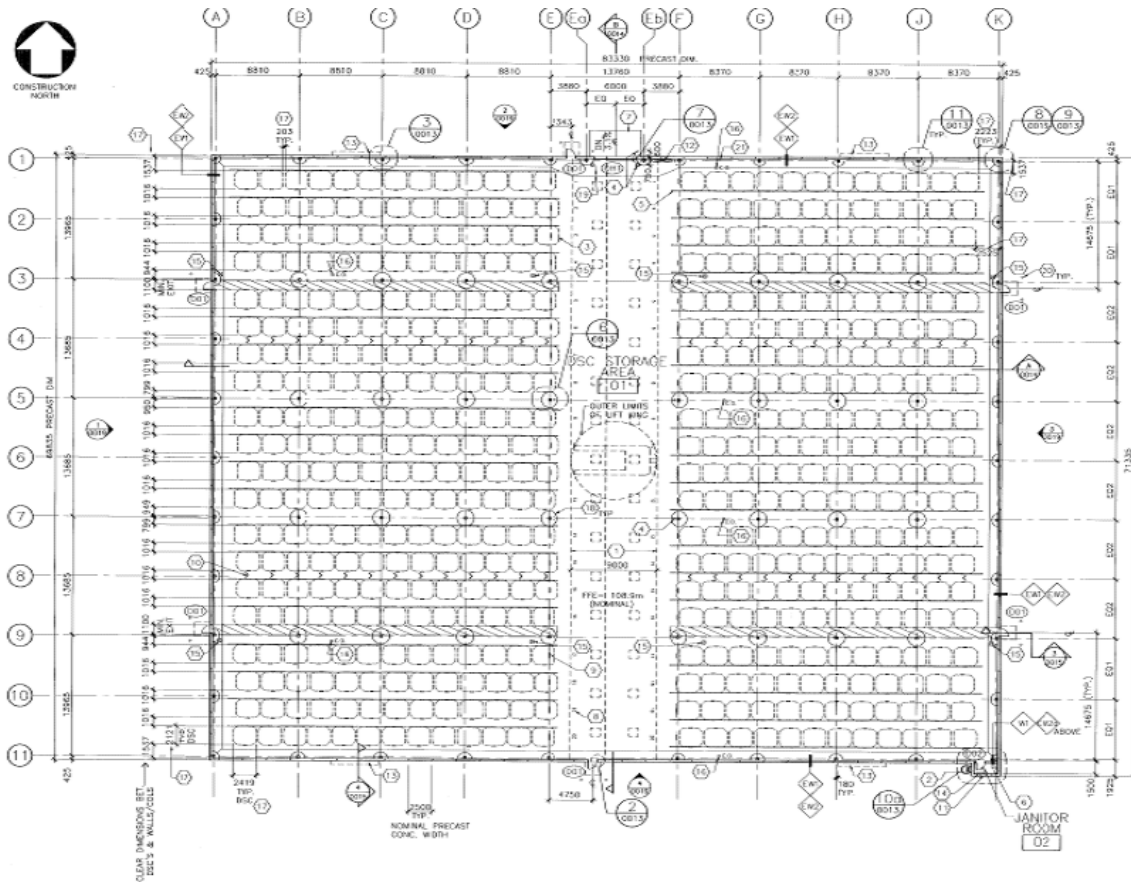


Figure 2-11: Layout of DSC Storage Building #2

2.2.4 Retube Waste Storage Building

The RWSB provides storage capacity for retube waste from the retubing of the four DNGS reactor units. The RWSB is located in a separate area, between the remainder of the DWMF buildings and the DNGS reactor buildings, surrounded by its own security fence.

The retube waste stored in the RWSB comprises of irradiated components such as pressure tubes, calandria tubes and end fittings. The waste will be stored in the RWSB for a minimum of 25 years, until radioactivity levels have reduced sufficiently for the waste to be transported to OPG's long-term disposal facilities for low-level waste (LLW) and Intermediate-level waste (ILW), respectively.

The RWSB has capacity for storing waste containers from the retubing of all four Darlington units and has a nominal capacity of 400 containers. The building is of an industrial/warehouse design, with pre-cast concrete walls that have a thickness of 340 mm (for shielding). No hazardous materials were used in the construction of this building. A preliminary layout of the RWSB is shown in Figure 2-12 [R-7].

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The retube waste arrives at the RWSB in shielded waste containers. The waste is stored inside mobile enclosures, each consisting of a container within a container. The inner container (which exists in different configurations to enable interim storage of different waste types) is referred to as the Retube Waste Container (RWC) and the outer as the Darlington Storage Overpack (DSO). The overall height of the DSO is 2.8 m and the outside diameter 2.4 m. The containers (RWC/DSO) are designed for a minimum fifty-year life. Similar to the DSCs, the RWC/DSOs will be removed from the DWMF prior to decommissioning and are therefore not described further in this PDP.

The RWSB is a single-storey building with three distinct areas: an unheated and passively ventilated truck bay, an unheated and passively ventilated container storage area, and a small heated and ventilated amenities area. The amenities area, which is predominately Zone 1, contains an area for radiation monitoring equipment, a janitor's closet and an electrical room. The unheated truck bay and storage area is Zone 2, with exterior and interior shielding walls to limit dose rates from stored containers.

The RWSB is provided with services such as fire detection, power (Class II, III and IV), ventilation, lighting and drainage. The floor plan is approximately 75 m by 45 m [R-7]. The interior height accommodates the movement and placement of containers stacked two high.

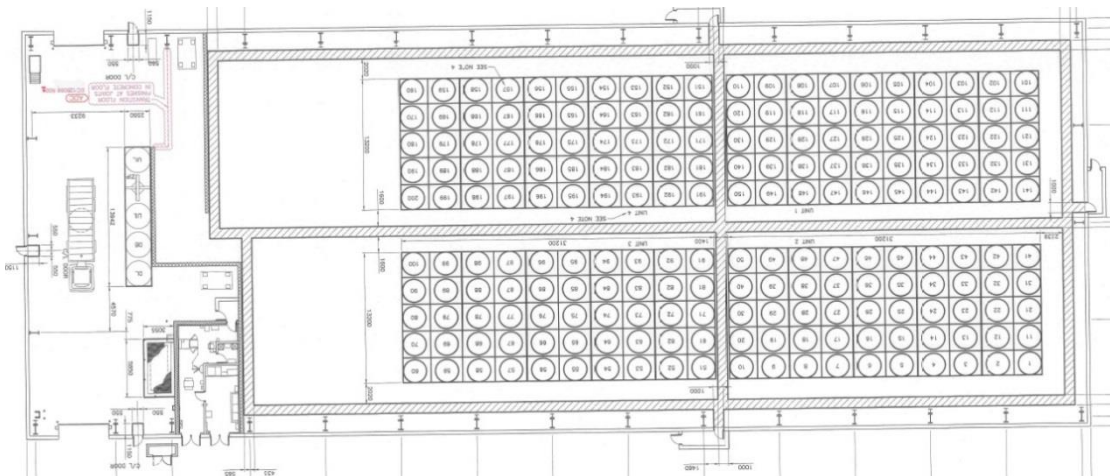


Figure 2-12: Layout of Retube Waste Storage Building

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2.2.5 Interfacing Systems and Services

There are multiple interfacing systems and services between the DWMF, DNGS and the Municipality of Clarington to ensure safe operations of the facilities.

The interfacing systems between the DWMF and the Municipality of Clarington include:

- Domestic Water;
- Sewage; and
- Class IV Electrical;

The interfacing systems between the DWMF and DNGS include:

- Fire Detection;
- Security; and
- Public Address (PA System).

The interfacing services between the DWMF and DNGS include:

- Environmental Monitoring;
- Radiation Protection;
- Security; and
- Emergency Response.

Although the life cycle plans of DNGS and the DWMF are separate from each other, the decommissioning of DNGS may have an impact on the DWMF. This impact along with the overall decommissioning timeline for the DNGS and the DWMF is described in detail in DNGS PDP [R-8].

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2.3 Description of the Environment

2.3.1 Natural Environment

The Darlington Nuclear site is situated in an undulating to moderately rolling limestone till plain, spotted with remnants of a lake plain deposit. Inland, the previously irregular terrain has been graded in the powerhouse area to an elevation of about 100 m. The surface elevation generally rises towards the north with a mean elevation of 122 m just south of the railway tracks. North of the tracks, the ground is irregular ranging from 120 to 128 m elevation. A higher ridge, starting from the shore just east of Raby Head, extends diagonally across the site in a northwesterly direction with levels ranging up to 15 m above surrounding ground. On the west half of the site, the land generally slopes from 100 m elevation at the Darlington powerhouse to 130 m at the east end of the site. Offshore from the site, the lake bottom slopes away gradually, reaching a depth of 6 m at about 425 m from shore and 14 m at 1,200 m from shore [R-6].

Nearby vegetation is dominated by herbs characteristic of open, disturbed habitats. Scattered shrubs are present throughout the site and discontinuous tree cover is present along the fences. The DWMF is located within a cultural meadow comprised of dry-moist old field meadow type vegetation community that provides approximately 5-10 percent cover. Small areas of shallow marsh vegetation may be present within drainage ditches. A cultural thicket vegetation unit is located adjacent to the north-east corner of the DWMF site area. The area to the south and west of DWMF is built-up, consisting of buildings, parking lots and roads [R-6].

The Darlington Nuclear site provides habitat for breeding and migrant bird species and provides breeding and foraging habitat for a variety of herpetofauna and mammals. Over 70 bird species have been identified as breeding on the DNGS site. Four main breeding bird communities are present on the DNGS site in association with distinct habitat types including wetlands, grassland, and upland shrubland-succession, as well as habitat generalists that use non-specific habitat types and are favoured by site conditions that include an abundance of edge habitat [R-6].

The site also supports a population of white-tailed deer concentrated in the area immediately east of the landfill. Other mammals include a number of small and medium-sized species, such as white-footed mouse, meadow vole, eastern chipmunk, common shrew, groundhog and eastern cottontail. American beaver and muskrat have both been reported in the area of Coot's Pond. Predators include short-tailed weasel, red fox and coyote [R-6].

Amphibians that currently breed within the area are American toad, northern leopard frog and green frog. Eastern garter snake is the only snake species that breeds within the area [R-6].

At least 28 butterfly species, 208 moth species and 36 species of dragonfly have been recorded. Regionally rare butterfly species recorded include little sulfur, buckeye and fiery skipper [R-6].

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2.3.2 Geophysical Environment

2.3.2.1 Soils

The soils on-shore are about 21 to 36 m thick and consist of thin topsoil and up to 3 m of loose to dense silt clay and fine sand overlaying 2 to 20 m of dense to very dense sandy till. The till is underlain by interglacial soils consisting of alternate layers of very dense, pervious fine sand and hard, impervious varved silt and clay. The interglacial soil complex ranges in thickness from 3 to 25 m. A very dense silty fill lies on the bedrock beneath the interglacial soils and is generally less than 5 m thick [R-6].

The offshore soils range from 7 to 8 m thick at the shoreline and become less than 1 m thick about 1,000 m offshore. The soils consist of thin interglacial soils overlaying silty till. Gravel, cobbles and boulders are found in some areas [R-6].

2.3.2.2 Bedrock

Over most of the site, bedrock is covered by deep soil deposits. The bedrock surface slopes gently southeasterly. The bedrock elevation north of the powerhouse area near the Canadian National Railway tracks is about 91 m while the bedrock at the shoreline is around 88 m. At a distance of 1,000 m from the shoreline, the bedrock elevation is about 85 m [R-6].

The bedrock is composed of nearly flat lying sedimentary rocks of Middle Ordovician age. The upper rock unit consists of dark brown, very thin to medium bedded shaley limestone of the Whitby Formation. The Whitby Formation ranges in thickness from 8 to 1.5 m, thinning towards the eastern part of the site [R-6].

The shaley limestone is underlain by grey, thick to massive bedded, fragmental limestone of the Lindsay Formation, which has thin inter-beds of shaley limestone throughout. The Lindsay Formation has a confirmed thickness of about 61 m at the site [R-6].

The bedrock is hard and sound. At the bedrock surface, there is a zone of broken, weathered rock up to 2 m in thickness. This zone is characterized by weathered, open, water-bearing bedding joints [R-6].

2.3.2.3 Groundwater

The regional direction of groundwater flow is southward from the Oak Ridges Moraine toward Lake Ontario, parallel to the slope of land. Groundwater that recharges the superficial soil deposits and bedrock surface ultimately discharges to either the southward flowing surface streams crossing the area or directly to Lake Ontario [R-6].

The majority of the groundwater within the Interglacial Deposits is most likely recharged up gradient from the DWMF, north of the Canadian National line where the deposits are close to surface and the upper till is thin. Recharge at the DWMF to the interglacial deposits is limited due to the thick upper till layer comprised of fine-grained, low permeability soils [R-6].

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Since 2002, DNGS has undertaken a voluntary program for a reconnaissance-level groundwater impact evaluation in the powerhouse area. Ten multilevel monitoring wells, having a total of 25 groundwater intake zones, were installed in the vicinity of the powerhouse in the bedrock and the overburden [R-6].

2.3.2.4 Seismicity

The western Lake Ontario region lies within the tectonically stable interior of the North American continent, which is characterized by low rates of seismicity. The region experiences low to moderate levels of seismicity. Most events have magnitude (M, called 'Richter' magnitude) less than 5, with rare occurrences of larger events. In general, earthquakes in stable interior regions, such as the Lake Ontario region, occur at depths of 5 to 20 km, on faults formed hundreds of millions of years ago during previous active tectonic episodes. These faults are widespread throughout the crust, and typically have little to no surface expression [R-6].

The historical record of earthquakes for the region confirms relatively low seismic activity. Over the period of record since 1840, within the region to 150 km from the Darlington Nuclear site, the maximum seismic event has only generated a calculated peak ground motion at the site of less than 1.5 percent of gravity. Over this period of records, only seven events were reported to have occurred within 150 km of the site with sufficient magnitude to generate a calculated peak ground motion at the site greater than 0.5 percent of gravity. The DWMF site can, therefore, be considered seismically stable [R-6].

From July 2017 to March 2021 inclusive, there have been an additional 12 seismic events reported in Ontario of a magnitude greater or equal to 3.0 (range between 3.0 and 4.1, one earthquake of 3.0 magnitude within 100-km radius of DNGS) [R-9].

2.3.3 Aquatic Environment

2.3.3.1 Drainage

Few significant streams traverse the Darlington Nuclear site. Darlington Creek runs across the northeast corner of the Darlington Nuclear site and has been diverted away from the St. Marys Cement site to intercept drainage from the small intermittent drainage course (Stream E) that originates in the eastern section of the site. Darlington Creek empties into Lake Ontario between the headland bluff known as Raby Head and the non-provincially significant wetland known as Raby Head Wetland [R-6].

Around the DWMF site, there is a grade of approximately 2.5 percent southwest to the lake. Perimeter ditches tie into existing site drainage ditches and discharge via a storm water containment pond to Lake Ontario [R-6].

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2.3.3.2 Fish

The shallow near shore habitats that may be subject to run-off from the Darlington Nuclear site are dominated by relatively few fish species. Immediately next to shore, emerald shiner is the most numerous and commonly encountered small planktivorous fish; emerald shiner is tolerant of both warm water and cold water conditions that occur within the near shore and, as a result, may be found in the shallows year-round. Emerald shiner is also found within lower reaches of tributary streams, such as the realigned Darlington Creek. White sucker is a dominant medium/large benthivorous fish species in the Lake Ontario near shore. Being tolerant of warm water and cold water conditions, it is also a year-round inhabitant [R-6].

2.3.3.3 Lake Water Levels

The Darlington Nuclear site is protected from high lake levels by the protected face of the new shoreline, which is built to elevation 101 m, 1 m above site grade level and about 2.9 m above the highest water level recorded. This new shoreline provides an adequate safety barrier against the severest anticipated combination of spring runoff and wave action [R-6].

Based on measurements of the monthly water level of Lake Ontario (i.e., the average levels of the whole lake) from 1918 to 2019, the annual maximum monthly average water levels range from a low of 73.74 m relative to the International Great Lakes Datum (IGLD) (1934) to a high of 75.91 m relative to the IGLD (2019). Lake Ontario water levels have been regulated since the completion of the St. Lawrence Power Project in 1958. The mean Lake Ontario water level from 2004 to 2019 has been 74.63 m (December) – 75.79 m (June) above mean sea level [R-10].

2.3.4 Current Use of the Adjacent Land

The regional economy has a robust manufacturing base, combined with agriculture and aggregate extraction. A large cement plant and quarry, St. Marys Cement, adjoins the eastern boundary of the Darlington Nuclear site. The City of Oshawa is a major centre of heavy manufacturing activity with the largest segment of this employment associated with the automobile industry.

The main recreational facility in the area is the 209 ha Darlington Provincial Park located 4.8 km west of the Darlington Nuclear site. It is a popular facility, with campsites, swimming facilities, fishing, controlled hunting, boating, etc. There are also 19 conservation areas within 40 km of the site: three within the Metropolitan Toronto and Region Conservation Authority, 11 within the Central Lake Ontario Conservation Authority and five within the Ganaraska Conservation Authority.

The DWMF is located entirely within the Darlington Nuclear site property. The DNCS site is located on a 485 ha site bordering Lake Ontario. The entire site is fenced and access to the site is restricted and controlled by OPG. Within the Darlington Nuclear site, existing land uses consist of buildings, structures, switchyards, and transportation access that are required to operate and support the station's functions. The buildings include the reactor buildings, powerhouses, a variety of low-rise office, warehouse,

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maintenance, and storage facilities as well as structures designed specifically for the technical functions required for generating and transmitting electricity from nuclear power. Other land uses within the Darlington Nuclear site boundaries include landfills and waste management facilities.

2.3.5 Local Communities

The DWMF is located in the Municipality of Clarington. Other nearby municipalities include City of Oshawa and Municipality of Port Hope. The population of nearby municipalities in 2016 are shown in Table 2-1 [R-11]. The local and regional areas have experienced strong population and economic growth over the last decade.

Table 2-1: Population of Nearby Municipalities

Municipality	2016
Oshawa	159,458
Town of Ajax	119,677
Town of Whitby	128,377
Clarington	92,103
Port Hope	16,753
Township of Scugog	21,617
Township of Uxbridge	21,176

OPG is a large local employer. It is estimated that about 300 local jobs are created indirectly, because of the DNGS and DWMF operation. Most of the employees live in the local area.

The 10-year DNGS Refurbishment Project will help extend the operational life of the DNGS reactors to up to 2055, contributing a total of \$90 billion to Ontario's Gross Domestic Product. The Refurbishment Project will create up to 11,800 jobs annually while contributing nearly \$15 billion to Ontario's economy.

While there is a significant impact of DNGS on the community, the DWMF is a small but integral part of Darlington Nuclear. The DWMF has only a minimal impact on the social and community environment, mainly due to its limited size and number of employees. However, the DWMF supports the continued operation of DNGS, and thus contributes indirectly to the social economic benefits of the Darlington site to the neighbouring communities.

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2.3.6 Indigenous Communities

There are six indigenous communities located within distances between 50 km to 135 km of the DNGS, one each in Durham Region and Northumberland County, two in southern Peterborough County, another located on Georgina Island in south Lake Simcoe in York Region and another in Quinte West. These six indigenous communities all have a historical relationship with the lands along the north shore of Lake Ontario (from Toronto east to the Bay of Quinte) and north to Lake Simcoe and Rice Lake as a result of their occupation and traditional use of these lands prior to European settlement and subsequent signing of treaties.

These indigenous communities are listed below along with their approximate locations:

- **Alderville First Nation:** 20 km southeast of Peterborough on south side of Rice Lake
- **Curve Lake First Nation:** 15 km north of Peterborough on Buckhorn Lake.
- **Hiawatha First Nation:** 15 km southeast of Peterborough on north side of Rice Lake.
- **Mississauga's of Scugog Island First Nation:** 35 km north of Oshawa on Scugog Island in Lake Scugog.
- **Chippewa's of Georgina Island First Nation:** 10 km north of Sutton West on the southern end of Lake Simcoe.
- **Mohawk's of the Bay of Quinte:** 35 km east of Belville.

There are no Métis settlements in or near the Darlington Nuclear Site property; however, there are Métis persons residing within the regional area. The Oshawa and Durham Region Métis Council represents Métis people in Durham Region [R-6].

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2.3.7 Community Relationships

OPG believes in open and transparent communication with the public in a timely manner, in accordance with CNSC REGDOC-3.2.1 [R-12]. As such, OPG regularly and proactively provides information to the public on its operations and projects. OPG's Corporate Relations manages communications and relationships between the nuclear facilities and the host communities by fostering healthy, open relationships and sustainable partnerships with community stakeholders, including government, media, business leaders, educational institutions, interest groups and community organizations. OPG's Corporate Relations organization adheres to the principles and process for external communication as governed by the nuclear standard N-STD-AS-0013, Nuclear Public Information and Disclosure.

OPG conducts integrated communications and regular community liaison activities. For Darlington Nuclear site, the community relations program proactively provides information to the stakeholders on DNGS and DWMF operation and the status of key projects, including the Darlington Refurbishment Project, and the Darlington New Nuclear Project (DNNP). OPG regularly provides milestones and regular waste management updates to key stakeholders. Presentations are regularly made at the Darlington Community Advisory Committee and Durham Nuclear Health Committee. In addition, presentations and informal meetings are held with local elected officials and community leaders a number of times each year to provide updates on performance and other activities taking place both at the stations and waste facilities.

A number of media communication products are also produced, and the OPG corporate website, www.opg.com, provides online access to information. Both information brochures and videos are available on the website, and email addresses are provided for questions, comments and concerns from the public.

Other major components of OPG's public affairs program at Darlington include the Darlington Information Centre, the Darlington "Neighbours" newsletter and Speaker's Bureau. Of particular note was Darlington's response to the local public's concerns over nuclear safety following the nuclear incident at Japan's Fukushima nuclear power plant in 2011. A two-page insert into the Darlington Neighbors Newsletter was distributed throughout the community, explaining the roles and responsibilities of OPG and other organizations, as well as providing responses to a number of commonly asked questions following the incident. Ongoing communication of Darlington Nuclear operations is provided through these public information programs and vehicles, including social media (Facebook, Twitter, and Instagram). It is expected that the same mechanisms will be employed during the site's decommissioning phase.

In 2017, OPG conducted a one-day emergency exercise at the Darlington Nuclear to test the emergency response plans and demonstrate how the participating agencies and government work together. OPG also conducts multiple Emergency Response Organization drills throughout the year to demonstrate proficiency and capture lessons learned. OPG regularly meets with citizens and community groups in a variety of forums to discuss issues related to the Nuclear Emergency Preparedness program. Under CNSC's mandate, potassium iodide (KI) pills have been distributed by OPG to all homes and businesses within a 10 km zone surrounding Darlington Nuclear Site in 2015. New

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residents and businesses within the 10 km zone are sent KI pills every year based on data provided by Canada Post, and KI pills remain available to the public within 50 km around Darlington Nuclear Site through a dedicated website.

In addition to operationally-related liaisons, Darlington also supports a large number of local not-for-profit organizations. Of note, OPG has worked with Bring Back the Salmon, Scientists in School, Toronto & Region Conservation Authority, Rouge Valley Health System Foundation (Ajax & Pickering Site), and the Oshawa & Durham Region Métis Council's Heritage Celebration in a corporate-wide initiative to better the local environment, education, and community.

OPG's community relations and public information program has been recognized as a strength by national international utility peers. OPG benchmarks current practices amongst other industries to ensure continuous performance improvement.

OPG's Centre for Canadian Nuclear Sustainability (CCNS) is focused on community and stakeholder communications and relationships specifically related to decommissioning. The CCNS communication program is integrated into OPG's existing public information program and focuses on research and development, innovation and collaboration in decommissioning. It holds meaningful interaction with CCNS partners, committees, Indigenous communities and the broader community through a variety of channels including social media, Neighbours Newsletter, community presentations and events, and collaboration with the Pickering Community Advisory Council. The CCNS also has its own website, www.theccns.com, which provides online access to the general public about CCNS projects and opportunities to engage with the CCNS team.

The CCNS has also launched an Indigenous Advisory Council (IAC) that provides advice and insight to CCNS on how indigenous communities, organizations and businesses can bring indigenous values and content into the Centre's mandate. The IAC is comprised of indigenous individuals and representatives of specific indigenous organizations within Durham Region and the surrounding area.

2.3.7.1 Indigenous Relations

OPG has a board-level Indigenous Relation Policy [R-13] and active community relations program that focuses on:

- Community relations and outreach;
- Capacity building support with communities;
- Employment/business contracting opportunities; and
- OPG staff education.

Building positive, community-minded relationships with indigenous communities is important to OPG with respect to current operations and the planning of new projects. OPG recognizes close consultation with community members and leaders is an essential part of the process. OPG continues to engage in active dialogue with

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indigenous people on a number of issues and operational decisions related to our nuclear operations. Discussions and information sharing are undertaken to build long-term mutually beneficial working relationships with Indigenous communities near our nuclear host communities and along our radioactive transportation routes on a regular basis [R-6].

Nuclear Waste operations is an important issue for indigenous people. OPG has on-going discussions and information sharing with Williams Treaty First Nations (Alderville First Nation, Chippewas of Georgina Island First Nation, Curve Lake First Nation, Hiawatha First Nation, and Mississaugas of Scugog Island First Nation) and more detailed discussions with Alderville First Nations, Métis Nation of Ontario and Oshawa and Durham Region Métis Councils. During the recent Pickering licence hearing OPG engaged the Métis Nation of Ontario – Toronto/Durham Councils with an information sharing session, community exchange and tours to discuss station and waste operations. This engagement will continue.

2.4 History and Current Status

In April 2008, the DWMF received its first DSC loaded with used fuel from the DNGS. At that time, the DWMF consisted of the DSC Processing Building and the attached DSC Storage Building #1 with a capacity to store approximately 500 DSCs. DSC Storage Building #2, with a capacity to store an additional 500 DSCs, came into service in March 2016.

The RWSB was declared available for service in 2017 to provide storage for RWC/DSOs containing retube waste from the DNGS refurbishment. As of July 7, 2021, a total of 97 RWC/DSOs containing refurbishment waste are being stored in the RWSB.

Following the construction of DSC Storage Buildings #3 and #4, further storage capacity will be provided over the 2023-2031 timeframe.

DSCs containing used fuel from the DNGS are currently processed in the DSC Processing Building and placed in the storage buildings on a routine basis. As of July 7, 2021, a total of 729 DSCs have been successfully placed into dry storage at the DWMF.

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3.0 PRELIMINARY DECOMMISSIONING PLAN

3.1 Applicable Legislation, Standards and Regulatory Guidance

Work related to the decommissioning of the DWMF will be performed in accordance with the requirements of applicable legislation and regulations. The following list details some of the current legislation applicable to OPG's decommissioning activities. It is important to note that whilst the list is accurate at the time of writing, it is assumed that a number of items will be updated, amended or replaced at a later time. As a result, it is necessary that the list is carefully reviewed during future revisions of the decommissioning plan.

Key legislation and other regulatory controls include:

- Nuclear Safety and Control Act;
- Environmental Protection Act, R.S.O. 1990, c.E.19 (Ontario);
 - R.R.O. 1990, Regulation 347: General – Waste Management
- Ontario Water Resources Act, R.S.O 1990, C.O.40;
- Occupational Health and Safety Act (OHSA), R.S.O 1990, C. O.1; and
- National Pollutants Release Regulations.
- Impact Assessment Act (IAA)⁴, if applicable;

CSA standards and regulatory documents and guidance that are applicable for decommissioning of the DWMF include:

- CSA N286: Management System Requirements for Nuclear Facilities;
- CSA N292.5: Guideline for the Exemption or Clearance from Regulatory Control of Materials that Contain, or Potentially Contain, Nuclear Substances;
- CSA N294: Decommissioning of Facilities Containing Nuclear Substances;
- CSA N393: Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances;
- Regulatory Guide G-206⁵: Financial Guarantees for the Decommissioning of Licensed Activities;

⁴ Canadian Environmental Assessment Act (CEAA) 2012 has now been superseded by the IAA.

⁵ REGDOC-3.3.1, Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities was published in January 2021 and supersedes G-206. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-3.3.1 [R-5].

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- Regulatory Guide G-219⁶: Decommissioning Planning for Licensed Activities;
- Regulatory Document REGDOC 3.2.1: Public Information and Disclosure; and
- Regulatory Document REGDOC 3.2.2: Indigenous Engagement.

OPG will also consider the recommendations and guidance from the IAEA relevant to decommissioning. At this stage, specific IAEA standards and other guidance documents are referenced in this PDP, as applicable, whereas a complete list will be provided closer to the time of preparing for decommissioning.

3.2 Planning Assumptions

Planning for the eventual decommissioning of the DWMF is an ongoing process, and planning assumptions can be expected to evolve over time, but as input to this PDP, the following assumptions have been made:

1. The PDP scope is limited to the DWMF protected/licensed area. Any contamination found outside of the licensed/protect area is expected to be low and provisions will be made at that time for its remediation.
2. In 2016 and 2017, the DWMF was expanded to include DSC Storage Building #2 and the RWSB. These two buildings are therefore included in the scope of this PDP.
3. In 2023 and 2031 respectively, DWMF will be expanded with two additional DSC Storage Buildings. DSC Storage Building #3 (planned to be in service in 2023) is within the scope of this PDP but DSC Storage Building #4 (planned to be in service in 2031) is beyond the scope of this PDP.
4. Retube waste will be transferred to a long-term disposal facility for LLW and will not require retrieval and repackaging prior to transfer from the DWMF. Retube waste at the DWMF will be removed prior to DWMF shutdown.
5. All used fuel will be transferred from the DWMF to a long-term used fuel disposal facility (i.e., Adaptive Phase management (APM)⁷) prior to its decommissioning. Operations to remove used fuel from the site for transferral to a long-term used fuel management facility are assumed to start in 2055, facilitating the start of DWMF decommissioning in 2089. OPG intends to have the used fuel removed from the DWMF and transferred to a long-term used fuel management facility by this date. All other dates in this document follow from this date and are shown for financial planning purposes only.

⁶ REGDOC-2.11.2, Decommissioning, was published in January 2021 and supersedes G-219. OPG has communicated the timing for a gap analysis and implementation plan to REGDOC-2.11.2 in [R-5].

⁷ On June 14, 2007, the Government of Canada selected APM as the best plan for Canada for safeguarding the public and the environment over the very long time in which used nuclear fuel must be managed [R-14].

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6. Decommissioning waste from the DWMF will be disposed of in a long-term disposal facility for LLW. The disposal facility is currently assumed to be available prior to the start of DWMF dismantling and demolition activities.
7. Low-level decommissioning waste will be packaged in containers similar to B-25 containers due to the higher payload capacity. Intermediate-level decommissioning waste will be placed in modular shielded containers with all metal shielding.
8. Contaminated concrete will be packaged and shipped to a licensed long-term waste management facility. Remaining concrete that meets the free-release criteria will be crushed, graded and used on-site as back fill.
9. Hazardous wastes that do not form part of the DWMF's structures, systems or components will be removed prior to dismantling and demolition and therefore are not included as part of the decommissioning activities.
10. Non-radioactive hazardous waste will be disposed of at approved disposal facilities. Mixed waste (i.e., radioactive waste that also is hazardous), if any, will also be disposed of in an appropriate licensed facility.
11. Removal of DSCs and removal of retube waste from the DWMF is outside the scope of the decommissioning of the DWMF. These activities are planned and funded by separate means. The empty DSCs are considered operational waste and are not included in the cost estimate of this PDP.
12. A Decommissioning Operations Contractor (DOC), a company or consortium, will perform all work during the dismantling, demolition and site restoration period and will bring in the required power supply to carry out the work. OPG will provide the necessary oversight during this time period.
13. "Clearance Levels" will be developed based on CSA Standard N292.5 along with the Nuclear Substances and Radiation Devices Regulations and OPGN Governance [R-15] to determine clearance levels acceptable to CNSC prior to dismantling and demolition. These will permit segregation of the decommissioning wastes into those requiring long-term management and those that can be recycled, left on site or disposed of as conventional waste.
14. Above-ground structures within the protected area will be demolished. The structures will be surveyed for contamination and decontaminated, if required. Contaminated concrete surfaces will be decontaminated via scabbling, vacu-blasting or other surface decontamination techniques. Where contamination is found in the bulk material, chipping or cutting techniques will be used. Resultant contaminated materials will be shipped to the long-term disposal facility for LLW. Future use of the site has not been defined. As such, demolition, not reuse of buildings or facilities is considered in the decommissioning cost in this PDP.

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15. Sub-surface drainage and monitoring wells and drains below a nominal depth 1 m below grade (nominal removal depth) will be surveyed for contamination, decontaminated, if required, and abandoned in-place.
16. Underground piping and utility lines will be de-energized, capped and abandoned in-place if demonstrated as free from contamination.
17. At-grade foundation slabs exceeding 1 m in thickness will be abandoned in-place and covered over with a 1 m thick layer of backfill.
18. No salvage credit is assigned to equipment and components removed during decommissioning and such equipment is considered waste for costing purposes. However, recycling of clean materials will be pursued.
19. OPG will retain ownership of the DWMF site areas throughout the course of the decommissioning.
20. The site will be made available for other OPG uses after completion of decommissioning as a brownfield⁸ (industrial).
21. No radiologically contaminated soil that requires remediation exists within the licensed/protected area of the DWMF.

Many of the above assumptions are based on the required used fuel and waste repositories becoming available prior to the shutdown of the DWMF. In the event that consensus and subsequent commissioning of these repositories do not occur within these timescales, there are numerous potential consequences that should be considered. For example:

- The structural integrity of existing structures may not be guaranteed for an extended (unknown) period. If wastes are not disposed of within the timeframes specified within the design intent, degradation of storage containers and other structures may occur. Contingency strategies will need to be considered, such as increased inspection, surveillance, and maintenance to safely extend the design life of containers/structures or alternative disposal options.
- Alternatively, external pressures (e.g., from unexpected environmental changes or pressure from the government or public) may result in it becoming necessary to remove the wastes ahead of schedule. If adequate facilities are not in place, significant cost implications may be incurred.

It is therefore envisaged that, in future revisions of this PDP, strategies for managing such scenarios are developed, taking into account unexpected changes in the availability of a long-term disposal repository (or other resources).

⁸ As per nuclear industry practice, a brownfield is defined as a former industrial land that has the potential to be developed for new industrial uses.

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OPG maintains a systematic care, maintenance, monitoring and inspection program, and implements the surveillance and Integrated Aging Management Program activities at DWMF. These activities will be continued to ensure that the DWMF remains in a safe, sustainable, and secure state until such time that the facility reaches the currently planned final decommissioning end-state site suitable for other industrial and commercial use.

3.3 Scope of the Preliminary Decommissioning Plan

This plan describes the decommissioning of the DWMF, comprising the following:

- The DSC Processing Building;
- DSC Storage Buildings #1 and #2;
- The RWSB;
- DSC Storage Building #3 (planned to be in service in 2023); and
- The site areas contained within the two DWMF security fence lines.

The DWMF is an operating facility that may be expanded to support OPG's future radioactive waste storage requirements. This plan describes the decommissioning of the DWMF as it exists at the end of December 2021, while taking into account any planned expansions up to and including 2027 (that is, until the end of this financial guarantee period).

This plan does not cover the decommissioning of DNGS or any buildings associated with the operation of the station.

This plan will be subject to periodic review to ensure that any future changes in the facility or scope of decommissioning are incorporated. This would include:

- Changes in site conditions, including climate;
- Changes to the proposed decommissioning objectives or strategy;
- Advances in decommissioning technology;
- Modifications to the facility;
- Updated schedule, cost and funding information;
- Operational experience and lessons learned;
- Revised regulatory requirements;
- Revised records requirements; and

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- Availability of long-term disposal facilities for used fuel and waste.

3.4 Objective of the Decommissioning

The objective of decommissioning is to permanently retire the DWMF from service in a manner that ensures that the health, safety, and security of workers, the public, and the environment are protected. Decommissioning involves removing any residual radioactive and other hazardous materials from the site and restoring the site to an agreed end state for removal from regulatory control. After decommissioning, OPG will retain ownership of the property and the site will then be available for other OPG uses.

3.5 Decommissioning Strategy

OPG has chosen a “Prompt Dismantling” strategy for decommissioning the DWMF. This strategy is consistent with international practice for similar waste management facilities. In general, after their operational life, waste management facilities are decommissioned as soon as is reasonably practical.

OPG’s decommissioning strategy for the DWMF is based on the assumption that used fuel and retube waste will be removed from the site (prior to execution of decommissioning) to the respective long-term waste management facilities as they become available (i.e., used fuel will be moved to the APM facility, and retube waste will be moved to a long-term disposal facility for ILW). Since little to no residual radioactivity is expected to be present at the DWMF after all the operational waste is removed, OPG does not currently anticipate the need for any deferment of decommissioning.

However, in order to take advantage of economies of scale, decommissioning of the DWMF is assumed to take place concurrent with DNGS decommissioning. The decommissioning work at the DWMF will continue until the site is in a condition that meets the criteria for removal from regulatory control. The contaminated material from decommissioning activities will be sorted, packaged and removed from site in accordance with CNSC regulations, and is assumed to be disposed of in a long-term disposal facility for LLW.

An alternative decommissioning strategy (i.e., in-situ decommissioning) was considered but deemed to not be a reasonable decommissioning option for planned decommissioning of DWMF as removal is possible and practicable.

3.6 Predicted Characteristics at Decommissioning

At the time of decommissioning, the DWMF will consist of one DSC Processing Building, up to four DSC Storage Buildings and one RWSB.

This section summarizes the expected radiological conditions of the DWMF buildings and site areas requiring decommissioning, as well as other hazards that may require consideration during decommissioning activities.

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3.6.1 Dry Storage Container Processing Building

No significant radiological or chemical hazards are expected to be present in the DSC Processing Building at the time of decommissioning. This is because any radioactive materials held or hazardous materials used within this building (including compressed gas, paint, helium and cleaning supplies) as part of normal operations will have been removed prior to this phase. General hazards that could be encountered during decommissioning include conventional hazards that would be associated with any structural demolition project.

The facility has an active ventilation system due to the potential for low levels of contamination resulting from DSC operations. Any contamination will be detectable by practical survey methodologies similar to those used to monitor the facility for contamination during routine operations.

The DSC Processing Building, due to the nature of its operations, will store a variety of consumables, some of which are classified as hazardous materials (see Appendix B). There will be no laboratory or bulk chemical store in the building.

3.6.2 Dry Storage Container Storage Buildings

No radiological or chemical hazards are expected to be present in the DSC Storage Buildings at the time of decommissioning.

The DSCs are designed to provide a storage life of at least 50 years and to meet the shielding and containment requirements over this period.

The DSCs containing the used fuel are completely sealed and leak tested prior to transfer to the DSC Storage Buildings. In addition, periodic inspections are undertaken to check for signs of degradation such as corrosion or paint deterioration. If such damage is observed, the affected area is cleaned and repaired and/or recoated as required. An 'aging management' strategy that assesses the end-of-life for the DSCs and subsequently identifies an appropriate management strategy to maintain its integrity is also in place. These provisions significantly minimize any possibility of radiological contamination in the DSC Storage Buildings. Hence, the DSC Storage Buildings are not expected to become contaminated through DWMF operations. No hazardous wastes will be stored in the DSC Storage Buildings. General hazards that could be encountered during decommissioning include conventional hazards similar to those associated with any industrial structural demolition project.

No hazardous materials have been or will be used in the construction of the DSC Storage Buildings and no hazardous materials will be stored in these structures at the time of decommissioning.

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3.6.3 Retube Waste Storage Building

As concluded for similar refurbishment waste storage areas at OPG's other waste management facilities, it is expected that there will be no contamination present at the site at the time of decommissioning. However, if any potential for radioactive contamination or presence of other hazardous materials exists in this area, they will be included in later versions of this PDP, as more information becomes available.

3.6.4 Darlington Waste Management Facility Site Areas

The DWMF site is not expected to become contaminated throughout the DWMF operations. No radiological or chemical hazards are expected to be present outdoors within the DWMF site areas at the time of decommissioning. General hazards that could be encountered during decommissioning include conventional hazards that would be associated with removal of fencing and the excavation and removal of yard surfaces and demolition of the buildings.

3.7 Canadian and International Decommissioning Strategies and Experience

There is a growing body of experience related to the decommissioning of nuclear facilities in Canada, the United States and overseas. Much of the international experience noted in the DNGS PDP [R-8] relates to decommissioning facilities that are far more complex and that present greater hazards than the DWMF. Therefore, the Canadian experience included in this section is more relevant to decommissioning of the DWMF.

OPG has successful decommissioning experience at both the Bruce Heavy Water Plant (BHWP) and the SSTF, which are both located on the Bruce Nuclear site.

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The BHWP was in continuous operation from April 1973 until March 1998, for the purpose of producing reactor-grade heavy water [R-16]. After it was no longer in operation, the BHWP decommissioning project was carried out in accordance with a DDP, remediation and an environmental assessment and follow-up program. Demolition began in October 2004 and was completed in 2006. The buildings were demolished using standard demolition techniques. The debris was removed from the site for recycling or disposal. Bioremediation of oil-contaminated soil in the effluent lagoons was required and began in 2006. It involved removing the contaminated soil and placing it in cells in a biopile based on the level of contamination in the soil. Aerobic enhancers and local chicken manure were added to the biopile to promote the growth of the native bacteria that were already digesting the oils. This process continued until November 2009. About 25% of the soil was bioremediated to below the end-state criteria, and was used as clean backfill in the immediate area. Any soil that did not meet the end state criteria was disposed of off-site at a licensed facility. The radiological end state was that no nuclear substances would remain within the BHWP facility boundaries and the remaining structures, equipment and grounds were free of significant radiological contamination. In order to demonstrate that this end state criterion was met, a final radiological survey was performed in 2012 using the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) methodology [R-17]. This survey found no radioactive contamination on the BHWP [R-18][R-19] site and a licence to abandon the facility was granted by the CNSC in 2014 [R-20].

From May to December 2018, OPG completed decontamination of all radiologically contaminated piping in the SSTF. As decontamination progressed, each room or section was systematically surveyed and sampled for radiation in accordance with the MARSSIM methodology. A Site Survey and Characterization report was prepared and approved by OPG in March 2019. This report concluded that radioactivity levels in the SSTF were below the site unconditional release criteria. The demolition of the above ground structure occurred in November 2019 and the underground infrastructure were removed in February 2020. In June 2020, the site was graded and final remediation was completed. The CNSC also concluded that OPG satisfactorily demonstrated that the SSTF was free of any contamination above the regulatory limits [R-21][R-22][R-23]. This resulted in CNSC acceptance of OPG's request to remove the SSTF from licensing control [R-24].

Some domestic experience, including work performed at the Tunney's Pasture Isotope Processing Facility, the Whiteshell Laboratories, the Chalk River Laboratories, Bruce Heavy Water Plant [R-25] and Defense Research Establishment Suffield [R-26], is directly relevant to this plan and the experience gained during the course of this work has been considered in the development of this plan. The experience gained during the decommissioning of some other small nuclear facilities in Canada, including research reactors, fuel fabrication plants and research laboratories, has also been considered, as have reports of decommissioning work performed in other countries and guidance from international agencies, such as the IAEA [R-27] and the Nuclear Energy Agency within the Organisation for Economic Co-operation and Development.

This experience indicates that the strategy adopted for the decommissioning of the DWMF is technologically feasible and that the work can be completed in a manner that protects the health, safety and security of workers, the public and the environment.

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4.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

Decommissioning of the DWMF will commence after the retube waste, used fuel and hazardous materials have been removed from the facility, and all necessary licences, permits and approvals have been obtained. Removal of radioactive material prior to decommissioning will avoid the need for additional safeguards to be in place for decommissioning operations. A DDP will be submitted and, subsequent to and in accordance with regulatory approvals, decommissioning activities are expected to begin following removal of the used fuel and retube waste, and the receipt of a licence to perform decommissioning activities.

The major project milestones for decommissioning the DWMF are shown in Table 4-1. It is estimated that three years will be required to prepare for decommissioning of the DWMF. Physical decommissioning activities are assumed to begin in 2089 and will take approximately one year to complete. After that, a CNSC review period of one year is assumed; that is, upon completion of decommissioning and site restoration in 2090, it is estimated that removal from regulatory control will be achieved in 2093.

Table 4-1: Darlington Waste Management Facility Decommissioning – Project Milestones⁹

Event	Year*
DWMF shut down (after all retube waste and used fuel removed from DWMF)	2082
Begin preparation for decommissioning of DWMF	2086
Begin decommissioning	2089
End of decommissioning and site restoration	2090
Removal from regulatory control**	2093

*For financial planning purposes only, any modifications associated with end of life of DNGS and in-service date of long-term disposal facilities may impact these dates.

**There is a possibility that site restoration will be postponed by the DOC for overall optimization between DWMF and DNGS site restoration, followed which they will be released from regulatory control.

⁹ The decommissioning timeline provide in this PDP is based on the most recent OPG planning assumptions.

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4.1 Decommissioning Phases

The decommissioning work is divided into four main phases in accordance with CSA N294:19 [R-4]:

- Planning for Decommissioning;
- Preparation for Decommissioning;
- Execution of Decommissioning; and
- Completion of Decommissioning.

OPG is responsible for planning, including development of all required documents throughout the life cycle of decommissioning, executing and funding all phases of decommissioning.

The key requirements of this standard are summarized in the following subsections. These key stages will be more closely reviewed within the DDP.

4.1.1 Planning for Decommissioning

According to CSA N294:19, planning for decommissioning begins at the siting/design phase (or as early as possible) and continues throughout the lifecycle of the facility. A decommissioning strategy and a PDP are developed in this phase. The DWMF is currently considered to be in 'Phase 1 – Planning for Decommissioning', per CSA N294:19 [R-4].

Aspects that have been or will be considered as part of this phase include but are not limited to:

- Determine the regulatory and licensing requirements.
- Develop and review the decommissioning strategy, including assessment of optimal techniques and technologies. Planning considerations such as regulatory requirements, stakeholder input, potential environmental impacts, safety and availability of a final waste disposal facility will be considered in the development of a decommissioning strategy¹⁰.
- Develop and regularly review and update the PDP.
- Develop and maintain a record management system to ensure that all sources of information that affect decommissioning can be readily identified and retrieved.

¹⁰ CSA N294:19 Clause 6.1.3 [R-4] lists the items to be considered when determining appropriate decommissioning strategy. This list is considered when selecting appropriate decommissioning strategy for each site.

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- Review the history of the facility (operational and maintenance records) and assess how it could affect decommissioning.

4.1.2 Preparation for Decommissioning

According to CSA N294:19, this phase begins with the regulators being informed of the intent to cease operations and prepare for decommissioning. This phase normally includes the further development of the PDP into a DDP and securing the necessary regulatory approvals, as required. Key activities within this phase of work include, but are not limited to:

- Notify regulator of intent to permanently shut down the facility.
- Review and update (if required) the decommissioning strategy.
- Obtain the necessary regulatory approvals/acceptance; see Section 4.1.2.1 for further details.
- Place the facility in a safe shutdown state, including removal of used fuel, retube waste and hazardous materials. See Sections 4.1.2.2, 4.1.2.3 and 4.1.2.4 respectively for further details.
- Review the history of the facility (operational and maintenance records) and assess how it could affect decommissioning.
- Assess the state of the facility after shutdown.
- Perform a safety assessment (i.e., what operations could pose a significant hazard to operators, members of the public and the environment).
- Perform an impact assessment or environmental review, if required (see Section 7.0).
- Develop a DDP; see Section 4.1.2.5 for further details.
- Further develop a waste management plan.
- Refine public and stakeholder engagement program (see Section 12.0), if required.

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4.1.2.1 Regulatory Approvals

When OPG has made the decision to decommission the DWMF, it will notify the CNSC of the intention to decommission. OPG staff will prepare an application for a licence to perform decommissioning activities that contains the information required by the Class I Nuclear Facilities Regulations, along with such other information as may be appropriate. The DDP will form part of the application for the licence to perform decommissioning activities, as well as the plans and protocols for radiological monitoring. After obtaining CNSC acceptance of the decommissioning plans, OPG will obtain a licence to perform decommissioning activities for the DWMF, as required by the Class I Nuclear Facility Regulations, before any decommissioning work begins.

In addition, OPG and/or the DOC will obtain all of the other required permits and licences from federal, provincial and municipal agencies before starting any decommissioning work. A list of the required permits and licences will be included in the DDP.

4.1.2.2 Removal of Used Fuel

DWMF decommissioning will commence only after the removal of all used fuel from the facility. For planning purposes, transfer of used fuel to a long-term used fuel disposal facility (i.e., APM) is assumed to be completed by the end of 2082 and is not considered to be part of the decommissioning activities of the DWMF.

4.1.2.3 Removal of Refurbishment Waste

Decommissioning of the DWMF will also be able to commence only after all retube waste has been removed from the facility. For planning purposes, removal of RWCs from DWMF is assumed to be completed by the end of 2082.

4.1.2.4 Removal of Hazardous Materials

Hazardous waste that is not part of DWMF systems, structures or components will be removed prior to decommissioning (see planning assumption in Section 3.2). Section 4.1.3.5 details the waste management steps that may be taken if conditions at the time so require.

It is expected that remaining inventories of non-radioactive hazardous materials, such as small quantities of unused paint supplies and remaining chemical waste, will be disposed of in accordance with the applicable Ministry of Environment and Climate Change regulatory requirements in use at the time.

4.1.2.5 Detailed Decommissioning Plan

A DDP will be prepared when the decision is made to permanently shutdown the facility (i.e., cease the operations). The DDP will describe the actions required to permanently retire the facility from operation in a manner that ensures the health, safety, and security of workers, the public, and the environment. It will present a complete description of the work that will be performed and establish the clearance levels that will be used to determine if materials are suitable for uncontrolled release from the site, and if the site

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itself is suitable for release from further regulatory control. The content of the DDP will follow the regulatory requirements at the time of decommissioning. Currently, the content requirements for the DDP are contained in CSA N294:19 [R-4].

The DDP will be developed in accordance with the principles of the waste management hierarchy (see Figure 4-1), whereby decommissioning techniques that minimize waste generation as far as possible are favoured. Where this is not possible, items requiring disposal will be volume reduced (to optimize the loading capacity of the disposal space) prior to consignment to a conventional waste disposal facility for clean waste, and a long-term disposal facility for LLW respectively.

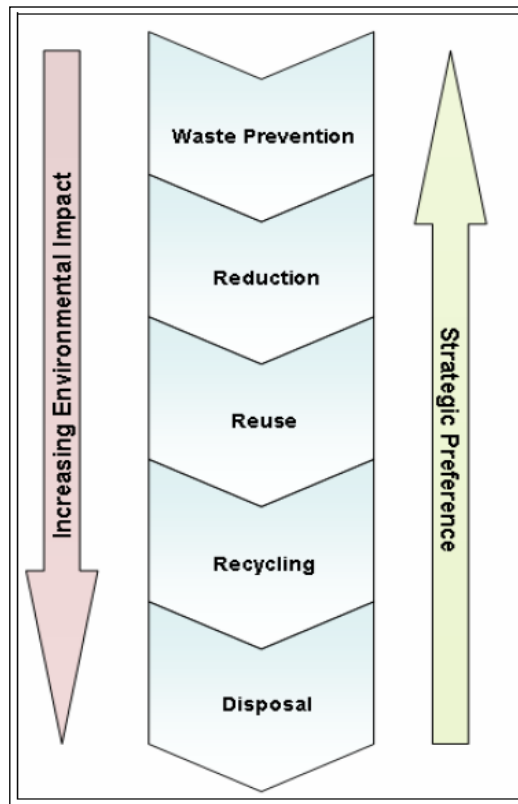


Figure 4-1: Summary of the Key Principles of the Waste Management Hierarchy

The DDP will describe the 'Decommissioning Planning Envelopes', which will be integrated with an overall plan to ensure the work is done efficiently with safety being the top priority. The Decommissioning Planning Envelopes will include:

- The DSC Processing Building;
- The DSC Storage Buildings;
- The RWSB; and
- The remainder of the DWMF site areas.

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Key activities that will be considered within the DDP for each envelope includes:

- Post-operational surveys (after used fuel, retube waste and hazardous materials have been removed);
- Site planning;
- Review of the operational history, including incidents or accidents that could affect decommissioning;
- Identification of the final radiological, physical and chemical end-state objectives;
- Decontamination of systems and structures;
- Review and update the applicable decommissioning strategy;
- Dismantling of systems and structures;
- Identification of potential environmental effects and mitigation measures;
- Update the decommissioning cost estimates and any financial guarantee arrangements;
- Identification of the applicable programs (e.g., human and organizational factors, quality assurance, emergency response, etc.);
- Undertake public consultations;
- Post-decommissioning surveys; and
- Further develop a waste management plan.

Some of these activities may occur simultaneously. For example, surveys for any residual radiological and hazardous materials will be carried out prior to and throughout dismantling work.

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4.1.3 Execution of Decommissioning

According to CSA N294:19, this phase of work will begin with the implementation of the decommissioning plan after all necessary regulatory approvals have been obtained. The activities under this phase include the execution of the physical works (i.e., decontamination and dismantling of the facility).

The activities listed below can be performed with currently available technology, but the required procedures to complete the tasks will depend on the technology available at the time of decommissioning. The activities to be performed (but not limited to), may not be performed in the order listed, but can be divided into a series of conceptual stages:

- Post-operational surveys; see Section 4.1.3.1 for further details;
- Preparation and mobilization; see Section 4.1.3.2 for further details;
- Decontamination and dismantling of systems and structures; see Section 4.1.3.3 for further details;
- Site restoration; see Section 4.1.3.4 for further details;
- Waste management; see Section 4.1.3.5 for further details; and
- Surveys of decommissioning planning envelopes; see Section 4.1.3.6 for further details.

Decontamination, dismantling and waste management phases may occur simultaneously. Surveys for radioactive and other hazardous materials will be performed throughout the dismantling work, culminating in a final survey.

4.1.3.1 Post-Operational Surveys

Surveys will be performed at the end of storage operations to identify and characterize any residual radioactive contamination of the DSC Processing Building, the DSC Storage Buildings, the RWSB and site areas.

4.1.3.2 Preparation and Mobilization

The initial phase of the project is intended to prepare the site for subsequent decommissioning and dismantling work. Detailed procedures for the dismantling operations will be prepared to meet As Low As Reasonably Achievable (ALARA) guidelines for the protection of personnel and address the continued protection of health and safety of the public and the environment. The dismantling operations include decontamination, removal of residual radioactive materials and demolition of systems and structures.

The following activities are to be completed in this phase:

- Selecting a DOC to assume responsibility for decommissioning the DWMF.

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- Performing a hazardous materials survey to confirm the location and identity of any hazardous materials that are stored on the site.
- Developing procedures for occupational exposure control, emergency programs, industrial safety, control and release of liquid and gaseous effluent, and processing of radioactive waste, including filter media, metallic and non-metallic components generated in dismantling.
- Cleaning all facility areas of loose contamination, and removing and processing liquid and solid wastes.
- Disposing of any remaining furniture, cleaning products, paints and other hazardous materials that will not be required during the decommissioning.
- Preparing any required site support storage areas.
- Installing or restoring any site services (electric power, domestic and service water, sewage, active and inactive drainage, fire protection, etc.) that will be required during the dismantling work.
- Disconnecting and isolating the remaining site services, such as electric power, service water and sanitary services that are not required during dismantling.
- Staff will be provided with the required training.

4.1.3.3 Decontamination and Dismantling of Systems and Structures

This phase involves the removal of all contaminated equipment and components from the DWMF, and the decontamination or removal of all concrete and metal. The decontamination and dismantling of the systems and structures will be performed by the DOC and will provide the required power supply to carry out the work. The decontamination and dismantling must be undertaken using safe and effective methods that will be determined during the development of the DDP.

Little radioactive contamination is expected at this facility. Components such as active ventilation filters and DSC vent hoses may show some contamination. However, these items are replaceable and would be disposed of prior to decommissioning. As the facility ages, the nature and extent of any radiological contamination will be monitored. If it is found to be significant, this will be included in future revisions of the PDP.

For planning purposes, it is conservatively assumed that the active ventilation system is contaminated and that, during operation, some contamination on the floors of the DSC Processing Building and DSC Storage Buildings has occurred. Depending on the effectiveness of decontamination techniques employed and the level of contamination found, the ventilation system will be carefully dismantled and may be sent for long-term disposal as LLW.

In the event that contamination is found, a number of decontamination techniques will be employed as appropriate. Examples include, but are not limited to:

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- Vacuuming of loose material;
- Chemical decontamination; and
- Physical decontamination (e.g., scabbling, vacuum blasting).

On completion of decontamination activities, an endpoint radiological survey will be carried out in accordance with regulatory requirements, so that it can be determined with a high level of confidence that any residual contamination within the facility falls below the approved release criteria.

All decontamination and dismantling work performed will be in accordance with OPG's Radiation Protection Program [R-28].

Dry Storage Container Processing Building

All equipment, furniture and supplies in radiologically zoned areas will be surveyed and decontaminated as necessary prior to clearance for non-radiological use, recycle, or disposal. The active ventilation system will be dismantled and, depending on the feasibility of decontamination, may be consigned (as LLW) to LLW long-term disposal facility along with other LLW generated.

In the event that some concrete cannot be decontaminated to desired levels, the affected material will be packaged and shipped to long-term LLW disposal facility. Remaining concrete that meets the release criteria will be crushed and graded, and used on-site as backfill.

Interior structural surfaces will be surveyed to identify areas requiring decontamination. The characterization survey will determine the nature and extent of contamination, for the purposes of hazard assessment as well as to facilitate and control decontamination work.

Decontamination activities may involve the following steps:

- Remove contaminated equipment and material from the DSC Processing Building;
- Remove contaminated concrete from surfaces and route for controlled disposition; and
- Remove, pack and dispose of contaminated piping, ducts and components in the facility systems.

On completion of decontamination work, a final clearance survey will be carried out. Non-radiologically zoned office space will be appropriately surveyed prior to clearance. If contamination is found in office areas, decontamination, followed by a clearance survey, will also be carried out.

While there is no reason to expect particulate contamination to be released from the HEPA-filtered active ventilation system, a confirmatory survey of roof surfaces as

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appropriate will be carried out prior to radiological clearance of the DSC Processing Building. Drain openings will be surveyed and decontaminated if necessary and the drainage system will be removed.

When the structure has been verified to meet clearance levels, it will be released for demolition. The building will then be demolished using conventional demolition techniques. Concrete foundations and exterior walls are assumed to be removed up to the 'nominal removal depth' of 1 m below grade wherever possible. This allows for the placement of gravel for drainage and topsoil so that vegetation can be established for erosion control. Clean demolition material will be crushed, graded and reused on site (in accordance with the waste management hierarchy) as infill.

Dry Storage Container Storage Buildings and Retube Waste Storage Building

The DSC Storage Buildings and the RWSB are expected to be free from radiological contamination. However, when decontamination or dismantling of structural components takes place, a radiological survey will be carried out to identify the presence of any detectable contamination in each building. Since the buildings are unlikely to be contaminated, this initial characterization survey should be designed to meet the full requirements of a final clearance survey.

Spot decontamination, followed by a final survey of potentially affected areas, will be carried out. When the structures have been verified to meet clearance levels, and with CNSC approval, they will be released for demolition. Concrete foundations and exterior walls are assumed to be removed to a 'nominal removal depth' of 1 m below grade wherever possible. This allows for the placement of gravel for drainage and topsoil so that vegetation can be established for erosion control.

Based on the identified requirements and needs for dismantling, appropriate subcontractors will be identified and selected to support the various phase and project deliverables.

4.1.3.4 Site Restoration

Once all the buildings have been demolished, the protective fences and any remaining site structures will be dismantled. It is unlikely that contamination will be present on outdoor surfaces (i.e., on asphalt or concrete yard surfaces). Nevertheless, a final clearance survey will be carried out across the site surfaces to confirm that the site is within the clearance limits derived in the DDP. Concrete rubble and clean fill produced by demolition activities will be used on-site to backfill voids. Areas affected by the dismantling activities will be cleaned and the site will be graded and seeded, consistent with future usage plans to be set out in the DDP.

Contaminated Land Management

Although current evidence suggests that the land in and around the DWMF site should be free from contamination with radioactive or hazardous materials, a remedial action plan will be developed or at least considered. This can be developed and deployed as necessary in the event that unexpected levels of contamination are identified during land

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surveys carried out through the decommissioning process. A report has been compiled [R-29] reviewing potentially suitable land remediation techniques and technologies (both novel and industry standard approaches) that may be suitable for use at the DWMF site.

4.1.3.5 Waste Management

Any contaminated materials removed during the dismantling operation will be routed for on-site processing, where they will be characterized and then packaged for ultimate disposal at a long-term disposal facility for LLW. The estimated size and weight will meet the waste acceptance criteria of the long-term disposal facilities.

Material found to be below the established 'clearance levels' for radioactive material will be released for recycling or disposal in accordance with the waste management hierarchy (see Figure 4-1). Clearance Levels will be developed based on CSA Standard N292.5-11 along with the Nuclear Substances and Radiation Devices Regulations and OPGN Governance [R-15] to determine clearance levels acceptable to CNSC prior to dismantling and demolition.

From the very start of the decommissioning process, techniques and technologies that prevent wastes being produced in the first instance will be utilized. Where the production of waste cannot be prevented, management techniques that minimize the quantity, volume or activity of waste requiring disposal will be favoured over options that require direct disposal. For example, materials will be reused or recycled wherever practicable (potentially following a pre-treatment stage, e.g., decontamination). If materials cannot feasibly be reused or recycled, treatment options that minimize the volume of waste to be disposed will be employed. Potentially viable options to achieve this include incineration, high-force compaction, in-drum compaction and shearing/shredding.

The sorting and segregation of wastes according to their physical, radiological and chemical properties will increase the effectiveness of this approach. Potentially contaminated material removed during the dismantling operation will be routed to an on-site processing facility, where they will be characterized, sorted, segregated and packed for disposal or alternative treatment at an appropriately licensed facility. All radioactive waste generated during decommissioning will be characterized as per CSA N292 series of Standards.

Where wastes have been cleared from further regulatory control, an alternative route (e.g., to a non-nuclear landfill site) will be defined. These routes will be identified during the development of the DDP.

Any hazardous material will be disposed of at a licensed hazardous waste storage or disposal facility.

All processing and packaging of decommissioning waste will be performed on site by the DOC and not by OPG.

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During the development of the DDP, a Waste Management Plan will be developed. This will provide more details on the proposed approach to waste management and will include:

1. Descriptions of procedures, equipment and criteria to be used to characterize, handle and segregate the waste streams;
2. Details of waste volume estimates for each category;
3. Specific plans for waste minimization, including reuse, recycling or disposal;
4. Options for volume reduction (such as supercompaction, shredding, incineration, etc.);
5. Clearance levels for decontaminated or otherwise clean items;
6. Long-term waste management strategy;
7. Cost-benefit analyses of the options available; and
8. Review of transportation requirements and waste receivers' acceptance criteria.

Radioactive Waste Management

OPG had planned to dispose of Low- and Intermediate-Level Waste (L&ILW) from its owned generating stations in a Deep Geologic Repository (DGR) at the Bruce Nuclear Site. Early in 2020, the L&ILW DGR Project was cancelled. OPG is exploring options and remains committed to permanent and safe disposal of its operational waste as well as future decommissioning waste.

OPG is also participating in Natural Resources Canada's work in public engagement on the existing Radioactive Waste Policy to ensure OPG is meeting international best practices. The Nuclear Waste Management Organization was asked to lead a dialogue to develop an integrated strategy for Canada's radioactive waste through close collaboration among waste owners and producers (including OPG), indigenous people and other interested Canadians. Any progress in regard to the policy and integrated strategy will be taken into consideration in OPG's decommissioning waste disposal strategy.

The majority of radioactivity from the facility in the form of used fuel and retube waste will be transferred to a long-term used fuel management facility (i.e., APM) and a long-term disposal facility for ILW respectively, before decommissioning work commences.

Although it is not expected that the DWMF will contain significant quantities of radioactive material, it is recognized that there is potential for small volumes to be produced as a result of decontamination and dismantling processes. This will primarily be through treatment of the drainage and active ventilation systems.

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The volume and characteristics of radioactive waste generated from the decommissioning will be estimated at the detailed decommissioning planning stage, when sufficient history of the facility conditions has been recorded, and further information is available. A preliminary estimate of the volume of LLW that will be generated during the decommissioning of the DWMF is shown in Table 4-2 [R-30]. In summary, it is estimated that 116.3 m³ of LLW will be generated during the decommissioning of DWMF. The figures provided cover estimates for the financial guarantee period 2023 to 2027.

Table 4-2: Low-Level Waste from Darlington Waste Management Facility Decommissioning

Facility Area	Estimate of Low-Level Waste Volumes (m ³)
	Financial Guarantee Period 2023-2027
DSC Processing and Storage Buildings	113.0
RWSB	3.3
Total	116.3

Hazardous Waste Management

A small inventory of materials used in the DSC Processing Building, listed in Appendix B, is hazardous. These materials will be removed from the DSC Processing Building at the end of facility operations. If required, the following activities will be performed:

- Appropriate licensed storage or disposal facilities will be identified prior to the beginning of the decommissioning project.
- Hazardous wastes will be packaged for transport and disposal according to applicable regulations.
- Waste manifests will be prepared and submitted as required by federal and provincial regulations.
- Hazardous wastes will be transferred to an appropriate, licensed waste management facility(ies) for storage or disposal.

Any hazardous wastes that cannot be reasonably removed at the end of facility operations will be included as part of dismantling and demolition activities.

Conventional Waste Management

Non-radioactive and non-hazardous waste, such as clean concrete, metals, roofing, cladding, etc., that has been free released will be recycled or disposed at an approved landfill site. Some clean concrete may be used to fill voids for site restoration.

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4.1.3.6 Surveys

A series of surveys for radioactive and other hazardous materials will be performed throughout the course of the decommissioning work, based on available guidelines at the time of decommissioning. If this work were to be performed today, the surveys would be based on current available guidelines [R-31] [R-32] [R-17]. In accordance with CSA N294:19, surveys would be carried out at the end of each decontamination or demolition work package to ensure that the planned end state had been achieved. The results of such surveys would be submitted in a formal report. This would also contain information on the criteria used to define the end state, and the assessment criteria used to establish whether the end points were met. Several different types of surveys are likely to be performed at different stages of the decommissioning.

To ensure that the surveys are properly executed, they will be performed when the remaining structures and materials are still accessible. All of the surveys will be performed according to approved procedures that will be based on the recognized standards and guidelines in use at the time.

The procedures will describe:

- Sampling strategies and methods that will be employed during the survey;
- Instruments and laboratory methods that will be used;
- Statistical techniques that will be used to analyze and interpret the data;
- Documentation that will be prepared and retained;
- Quality assurance and quality control program that will be in place;
- Performance and acceptance criteria;
- Roles and responsibilities; and
- Defined boundaries of survey.

Surveys will be carried out in each planning envelope to establish:

- Worker occupational safety and radiation protection programs;
- Environmental monitoring programs; and
- The processes required to release materials and equipment from site.

In addition, the surveys will help ensure that all radioactive materials in excess of permissible residual levels have been remediated.

The surveys conducted should be systematic and statistically robust. OPG's sampling plan will take in consideration CSA N294:19 recommendations in Annex G on the use

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of Data Quality Objectives (DQO) approach to develop a sampling plan that meets these requirements. The key steps of the DQO process are:

1. Identify the purpose and objectives of the survey;
2. Identify and review available information;
3. Define the boundaries of the survey;
4. Identify potential sampling and analytical techniques;
5. Specify the performance and acceptance criteria; and
6. Develop the survey plan.

Point 6 from this list can be achieved utilizing software developed by Pacific Northwest National Laboratory – Visual Sampling Plan. Further information on the development of a sampling plan can be found within Appendix G of CSA N294:19 [R-4], and more specifically, within the US Environmental Protection Agency’s guidance document on systematic planning and the DQO process [R-33].

As indicated in Section 4.1.3.1, a post-operational contamination survey will be performed, when the facility has ceased operation, in preparation for decommissioning. Characterization surveys may be performed to identify the nature and form of the remaining contamination in order to assist in the planning of the decontamination work.

Contamination control surveys will be performed periodically throughout the decommissioning process in order to guide and monitor the decontamination work. They are used to control the exposure of decontamination workers to radiation and hazardous materials. Contamination control surveys are typically based on simple measurements, such as contact radiation dose rates or direct contamination checks.

Regular surveying at the site will also help monitor the effectiveness of any mitigation measures implemented at preventing or minimizing potential impacts on receptors throughout the decommissioning process. Review of mitigation strategies may be necessary following the results of site surveys. If shortfalls are found when comparing monitoring data with predicted environmental conditions, checks will need to be made to ensure measures have been correctly implemented or alternative/additional measures will need to be considered. The implementation of a mitigation strategy is considered in more detail in Section 7.3.

Final surveys will be performed when the decontamination work is believed to be complete in order to confirm that residual activity levels of radioactive and hazardous material in buildings, components and the site are below the established clearance levels. When the results of these surveys have been accepted by the regulatory agencies, demolition work may proceed. The results of these surveys will (in accordance with CSA N294:19) be documented in an interim end state reports as well a final end-state report that will include:

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- The criteria used to define the end state.
- The methods and procedures used to ensure that the criteria were met.
- The measurement data, including appropriate statistical analysis and systematic approaches.

4.1.4 Completion of Decommissioning

According to CSA N294:19, this phase is considered to be achieved when the agreed final end state has been verified to have been achieved and documented; risks to operators, the public and the wider environment have been reduced to agreed levels; and the site has been released from regulatory control. Key steps required to achieve this include, but are not limited to:

- The final end state of the facility; see Section 4.1.4.1 for further details.
- Release of licensed facility from regulatory control; see Section 4.1.4.2 for further details.

Once this is complete, decommissioning records will need to be retained for at least 10 years (or alternative period as outlined in the relevant licence condition in place at the time of final decommissioning).

4.1.4.1 End State

By the end of site restoration, the site areas will be free of hazards. All radioactive contamination in excess of the established clearance levels and all other hazardous materials will have been removed from the site. All of the facility systems will have been dismantled and all of the buildings demolished. The site will have been restored to a state similar in nature to that of the surrounding DNGS site and will be suitable for other OPG uses. By the end of this phase, the DWMF site will meet the release criteria as agreed with CNSC for removal from regulatory control.

4.1.4.2 Release from Regulatory Control

A final end-state report on the decommissioning project will be prepared, describing the decommissioning work that has been performed, the outcome of that work, the results of the final surveys that were performed and the interpretation of those results. Other information required by the applicable regulations will also be included, including those required by the IAEA to confirm that no more safeguards will be required. The final end-state report will be submitted to the CNSC to support the application for release from regulatory control.

As an indicative guide, OPG is considering the recommendations put forward in the United States Code of Federal Regulations: Nuclear Regulatory Commission, Title 10 section 20.1402 (“Radiological Criteria for Unrestricted Use”); and Environmental Protection Agency, Title 40, Part 191, Subpart B, Section 191.15 (“Individual Protection Requirements”). Within these documents, maximum doses of 0.25 mSv/year (Nuclear

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Regulatory Commission) and 0.15 mSv/year (Environmental Protection Agency), including via drinking water, to an average member of a critical group is considered acceptable for future unrestricted use of the land.

5.0 DECOMMISSIONING COST ESTIMATE AND FINANCIAL GUARANTEE

This section summarizes the estimated costs associated with decommissioning the DWMF and provision of a financial guarantee for the accumulated liability.

5.1 Cost Estimate

The decommissioning cost estimate update was prepared by the TLG Services, LLC on behalf of OPG.

The cost associated with decommissioning DWMF is estimated to be \$25.1M (2022 dollars) for this financial guarantee period (2023-2027) [R-30]. The estimate is based on assumed facility physical configuration, conditions and radiological contamination after all stored waste has been removed. Expansions occurring after this financial guarantee period (e.g., UFDSB#4) are not included in these costs. A more detailed breakdown of this cost estimate is shown in Table 5-1 below. The decommissioning costs presented in this section are accurate as of the time of PDP approval. As OPG is currently in the process of finalizing its 2022 Ontario Nuclear Funds Agreement (ONFA) Reference Plan Update, these decommissioning costs may change pending further reviews by the Province.

Table 5-1: Darlington Waste Management Facility Decommissioning Cost Summary for the Financial Guarantee Period 2023-2027

Decommissioning Phase	Cost Estimate Period	Cost Estimate Financial Guarantee Period 2023-2027
Planning for Decommissioning	Planning and Preparation	9,004
Preparation for Decommissioning		
Execution of Decommissioning	Site Decommissioning	7,718
	Site Restoration	5,872
Completion of Decommissioning	N/A	-
N/A	Oversight (all stages)	2,470
Total Cost		25,064

Note: The estimated costs in Table 5-1 are a summary of the associated costs in [R-30]; the periods used for purposes of the cost estimate generally align with the decommissioning phases in CSA N294:19 as illustrated in the table. All costs are in 2022 k\$.

A summary of the cost estimate for decommissioning the DWMF can be found in Appendix C. The cost estimate will be updated when changes to DWMF planning assumptions occur. These changes may include addition of facilities, systems and equipment or other changes to planning assumptions.

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The costs associated with the management of used fuel, including interim storage, transportation and disposal, are not included in this estimate. Plans and cost estimates for these activities are described in separate documents.

OPG will continue to provide an annual status report to the CNSC staff detailing amounts accumulated in applicable segregated funds for decommissioning and management of used fuel. The report will also identify any material changes in decommissioning plans or cost estimates, which may impact the financial liability incurred.

Only facilities and land within the licensed/protected area are covered by the decommissioning segregated funds.

5.2 Financial Guarantee

For the 2023-2027 Financial Guarantee liabilities calculations, the TLG cost estimates will be adjusted to incorporate costs from the Financial Guarantee year onwards. The Financial Guarantee will be submitted to the CNSC for all licensed OPG facilities in 2022.

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6.0 HUMAN AND ORGANIZATIONAL FACTORS

The change of mission from operations (DSC processing and storage as well as storage of retube waste) to decommissioning, and the resulting loss of competence as facility staff leave for other duties, is not expected to be a major human and organizational factor issue due to the small size of the operating staff. However, there may still be some risk that existing knowledge and experience will be lost as a result of staff retirement or redeployment. It is therefore essential that mechanisms are put in place to capture this information. Techniques may include but are not limited to staff interviews, questionnaires, succession planning, knowledge transfer, etc.

OPG will ensure that human and organizational factors issues are considered throughout the planning and execution of decommissioning. As development of the decommissioning plan progresses, OPG will liaise with the CNSC to establish a set of human and organizational factors requirements and expectations guided by CNSC's REGDOC-2.2.1, Human Factors [R-34], or a revised version available at the time of writing. These will be incorporated into the DWMF DDP. Special attention will be given to staffing and training in order to minimize potential problems resulting from the loss of experienced personnel over time.

OPG will be responsible for decommissioning throughout all four phases, and OPG will retain responsibility for the facility throughout the course of the preparation phase. A DOC will be contracted to perform the dismantling, demolition and site restoration work, but OPG will maintain oversight of its activities. The appropriate number of staff will be established for decommissioning based on OPG's forecasts and industry experience. The estimated staffing number for each phase of decommissioning are based on activities in each phase, schedule, work difficulty factors and industry experience [R-30]. The staff numbers presented in the cost estimate should be considered preliminary (i.e., for cost estimating purposes only). Business plan staffing numbers have not yet been established and will be determined at a later date.

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7.0 POTENTIAL ENVIRONMENTAL AND SOCIO-ECONOMIC EFFECTS

Over the course of the decommissioning work, there may be impacts on the natural and socio-economic environment. The listing in this section is not intended to be exhaustive since, at this time, the PDP only highlights some of the potential effects.

As the decommissioning plan develops, and the nature and extent of potential impacts are better understood, it is expected that an 'environmental scope' would be defined. It is likely that the majority of the impacts identified will have very localized effects – restricted to areas within or very close to the site boundary. As a result, it is recommended that a spatial boundary is defined, beyond which environmental impacts would not be considered. This is due to the low risk of occurrence and/or low risk of harm being caused as pathways are interrupted and sources dispersed. This would be developed as results from initial survey data are collated.

It is recognized that the baseline conditions for each of these aspects would first need to be defined before decommissioning activities are commenced to allow impacts to be accurately quantified, and appropriate mitigation measures identified. It will also help to establish meaningful remediation targets.

Baseline data would be collated from data produced as a result of historical and continued monitoring programs. At the time of writing, it is recognized that an extensive and comprehensive radiological monitoring program is in place at the Darlington Nuclear Site. It has been designed to measure environmental radioactivity in the vicinity of the Darlington Nuclear Site from all sources. To achieve this, the radiation and radioactivity in air, water, soil, groundwater, foodstuffs and fish in the region are monitored. In addition, OPG has and will continue to have monitoring programs in place for non-radiological contaminants, to ensure compliance with applicable federal and provincial regulations.

Other monitoring carried out specifically at the DWMF includes:

- Groundwater monitoring via a local well nest;
- Stack discharge monitoring at the DSC Processing Building;
- Surface contamination monitoring (including on DSCs and the internal surfaces of buildings);
- Gamma radiation surveys covering the entire sequence of DSC handling and storage; Thermoluminescent dosimeter (TLD) monitors are positioned around the perimeter of the DWMF site; and

In addition, the DWMF operates a radiological zoning plan to provide optimal control of radioactive contamination. Each zone area is kept as small as possible, with zone boundaries clearly defined.

Historic and continued monitoring data, combined with the results of historical environmental assessments (the Darlington Environmental and Biodiversity Monitoring

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Plans) will provide a fundamental basis for future impact assessment or environmental review work covering decommissioning activities, if required.

The IAA [R-35], came into force in 2019 and is the legal basis for the federal environmental assessment process in Canada (also known as Impact Assessment). In consultation with the CNSC and to comply with all applicable laws and regulations, OPG will determine the requirements of performing an Impact Assessment, if required, prior to dismantling and demolition to ensure that adequate provisions for the protection of the environment and the health and safety of persons are made during decommissioning.

7.1 Natural Environment

The decommissioning activities to be carried out at the DWMF have the potential to exert negative impacts on staff, local communities and the wider environment. OPG is therefore committed to running its site, from operational through to decommissioning and dismantling activities, in a way that minimizes impacts as much as possible.

Environmental impacts depend on the 'source → pathway → receptor' chain; if any of these links are removed, a potential impact cannot be realized. This is applicable to all the receptors discussed in the following subsections. It is recognized that where the source of an impact cannot be removed, disrupting the pathway to the receptor is often an effective management approach. If this is not possible, steps must be taken to mitigate or remediate identified impacts.

7.1.1 Air Quality

The heavy construction equipment used during the decommissioning work and the vehicles used for transport of waste and other materials will release particulate (dust) and exhaust gases into the atmosphere. The nature and extent of these releases will depend on the type of equipment in use at the time of the decommissioning. Dusts, fumes and other emissions from cutting or blasting operations, particularly during the dismantling operations, may have some impact on air quality. Emissions from these activities are common in many other industrial activities and the impact can be reduced through proper equipment maintenance and currently available dust suppression technologies.

Traffic resulting from the movement of heavy vehicles to and from the DWMF during decommissioning may have an impact on the surrounding community but the additional impact on the environment should not be significant. Shipment of radioactive waste and used fuel from the site is governed by the Radioactive Materials Transportation program [R-36] and will be subject to strict application of the following transportation regulations [R-37], [R-38] and [R-39].

As described in Section 7.1.6, there may be noise pollution resulting from use of heavy equipment, but this should be limited to a small number of distinct events during the dismantling and demolition work.

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7.1.2 Land Use

Since it is expected that the site itself will continue to be used for industrial uses, the current land use will not change. It is not anticipated that the decommissioning itself will have any impact on the use of the surrounding lands.

7.1.3 Vegetation

The vegetated areas of the site are not likely to be impacted during the course of the decommissioning work since they are well removed from the facility. Vegetation growing in the vicinity of the DWMF has been identified as being synonymous with disturbed areas, and is therefore suited to the potentially disruptive conditions present at the time of decommissioning.

7.1.4 Wildlife

The DWMF site contains asphalt and gravel surfaces, which are separated from the rest of the Darlington Nuclear site by a security fence. Wildlife activity within the site boundary of the DWMF during its operating phase is expected to be minimal (due to the lack of natural habitat). This is expected to remain unchanged due to the continuous human activity expected at the site during the shutdown and decommissioning phases.

Potential effects on some species may be caused by dust, noise and sedimentary runoffs as a result of the dismantling work. Increased traffic volumes during some phases of the decommissioning may also have an impact on wildlife due to the traffic noise, as well as collisions between vehicles and animals. The potential effects described above are expected to be minimal based on prior evidence of large construction/demolition projects performed at DWMF site. The impact on species and wildlife will be further assessed and mitigation strategies will be put in place prior to dismantling and demolition.

7.1.5 Water Quality and Aquatic Life

Some temporary increase in turbidity of the water along the lakeshore may result from the dismantling and site restoration work. This may have a temporary effect on some aquatic life forms. The potential impacts of turbidity will be assessed and appropriate mitigation strategies will be put in place prior to dismantling and demolition. All feasible measures will be taken to prevent sedimentary discharges reaching local water bodies from the decommissioning site.

7.1.6 Noise

Heavy construction equipment may be used during the dismantling work performed towards the end of the decommissioning. This work may produce localized elevated noise levels in the immediate surroundings, but the effect will probably be limited to the Darlington Nuclear site. Site workers and wildlife may be affected temporarily by the increased noise. The potential impacts of demolition noise will be assessed prior to dismantling and demolition and appropriate mitigation strategies will be put in place, such as not using certain demolition methods.

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7.2 Human and Socio-Economic Environment

7.2.1 Purpose

The Regulatory Guide G-219 [R-3] and CSA N294:19 [R-4] specifies that a PDP should include the “identification of any features of the surrounding natural and social environment that could be significantly affected by the decommissioning process”. The purpose of this section is to identify specific human environmental features that may experience impacts when decommissioning occurs. A range of potential sources of effects is discussed, focusing on the potential for socio-economic impacts, at the local, community and regional level, associated with the decommissioning of DWMF.

This section does not attempt to assess or evaluate what impacts may result at the time when decommissioning actually occurs. The determination of impact, or significance of effect, is made by those affected by these changes and, hence, socio-economic impacts are specific to time and place. The impacts resulting from the decommissioning process will be assessed in a future impact assessment or environmental review, if required, and their significance determined at that time.

7.2.2 Scope

At a future time, when an impact assessment or environmental review would be undertaken, if required, the scope of the socio-economic assessment considerations would include the other planned activities occurring in the same time period, such as decommissioning of DNGS, which when taken together with the planned decommissioning of DWMF may have the potential for cumulative impact on the local communities.

Aspects to be considered include:

- Direct economic impacts – employment (local/non-local), skill groups required, labour supply, etc.;
- Indirect economic impacts – employee expenditure, suppliers, labour markets, etc.;
- Demographics – changes in population size and characteristics (long and short term);
- Housing; and
- Other local services – police, health, social, education, etc.

7.2.3 Definitions

Socio-economic impacts are defined as changes in people’s wellbeing and/or changes in significant aspects of their communities as a result of a development or project.

Socio-Economic Impact Assessment (SEIA) is a process designed to identify and evaluate the potential social, cultural and economic effects of a proposed project, policy,

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program or plan on people, organizations, institutions, communities and social systems. The purpose of the SEIA is to recommend impact management measures that would improve a project by reducing negative community effects and enhancing community benefit.

Impact management involves the coordinated application of measures designed to mitigate, enhance, compensate, plan for contingencies, monitor, and to ensure continuing liaison. Measures could also include formal impact agreements.

SEIA and impact management improve projects by identifying and managing the costs and benefits, and by facilitating decision-making. A SEIA would be undertaken as part of the environmental assessment for decommissioning, if required.

7.2.4 Temporal Considerations

As mentioned in Section 0, decommissioning of the DWMF is associated with several phases: planning, preparation, execution and completion of decommissioning.

Each of these phases will involve discrete activities that will result in effects on local communities. Socio-economic effects will begin with the commencement of activities that engage the local communities. For planning purposes, it is assumed that these effects will commence when the preparation phase begins and extend until the execution phase is complete. That is, the planning phase and the completion phase are not expected to cause any socio-economic effects on the local communities.

By 2082, all the used fuel and retube waste will have been removed from the site. The transfer of the used fuel and waste will have associated activities, including planning, licensing and transportation. The nature and extent of any associated socio-economic effects would be determined at that time in separate impact assessments or environmental reviews, if required, perhaps in the context of licensing of the long-term used fuel management facility and/or the decommissioning of the DNGS.

In accordance with Table 4-1, the time period during which socio-economic effects may occur is eight years (2086-2094). Actual activities associated with these planned phases will be intermittent; however, it is important to understand the overall flow of activities, as these will be the source of potential socio-economic impacts.

Under current assessment legislation, OPG will continue to pay the property tax on the same buildings and structures until they are removed. The tax amount paid after the dismantling of all buildings will depend on the future uses of the land. The Darlington Nuclear site is anticipated for OPG's other uses after decommissioning. The future use of the site will be discussed/consulted with the local and regional community.

These considerations will be evaluated in the decommissioning impact assessment or environmental review, if required, prior to the commencement of decommissioning, and an impact management plan will be developed.

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7.2.4.1 Preparation for Decommissioning: Sources of Effects

Preparation for decommissioning will start in 2086 when the detailed planning activities are scheduled to commence. The preparation of the decommissioning impact assessment or environmental review, if required, and the DDP will involve the local community. This involvement and the associated concerns about the impending shutdown and decommissioning of the DWMF may have related socio-economic effects.

The size of the DWMF workforce will decline in the years before shutdown as used fuel storage operations will be moved elsewhere and the used fuel will be transferred to a long-term used fuel management facility. When the DWMF is shut down, the remaining operations workforce will no longer be required.

Potential socio-economic effects will be evaluated as required. For planning purposes, it is assumed that the amount of local taxation would not change when the facility is no longer operating up to the end of decommissioning.

7.2.4.2 Execution of Decommissioning: Sources of Effects

During the execution phase, the number of staff and trades will vary. This work may represent opportunities for the local labour force, but because of the short duration and the nature of the work, workers may commute from outside the region and seek only temporary accommodation.

Local spending associated with the dismantling activities may benefit local contractors and suppliers.

The concrete-based materials free of contamination and clean fill produced by the demolition work will be used on site for fill. The volume of the contaminated materials requiring shipping to a long-term disposal facility for LLW will not be large (see Section 4.1.3.5), so the number of truck trips will be small. These sources of effects will be evaluated in the impact assessment or environmental review, if required, at the time.

At the conclusion of this phase, the workforce will no longer be required, and any local spending associated with the decommissioning work will conclude.

7.3 Mitigation Measures

It is recognized that many of the decommissioning operations to be undertaken at the DWMF site have the potential to have impacts both on and off site. There is scope for staff and members of the public and the wider environment to be affected. It is therefore recommended that, as the decommissioning plan develops, a mitigation strategy is also formed in conjunction. This will need to consider specific activities for which additional protection/mitigation procedures will be required.

The purpose of creating and implementing a mitigation strategy is to reduce or remedy significant adverse effects to the environment and human populations. Emphasis is placed on proactive mitigation measures that prevent identified impacts from occurring

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in favour of reactive measures that manage impacts once they have occurred. A diagram summarizing the hierarchy of mitigation measures is provided in Figure 7-1.

Mitigation measures can be grouped into four main categories: 'alternative options', 'physical controls', 'managerial controls' and 'deferred mitigation'. If a particular operation or technique is identified as being a potential source of harm, it is necessary to consider alternative options that are capable of producing the desired result, but also prevent or (where this is not possible) minimize the identified impact. Physical control measures are generally engineered solutions aimed at preventing identified impacts from reaching potential receptors. Examples could include: construction of physical barriers, such as bunds, enclosed structures for carrying out activities, landscaping to minimize visual or noise impacts, undertaking of regular maintenance work to sustain site conditions, and installation of sediment traps, etc. Managerial measures rely on controlling how activities are carried out on site to minimize impacts. Examples might include regulating certain activities, limiting the duration of noisy activities, ensuring work is carried out within normal working hours only, limiting the extent of the operation undertaken, ensuring work is carried out in accordance with approved method statements and operational controls, etc. Deferred mitigation might occur where an impact is unavoidable, and remedial/restorative action is required instead. This might include site decontamination, re-locating amenities to another area, site landscaping, etc.

When developing the mitigation strategy, it is essential that the process is carefully managed and reviewed to ensure that the proposed measures are effective, do not conflict with other mitigation measures or site activities, and do not simply shift the problem from one medium to another. It is also valuable at this stage to systematically record this process. It will be necessary to identify each impact, its source(s), receptors to the impact, and potential significance of the impact in both a mitigated and unmitigated scenario. This will help determine whether the cost of implementing a mitigation measure is proportionate to the benefits gained.

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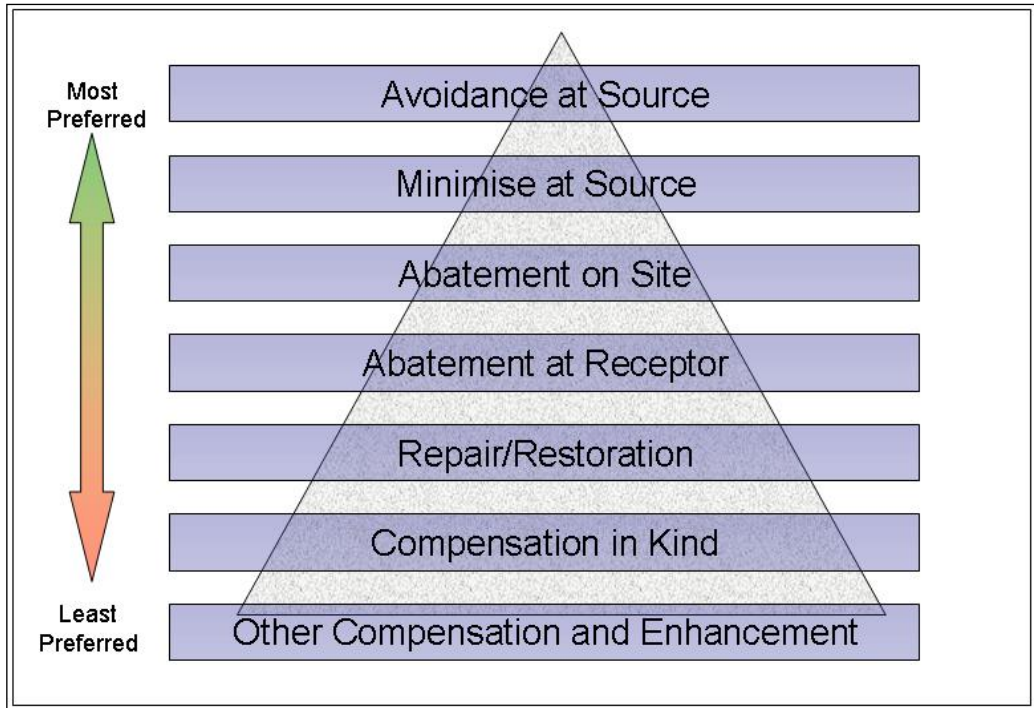


Figure 7-1: Hierarchy of Mitigation Options

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8.0 POTENTIAL HAZARDS AND HEALTH & SAFETY

During preparation for decommissioning, a safety assessment will be performed to identify potential hazards to workers, the public and the environment from both routine decommissioning activities and credible accidents during decommissioning as per CSA N294:19 [R-4]. This safety assessment will describe potential hazards and methods to reduce the risk associated with the hazards.

8.1 Hazard Assessment

The radiological, chemical and construction hazards that might be encountered during the decommissioning will be similar to those that may arise during any industrial dismantling or demolition work. A thorough assessment of the hazards to workers, public and environment, as well as credible accidents that might be encountered during the decommissioning will be performed during the detailed planning process prior to shut down of the DWMF.

A workplace health and safety assessment will be carried out to formally identify and quantify the potential hazards to operators resulting from decommissioning activities. This will help OPG meet their obligations under the OHSA, in which it is the responsibility of the employer to inform all employees about the potential hazards that they may come into contact with as part of their day to day work. Specifically, an employer must: *“acquaint a worker or a person in authority over a worker with any hazard in the work and in the handling, storage, use, disposal and transport of any article, device, equipment or a biological, chemical or physical agent”*. Approaches to hazard assessment (which are considered in numerous aspects of the OHSA) include:

- Carrying out detailed inspections and/or testing of the hazard;
- Recording of physical observations made by trained staff;
- Investigations of near misses;
- Conducting operator interviews; and
- Reviewing records such as first aid records and minutes of joint Health and Safety committee meetings.

In addition, under OHSA, it is also the legal obligation of staff to report unsafe conditions so that they can be promptly acted on.

In order to identify (and subsequently manage) the potential hazards, a workplace health and safety assessment will be carried out, in accordance with the applicable regulations at the time, to formally identify and quantify potential hazards to operators resulting from decommissioning activities. OPG will undertake a hazard assessment that will take into account the following:

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1. The nature of the hazard;
2. The potential level of exposure of staff to the hazard;
3. The frequency and duration of exposure of staff to the hazard;
4. The effects on the health and safety of employees;
5. Mitigation measures proposed to address the hazard; and
6. Any other relevant information, including staff reports on incidents or near misses.

To ensure the hazard assessment is comprehensive, the methodology used will detail the resources and timeframes required for assessing the hazards, the proposed record keeping system and a timeframe for reviewing and revising the methodology in light of additional information. In addition, the following information will be reviewed and included as appropriate:

- Hazardous occurrence reports;
- First aid/minor injury reports;
- Details of existing health and safety protection programs;
- Results of workplace inspections;
- Employee incident/near miss reports;
- Government or employer reports, studies and tests concerning the health and safety of employees;
- Records of holdings of hazardous substances; and
- Any other relevant information that might help identify and/or quantify potential hazards.

On completion of the hazard review, a 'hazard prevention program' will be developed from the results of the assessment. In addition to physical and managerial preventative measures, the program should include provisions for staff education.

This is a future activity, the results of which will be incorporated into later revisions of the decommissioning plan documentation.

Some of the possible hazards are summarized below.

The health and safety management system currently employed at the Darlington site meets the requirements of the Occupational Health and Safety Assessment Series 18001 standard. This system will continue to be followed during decommissioning.

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8.1.1 Radiological Hazards

8.1.1.1 Hazards to Workers

All of the stored used fuel and retube waste will be removed from the DWMF prior to the start of decommissioning. The remaining radioactive material on the site will be low levels of contamination on the surface of equipment and structures. Radiation fields will be low and the external radiation hazard will be minimal. Contamination control will be the major focus of the radiation protection program.

8.1.1.2 Hazards to the Public

OPG radiation protection procedures will be maintained to prevent the unlikely occurrence of loose contamination being present on persons, packages or containers leaving the site. In addition, an environmental monitoring program looking at emissions and effluents will be maintained through waste removal and decommissioning operations.

The facility is physically remote from public use areas. The volume of LLW generated during the decommissioning will be small (shown in Table 4-2); hence, the frequency of the off-site shipments should not cause any radiological risk to the public over current levels.

The risk to members of the public will be further reduced through the use of approved packages and containers, deployment of fully Suitably Qualified and Experienced Persons (SQEP) staff, use of approved procedures and adherence to applicable regulatory requirements regarding radioactive waste transport and disposal.

Finally, clearance surveys will be carried out to confirm that clearance objectives have been achieved for areas and materials destined for unrestricted public use.

8.1.1.3 Occupational Dose

Occupational doses are expected to be low, since the only radioactive materials remaining on-site at the beginning of decommissioning will be the low-level contamination on equipment and structures.

8.1.2 Chemical Hazards

During decommissioning, potential chemical hazards may come from the handling of cleaning agents used during the decontamination work, and from concrete dust generated during the dismantling work.

The risk of harm will be significantly reduced through the use of correct personal protective equipment and staff training. Chemical storage during decommissioning will also include appropriate storage requirements including separation of chemicals, where required, to avoid potential chemical hazards/explosions in case of spills or common mode event (earthquake).

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8.1.3 Industrial and Demolition Hazards

Demolition hazards that might be encountered during the decommissioning activities will be similar to those encountered in any other industrial decommissioning project. These may include:

- The operation of heavy construction equipment in close proximity to workers;
- Fires caused by cutting torches and grinders;
- The collapse of equipment or structures during demolition;
- The use of blasting and other techniques to demolish concrete structures; and
- Falls, lifting of heavy objects, falling objects, use of hand tools and the other hazards routinely encountered during demolition/de-construction work.

8.2 Radiological Safety

All decommissioning activities will be carried out in accordance with the ALARA principle and OPG's approved radiation protection procedures. Where required, a radioactive work planning approach will be utilized.

Throughout the decommissioning phases, qualified staff will be used to perform the work assigned to them, using approved procedures to mitigate/eliminate hazards associated with potential release.

8.3 Chemical and Demolition Safety

OPG will ensure that decommissioning work will be conducted in accordance with the requirements of the applicable federal and provincial occupational health and safety regulations. OPG currently has a comprehensive occupational health and safety program that meets the requirements of the OHSA of Ontario. This program recognizes:

- The right of employees to know of the hazards associated with their work;
- The right of employees to participate in decisions related to health and safety; and
- The right of employees to refuse to perform work that is unsafe.

OPG will ensure that the DOC and any subcontractors maintain occupational health and safety programs that are compatible with OPG's programs.

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8.4 Emergency Response Planning

During the preparation of the DDP, OPG will prepare an assessment of the potential hazards to workers, the public and the environment.

At all stages of the project, OPG will ensure that:

- The required emergency response plans and procedures will be in place;
- The plans will be reviewed and exercised appropriately;
- An adequate number of personnel will be available to respond to a real or potential emergency situation that may occur; and
- The necessary equipment and supplies will be available for use by emergency response personnel.

9.0 SECURITY AND SAFEGUARDS

9.1 Security

During decommissioning, OPG will continue to comply with the CNSC regulations on the physical security of nuclear facilities.

OPG will be responsible for the security of the site throughout the course of the decommissioning, and the DOC and subcontractors will be required to comply with OPG procedures regarding physical security.

9.2 Safeguards

In accordance with an agreement between the Government of Canada and the IAEA, nuclear safeguards are implemented at OPG's nuclear generating stations. These international safeguards apply to the DWMF until all the used fuel is removed from the site. The decommissioning of the DWMF will not be impacted by safeguards requirements since all used fuel will have been removed from the site prior to the implementation of the decommissioning program. Once all the used fuel has been removed from the DWMF, OPG will provide the required information and access to the IAEA for confirmation that no more safeguards will be required.

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10.0 QUALITY ASSURANCE

OPG will incorporate quality programs as per CSA N286 to assure that all appropriate requirements, including occupational, public and environmental protection, are met during the decommissioning of the DWMF. The aspects that will be considered within the quality program may include but are not limited to:

- Development of a project organization chart, identifying key roles and responsibilities;
- A method for certifying/qualifying SQEP;
- A system for the production of documents and their control;
- A mechanism for the resolution of comments or project issues;
- A system for managing staff training requirements;
- A system for the control of procurement (i.e., ensuring that subcontractors, material suppliers, etc., conform to an equally high quality standard);
- A system for labelling, identifying and tracking waste packages;
- Systems for undertaking and checking calculations, models and analyses;
- Provisions for independent technical reviews;
- An approved document/record keeping system; and
- Provisions for the undertaking of quality assurance audits.

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11.0 DOCUMENTATION (RECORDS)

It is recognized that there is a potential for information about the DWMF to be lost as individual facilities within the site shut down and staff numbers decrease. It is therefore necessary that measures be taken early on to preserve and improve the existing records database, capturing all potentially relevant information. Decommissioning-related documentation will be managed and maintained in accordance with OPG's Record Management requirements, CSA N294:19 and IAEA guidance related to record keeping (e.g., Technical Reports Series No. 411 [R-40]). These records include:

- Design of facilities and buildings included in the decommissioning plan;
- Details of the initial design and configuration of the facility and the modifications made over its operating lifetime;
- Descriptions of the nature and location of hazardous materials in the facility and the disposition of hazardous materials that have been removed;
- Records of the worker health and safety, including information required by applicable regulations and doses of ionizing radiation received by workers from the decommissioning work;
- Details of spills, releases of radioactive materials or environmentally hazardous substances that may have occurred during the facility's operational lifetime;
- Records will be kept in the storage medium for standard use at the time of the decommissioning;
- Duplicate copies will be maintained; and
- Records will be assembled and maintained in secure storage.

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12.0 PUBLIC AND STAKEHOLDER ENGAGEMENT PROGRAM

A public and stakeholder engagement program as well as an indigenous engagement program will support the development of the DDP. The program will include both information and consultation opportunities. It will be designed to involve a broad cross-section of stakeholders employing a variety of methods that will meet the needs of the participants and the objectives of the business.

The program will identify issues and concerns, ensure opportunities for involvement, ensure all input was considered in decommissioning planning and impact assessment or environmental review activities, if required, and include the documentation of the process and results. The program will also support the development of an integrated community impact management plan.

The public and stakeholder engagement program will comply with the applicable requirements of REGDOC-3.2.1 [R-12] and REGDOC-3.2.2 [R-41].

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Appendix A: Darlington Waste Management Facility Major Systems and Components

Item	System/Component	Function
1	DSC Processing Building, including: <ul style="list-style-type: none"> • Paint Facilities • Maintenance Facilities • Control Rooms • Equipment and Tool Rooms • Offices • Truck Bay • IAEA Office • Amenities • Phased Array Ultrasonic Testing (PAUT) Facility • Welding Facilities 	Provides for safe and efficient handling and processing of DSCs. See Figure 2-6 to Figure 2-9.
2	DSC Storage Buildings	Provides for indoor storage of DSCs and allows for access to and retrieval of any DSC at any time. See Figure 2-5, Figure 2-10 and Figure 2-11.
3	RWSB	Provides for indoor storage of retube waste and allows for retrieval of any RWC at any time. See Figure 2-12
4	DSC Transporter	Provides for safe transportation of new or loaded DSCs within the DWMF, and on-site to and from the DNGS.
5	Overhead Crane, Rails and Controls	Provides for lifting and transferring DSCs within the DSC Processing Building.
6	Welding Equipment and Controls	Provides for a seal weld between the lid and body of the loaded DSC and drain port plug welds.
7	PAUT Inspection Equipment and Controls	Provides for inspection of the DSC seal weld.
8	DSC Vacuum Drying Equipment and Controls	Provides for vacuum drying the DSC interior to ensure a moisture-free environment for the used fuel.
9	Helium Backfill Equipment and Controls	Provides for helium backfilling of the DSC after evacuation of its interior atmosphere.
10	Helium Leak Test Equipment and Controls, Including Bell Jar	Provides for leak testing the final seal weld, drain and port welds and the drain port helium pin weld.
11	DSC	Provides for safe storage of used fuel from DNGS. See Figure 2-4 and Figure 2-5.
12	DSC Tools, Transfer Clamp(s) and Transfer Clamp Stands	Provides for handling and securing the loaded DSC while in transit between DNGS and the DWMF
13	DSC Lifting Beam and Storage Stand	Provides for lifting the DSC by the overhead crane.
14	Work Station Platforms	Provides for working on the DSC during its various stages of processing.
15	DSC Commissioning Tools/Gauges	Provides for commissioning new (unloaded) DSCs.
16	Radiation and Contamination Monitoring Equipment	Provides for radiation protection, contamination control and monitoring.

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Item	System/Component	Function
17	Lifting Devices and Slings for All Processing Equipment, Including Lift Truck/Tow Motor(s).	Provides for lifting/moving and maintenance of processing equipment.
18	Air Systems	Provides for service air.
19	Water Systems – Domestic and Firewater	Provides domestic water for drinking, washroom and services and for fire protection.
20	Electrical Power, Distribution and Lighting Systems	Provides for normal operation of electrically operated components and systems, operation of security and safeguards systems under normal and abnormal conditions, which includes an uninterruptible power supply supported by an alternate power source for short-term power back-up (stand-by generator) in the event of loss of normal power. Provides lighting for all buildings and yard, and for meeting security and safeguards requirements.
21	Heating, Ventilation, Air Conditioning and Active Ventilation Systems	Provides for control of interior ambient temperatures, prevents ventilation backflow in areas subject to airborne contamination, includes HEPA filters and pre-filters for removal of contaminated particles prior to being exhausted into the environment, and for measurement of air flow and collection of ventilation stack air samples.
22	Sanitary Systems	Provides for sewage collection and removal to existing site sewage treatment plant.
23	Drainage Systems (Inactive and Provisions for Future Active Drainage Systems)	Provides for collection and removal of liquid waste to existing site system.
24	Fire Protection	Provides for detection, prevention and impeding the spread of fires.
25	Communications, Including Local Area Network, Public Address and Phone	Provides for normal communication within and between DWMF and the DNGS site, emergency communication under abnormal conditions and for security and safeguards.
26	Security/Access Control	Provides for a “protected area” designation under the CNSC Class I Nuclear Facilities Regulations and is designated as a Class II facility.

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Appendix B: Estimated Type and Location of Hazardous Materials Stored in the Dry Storage Container Processing Building

Table B-1: Hazardous Materials Stored in the DSC Processing Building

Material	Type	Estimated Quantities*	DSC Processing Building Location
Compressed gas	Helium, oxyacetylene, argon, carbon dioxide	6,300 L (actual bottle volume)	Inert gas store on ground floor.
Flammable chemicals	Paint, solvents, oil	250 L	Paint storage on ground floor.
Corrosive chemicals	Cleaning agents	40 L	Janitor's room on ground floor.

* Based on quantities from operations at the Western Waste Management Facility (WWMF) [R-42].

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Appendix C: Summary of Decommissioning Cost Estimate for the Darlington Waste Management Facility

This study, prepared for OPG by TLG Services, LLC, estimates the decommissioning costs of the DWMF to be \$25.1M (2022 dollars) for this financial guarantee period (2023-2027) [R-30]. These costs are based on the unique features and expected condition of the facility after removal of the retube waste containers and all stored radioactive waste contained in the DSCs and planning assumptions for the 2023-2027 financial guarantee period. Expansions occurring after this financial guarantee period (e.g., UFDSB#4) are not included in this estimate. A more detailed breakdown of the cost estimate is shown in Table C-1 below.

The costs associated with the management of used fuel, including interim storage, transportation and disposal at the APM, are not included in this estimate. Plans and cost estimates for used fuel related activities, as well as the removal, transportation and disposal of retube waste are described in separate documents.

Table C-1: Darlington Waste Management Facility Decommissioning Cost Summary for the Financial Guarantee Years 2023-2027

Decommissioning Phase	Cost Estimate Period	Cost Estimate Financial Guarantee Period 2023-2027
Planning for Decommissioning	Planning and Preparation	9,004
Preparation for Decommissioning		
Execution of Decommissioning	Site Decommissioning	7,718
	Site Restoration	5,872
Completion of Decommissioning	N/A	-
N/A	Oversight (all stages)	2,470
Total Cost		25,064

Note: The estimated costs in Table C-1 are a summary of the associated costs in [R-30]; the periods used for purposes of the cost estimate generally align with the decommissioning phases in CSA N294:19 as illustrated in the table. All costs are in 2022 k\$.

Regulations:

The cost estimate was prepared following the guidance on decommissioning planning found in CNSC regulatory guide G-219, "Decommissioning Planning for Licensed Activities", and CSA N294:19 "Decommissioning of Facilities Containing Nuclear Substances". The regulatory guidance document and standard provide guidance regarding the preparation of decommissioning plans as well as the basis for calculating financial guarantees. Regulatory guide G-219 provides CNSC guidance recommended for meeting regulatory requirements associated with decommissioning nuclear facilities. It addresses requirements for choosing a basic strategy for decommissioning, materials and waste management, radiological surveys, human and organizational factors, conventional health safety and security, environmental assessment, emergency response, quality assurance and final end-state reporting. The CSA standard N294:19 also highlights the requirement for a decommissioning cost estimate, stating in

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Section 6.2.3 that “cost estimates shall include all decommissioning activities from operations, during shutdown to the final release from regulatory control...”. It also recommends that the estimate is periodically reviewed to reflect changes in the facility, economic climate, regulatory requirements or available technologies.

Methodology:

The methodology used to develop this decommissioning cost estimate follows the basic approach originally presented in the cost estimating guidelines¹¹ developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference describes a unit cost factor method for estimating decommissioning activity costs. The unit cost factors used in this plan reflect site-specific costs, as well as the latest available information about worker productivity in decommissioning. An activity duration critical path is used to determine the total decommissioning program schedule required for calculating the carrying costs, which include program management, administration, field engineering, equipment rental, quality assurance and security. This systematic approach employed to assemble the decommissioning estimates ensures confidence in the reliability of the results.

Allowance:

Consistent with accepted cost estimating practice, allowances are applied to the decontamination and dismantling costs developed as ‘specific provision for unforeseeable elements of cost within the defined project scope, particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur.’¹² The cost elements in the estimate are based on normal conditions plus difficulty factors; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage allowance applied on a line-item basis. This allowance factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that allowance, as used in this estimate, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station and subsequent storage period, nor include changes in scope and unforeseeable major events such as earthquakes, strikes, etc.

The use and role of allowances within decommissioning estimates are not a safety factor issue. Safety factors provide additional security and address situations that may never occur. Allowance funds, by contrast, are expected to be fully expended throughout the program. Inclusion of allowance is necessary to provide assurance that sufficient funding will be available to accomplish the intended tasks.

Radioactive Waste Management:

Allowance is made for generation of 116.3 m³ of LLW during the decommissioning of DWMF for financial guarantee years 2023-2027. This study uses unit costs adopted by other OPG cost studies to estimate waste packaging, transportation and long-term disposal costs for this waste.

¹¹ T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986.

¹² Project and Cost Engineers' Handbook, Second Edition, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, p. 239.

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Site Restoration:

Site restoration, which includes the demolition of 'clean' structures, will occur promptly after radioactive material has been removed from the facility (site meets radiological release criteria).

It is assumed the site structures within the restricted access area are removed to a nominal depth of 1 m below the local grade level wherever possible. Foundation grade slabs greater than 1 m in thickness (if any) will be abandoned in place and covered over with a layer of backfill. The site is then graded and stabilized.

Summary:

An estimate is provided in 2022 Dollars for the cost of decommissioning the DWMF under current requirements, based on present-day costs and available technology.

The cost study [R-30] is designed to provide sufficient information to assess financial obligations. The estimate was prepared by developing an inventory of installed components and structures based on drawing and document reviews. Costs for labour, materials, equipment, waste disposal, insurance, taxes and program management were estimated using OPG (or regional) specific cost data.

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Appendix D: Compliance Matrix with CSA N294:19

Table D-1: Compliance Matrix with CSA N294:19 (Mandatory Requirements)

Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
4.1	The owner of a nuclear facility shall be responsible for planning, executing, and funding all phases of decommissioning.	4.1
4.2	Decommissioning activities shall be planned and executed in accordance with relevant regulations and standards and in keeping with relevant guides.	3.1
	Responsibilities for decommissioning, preparing documents, and recordkeeping shall be clearly established throughout the life cycle of a facility.	4.1, 6.0, 11.0
4.3	Responsibility for the funding of the decommissioning shall be identified and financial guarantee shall be established to ensure adequate funding for decommissioning	5.0
	The owner shall consider the requirements of CSA N286 when executing decommissioning works, including the following: a) protecting the health and safety of workers and the public; b) protecting the environment; c) complying with requirements of the AHJ; d) keeping radiation exposures as low as reasonably achievable (ALARA); e) managing all radioactive and hazardous materials generated by the decommissioning; f) security; and g) safeguards	10.0 8.0 7.0 3.1 4.1.3.2; 8.2 4.1.3.5 9.1 9.2
4.4	Programs shall be developed and implemented to support decommissioning.	6,7,8,9,10,11,12
5.1.1.3	A financial guarantee for decommissioning shall be established to ensure that adequate funding is available at the time of decommissioning. The financial guarantee for decommissioning shall be maintained throughout the life cycle of the facility.	5.0
5.1.6	The final end-state shall be considered reached when the end-state objectives as set in the DDP are verified to have been achieved (Annex F describes how to establish the end-state objectives).	This pertains to the completion of decommissioning and is, as such, not applicable for this PDP.
5.1.7	The party accountable for decommissioning shall identify the applicable institutional control requirements following decommissioning as well as the available administrative processes in the jurisdiction in which they are located.	This will be done as part of preparing the DDP (described in 4.1.2.5).

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
5.2.5	Decommissioning records shall include, as applicable, a) the DDP(s); b) public and Indigenous engagement/communication records (as per CNSC REGDOC-3.2.2); c) if required by the AHJ, an impact assessment or environmental review in accordance with applicable legislation; d) licences and permits required for the decommissioning work; e) the plans and procedures used in decommissioning; f) reports and other documents that describe i) the criteria used to define radioactive and hazardous materials and to distinguish contaminated from uncontaminated materials; ii) the criteria used to define the final contamination status of the facility; iii) the principles and models used in deriving the criteria in Items i) and ii); iv) the residual radionuclide inventory after decontamination; v) the amounts of radioactive and hazardous materials removed and the disposition method; vi) waste management and transfer records; vii) the equipment and materials removed from the facility for recycling or use elsewhere, their treatment prior to removal from the site, and the disposition method; viii) the survey methods and the types of instruments used; ix) the equipment, nuclear and non-nuclear materials, and structures remaining at the end of decommissioning; and x) land remediation undertaken, results of verification analyses as compared to criteria used or derived for soil and water quality, and the disposition of affected media; g) reports, other documents, and photographs describing findings from inspections, modifications, and repairs to SSCs; h) reports and other documents that describe unplanned or unusual occurrences; i) results and interpretations of environmental monitoring programs; j) occupational dose records; k) deviations from plans and procedures; l) quality assurance records; m) storage-with-surveillance plans; n) facility inspection, maintenance, and equipment records; o) the final radiological and hazardous materials surveys; and p) interim and final end-state reports.	This pertains to records following the completion of decommissioning.
5.4.2	The facility shall be characterized. See Annex G for guidance.	4.1.3.1, 4.1.3.6
5.4.3	All radioactive waste generated shall be characterized as per the CSA N292 series of Standards.	4.1.3.5
5.5.1	A strategy shall be developed for the management of all radioactive, hazardous, and conventional waste that will be generated throughout the course of the decommissioning.	4.1.3.5
5.6	A hazard assessment commensurate with the tasks to be performed shall be completed prior to decommissioning.	8.1
5.8.1	A quality assurance program shall be implemented.	10.0

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
6.1.1	The owner shall demonstrate that, under the strategy selected, the facility will be maintained in a safe configuration at all times.	8.0, In addition, development of PDPs in itself addresses this requirement.
6.1.2.2	In such cases where the end-state for in-situ decommissioning results in a waste disposal site, an applicant shall satisfy all regulatory requirements for a radioactive waste disposal facility and demonstrate safety via a safety case and post-closure safety assessment of a disposal facility.	Not Applicable.
6.2.1	For sites with more than one facility, a site decommissioning plan shall be developed to ensure that interdependencies are taken into account.	2.2.5
6.2.3	<p>Cost estimates shall include all decommissioning activities from operations, during shutdown to the final release from regulatory control.</p> <p>The cost estimate for decommissioning shall address the cost of the following principal activities, if applicable:</p> <ul style="list-style-type: none"> a) preparation for final shutdown; b) site characterization, site surveys; c) facility shutdown activities; d) additional activities for safe enclosure; e) decontamination and dismantling activities; f) processing, storage and disposal of all waste including used fuel; g) project management, engineering, and site support; h) site clean-up, landscaping, and restoration; i) long-term management of radioactive waste and used fuel; j) long-term monitoring and maintenance of the site and institutional control; k) licensing costs; and l) miscellaneous expenditures. 	Section 5 and Appendix C
7.1.1	<p>Preparation for decommissioning shall include</p> <ul style="list-style-type: none"> a) an assessment of the records from the previous life cycle stages and the state of the facility (e.g., baseline configuration) at the time of shutdown; b) an impact assessment or environmental review in accordance with applicable legislation, if required; c) a safety assessment for decommissioning; d) ensuring that there is a sufficient number of qualified staff to ensure safe operation during the approach to shutdown; e) further development of the PDP into the DDP; f) placing a facility in a permanent shutdown state; and (a) any additional requirements specified by the AHJ. 	4.1.2 describes overall activities involved preparation for decommissioning requirements however, it should be noted that these requirements pertain to the actual preparation phase and are, as such, not applicable for this PDP.

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.1.2	The owner shall ensure that processes, systems, and personnel are in place to maintain the facility in a safe state during the transition to decommissioning.	4.1.2 describes the overall activities for preparation for safe transition to decommissioning. However, it should be noted that that this requirement pertains to actual transition/preparation phase and as such, not applicable to this PDP.
7.4.1.1	To ensure a smooth transition from operation to decommissioning, the facility shall be prepared to complete stabilization activities as soon as practical after the permanent shutdown date.	These requirements pertain to the preparation phase.
7.4.3	During the transition period between shutdown and decommissioning, monitoring and maintenance activities shall be conducted to ensure the health and safety of persons and the protection of the environment.	These requirements pertain to the preparation phase.
7.5.1	An assessment of the state of the facility shall be performed to provide baseline information for condition of the building and SSC, and evaluation of the hazards to be controlled during decommissioning. A thorough survey shall be performed and supplemented by a review of existing records, as applicable.	4.1.2 describes the overall activities for preparation for safe transition to decommissioning. However, is should be noted that that this requirement pertains to actual transition/preparation phase and as such, not applicable to this PDP.
7.5.2.1	The following hazards shall be investigated and assessed: a) radiological hazards; b) biologically, chemically, and physically hazardous materials; c) hazards from concealed or hidden services; and d) structural hazards.	These requirements pertain to the preparation phase.
7.5.2.2	Historical information shall be preserved that is relevant to the eventual decommissioning of the facility.	11.0
7.6.1	A DDP shall be developed for nuclear facilities, in accordance with Annex C and regulatory requirements, and submitted to the AHJ for acceptance.	4.1.2.5 describes the development of a DDP, however these requirements pertain to the actual DDP preparation for the Dismantling & Demolition phase. Relevant for the DDP not the PDP.

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Section in CSA N294:19	Requirement in CSA N294:19	Section in This PDP
7.6.5.2	<p>The waste management program shall cover the following processes, as applicable:</p> <ul style="list-style-type: none"> a) characterization; b) classification; c) minimization; d) segregation; e) clearance; f) handling; g) volume reduction; h) treatment; i) packaging; j) storage; k) transportation; and l) final disposition. <p>Transportation requirements and the waste receiver's acceptance criteria shall be reviewed to ensure that the waste is appropriate for shipment and acceptable to the waste receiver.</p>	4.1.3.5 provides high level plan for waste management strategies during decommissioning. However, it should be noted that these requirements pertain to the preparation phase, during the development of DDP.
8.1.2	The work to be performed during the decommissioning shall be described in a DDP.	This requirement pertains to the preparation phase.
8.1.3	The physical work to be carried out shall be defined in terms of work packages and work procedures to the level of detail required for safe, effective, and efficient decommissioning.	These requirements pertain to the execution phase and are, as such, not applicable for this PDP.
8.1.7.1	<p>Where decontamination is being used as part of decommissioning, the following shall be identified:</p> <ul style="list-style-type: none"> a) the areas, locations, and equipment to be decontaminated; b) the objectives of the decontamination (e.g., decontamination of equipment for salvage and reuse, decontamination of metals for recycling, decontamination of building foundations that are to remain in place, decontamination for clearance of materials to be disposed of as non-radioactive); c) the decontamination methods to be employed; and d) the residual level of radioactivity that is to be achieved. 	These requirements pertain to the execution phase.
8.1.8.1	<p>A demolition plan shall be prepared.</p> <p>The equipment and structures to be dismantled or demolished shall be identified.</p> <p>The equipment and structures that are to remain at the completion of decommissioning shall also be identified.</p> <p>Procedures for dismantling and demolition shall take into account the associated hazards.</p>	These requirements pertain to the execution phase.

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8.1.8.2	<p>The following factors shall be considered when selecting dismantling/demolition methods:</p> <ul style="list-style-type: none"> a) availability of professional competence associated with the operations of the chosen equipment; b) the equipment should be simple to operate, decontaminate, and maintain; c) remaining structural elements shall be kept in a physically stable state; d) measures to prevent unintentional releases to the environment; e) planned discharges to the environment shall be controlled as per licence conditions and previous commitments; f) when underwater dismantling and cutting is used, provisions shall be made to process the water to promote and assist in effluent treatment; g) the effect of dismantling tasks on adjacent systems and structures and on other work in progress shall be evaluated; h) waste containers, handling systems, and routes shall be defined before the start of dismantling work; and i) federal, provincial/territorial and/or municipal requirements. 	These requirements pertain to the execution phase.
8.1.9.1	<p>Surveys during decommissioning shall be performed to comply with</p> <ul style="list-style-type: none"> a) worker occupational safety and radiation protection limits; b) environmental monitoring criteria; and c) processes to release materials and equipment from the site. 	4.1.3 and 4.1.3.1 provides high level plan for surveys to be performed during decommissioning. However, it should be noted that these requirements pertain to execution phase.
8.1.9.2	<p>At the completion of a decontamination or dismantling work package, a survey shall be performed, if required, to demonstrate that the planned end-state has been achieved.</p> <p>The results of the survey shall be documented in a report that includes</p> <ul style="list-style-type: none"> a) the criteria used to define the end-state; b) the methods and procedures used to ensure that the criteria were met; and c) the measurement data, including appropriate statistical analysis and systematic approaches. 	4.1.3.6 provides high level plan for surveys to be performed after decontamination or dismantling. However, it should be noted that these requirements pertain to execution phase.
8.2	Where decommissioning of the facility is to take place in discrete stages, an interim end-state report shall be prepared when each planned interim end-state is achieved.	These requirements pertain to the execution phase.
8.3	<p>A plan for surveillance, monitoring, physical protection, and maintenance of the facility during such periods shall be developed and implemented to</p> <ul style="list-style-type: none"> a) maintain the facility in a safe state; b) control the release of materials to the environment; c) prevent access by unauthorized persons; and d) mitigate infestations of vermin and other organisms. 	These requirements pertain to the execution phase.

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8.4	Lands associated with a facility or a standalone site that might have been impacted by previous nuclear activities shall be remediated to the degree required to meet the end-state criteria.	4.1.3.4 provides high level plan for land remediation, however, this requirement pertains to completion of decommissioning.
8.5	<p>At the completion of this phase, final surveys of residual radioactive and hazardous materials shall be performed and documented to demonstrate that the final end-state for remaining equipment, structures, and the site has been achieved in accordance with the criteria specified in the DDP.</p> <p>The results of the final survey shall be documented in a report that includes</p> <ul style="list-style-type: none">a) the criteria used to define the end-state;b) the methods and procedures used to ensure that the criteria were met; andc) the measurement data, including appropriate statistical analysis and systematic approaches.	This pertains to the completion of decommissioning.
9.1	<p>Following the completion of decommissioning, a final end-state report shall be prepared and retained.</p> <p>Where a decommissioning program involves completing a number of separately approved decommissioning projects, interim end-state reports shall be submitted for each project.</p>	4.1.4.2 provides high level plan for the final end state report, however, this requirement pertains to completion of decommissioning.

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Table D-2: Compliance Matrix with CSA N294:19 Annex A (Non-Mandatory Requirements)

Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2	A PDP may include the following, unless they are not applicable to the facility:	
A.2 a)	a description of the location of the facility, including <ul style="list-style-type: none"> i) a map of the facility and its specifications; ii) geographic information; iii) details regarding the surrounding environment; iv) land uses; and v) illustrations and maps of the facility in relation to the municipality; 	2.2 2.1 2.1; 2.3 2.3 2.3.4 Figure 2-1
A.2 b)	purpose and description of the facility, including <ul style="list-style-type: none"> i) primary components and systems; ii) building type and construction, including location of any hazardous building materials (e.g., asbestos, PCBs); iii) building services (e.g., power, heating, ventilation, sewer, water, fire protection); iv) laboratories and other hazardous handling areas; v) type, quantity, and form of radioactive and hazardous materials stored, produced, or used during operation; and vi) design features used to reduce the spread of contamination and facilitate decontamination and dismantling; 	1.0 2.2; Appendix A 2.2 2.2; Appendix A 2.2; Appendix A 2.2; Appendix B 2.2; 3.6
A.2 c)	post-operational conditions, including <ul style="list-style-type: none"> i) a summary of the shutdown process, including planned removal of stored inventories of hazardous or radioactive materials; ii) the predicted nature and extent of contamination remaining in the primary systems and components (in list or table format with reference to applicable illustrations); iii) the predicted nature and extent of contamination on floors, walls, work surfaces, ventilation systems, etc.; iv) the identification of any separate planning envelopes; and v) an overview of the principal hazardous conditions anticipated to exist; 	3.5; 4.1.2 3.6 3.6; 8.1.1 4.1.2.5 8

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Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 d)	<p>the decommissioning strategy, including</p> <ul style="list-style-type: none"> i) the final end-state objective; ii) rationale for <ul style="list-style-type: none"> 1) the decommissioning strategy selected; 2) interim end-states; 3) periods of SWS; and 4) in-situ decommissioning concepts; iii) the requirements for long-term institutional controls; and iv) the assessment of alternative strategies (or a rationale for why alternatives do not exist or do not warrant consideration); 	<p>3.5 4.1.4.1</p> <p>3.5 Not applicable. Not applicable. Not applicable. N/A: No long-term institutional control will be established 3.5</p>
A.2 e)	<p>a plan of the decommissioning work, including</p> <ul style="list-style-type: none"> i) a work breakdown structure; ii) a summary of the main steps for decontamination/disassembly/removal of each of the systems (preferably grouped into work packages); iii) for each work package, identification of those types of activities that could pose a significant hazard to workers, the public, or the environment; iv) the role of existing operational standard procedures for radiation protection, hazardous materials handling, industrial safety, and environmental protection in managing hazards; v) specific activities for which additional protection/mitigation procedures will be required at the detailed planning stage; vi) a summary of the final dismantlement of the structures; and vii) a conceptual schedule showing the approximate year of facility shutdown and the approximate sequencing and duration of the decommissioning work packages and, where relevant, storage periods; 	<p>4.1 4.1.3</p> <p>4.1.3; 8.0</p> <p>8.0</p> <p>7.3</p> <p>4.1.3</p> <p>Table 4-1</p>
A.2 f)	<p>radiological monitoring and survey commitments, including</p> <ul style="list-style-type: none"> i) a program for conducting periodic contamination surveys and the recording of contamination events during facility operation; ii) a commitment to conduct detailed post-operation surveys in support of DDP development; and iii) a commitment to develop plans and protocols acceptable to the AHJ at the detailed planning stage for monitoring <ul style="list-style-type: none"> 1) work hazards during decommissioning; 2) personnel dosimetry; 3) environmental emissions and effluents; and 4) materials, sites, and structures to be cleared from regulatory control; 	<p>8.0; 11.0 4.1.2.5; 4.1.3.1; 4.1.3.6</p> <p>4.1.2; 4.1.2.1, 8.0</p>

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Section in CSA N294:19 Annex A	Requirement in CSA N294:19	Section in This PDP
A.2 g)	a waste management strategy specifying <ul style="list-style-type: none"> i) the approximate quantities and characteristics of radioactive and chemically hazardous wastes expected to arise from the decommissioning (tied to specific work packages, if possible); ii) the anticipated final disposition of radioactive and chemically hazardous materials; and iii) a commitment to segregate as much material as possible for reuse and recycling; 	4.1.3.5
A.2 h)	a commitment to prepare a DDP for regulatory approval prior to dismantling and demolition;	1.0; 4.1.2.5
A.2 i)	a commitment to periodically review and update the PDP until a DDP is prepared, in accordance with Clause 6.2.2;	1.0; 3.3
A.2 j)	the physical state of the facility at <ul style="list-style-type: none"> i) the end of operations; and ii) the start of decommissioning; 	3.5 3.6
A.2 k)	the records required for decommissioning, including a description of the facility operational records that will be maintained to periodically update the PDP and prepare the DDP(s);	11.0
A.2 l)	a public engagement plan, including a public information program and avenues for public participation;	12.0
A.2 m)	an Indigenous engagement plan as per the requirements and guidance of CNSC REGDOC-3.2.2; and	2.3.7.1, 12.0
A.2 n)	the cost and a financial guarantee, specifying <ul style="list-style-type: none"> i) an estimate of the total present-value cost of the decommissioning; ii) a reasonable basis for how cost estimates were derived; and iii) a description of how the required funds will be provided; 	5.0; Appendix C