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Supplier Document

Environmental Risk Assessment for Douglas Point Waste Facility

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Revision 2.0

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Canadian Nuclear Laboratories

ENVIRONMENTAL RISK ASSESSMENT FOR THE DOUGLAS POINT WASTE FACILITY

Revision 2

May 2025

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CONTENTS

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AECL	Atomic Energy of Canada Limited
ALHS	Active Liquid Handling System
BDF	Dairy Farm Resident
BEC	Bruce Eco-Industrial Park Worker
BF	Farm Resident
BHF	Generic Hunter/Fisherman
BP	Bruce Power
BR	Non-farm Resident
BSF	Mennonite Farm Resident
CANDU	CANada Deuterium Uranium
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Act
CL4	Construction Landfill #4
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COPC	Contaminant of Potential Concern
CR	Concentration Ratio
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
DC	Dose Coefficient
D&D	Decommissioning & Demolition
DPNGS	Douglas Point Nuclear Generating Station
DPWF	Douglas Point Waste Facility
DRL	Derived Release Limit
ECIS	Emergency Coolant Injection System
ELC	Ecological Land Classification
EMP	Effluent Monitoring Program
EPC	Exposure Point Concentration
ERA	Environmental Risk Assessment
EcoRA	Ecological Risk Assessment
ERICA	Ecological Risk from Ionizing Contaminants Assessment and Management
ESA	Endangered Species Act
FNFNES	First Nations Food, Nutrition, and Environmental Study
FSL	Former Sewage (commissioning waste) Lagoon
HEPA	High Efficiency Particulate Air
HHRA	Human Health Risk Assessment

HSM	Historic Saugeen Métis
LOAEL	Lowest-Observed-Adverse-Effect Level
MECP	Ontario Ministry of the Environment, Conservation and Parks
MNO	Métis Nation of Ontario
NNW	North-Northwest
NOAEL	No-Observed-Adverse-Effect Level
OPG	Ontario Power Generation
PCB	Polychlorinated Biphenyl
PHC	Petroleum Hydrocarbon
QA	Quality Assurance
QC	Quality Control
SAR	Species at Risk
SARA	*Species at Risk Act*
SARO	Species at Risk in Ontario
SW	Southwest
SSE	South-Southeast
SSW	South-Southwest
SWS	Storage with Surveillance
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WWMF	Western Waste Management Facility

1.0 INTRODUCTION

1.1 Background

The Douglas Point Waste Facility (DPWF), located in Tiverton, Ontario, contains a shut-down prototype nuclear reactor and its associated facilities and infrastructures. This facility is owned by Atomic Energy of Canada Limited (AECL) and operated by Canadian Nuclear Laboratories (CNL) under the Reactor Decommissioning group. The reactor site and its associated infrastructure are currently in different stages of decommissioning from Phase 2 (i.e., safe Storage with Surveillance (SWS)) to Phase 3 (Decommissioning & Demolition i.e., D&D).

1.2 Goals, Objectives, and Scope

The objective of this report is to prepare an Environmental Risk Assessment (ERA) for the DPWF, including a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (EcoRA), that assess the potential risk of radiological, chemical and physical stressors resulting from normal operations in the facility's current state. This DPWF ERA has been completed for current conditions, i.e., SWS, and is consistent with the following guidance documents:

- REGDOC 2.9.1, *Environmental Principles, Assessments and Protection Measures, Version 1.2,* (CNSC 2020).
- Nuclear Safety and Control Act Radiation Protection Regulations (CNSC 2000).
- Canadian Standards Association (CSA) Standard N288.6-22, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* (CSA 2022a).
- CSA Standard N288.1-20, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* (CSA 2020).
- CSA N288.0:22, Environmental management of nuclear facilities: Common requirements of the CSA N288 series of standards" (CSA 2022b), Section 7.1.2 (Quality Assurance (QA) Program).
- International Standard for Standardization (ISO) 9001:2015 Quality management systems.

This ERA is prepared as part of the periodic review and update required by REGDOC 2.9.1 (CNSC 2020) and CSA N288.6-22 (CSA 2022a); the previous iteration was completed in 2019. As per REGDOC 2.9.1 (CNSC 2020), the scope of this ERA is commensurate with the scale and complexity of the very low environmental risks associated with the DPWF. Furthermore, the DPWF site is within the Bruce Power (BP) site and occupies less than 1% of the total BP site footprint, emissions consistently represent less than 0.01% of its Derived Released Limits (DRL), the source term is well understood and unchanging in the current Phase 2 (i.e. SWS state), and hazards are being reduced due to continued Phase 3 (i.e., D&D) hazard reduction campaigns.

As per CSA N288.6-22 (CSA 2022a), this ERA follows a tiered approach, starting from a broad evaluation using protective generic parameters and a high degree of conservatism and advancing towards more precise analysis involving site-specific realistic parameters and less conservatism as needed. Risks that require more detailed consideration are identified and assessed in greater detail (if any).

1.3 Organization of Report

The main report sections are as follows:

Section 1: Presents background information for context and briefly outlines the scope of this report.

Section 2: Provides a site and project description, including the engineered site features and the natural/physical environment surrounding the facility.

Section 3: Presents the HHRA for radiological contaminants.

Section 4: Presents the EcoRA for radiological contaminants.

Section 5: Presents the HHRA for chemicals and physical stressors.

Section 6: Presents the EcoRA for chemicals and physical stressors.

Section 7: Discusses the conclusions and recommendations of the assessment.

Section 8: Presents cited references.

This report has been prepared in accordance with the requirements of CSA Standard N288.6-22: *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* (CSA 2022a). Appendix A presents a concordance table demonstrating how the sections of the present ERA align with the ERA contents suggested in CSA N288.6-22 (CSA 2022a).

2.0 SITE DESCRIPTION

This section is based on information from the following sources, unless otherwise stated:

- The Effluent Monitoring Plan (CNL 2021a);
- The Detailed Decommissioning Plan (CNL 2019b);
- The Storage with Surveillance Plan (CNL 2022);
- The Bruce Power Environmental Quantitative Risk Assessment (BP 2022); and,
- Descriptions and feedback provided by CNL facility staff.

2.1 Project Description

The DPWF, owned by AECL, was formerly the Douglas Point Nuclear Generating Station (DPNGS). It is located on the Bruce Power (BP) site on the east shore of Lake Huron in the Province of Ontario and comprises parts of Lots 15 and 16 in Lake Range, in the Township of Bruce in the County of Bruce (Figure 2-1). The DPWF consists of a permanently shutdown, partially-decommissioned prototype CANada Deuterium Uranium (CANDU) reactor and associated structures and ancillaries.

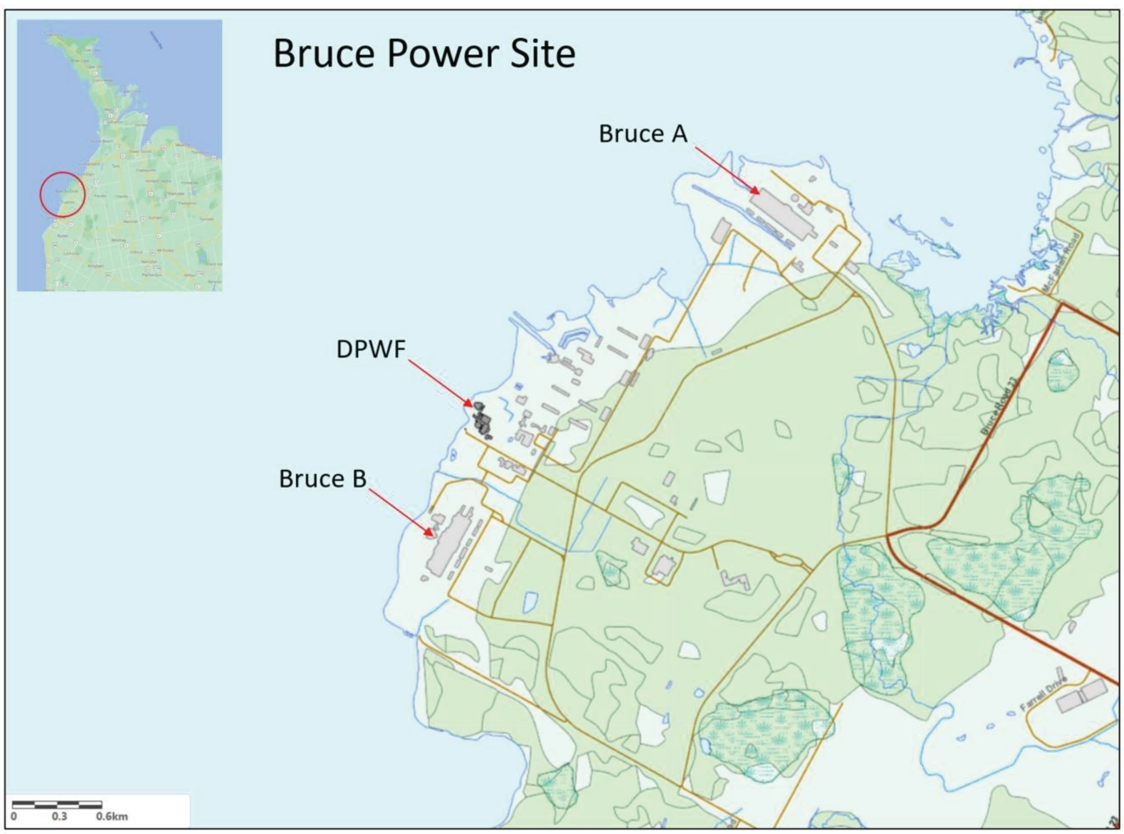


Figure 2-1 Location of the DPWF (CNL 2023a)

After complete shutdown in 1985, the DPNGS (now DPWF) was decided to be decommissioned by following the "Deferred Decommissioning" strategy in the following three phases:

Phase 1 Safe Sustainable Shutdown (1985-1994): This phase of the decommissioning brought the facility to a safe and sustainable, shutdown state, suitable for a period of SWS. This work was completed in 1994 and included the following major activities:

- Defueling of the reactor;
- Removal of heavy water from Heat Transport and Moderator systems;
- Removal of booster rods and their assemblies;
- Identification and removal of hazardous materials;
- Transfer of spent fuel from wet storage in the reactor pool to a dedicated dry-storage facility (i.e. Spent Fuel Canister Area);
- Major and minor decontamination activities (disassembly, decontamination, and consolidation);
- On-site consolidation of radioactive or radioactively contaminated components; and
- Radiological surveys on completion of each decommissioning activity.

Phase 2 Storage with Surveillance (1994-to-date): This is the current phase of the facility and referred to as the SWS phase. To ensure continued safe and secure storage of the DPWF site during SWS, required Items Important to Safety and Items not Important to Safety are retained and kept functional. Items Important to Safety include Spent Fuel Canisters, Reactor Building Containment Structure, and Fire Alarm and Detection System. While Items not Important Safety include Alarms Annunciation System, Heating and Ventilation System, Radiation and Containment Monitoring Equipment, Fire Protection System, Drainage System, and Water and Sewer System.

Phase 3 Final Decommissioning (2021-to-date): This phase is also called Decommissioning & Demolition (i.e., D&D) which started in 2021 after receiving the amended Waste Facility Decommissioning Licence (CNL 2021b) allowing the commencement of active decommissioning. The D&D activities include the final decommissioning activities, implemented in a series of sub-phases that will result in the removal of the equipment and components, buildings and structures, and the return of the land for reuse consistent with its location adjacent to the Bruce site.

At the present time, DPWF is in planning and execution of Phase 3 (i.e., D&D) while maintaining the facility in Phase 2 (i.e., a safe SWS state) in compliance with the obligation for Health, Safety, Security and Environment and regulatory requirements. An aerial photo of the DPWF is provided in Figure 2-2.

Figure 2-2 Aerial Photo of the DPWF

2.2 Location and Relationship to the Bruce Power Site

CNL currently operates the DPWF site, which contains the structures and infrastructure of the DPWF (referred to as the "DPWF site" or simply as the "DPWF"). The Bruce Power (BP) site encompasses Bruce Nuclear Generating Stations (Bruce 'A' and Bruce 'B'), support facilities including Hydro One's Switchyards and Transformer stations, and DPWF. The DPWF occupies a small fraction of the total area of the BP site i.e. 0.59% which is equivalent to 5.5 hectares. The BP site is operated by BP. The BP site also contains other small sites that are owned or operated by other entities, such as Ontario Power Generation's (OPG's) Western Waste Management Facility (WWMF). Figure 2-3, from BP (2022), shows the location of the DPWF site (and other owned/operated sites) within the BP site.

The fact that the DPWF site is located within the BP site is an important consideration for this ERA. First, locations that are beyond the DPWF site (or "offsite" from the DPWF site), for example, monitoring locations, might still be within the boundaries of the BP site. Second, it means that the environmental and land use conditions surrounding the BP site are also applicable to the DPWF site – in other words, the DPWF site and BP site share the same wider surroundings.

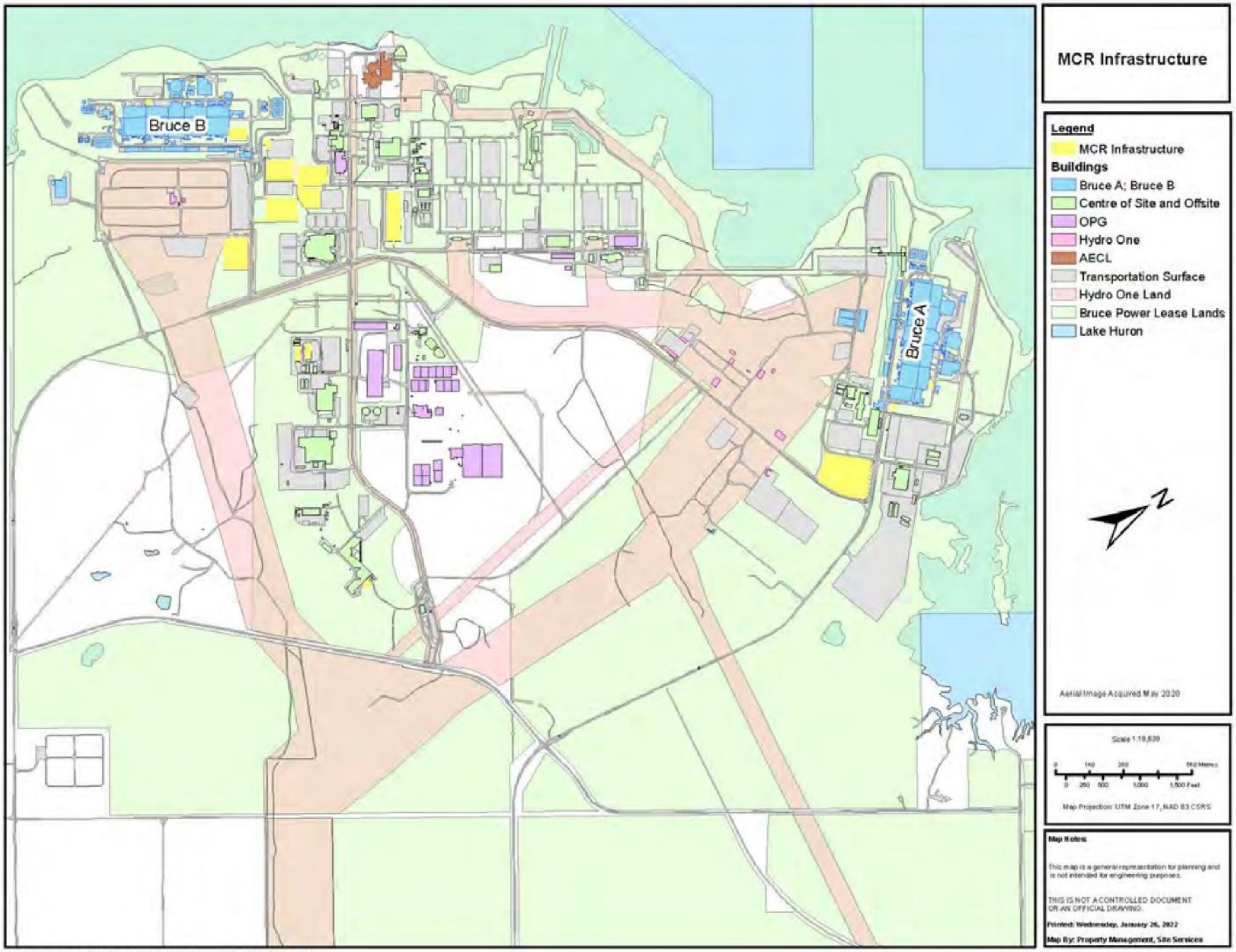


Figure 2-3 DPWF Site (noted at AECL) within the BP Site (BP 2022)

2.3 Engineered Site Features

The DPWF encompasses a number of buildings and structures such as the Reactor Building; Service Building, including the ventilation stack and fuel bays; Purification Building; Turbine Building, including the Administration Wing and the Carpenter's Shop; Spent Fuel Canister Area; and the ancillary facilities, including resin storage tanks and vault and active liquid handling system. Each one of these buildings and structures is designated either as a Nuclear Area or a Non-Nuclear Area (CNL 2019a). On-site buildings and structures are currently in different stages of decommissioning, from SWS to demolition. All buildings, except a new trailer complex, are within the licensing boundary and are hence subject to the Waste Facility Decommissioning Licence (CNSC 2021) requirements. A general layout of the facility is presented in Figure 2-4.

The buildings and structures that are deemed Nuclear Areas are as follows (from CNL 2019b):

- Reactor Building;
- Service Building (includes Ventilation Stack and Fuel Bays);
- Weld Test Shop (inside the Service Building);
- Purification Building;
- Spent Fuel Canister Area (east of the Turbine Building); and,
- Ancillary Facilities (nuclear area): includes the Resin Storage Tanks (underground northeast of the Reactor Building) and the Vault and Active Liquid Handling System (south end inside the Service Building).

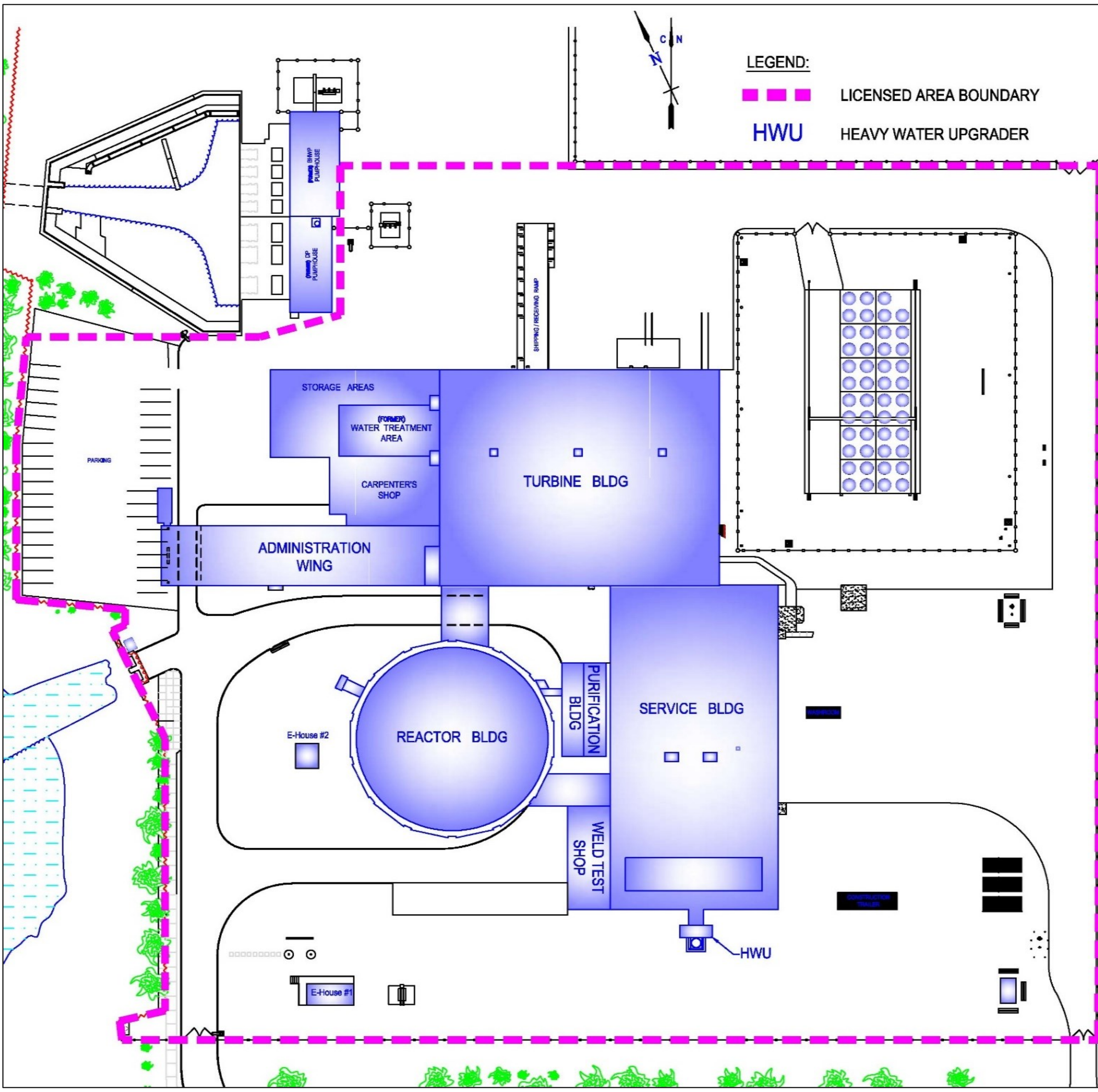


Figure 2-4 Layout of Douglas Point Waste Facility (DPWF) (CNL 2019a)

The following buildings and structures are considered Non-Nuclear Areas (from CNL 2019b):

- Turbine Building;
- Administration Building; and,
- Ancillary facilities (Carpenter's Shop, Water Treatment Area, former Garage, and Diesel Rooms).

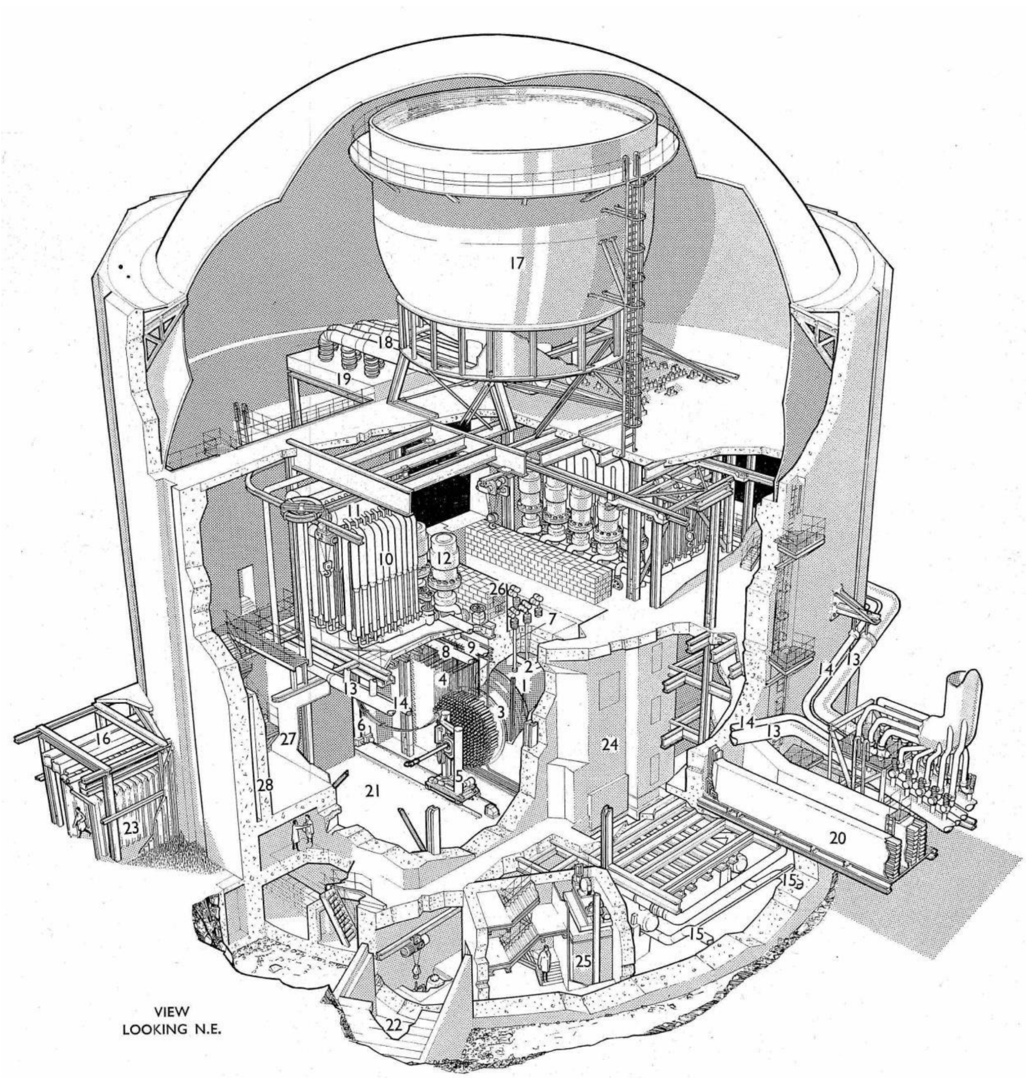
The following subsections provide a brief description of the Nuclear and Non-Nuclear Areas that comprise the DPWF complex.

2.3.1 Reactor Building

The Reactor Building at the DPWF consists of a permanently shutdown, partially decommissioned 200-megawatt prototype CANDU reactor, which operated from 1968 to 1984 under licence from the Atomic Energy Control Board. It was owned by AECL and operated by Ontario Hydro until its permanent shutdown in May 1984 (CNL 2019b).

The Reactor Building is a cylindrical, reinforced-concrete structure with a hemispherical welded steel dome, which provides the enclosure for the reactor and associated systems as shown in Figure 2-5. The reactor was heavy-water moderated, heavy-water (pressurized) cooled, and fuelled with natural uranium. The Reactor Building, which is divided horizontally into six floor levels including the basement, contains the reactor core, heat transport systems, shielding and safety systems, and associated equipment. The reactor core, known as the calandria, contained 306 horizontal fuel containing pressure tubes and was surrounded by the heavy-water moderator. Radioactive waste stored in the Reactor Building includes reactor core components, the primary heat transport and moderator system, the biological shield, irradiated fuel, contaminated soil, and miscellaneous low and intermediate level waste (CNL 2019b).

The Reactor Building provides long-term security for the stored radioactive materials and sufficient shielding of gamma radiation from the stored materials (CNL 2019b).



KEY TO REACTOR BUILDING

1. Calandria
2. Helium line
3. End shield
4. Coolant feeders
5. Fuelling machine
6. Cable cart
7. Booster and absorber rods
8. Hot primary header
9. Cold primary header
10. Boiler
11. Steam drum
12. Primary pumps
13. Steam header
14. Feedwater headers
15. Process water inlets
16. Ventilation ducts
17. Dousing tank
18. Dousing pipes
19. Spray tank
20. Cable trays
21. Fuelling machine vault
22. Spent resin storage
23. Manway
24. Labyrinth
25. Elevator
26. Thermal shield cooling ducts
27. Blow-out panel
28. Pressure wall
29. Dump tank
30. Building ventilation
31. Fuelling machine access duct
32. Dousing water passages
33. Decontamination tank
34. Boiler insulation
35. D_2O storage tank
36. Shield tank
37. Ion chambers

Figure 2-5 Layout of Reactor Building (CNL 2019b)

2.3.2 Service Building (including Ventilation Stack and Fuel Bays)

The Service Building, which is currently unoccupied, is a two-story non-combustible steel frame structure, constructed with perimeter walls of 0.2 to 0.3 m thick concrete blocks, clad on the exterior with corrugated aluminum sheets. The northern section of the building was used to house workshops, offices, washrooms, etc. The former Spent Fuel Storage Bay is located at the south-east corner of the service building and attached to the west wall of the Spent Fuel Storage Bay is the former Fuel Inspection Bay. An underground fuel transfer tunnel, which served as a passage for the spent fuel from the reactor, links the Inspection Bay to the Reactor Building. The Service Building is also used for interim storage of low-level waste resulting from initial decommissioning activities, routine monitoring and surveillance operations, and cleanup activities. The 45-metre-tall Ventilation Stack is located on the south end of the service building (CNL 2019b).

2.3.3 Purification Building

The Purification Building housed the heavy water purification facilities when the DPNGS was in operation (CNL 2019b).

Following the permanent shutdown of the reactor, major components of the heavy water purification system and associated facilities were removed from the building. Resin from the ion exchange column was removed and stored in the spent resin storage tanks (CNL 2019b).

2.3.4 Spent Fuel Canister Area

The spent fuel canister area houses a dry fuel storage facility which holds the inventory of used fuel generated by the DPNGS over its operating lifetime (CNL 2019b).

These storage structures consist of 47 poured-in-place concrete silos, or “canisters,” arranged in four rows. The canisters are cylindrical in shape and each structure accommodates the storage of 9 fuel baskets. Out of the 47 canisters, 46 contain used fuel and the other one was constructed to provide storage contingency (CNL 2019b).

2.3.5 Ancillary Facilities

2.3.5.1 Resin Storage Vault and Tanks

There are two stainless steel resin storage tanks located underground in a specially designed and engineered concrete vault that is connected to the northeast area of the Reactor Building (CNL 2019b).

The two stainless steel tanks are now empty, but previously stored used radionuclide-contaminated ion exchange resin, that was generated during operation of the DPNGS. The resin in the tanks has been retrieved and sent offsite for treatment (CNL 2019b). The resulting volume-reduced waste residue was sent to Chalk River Laboratories (CRL) for storage. Additionally, after resin retrieval, the recovered low-level waste water from resin tanks was sent to CRL Waste Treatment Centre for processing.

2.3.5.2 Active Liquid Handling System

The former Active Liquid Handling System (ALHS) was used to control and dispose of all active liquid wastes at the station. The active liquid handling facilities are located in the south end of the Service Building and include the hold-up tank, evaporator feed tank, and two dispersal tanks (CNL 2019b).

The ALHS ceased to be functional following reactor shutdown and achievement of the Phase 1 decommissioning objectives. Currently, the Hold-up Tank and Dispersal Tanks are empty (CNL 2019b), while the Evaporator Feed Tank continues collecting excess groundwater that may come into the facility, mostly from the Service Building basement and fuel transfer tunnel. Any collected liquid waste will be pumped out and shipped off-site for processing (CNL 2019b). See Section 2.2.8.3 for further discussion on the Evaporator Feed Tank.

2.3.6 Turbine Building (Including Administration Building and Carpenter's Shop)

The Turbine Building originally housed the turbine generator and all associated process systems and switchgear, a control center and the 250-volt DC batteries. Much of the equipment originally present in the Turbine Building has been removed during the safe shutdown activities completed to-date. The Turbine Building is a non-nuclear building and no storage, handling, or use of radioactive materials occurs in the building (CNL 2019b).

Adjacent to west side of the Turbine Building is the Administration Wing or Administration Building. The lower level used to house the Administration Office when the plant was operating. The upper floor of the building has a number of offices, washrooms, and a conference room. In 2017 December, as part of building removal planning activities, facility staff housed in the Administration Building were relocated to a newly installed Modular Trailer Complex located on the south parking lot outside the licensed boundary of the site (CNL 2019b).

A single-story structure attached to the west side of the Turbine Building houses the non-nuclear Ancillary Facilities. This wing is comprised of storage areas or rooms housing former facilities such as flammable liquid storage, the carpenter's shop, oil room, emergency power system (i.e. the diesel generators), garage, air conditioning equipment, process water valve system, rigging and staging area and chlorination and water treatment (demineralization) facilities. Much of the equipment originally present in these areas was removed during the preliminary (Phase 1) decommissioning stage in the early 1990's (CNL 2019b).

Currently, the Turbine Building, Administration Building and Ancillary Facilities are in cold and dark state (i.e., no class IV power and heating). These buildings are currently being prepared for demolition.

2.3.7 Transformer Station

The transformer station was removed in 2021 and new power feed - including new switchgear, transformer, and an electrical house - was installed.

2.3.8 Systems in Operation

2.3.8.1 Reactor Building Ventilation System

The Reactor Building exhaust fans 7314-F3 and 7314-F4 are operated alternately and exhaust the entire Reactor Building. Exhausted air is released to the atmosphere via the 45-metre Main Exhaust Stack located at the south end of the Service Building (CNL 2021a). Each of these fans consists of a pre-filter, high efficiency particulate air (HEPA) filter bank, and exhaust fan assembly, each with a nominal design capacity of 8.26 m^3/s (17,500 cfm) (CNL 2019b), although the current exhaust fan performance is set at 7.33 m^3/s (15,550 cfm). These exhaust fans are run to support SWS activities, hazard reduction campaigns, and activities supporting future decommissioning. They are only shutdown when the Reactor Building will not be occupied for an extended period of time.

There is an existing airlock between the Service Building and Reactor Building dating back to when the reactor was in operation. It is no longer treated as an airlock; it is the main entrance into the Reactor Building and is used to seal the Reactor Building when the ventilation is not operating. When the ventilation system is in operation, the airlock door is opened to allow airflow to draw from the Service Building. When the Reactor Building is not occupied, its entire ventilation system is turned off and the airlock is closed. According to CNL (2019b), in the past the Reactor Building exhausts fan have been run <1100 hours per year but could be run up to anywhere between approximately 1500 and 2300 hours per year depending on work activities. More recently, in 2023, the fans were run for over 5,000 hours.

2.3.8.2 Service Building Ventilation System

As of March 2024, the Service Building has no functioning ventilation exhaust. The F1 and F2 fans have been shut down for many years with no plans to reoperate. There is one supply air fan - which is undergoing refurbishment with plans to use it in the future - however this fan pulls fresh outside air into the Service Building.

2.3.8.3 Other Ventilation Systems

The Administration Building and Turbine Building were equipped with ventilation systems, but these systems have been removed and these buildings have been decommissioned to a cold and dark state. These buildings are no longer occupied.

Many other buildings, structures, or areas on the DPWF are subject to passive ventilation to the atmosphere via louvers, vents, or vent lines (CNL 2021a).

2.3.8.4 Active Drainage Systems

The Active Drainage System, also termed the 'Active Liquid Handling System', is a network of pipes, floor drains, and four tanks (Hold-up Tank 7921-TK1; two Dispersal Tanks 7921-TK2 and –TK3, and Evaporator Feed Tank 7921-TK4) formerly used to collect radioactive liquid waste. Portions of this network are still in place (CNL 2021a). The influence of the DPWF's drainage systems on the site's groundwater flow characteristics is discussed separately in Section 2.4.3.

All floor drains in the Reactor Building drain into what is termed the 'Reactor Building Sump'. The level of this Reactor Building Sump is monitored and, if required, will be manually pumped into containers and transferred to the Evaporator Tank 7921-TK4. All floor drains in the radiological areas of the Service Building are also directed to the Evaporator Tank (CNL 2021a).

Contents of the Emergency Coolant Injection System (ECIS) Building sump, 'Sump 7921-P15', located within the former ECIS Building could be directed to one of the four (4) collection tanks. Following the removal of the ECIS building the sump lines were filled with grout to isolate it from the rest of the system (CNL 2021a).

Under normal operation the DPWF has no processes that generate radioactive liquid wastes (CNL 2021a), however, small quantities of ingress groundwater are captured by the floor drains and sumps, which, as mentioned above, is manually pumped to the tanks as needed. Under the current configuration, the active drainage system cannot transfer liquids from the tanks to the Bruce Power radioactive liquid waste system (CNL 2021a). Presently, Evaporator Tank 7921-TK4 holds any captured groundwater. It is not anticipated that these tanks will fill to capacity as they will be periodically checked and drained as required. The drained liquid effluent would be handled as a non-routine discharge, and an appropriate disposition route would be chosen commensurate with the levels of contamination found (CNL 2021a).

2.3.8.5 Inactive Drainage System

The inactive drainage system is shown schematically in Figure 2-6 (CNL 2021a). Figure 2-7 shows the locations of the sumps and other drainage system components around the Reactor Building and the Service Building. The influence of the DPWF's drainage systems on the site's groundwater flow characteristics is discussed separately in Section 2.4.3.

The Inactive Drainage System directs storm water runoff (rain and melting snow) and ingress groundwater away from buildings and other structures or areas of the DPWF, and ultimately discharges these to Lake Huron. The system encompasses (CNL 2021a):

- Building roof drains;
- Some buildings' indoor floor drains (Administration Building and Turbine Building);
- Building sub-surface drainage systems (Reactor Building and Service Building; intended to prevent groundwater infiltration into these buildings); and,
- Various outdoor catch basin networks and drainage ditches.

There are several final discharge points to Lake Huron as part of this Inactive Drainage System, none of which are easily accessible (CNL 2021a):

- A 'Main Outfall', also known as '24" (0.61 m) Drainage Pipe', which is a 24 m (80') long corrugated steel pipe discharging into Lake Huron on the DPWF's central western side – has multiple upstream inputs including building roof drains, indoor floor drains, and building sub-surface drainage systems;
- A 'Northern 18" (0.46 m) Sub-Surface Drainage Pipe for the West Parking Lot' discharging into Lake Huron on the DPWF's northwestern side – has input from 1 catch basin;
- A 'Southern 18" (0.46 m) Sub-Surface Drainage Pipe for South Roadway' discharging into Lake Huron on the DPWF's southwestern side – has input from 5 catch basins;
- A 'Sub-Surface Drainage Pipe for East Parking Lot' discharging into Lake Huron on the DPWF's southeastern side – has input from 1 catch basin;
- A 'Sub-Surface Drainage Pipe for North Gravel Roadway & Loading Bay Areas' discharging into Lake Huron north of the boundary of the DPWF property and off of the BP property (but with a two catch basin input from the DPWF); and,
- A 'South Roadway Drainage Ditch', part of which is above grade, part below grade, and discharging into Lake Huron at the southern site shoreline via a corrugate steel culvert.

Note that since the DPWF is embedded within an operating reactor site (BP and Hydro One), there is a potential for impact on DPWF drainage system discharges from external operations (e.g., parking lot catch basins could be impacted by operations on neighbouring property) (CNL 2021a).

The D2 Sump, which is located outdoors at the northwest end of the Reactor Building, collects any storm water runoff that could enter the former D_2O Leakage Detection Chamber. This chamber is equipped with an aluminium roof hatch and was formerly used as a monitoring access point to the Reactor Building process water discharge line for the purpose of detecting any leaked heavy water. The Leakage Detection Chamber is monitored for the presence of water within the chamber. No water has been detected in this chamber for several years. Should water accumulate in the chamber, it would be sampled and pumped into specific containers and sent for processing based on activity levels detected (CNL 2021a).

In summary, based on Figure 2-6 , Figure 2-7, and the discussions above, DPWF liquid effluent released through the Main Outfall is comprised of:

- Stormwater collected by several roof drains and catch basins;
- Groundwater collected and diverted from around the Reactor Building and Service Building;
- Water collected by floor drains in the Turbine Building and Administration Building (both buildings are non-contaminated zones (radiological safety contamination zone 1 categorization), and therefore no radiological contaminants are expected in this effluent); and,
- Stormwater that could potentially be collected by the D2 sump (as discussed above, monitoring is conducted and no water has been detected for several years).

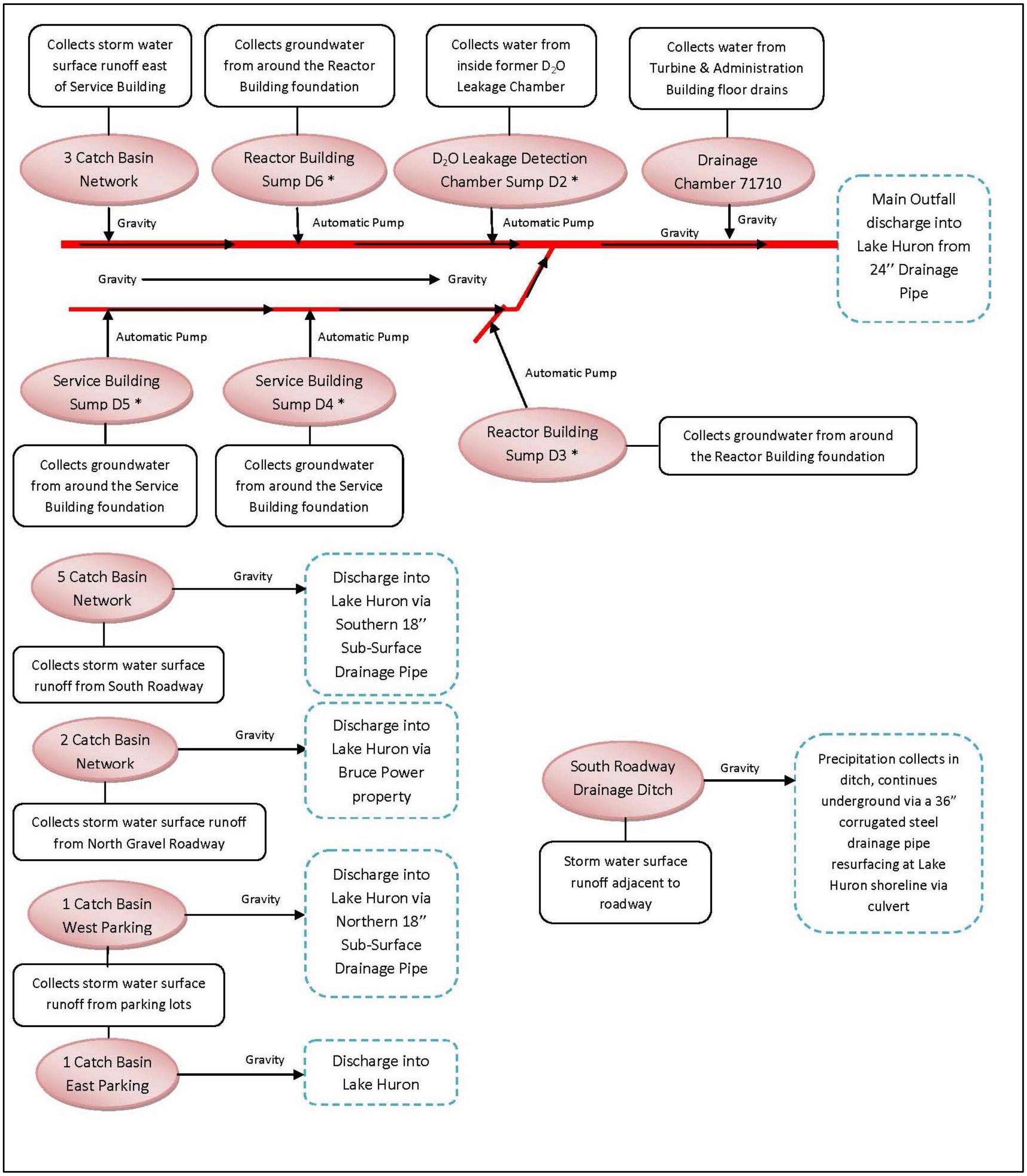


Figure 2-6 Flow Sheet: Inactive Drainage System (CNL 2021a)

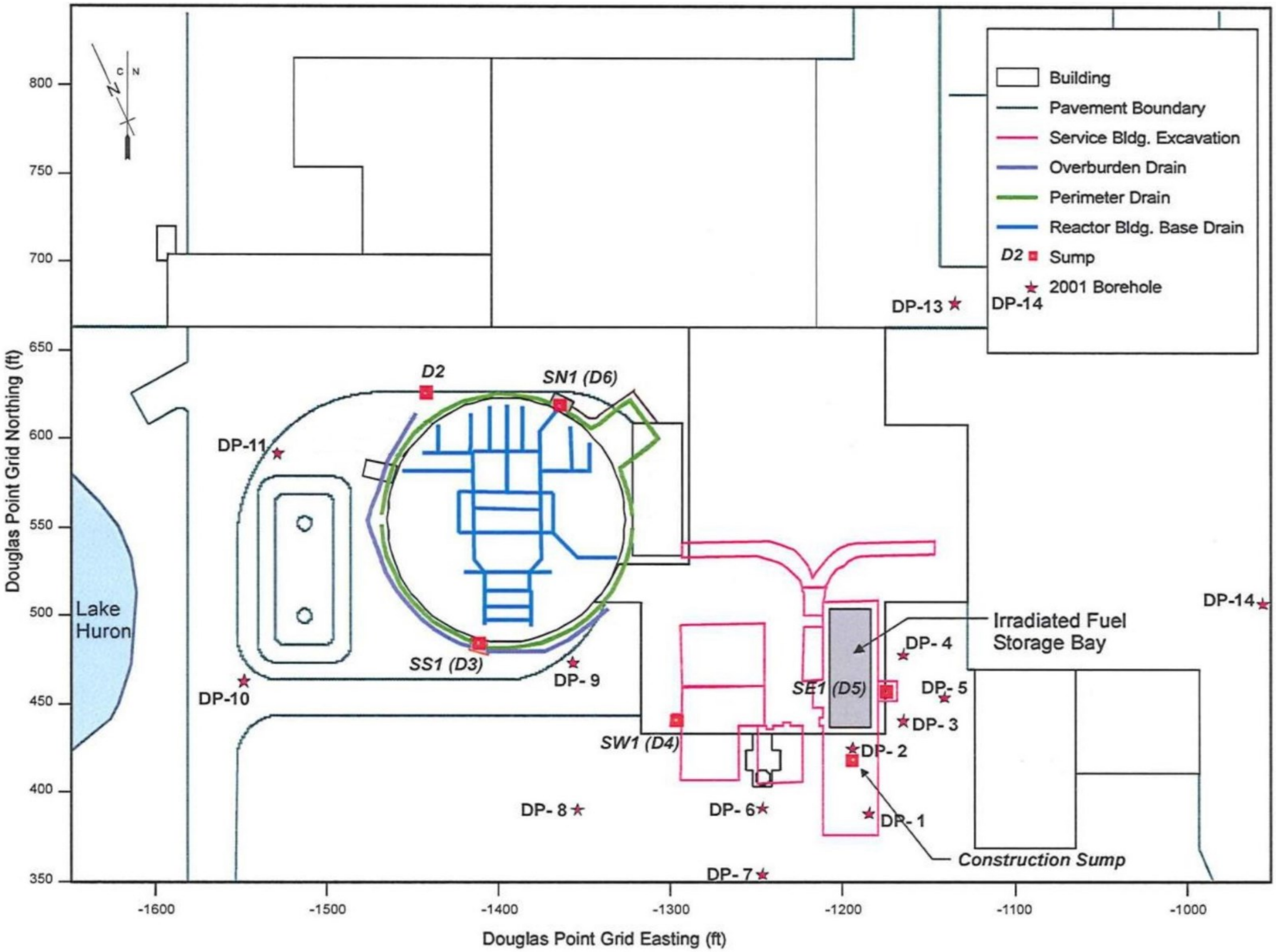


Figure 2-7 Reactor Building & Service Building Sub-Surface Drainage Systems (CNL 2021a)

2.4 Description of Natural and Physical Environment

Since the DPWF site is located within the BP site, characterizations of the natural and physical environment compiled in the BP ERA (BP 2022), for the BP site, also adequately describe conditions surrounding the DPWF site. Thus, the characterization information in the following subsections relies primarily on the BP ERA (BP 2022).

The BP site is located on the east shore of Lake Huron approximately 18 km north of Kincardine and 17 km southwest (SW) of Port Elgin (see Figure 2-8). The site encompasses an area of 932 hectares (2300 acres) within the Municipality of Kincardine, County of Bruce in the Province of Ontario. The BP site encompasses the Bruce Nuclear Generating Stations (Bruce 'A' and Bruce 'B'), support facilities including Hydro One's switchyards and transformer stations, and CNL's DPWF. The entire property is fenced, and access to the BP site (including the DPWF site) is restricted and controlled by BP.

The BP site and its surroundings have features of natural, physical, and cultural significance including the Lake Huron shoreline, Lake Huron commercial, recreational and traditional fisheries, and the Baie du Doré Provincially Significant Wetland. Two provincial parks (Inverhuron and McGregor Point) and two conservative areas (Brucedale and Saugeen Bluffs) are in close proximity to the site.

Land use in the immediate vicinity of the BP site is consistent with rural development throughout the township, consisting primarily of agriculture, recreation and rural residential development. There is a 1.6 km non-residence radius around the development. Beyond this limit, structures include seasonal and permanent year-round dwellings, and agricultural buildings. The immediate land surrounding the BP site also includes former gravel pits, fragmented woodlands, streams, and wetlands. Recreational land use includes Inverhuron Park and cottages in the hamlet of Inverhuron (south of the BP site) and Baie du Doré/Scott Point area (north of the BP site). The towns of Kincardine, Port Elgin, Southampton, and Walkerton are the largest communities in the area.

The protection of Species at Risk (SAR) is based on applicable acts, *Species at Risk Act* (*SARA*) or the *Endangered Species Act* (*ESA*). The applicable acts differ between the BP and DPWF sites; the BP site is located on provincially owned lands, hence the provincial ESA is applicable, whereas the DPWF is located on federally owned lands, hence the federal SARA is applicable.

The site descriptions included in the following sections are for the Bruce Nuclear Facility, which encompasses the DPWF.

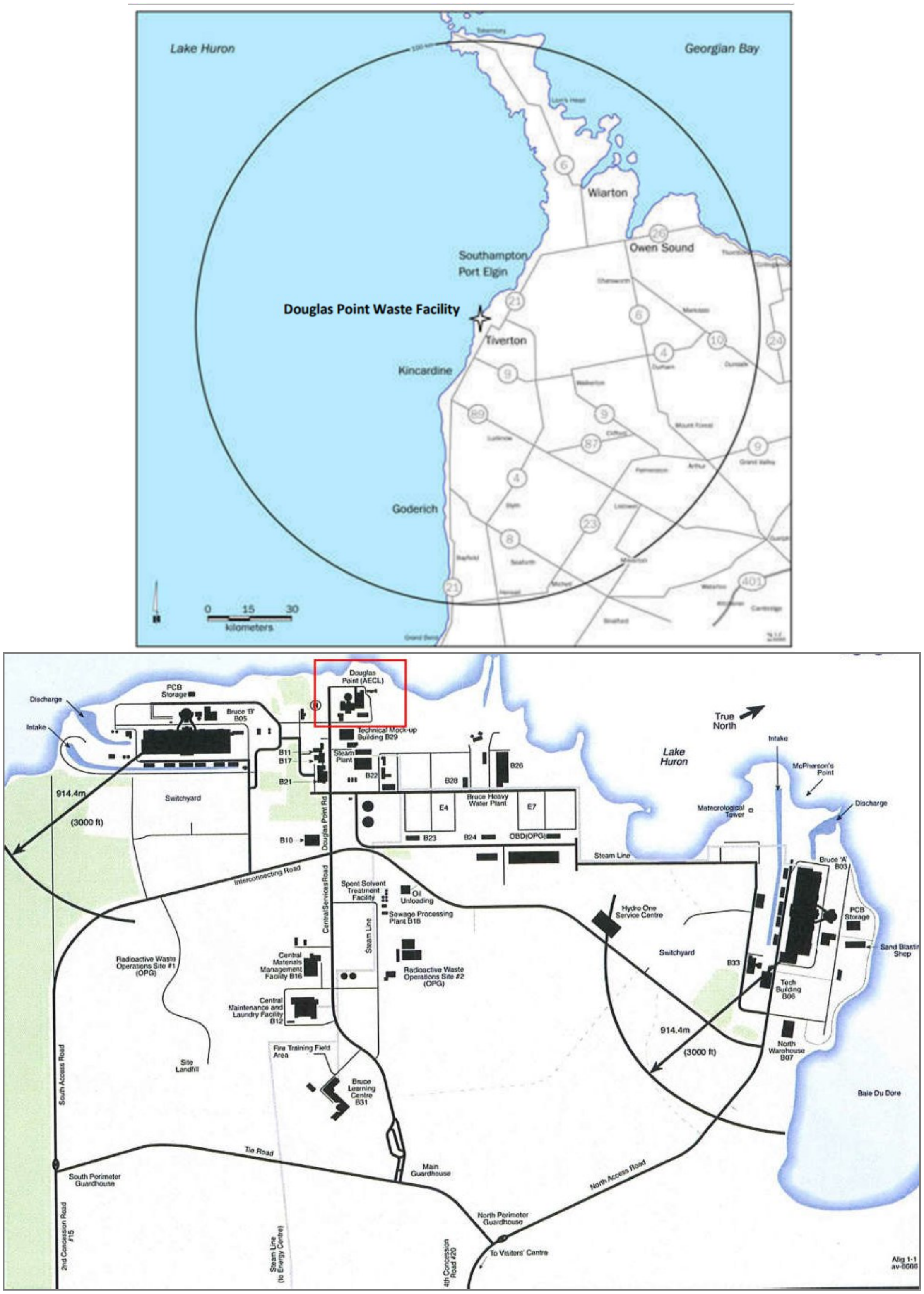


Figure 2-8 Location of DPWF site within the BP Site (CNL 2019a)

2.4.1 Meteorology

Since the DPWF site is located within the BP site, meteorological data compiled in the BP ERA (BP 2022), for the BP site, also adequately describe conditions at the DPWF site. The following descriptions of meteorology are taken from the BP ERA (BP 2022).

2.4.1.1 Wind

Wind data for the BP site are obtained from two meteorological towers (50 m on-site tower and 10 m off-site tower on Part Lot 1, Concession 5, and Bruce Township) installed in 1990. The towers have been situated to ensure that meteorological measurements are representative of atmospheric conditions relevant to emissions conveyed inland. The on-site tower measures wind speed and direction at 10 m and 50 m elevation. The off-site tower measures wind speed and direction at 10 m elevation (BP 2022).

Since 2017, there have been recurring technical issues regarding on-site meteorological data recording (BP 2022). Therefore, the five-year dataset from 2011-2016 (excluding 2014) were used in the BP ERA (BP 2022) to represent the wind conditions for the Bruce Power site for both the average and upper-range exposure assessments. Data from 2014 and 2017 to 2019 cannot be used due to the technical issues. The 2011-2016 meteorological data was processed in triple joint frequency format that contains the annual frequency of specific wind conditions based on wind speed, direction and Pasquill stability. The predominant wind directions measured over the 2011 to 2016 (excluding 2014) period were from the SW, south-southwest (SSW), south, and south-southeast (SSE) (BP 2022).

Figure 2-9 presents the wind rose for the site (BP 2022).

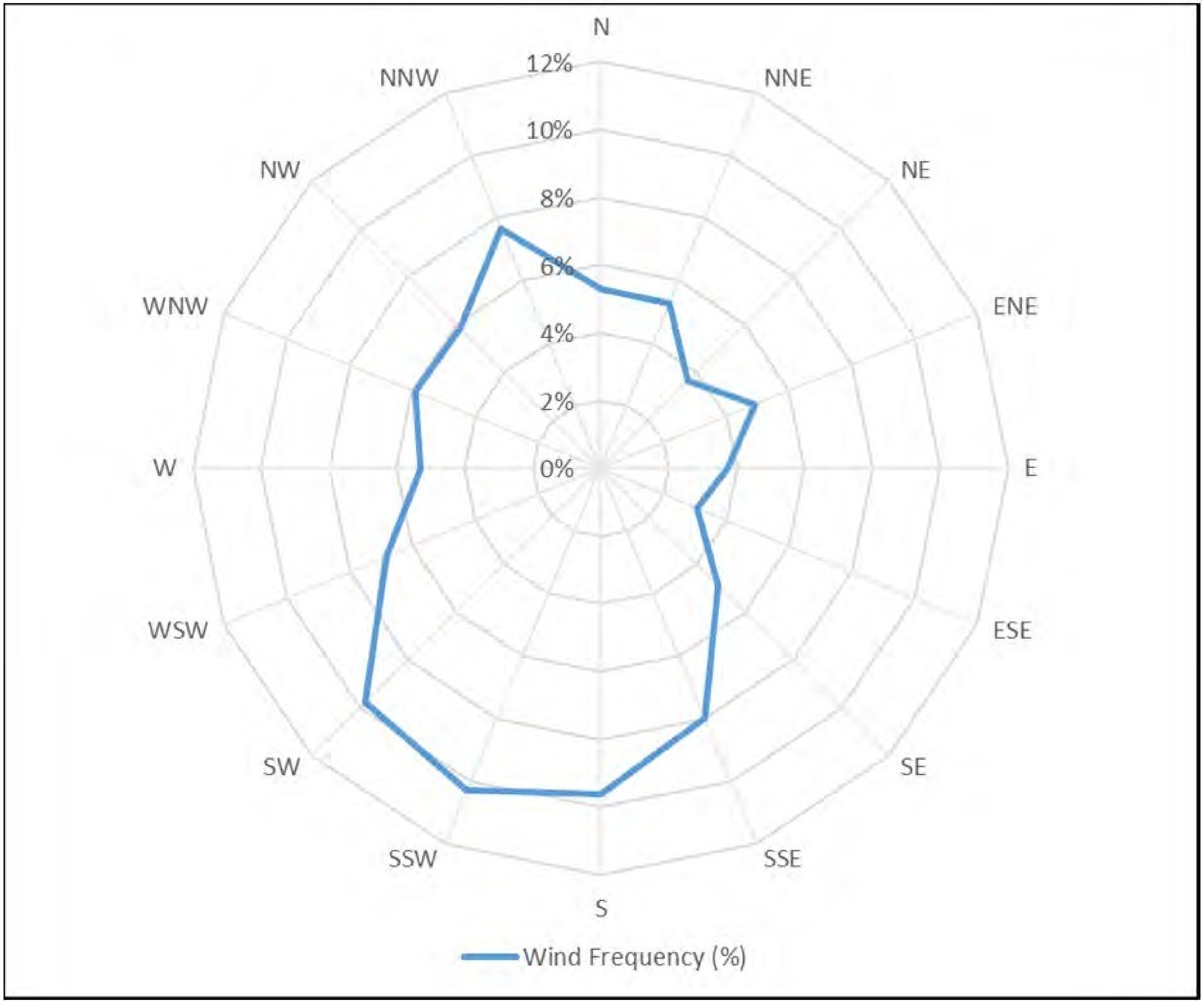


Figure 2-9 Wind Rose (BP 2022)

It is acknowledged that newer wind data became available after completion of the BP ERA (BP 2022). This new wind data was documented in BP's *2022 Environmental Protection Report* (released in 2023) and BP's 2023 Environmental Protection Report (released in 2024) (BP 2023; BP 2024). The following discussion compares the new wind data to the data from the BP ERA (BP 2022).

Based on data from 2011 to 2016 (excluding 2014) – that which was used in the BP ERA (BP 2022) - the wind rose shows the main directions the wind blows from are: SSW, SW, south (S), SSE, and north-northwest (NNW).

The double-joint frequencies outlined in Table 71 of BP (2023) indicate that the most frequent wind directions are winds blowing from: SSW [11.55%], S [9.52%], SW [7.57%], SSE [7.26%], and NNW [7.25%].

The double-joint frequencies outlined in Table 71 of BP (2024) indicate that the most frequent wind directions are winds blowing from: SSW [10.43%], NNW [8.01%], north (N) [7.21%], SW [6.99%], and S [6.87%].

At a high-level, wind direction information from all three of these supporting documents (BP 2022; 2023; 2024) consistently indicate SSW as the main direction that wind blows from.

2.4.1.2 Temperature

Air temperature data is collected from the on-site meteorological tower at 10 m elevation. The hourly average monthly temperature, including maximum and minimum values averaged over the ten-year period between 2007 to 2016, are shown in Table 2-1 (BP 2022).

Table 2-1 Air Temperature Data from BP On-site Meteorological Tower (2007–2016) (BP 2022)

Month	Hourly Temperature Max. (°C)	Hourly Temperature Min. (°C)	Monthly Temperature Mean. (°C)
January	17.3	-20.3	-4.0
February	10.9	-26.7	-5.0
March	25.1	-18.6	0.7
April	28.4	-7.7	5.9
May	31.1	-0.3	12.5
June	31.0	3.1	16.6
July	34.1	8.3	20.4
August	31.2	8.9	20.2
September	31.9	3.2	17.0
October	27.1	-1.7	10.4
November	20.8	-11	5.6
December	16.1	-14.3	-0.9
Year	34.1	-26.7	8.3

Since there is a gap in temperature data for 2017-2020, consideration has been given to utilizing air temperature data collected by Environment Canada at weather stations within the vicinity of the Site. The hourly temperature maximum, minimum and monthly temperature mean for the weather stations at Wiarton and Kincardine between 2016 and 2020 are shown in Table 2-2. It should be noted that the Kincardine and Wiarton stations may not closely represent the near-shore temperature conditions of the Bruce Power site (BP 2022).

Compared to the 2007-2016 on-site data presented in Table 2-1, the total daily temperature maximum, minimum and total monthly temperature mean recorded for Kincardine and Wiarton is not significantly different. Differences between the on-site meteorological tower (Table 2-1) and Environmental Canada stations (Table 2-2) range from ±0.1°C (i.e., on-site hourly temperature maximum for the year of 34.1°C compared to Kincardine daily temperature maximum for the year of 34.0°C) to ±4.2°C (i.e., on-site hourly temperature minimum for the year of -26.7°C compared to Kincardine daily temperature minimum for the year of -22.5°C) (BP 2022).

Table 2-2 Air Temperature for Kincardine and Wiarton, Environment Canada Stations (2016-2020) (BP 2022)

Month	Kincardine			Wiarton		
	Daily Temperature Max. (°C)	Daily Temperature Min. (°C)	Monthly Temperature Max. (°C)	Daily Temperature Max. (°C)	Daily Temperature Min. (°C)	Monthly Temperature Max. (°C)
January	11.5	-17.5	-3.8	16.1	-26.5	-5.0
February	17.0	-22.5	-1.6	14.4	-26.6	-4.2
March	17.5	-14.5	0.6	16.6	-26.2	-1.4
April	23.0	-10.0	5.2	27.2	-14.0	3.6
May	33.0	-3.0	11.4	30.8	-5.0	10.9
June	33.0	4.0	17.6	31.7	2.4	15.8
July	34.0	8.5	21.7	34.2	7.2	19.9
August	33.0	10.0	21.4	32.6	4.8	19.0
September	32.5	2.0	18.2	30.7	-0.1	15.5
October	26.5	-1.0	11.1	27.0	-6.0	9.4
November	20.5	-11.0	4.1	23.6	-13.1	2.9
December	13.0	-15.0	-1.2	13.1	-26.9	-2.4
Year	34.0	-22.5	8.7	34.2	-26.9	7.0

2.4.1.3 Precipitation

As the meteorological stations at the BP site do not record precipitation, data available for Wiarton (approximately 55 km northeast of the site) were used. Precipitation data are collected by Environment Canada at weather stations within the vicinity of the site. The maximum precipitation of 1390.4 mm was in 2013 (BP 2022). Total annual precipitation data for the weather station at Wiarton over the ten-year period between 2010 to 2020 are shown in Table 2-3 (BP 2022).

Table 2-3 Precipitation Data for Wiarton Environment Canada Station (2010 – 2020) (BP 2022)

Year	Total Rainfall (mm)	Total Snowfall (mm)	Total Precipitation (mm)
2010	705.3	242.6	912.3
2011	1029.9	313.4	1281.9
2012	755.8	286.9	985.8
2013	954.0	500.0	1390.4
2014	818.3	359.8	1135.0
2015	705.4	272.9	961.0
2016	669.6	476.9	1099.0
2017	917.7	376.8	1240.2
2018	507.0	401.8	882.3
2019	823.6	405.7	1192.3
2020	864.8	291.1	1206.2

Note: At Environment Canada weather stations total rainfall is measured using a variety of different gauges but is typically reported as millimeters of liquid. Total snowfall is typically measured using either an acoustic sensor or a snow ruler and is reported as the snow amount (or 'depth') of accumulated snow-on-ground, in centimeters or millimeters (ECCC 2023).

2.4.1.4 Climate Change Impacts

CNL's updated Safety Analysis Report for the DPWF will address environmental impacts on the facility, including those driven by climate change. The updated SAR is anticipated to be completed by mid-2025.

2.4.2 Geology

2.4.2.1 Site Overburden Geology

The overburden geology of the BP site comprises variable thicknesses of sand and gravel (0 to 10 m) overlying a silt till sequence which has been divided into a "weathered till unit" and an underlying "un-weathered till unit". Near the Lake Huron shoreline, there is less than 3 m of overburden in the vicinity of the Bruce B generating station, former Bruce Heavy Water Plant, and parts of the Bruce A generating station prior to their construction (Golder 2008). These areas were graded with engineered fill to enable construction.

The generalized overburden stratigraphic sequence may be presented as follows:

- Surficial Sand and Gravel Unit;
- Upper Weathered Silt Till Unit;
- Upper Unweathered Silt Till Unit;
- Middle Sand / Layered Till Unit (vicinity of Western Waste Management Facility); and
- Lower Unweathered Silt Till Unit.

In the offshore areas along the Lake Huron shoreline, wave scouring has removed much of the overburden and left a residual lag of boulders (Golder 2008).

2.4.2.2 Site Bedrock Geology

The bedrock underlying the surficial deposits at the BP site consists of Middle Devonian age, buff dolostone interbedded with dark grey bituminous limestone of the Amherstburg Formation (Golder 2008). The bedrock surface under the BP site dips northeastward at approximately one percent, which likely reflects the influence of glacial erosion of the bedrock surface. By comparison, the bedding structure of the bedrock sequence (Amherstburg – Bois Blanc Formation contact) beneath the BP site dips gently westward to southwestward at approximately one percent, based on structural contours (Golder 2008).

The geology at the Douglas Point site consists of less than 1.5 m of unconsolidated sediment overlying bedrock. All of the unconsolidated material encountered during field investigations consisted of fill, generally a mix of sand and gravel, with, in grassed areas, a thin overlay of topsoil (CNL 2021c).

The bedrock stratigraphy encountered in the field study closely matches the sequence delineated in logs of pre-construction boreholes. Lithology was dominated by bedded dolomite with shaly interbeds containing calcite, a number of which can be traced from one borehole to the next. The fracture density in the bedrock suggests that the bedrock can be viewed as an equivalent porous medium (CNL 2021c).

2.4.3 Hydrogeology and Groundwater Flow

Interpreted groundwater flow across the BP site is shown in Figure 2-10 and Figure 2-11 for overburden and shallow bedrock, respectively.

Where unaffected by human activities, groundwater flow is from the east-southeast towards Lake Huron (CNL 2021c). However, this system is locally interrupted by the foundation drainage systems of Bruce A, Bruce B, and the DPWF (CNL 2019a; BP 2022). The drainage systems at the DPWF ensure that groundwater close to the Reactor Building and Service Building is directed to installed sumps (CNL 2019a). AECL (2003) mentions that the pumped sumps, and the drainage structures connected to them, are the dominant features in the local groundwater flow system (near the DPWF). The sumps and drains are positioned at elevations as low as 560.0’ (170.7 m), or about 17.5’ (5.3 m) below the nominal elevation of Lake Huron. These sumps and drains have, therefore, become the low point for all shallow groundwater flow in the study area (near the DPWF). They collect groundwater flow that is travelling from east to west in accordance with local topography, but they also induce flow from Lake Huron towards the DPWF (AECL 2003).

Grout curtains installed during construction of the facility may also continue to influence groundwater flow. Although some degradation of the grout may have occurred, the grout curtains may still restrict groundwater flow in upper bedrock (CNL 2021c) near the Reactor Building.

Figure 2-12 shows groundwater elevations and interpreted local shallow groundwater flow at DPWF, accounting for the sumps and drainage features (CNL 2023a).

CNL’s *Environmental Effects Review* report (CNL 2020) examined the planned Phase 3 decommissioning activities and determined that none of the activities have interactions with the site’s hydrology or hydrogeology. Building foundations and service lines are above the water table and therefore, excavation activities for removal of underground services and building foundations will not impact groundwater. Therefore, no impacts are anticipated on these aspects. Details are available in CNL (2020).

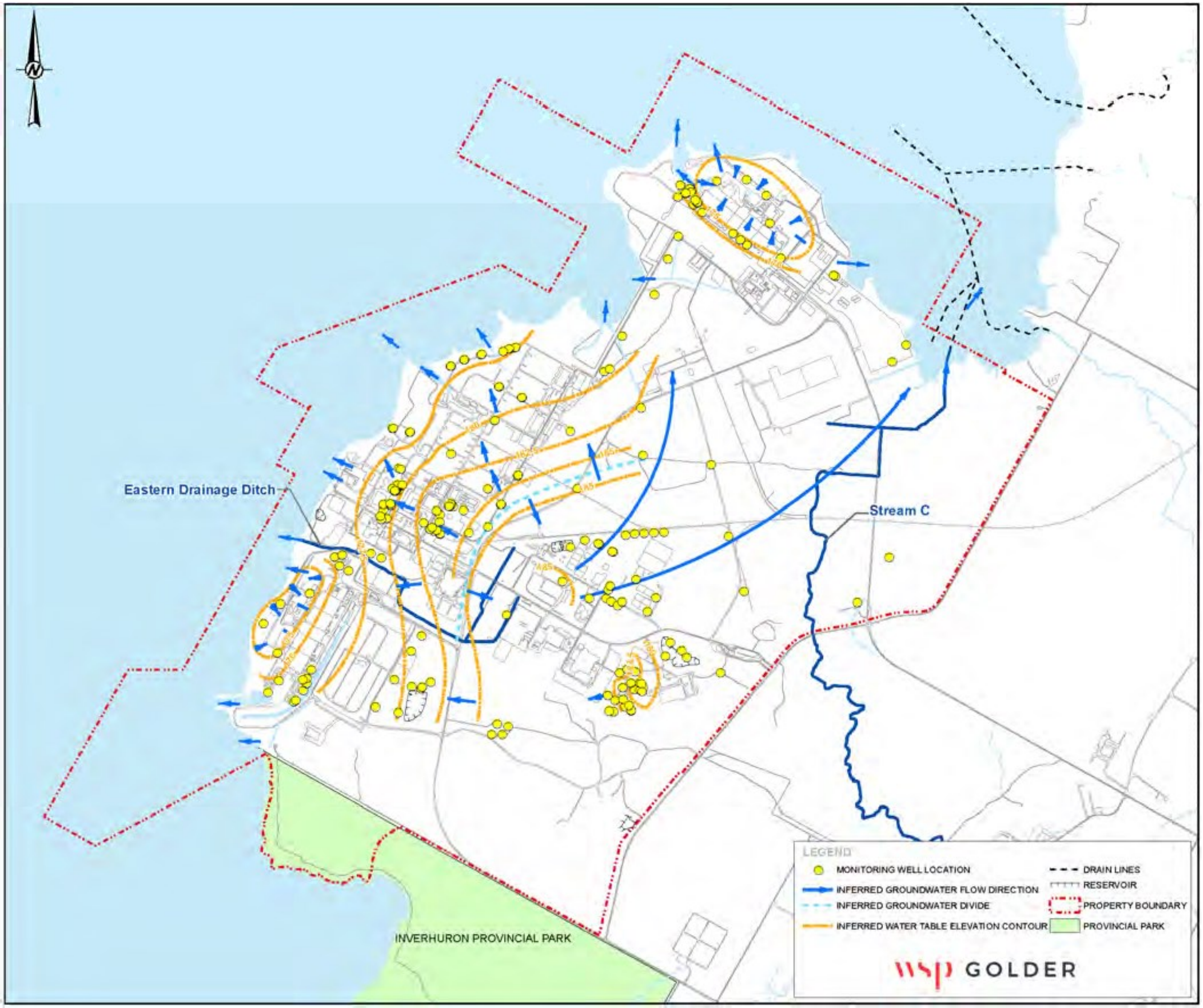


Figure 2-10 Groundwater Flow Direction for Overburden (BP 2022)

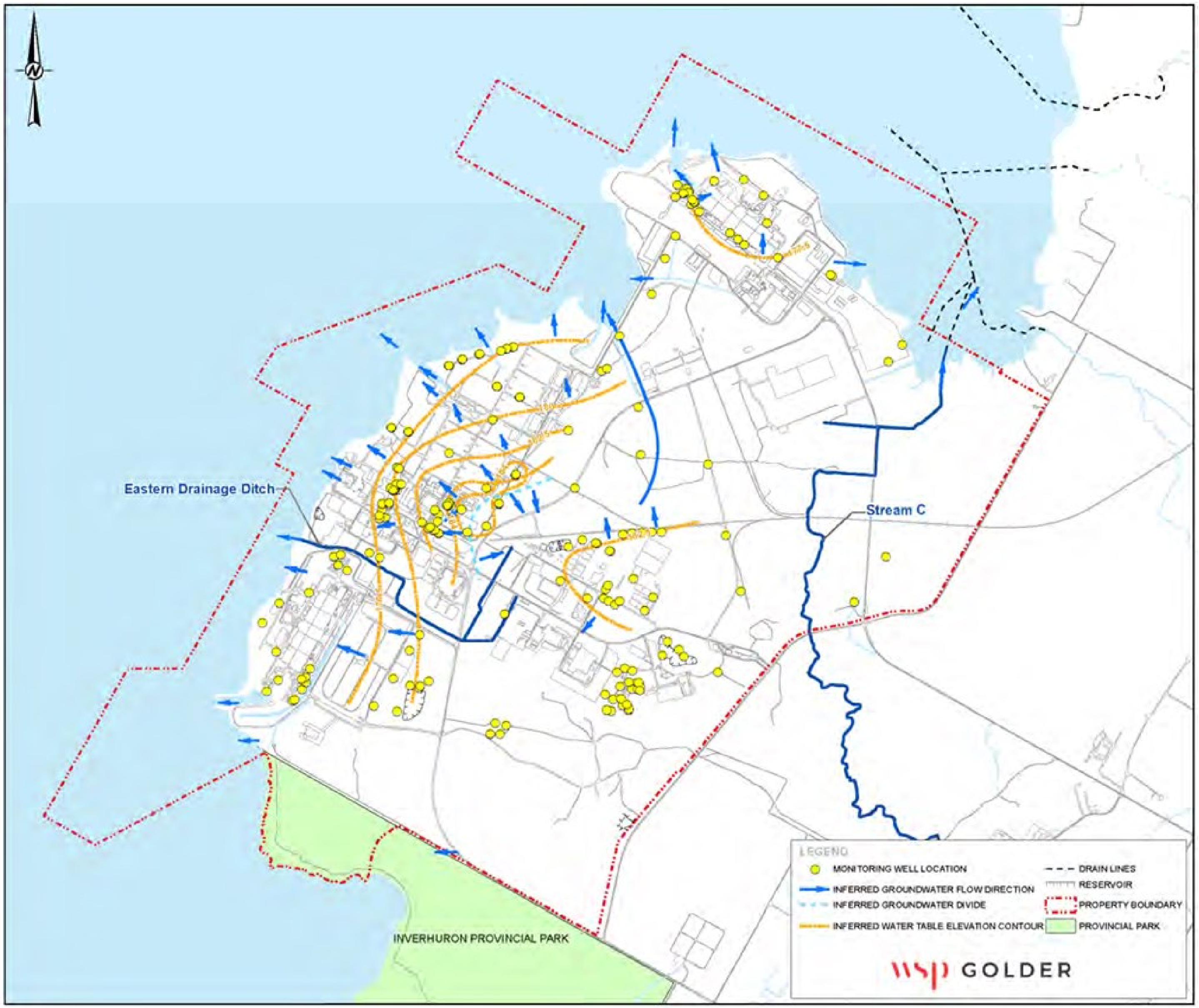


Figure 2-11 Groundwater Flow Direction for Shallow Bedrock (BP 2022)

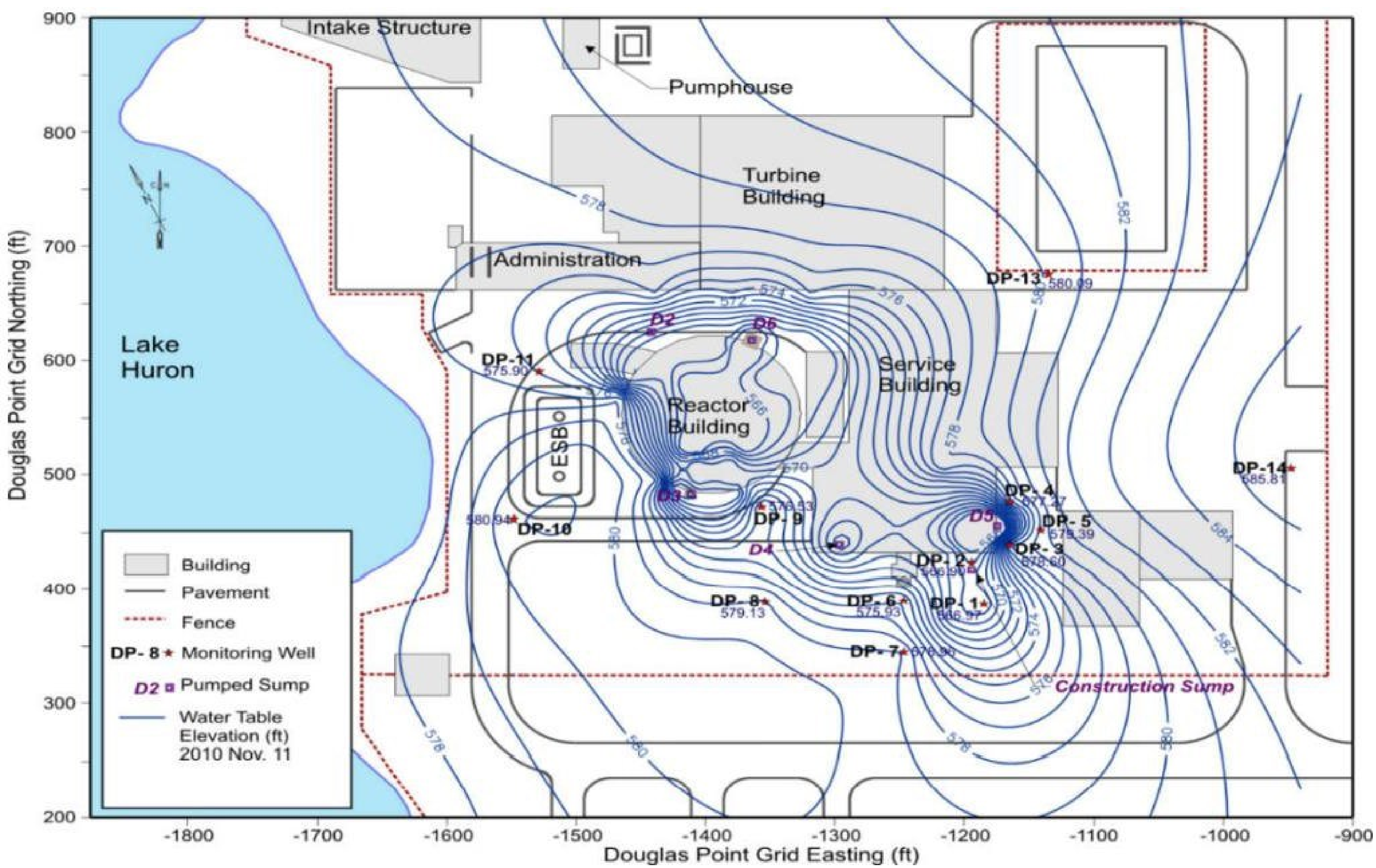


Figure 2-12 Local Shallow Groundwater Flow at the DPWF (CNL 2023a)

2.4.4 Plant Community

An ecological land classification (ELC) for the BP site (which encompasses the DPWF site) is documented in BP (2022). The resulting ELC classification is shown on Figure 2-13. Vegetation communities mapped in the area surrounding the BP site are shown in Figure 2-14.

As mentioned in BP (2022), the ELC system in current use in southern Ontario was developed to classify "more natural, less anthropogenic communities found in southern Ontario." As such, the ELC system provides inadequate treatment for culturally-affected areas and plant communities, with an acknowledgement that it is a working document and that additional unit descriptors will be needed. This difficulty also applies to the ELC classification of much of the vegetation of the Bruce Power Site (encompassing the DPWF), where the vegetation has a long-standing history of human use and anthropogenic modification, including logging, farming and recreational usage, as well as the present industrial use. Therefore, several "non-standard" ecological site-types are used to more appropriately characterize the site. These included the following (BP 2022):

- "Cultural Barren" for lands that have been cleared of vegetation but are presently idle and being recolonized by plants and those that have been cleared and graded, sometimes with imported fill, but are presently being recolonized by naturally-occurring vascular plants;
- "Cultural Grassland" that include lawns and manicured greenswards, sometimes complexed with "Cultural Woodland" where an extensive planting of shade trees or treed hedgerows has occurred;
- "Industrial Barren" where lands have been cleared of vegetation, graded, sometimes with imported fill, and often surfaced with fine or coarse gravel, for occasional or periodic industrial use, but are being sparsely recolonized by naturally-occurring plants; and,
- "Industrial Land" for lands that are presently occupied by buildings, storage compounds, parking lots and other intensive uses that severely limit plant colonization.

The ELC was conducted in stages, in 2007, 2009, and 2016, followed by additional botanical surveys in 2017 (BP 2022). In 2016-2017, a total of 72 separate ELC communities were identified within the study area. In 2007, a total of 195 plant communities were identified within the study area. These represent a total of 15 broad categories of plant communities that were identified within the BP site, including: agriculture, alvar, beach, cultural barren, cultural grassland, cultural meadow, cultural thicket, cultural woodland, forest, industrial barren, industrial lands (active use), marsh, open water, submergent aquatics and swamp (BP 2022).

Cultural communities occupy the largest proportion of the BP Site, and industrial lands occupy the largest area of that category. Generally, with the exception of the small patch of shrub-dominated alvar, the plant communities present within the BP site are not outstanding examples of their community types in this part of the province. The alvar community occurs in the portion of Inverhuron Provincial Park that lies within the BP exclusion zone of the site, and consists of creeping juniper (*Juniperus horizontals*), shrubby St. Johns-wort (*Hypericum kalmianun*), and shrubby cinquefoil (*Potentila fruticose*). Beach communities are present along the site's shoreline. Eastern white cedar (*Thuja occidentalis*) is the most common tree species, with balsam poplar (*Populus balsamifera*) and trembling aspen (*Populus tremuloides*) scattered through some patches. Unlike the alvar community, which has a unique occurrence, the beach communities occur along the length of Lake Huron shore in the wider area around the BP site (BP 2022).

A total of 437 species of vascular plants have been recorded within and surrounding the BP site to date. One hundred species or 24% of the total flora are identified as introduced or non-native to Ontario.

Ninety-seven (97) locally significant plant species were identified by BP during field investigations in 2016 -2017. Forty of these species are considered introduced to Ontario and have been identified as rare or uncommon. Many of the rare and uncommon species are found within the wetland swamp and fen communities (BP 2022). One SAR, Butternut (*Juglans cinerea*), was observed. This species is listed as Endangered under the *Ontario Species at Risk Act*, 2007 and the *Federal Species at Risk Act*, 2002. Butternut trees are in decline due to a fungal infection known as Butternut Canker which girdles the tree and eventually causes it to die. Occurrences of Butternut were found to occur outside of the fence (off site). Currently in Ontario, habitat for this species is considered to be a 50 m radius surrounding the tree.

*It is important to note that CNL's DPWF site is within the BP site (i.e.,*0.59% of the BP site footprint)*, and does not contain any significant amount of vegetation. Vegetation on the DPWF site is limited to an area of manicured lawn (see Figure 2-2). Vegetation communities and species that the ELC identified as being important (such as Butternut) are not present on the DPWF site .*

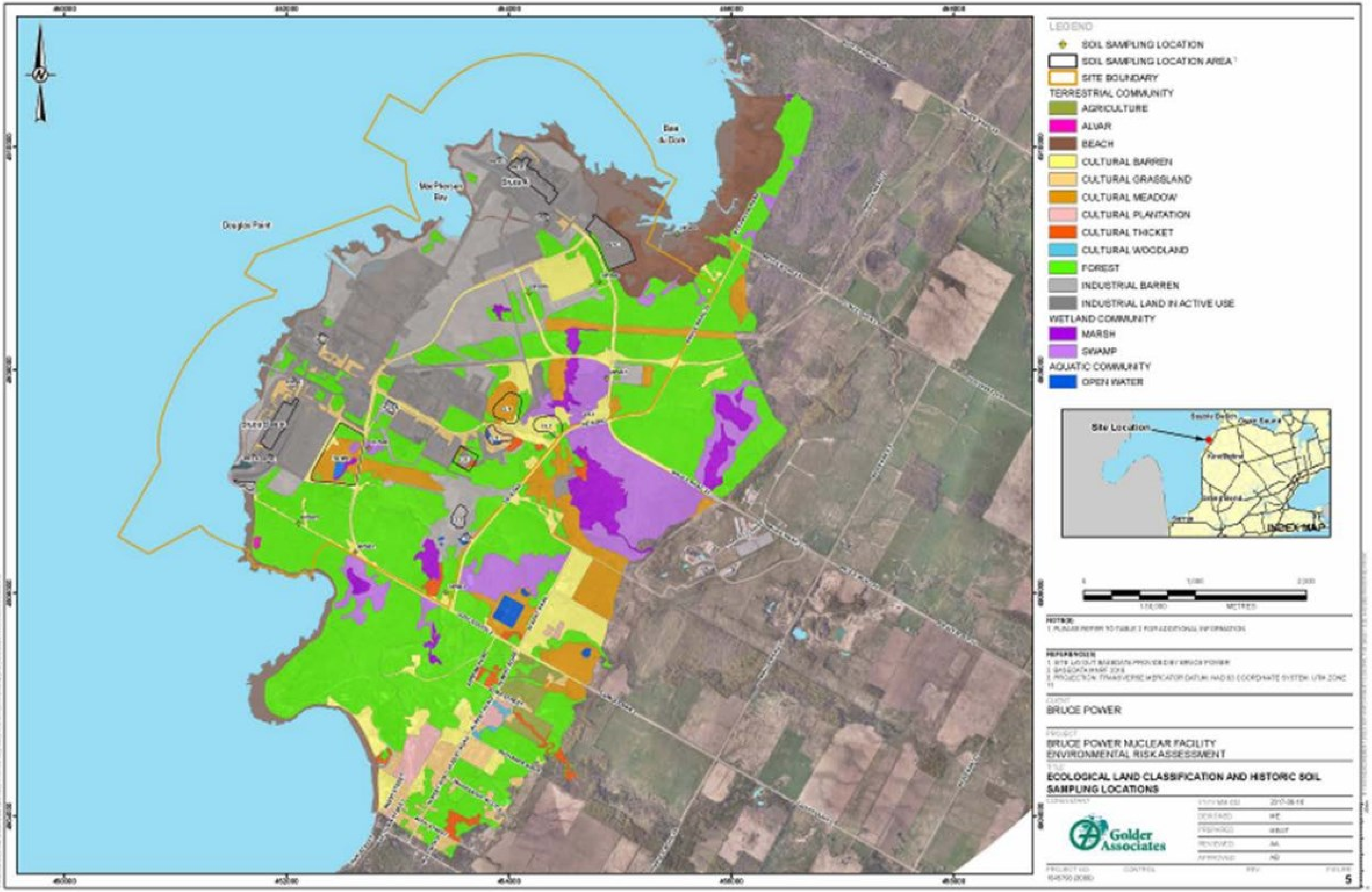


Figure 2-13 Ecological Land Classification (BP 2022)

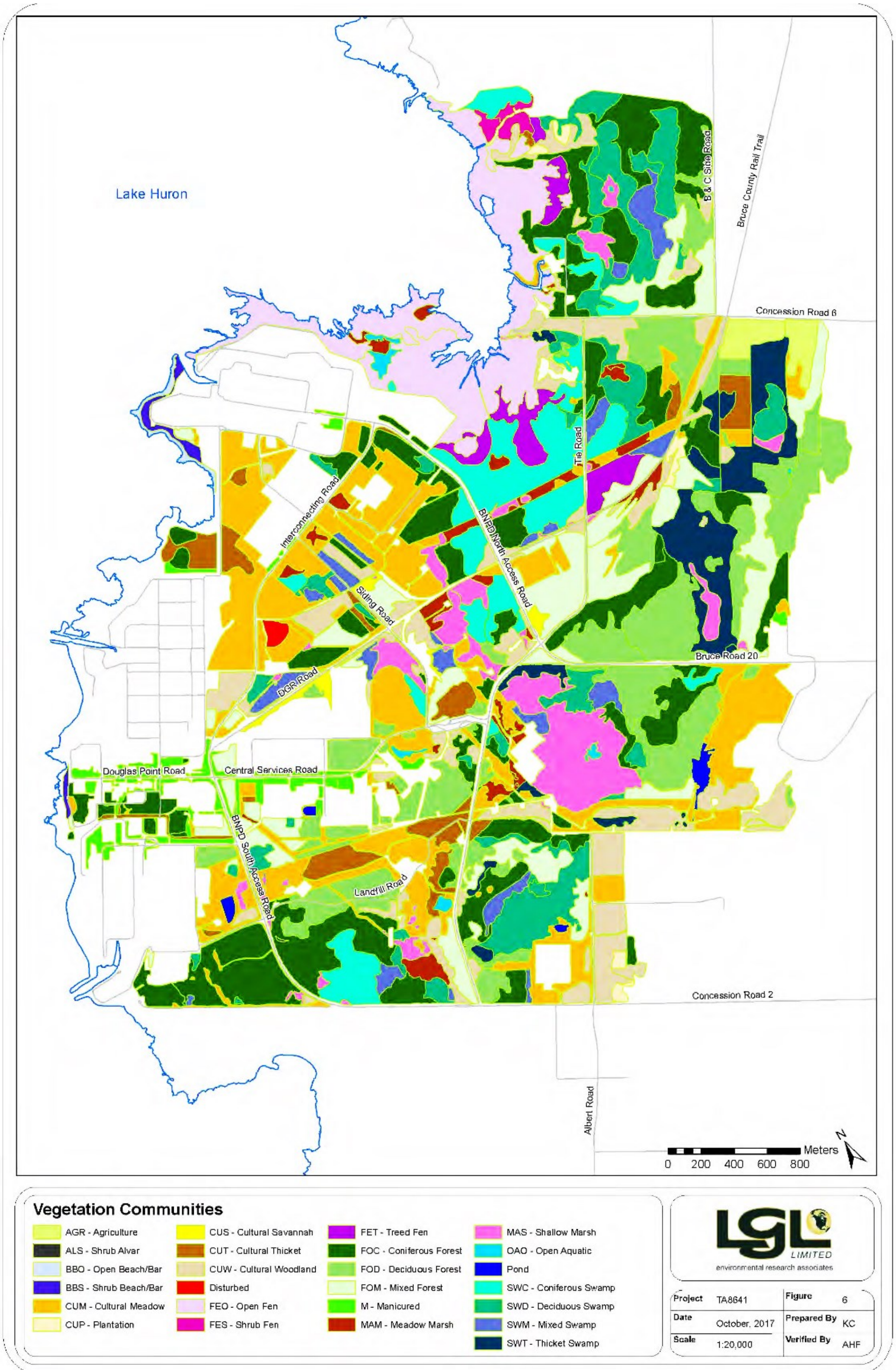


Figure 2-14 Vegetation Communities on the Bruce Nuclear Site (BP 2022)

2.4.5 Wildlife Community

Most of the wildlife habitat on the BP site occurs around the periphery of the site, in Inverhuron Provincial Park, in the Baié du Doré Wetland Complex, and in the conifer forest communities near or along the perimeter fence. These areas also provide access to a variety of different habitat types, such as the lake shore, dug ponds and the local watercourses, providing a range of foraging opportunities for locally resident wildlife, while acting as 'core' natural habitat within which disturbance is absent or infrequent (BP 2022).

*It is important to note that CNL's DPWF site is within the BP site (i.e.,*0.59% of the BP site footprint)*, and does not contain any significant amount of vegetation or habitat to support wildlife.*

2.4.5.1 Reptiles and Amphibians

Reptiles

BP observed five different snake species on the BP site from 2017 to 2020 (BP 2022): Eastern Garter Snake (*Thamnophis sirtalis*), Dekay's Brown Snake (*Storeria dekayi*), Red-bellied Snake (*Storeira ociptiomarulat*), Smooth Green Snake (*Opheodys vernalis*), and Eastern Ribbonsnake (*Thamnophis sauritus*). The Eastern Ribbonsnake is a listed SAR in Ontario and Canada with a conservation status of Special Concern. Snake species recorded on the BP site from year to year were generally consistent, with the Smooth Green Snake being first observed in 2020 (BP 2022). BP also noted incidental observations of Snapping Turtle (*Chelydra serpentina*) and Midland Painted Turtle (*Chrysemys picta marginata*) from 2017 to 2020. BP's monitoring also noted the presence of Painted Turtle in Baie du Doré in 2019 and 2020 (BP 2022).

Amphibians

BP noted an incidental observation of a Spotted Salamander (*Ambystoma maculatum*) and a Red-Spotted Newt (*Notophthalmus viridescens*) in 2019 and another observation of the Spotted Salamander in 2020 (BP 2022). Neither of these amphibians are listed as SAR (BP 2022). BP's incidental observations are recorded during vehicle-wildlife interaction surveys, pedestrian surveys and from employee sightings.

Targeted amphibian surveys were conducted by BP in the spring and summer of 2017 to 2020. Identified species include: Spring Peeper (*Pseudacris crucifer*), Wood Frog (*Lithobates sylvatica*), Northern Leopard Frog (*Lithobates pipiens*), American Toad (*Anaxyrus americanus*), Grey Treefrog (*Hyla versicolor*) and Green Frog (*Lithobates clamitans*) (BP 2022).

2.4.5.2 Birds

Raptors & Bald Eagle:

Bald Eagles (*Haliaeetus leucocephalus*) are currently listed as a species of Special Concern in Ontario. According to BP (2022), Bald Eagles are frequently observed at the BP site and the Baie du Doré. Overall, across the whole BP site, counts have increased in the last four years indicating an increase in the abundance of the local overwintering Bald Eagle population. Additionally, BP observed one Red-tailed Hawk in 2018-2019, and one Snowy Owl and one Northern Harrier were recorded in 2019-2020 (BP 2022).

<u>*Waterfowl/Shorebirds:*</u>

Across 2019 and 2020, BP's monitoring identified 44 species of waterfowl/shorebirds (BP 2022). The most common species included: Double-crested cormorant (*Phalacrocorax auritus*), Ring-billed (*Larus delawarensis*), and Herring gull (*Larus argentatus*). Ducks were relatively abundant. Bufflehead (*Bucephala albeola*) was the most abundant waterfowl species encountered with a total number of 150. Only 2 shore/wading birds species were recorded during BP's 2019 monitoring, they were single observations of a Greater yellowlegs (*Tringa melanoleuca*) and a Spotted sandpiper (*Actitis macularius*) (BP 2022).

<u>*Breeding Bird Surveys*</u>

BP conducted several point count surveys for breeding birds across the BP site throughout 2016. A total of 82 species were observed at the breeding bird point counts and an additional 12 species were observed incidentally during the breeding bird season. The most encountered species was Red-eyed Vireo (*Viero olivaceus*) followed by American Robin (*Turdus migratorius*) (BP 2022).

Monitoring performed by BP the morning of June 4th, 2020, identified a total of 43 bird species. The most commonly observed species were Red-Eyed Vireo (*Vireo olivaceus*) and American Goldfinch (*Spinus tristis*). Interesting observations included 4 SAR bird species: Eastern Wood Pewee (*Contopus virens*), Wood Thrush (*Hylocichla mustelina*), Eastern Meadowlark (*Sturnella magna*), and Bobolink (*Dolichonyx oryzivorus*) (BP 2022).

2.4.5.3 Mammals

BP has reported a total of 26 species of mammals on and around the BP site based on evidence of presence (e.g., tracks, scat) or actual sightings. These species include both small and large mammals such as the masked shrew (*Sorex cinereus*) and white-tailed deer (*Odocoiles virginianus*). BP has observed species such as beaver (*Castor canadensis*) and muskrat (*Ondatra zibethicus*) in wetland areas on the BP site and in the Baie du Doré wetland. Other species such as the red squirrel (*Tamiasciurus hudsonicus*) and meadow vole (*Microtus pennsylvanicus*) likely utilize the conifer woodlands and the cultural meadow and grasslands that are present on and around the BP site (BP 2022).

Black bears (*Ursus americanus*) have been reported around the BP site. White-tailed deer are the most common mammal species observed on and around the BP site (BP 2022).

In recent years, BP's monitoring efforts have been expanded to include bat surveying and eight bat species were identified during acoustic monitoring surveys completed in 2016. Four bat SARs were recorded in or around the BP site: little brown myotis (*M. lucifugus*, 'Endangered' (Species at Risk in Ontario (SARO), SARA)), eastern small-footed myotis (*Myotis leibii*, 'Endangered' (SARO)), northern myotis (*M. septentrionalis*, 'Endangered' (SARO, SARA)), and tri-coloured bat (*Pipistrellus subflavus*, 'Endangered' (SARO, SARA)) (BP 2022).

2.4.6 Aquatic Community

Information on aquatic communities on and around the BP site is available from the BP ERA (BP 2022). Aquatic communities in the areas surrounding the BP site include aquatic vegetation (macrophytes), periphyton and phytoplankton, zooplankton, benthic invertebrates and fish, which are discussed below (BP 2022).

2.4.6.1 Aquatic Vegetation (Macrophytes)

The occurrence of emergent aquatic macrophytes is sparse within the boundary of the BP site. These include semi-aquatic species such as *Phragmites*. This is consistent with the exposed environment of the Lake Huron near-shore and coastal embayments. Wind, wave and ice scour mean that coarse substrates prevail, and conditions do not exist for plant growth. A few small, localized patches of submerged vegetation have been noted in sheltered areas at the head of Baie du Doré and some species of emergent vegetation are present in this area (BP 2022).

2.4.6.2 Periphyton and Phytoplankton

In an algal growth study carried out by BP along the Lake Huron shoreline, the presence of periphyton (attached algae) was confirmed in the area. Locally, higher concentrations were noted in Baie du Doré, due to warmer temperatures in this area and limited ice scour, and shelter from the wind and wave actions of Lake Huron. Phytoplankton communities at Gunn Point, Bruce and Douglas Point discharge channels, and Baie du Doré were characterized as highly variable and were typically highest in Baie du Doré, and lowest at Gunn Point. In general, phytoplankton density and diversity in Lake Huron is low due to the limited productivity of this oligotrophic lake.

2.4.6.3 Zooplankton

It is generally reported that Lake Huron has experienced dramatic changes in its zooplankton community structure (i.e., types of animals present) and overall abundance (i.e., number of animals) since the early 2000s (BP 2022). Studies have reported significant reductions in zooplankton abundance and changes in community structure; all of which have been associated with reductions in nutrient loading (as a direct result of water quality management policies) and the entrance of exotic species such as the highly predatory non-native cladoceran (*Bythotrephes longimanus*) and the zebra mussel (*Dreissena polymorpha*). While recent studies indicate some stability in the Lake Huron zooplankton community in recent years, there continues to be evidence suggesting impacts linked to nutrient loss (oligotrophy), the effects of invasive species competition or predation and coastal area features (BP 2022).

2.4.6.4 Benthic Invertebrates

As outlined in BP (2022), benthic communities were limited to a number of primary groups including Oligochaeta (*Naididae*), Amphipoda, Chironomidae and Ephemeroptera. Amphipoda was the dominant group in the nearshore areas while oligochaeta were the dominant group in the Bruce A discharge channel. In the Bruce B discharge channel, the benthic community was dominated by oligochaetes in the shallow water and chironomids were the major species in deep waters. No organisms were observed on exposed bedrock surfaces, which is evidence that physical conditions or exposure to predation may render these areas too harsh for colonization of most benthic organisms. Similarly, it was found that the abundance and diversity of benthic invertebrates was limited in sandy depositional areas (which precludes the presence of most burrowing species such as chironomids and oligochaetes) and rocky substrates were colonized by a number of insect species, including mayflies, caddisflies, some chironomid, oligochaetes and isopod species and some zebra mussels (BP 2022).

In general, the diversity and abundance of benthic invertebrates is highest in Baie du Doré, which is a direct result of habitat quality and quantity in the near-shore area versus further off-shore. The documentation of a terrestrial burrowing crayfish (*Fallicambarus fodeins*) on the BP site, including in Baie du Doré, represents an expansion of its known range. The Ontario Ministry of Natural Resources and Forestry Natural Heritage Information Centre lists this species as uncommon but not rare (BP 2022).

2.4.6.5 Fish

The fish community of Lake Huron can be divided into two general categories: offshore and nearshore. The offshore or 'pelagic' fish community is generally composed of species that use open or deep coastal habitats for the majority of their life cycles. Species included in this category are Round Whitefish (*Prosopium cylindraceum*), Lake Whitefish (*Coregonus clupeaformis*), Lake Trout (*Salvenlinus namaycush*), Rainbow Smelt (*Osmerus mord*ax), and deepwater sculpin (*Myoxocephalus thompsonii*, 'Special Concern', SARA). These fish make use of the near-shore areas only during spawning and prefer cooler offshore deeper waters, particularly during the warmer summer months. Deepwater Sculpin generally only enter the hydraulic zone of influence (of the BP site) and become vulnerable to entrainment or impingement during a portion of the larval phase (BP 2022). Note though, that the DPWF has no water intakes.

The nearshore fish community is comprised of those species that prefer shallow, warmer water. Along the shoreline of the main Lake Huron basin these habitats are located within sheltered, shallow embayments such as Baie du Doré and the discharge channels. Species included in this category include Smallmouth Bass, Yellow Perch, Northern Pike, Rock Bass, and Mimic Shiner. Smallmouth bass (*Micropterus dolomieu*) are common in the Bruce A and B discharge channels and Baie du Doré, and have been observed spawning in these areas. The non-native species Alewife (*Alosa pseudoharengus*) and Round Goby (*Neogobius melanostomus*) have also been documented in the nearshore Baie du Doré area (BP 2022).

2.5 Emissions Data

Table 2-4 and Table 2-5 present airborne and waterborne emissions data (Bq/y), respectively, from various facilities located within the BP site. Data from 2016 to 2020 are obtained from the BP ERA [BP 2022]. Data from 2021 to 2023 are obtained from CNL's annual compliance monitoring reports (ACMRs) for the DPWF. Since data from 2021 to 2023 are from CNL's ACMRs, they focus on CNL, and emissions from other facilities are not available for these years.

Table 2-4 and Table 2-5 show that the DPWF site's emissions are generally a small fraction of emissions from Bruce A, Bruce B, and the WWMF. The one exception is gross alpha in waterborne emissions (i.e., drainage water from the DPWF). However, there are no known current sources of the alpha emissions on the DPWF site. The measured gross alpha levels in effluent are attributed to residual historical contamination, such as from the historical Spent Fuel Storage Bay leak (CNL 2021). For context, CNL continues to monitor gross alpha activity concentrations directly in Sumps D3, D4, D5, and D6, and from 2019 to 2023 the average annual concentration across all 4 sumps has ranged between 0.042 Bq/L and 0.53 Bq/L (CNL internal program data), the highest of these (i.e., 0.53 Bq/L) is only slightly greater than the 0.5 Bq/L drinking water criterion (HC 2022). Using the BP ERA's (BP 2022) exposure point concentrations also implicitly accounts for the DPWF's contribution to concentrations in environmental media.

Figure 2-15 to Figure 2-18 - from CNL's DPWF ACMR (CNL 2023c) - present trends in DPWF airborne and waterborne emissions of tritium and gross beta for the last 5 years (2019 to 2023). Figure 2-15 to Figure 2-18 show there were no significant changes in the DPWF's airborne or waterborne emissions over the past several years.

Together, these tables and figures also show that, although the BP ERA (BP 2022) uses emissions data from 2016 to 2020, emissions since 2020 (i.e., 2021 to 2023) are similar. Therefore, the 2016-2020 emissions data used in the BP ERA (BP 2022) are still representative of current DPWF emissions.

Table 2-4 Airborne Emissions (BP 2022) (CNL 2023c)

Radionuclide	Facility	Units	2016	2017	2018	2019	2020	2021	2022	2023
Tritium	Bruce A	Bq/y	5.66E+14	7.32E+14	6.08E+14	4.63E+14	3.35E+14	-	-	-
	Bruce B	Bq/y	5.70E+14	7.14E+14	3.86E+14	3.30E+14	3.06E+14	-	-	-
	CMLF	Bq/y	6.99E+09	1.52E+10	2.26E+10	2.23E+10	2.43E+10	-	-	-
	WWMF	Bq/y	2.06E+13	1.72E+13	3.25E+12	1.03E+13	1.73E+13	-	-	-
	CNL	Bq/y	1.59E+11	1.12E+11	7.96E+11	2.41E+11	4.10E+11	2.57E+11	2.41E+11	2.72E+11
	Kinectrics	Bq/y	N/A	N/A	4.20E+07	1.88E+11	1.18E+11	-	-	-
	CSF	Bq/y	N/A	N/A	N/A	N/A	1.26E+09	-	-	-
	TOTAL (all facilities)	***Bq/y***	1.16E+15	1.46E+15	9.98E+14	8.03E+14	6.59E+14	-	-	-
	DPWF's Fraction	*unitless*	1.37E-04	7.67E-05	7.98E-04	3.00E-04	6.22E-04	-	-	-
C-14	Bruce A	Bq/y	1.69E+12	1.89E+12	1.14E+12	1.34E+12	1.58E+12	-	-	-
	Bruce B	Bq/y	1.13E+12	1.23E+12	1.13E+12	1.08E+12	9.89E+11	-	-	-
	CMLF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	WWMF	Bq/y	3.94E+09	4.09E+09	1.57E+09	2.62E+09	2.63E+10	-	-	-
	CNL	Bq/y	6.10E+09	N/A	1.51E+09	N/A	N/A	Not Measured*	Not Measured*	Not Measured*
	Kinectrics	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	CSF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	2.83E+12	3.12E+12	2.27E+12	2.43E+12	2.60E+12	-	-	-
	DPWF's Fraction	*unitless*	2.16E-03	N/A	6.65E-04	N/A	N/A	-	-	-
Particulate (Beta/Gamma)	Bruce A	Bq/y	3.14E+05	4.39E+05	1.28E+06	1.97E+06	2.94E+06	-	-	-
	Bruce B	Bq/y	1.13E+06	2.34E+06	2.21E+06	4.76E+06	6.35E+06	-	-	-
	CMLF	Bq/y	<Ld	<Ld	<Ld	<Ld	<Ld	-	-	-
	WWMF	Bq/y	5.42E+03	4.52E+03	2.41E+04	6.52E+02	1.37E+04	-	-	-
	CNL	Bq/y	N/A	2.29E+04	4.55E+04	3.90E+04	1.38E+05	7.58E+04	1.17E+05	1.34E+05
	Kinectrics	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	CSF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	1.45E+06	2.81E+06	3.56E+06	6.77E+06	9.44E+06	-	-	-
	DPWF's Fraction	*unitless*	N/A	8.15E-03	1.28E-02	5.76E-03	1.46E-02	-	-	-

Radionuclide	Facility	Units	2016	2017	2018	2019	2020	2021	2022	2023
Particulate (Alpha)	Bruce A	Bq/y	2.46E+03	4.08E+03	1.10E+04	2.43E+04	2.96E+04	-	-	-
	Bruce B	Bq/y	1.85E+03	3.70E+03	2.37E+04	2.63E+04	4.29E+04	-	-	-
	CMLF	Bq/y	<Ld	7.84E+01	<Ld	<Ld	<Ld	-	-	-
	WWMF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	CNL	Bq/y	N/A	1.64E+03	3.07E+03	4.94E+03	8.44E+03	N/A	N/A	N/A
	Kinectrics	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	CSF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	4.31E+03	9.50E+03	3.78E+04	5.54E+04	8.09E+04	-	-	-
	DPWF's Fraction	*unitless*	N/A	1.73E-01	8.12E-02	8.92E-02	1.04E-01	-	-	-

Notes:

N/A – Not Available
<Ld – less than detection limit
* Not measured: there were no projects in 2021 that generated C-14 emissions (per DPWF ACMRs).

Table 2-5 Waterborne Emissions (BP 2022) (CNL 2023c)

Radionuclide	Facility	Units	2016	2017	2018	2019	2020	2021	2022	2023
Tritium	Bruce A	Bq/y	2.36E+14	2.26E+14	1.96E+14	2.12E+14	2.50E+14	-	-	-
	Bruce B	Bq/y	5.07E+14	7.15E+14	5.60E+14	8.82E+14	5.73E+14	-	-	-
	CMLF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	WWMF	Bq/y	6.12E+11	2.59E+11	3.64E+11	1.60E+11	2.36E+11	-	-	-
	CNL	Bq/y	2.23E+10	3.57E+10	2.73E+10	3.73E+10	1.74E+10	2.30E+10	2.40E+10	2.44E+10
	Kinectrics	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	7.44E+14	9.41E+14	7.56E+14	1.09E+15	8.23E+14	-	-	-
	DPWF's Fraction	*unitless*	3.00E-05	3.79E-05	3.61E-05	3.42E-05	2.11E-05	-	-	-
C-14	Bruce A	Bq/y	1.66E+09	9.13E+08	9.73E+08	8.17E+08	1.14E+09	-	-	-
	Bruce B	Bq/y	1.76E+09	2.39E+09	1.38E+09	4.68E+09	1.79E+09	-	-	-
	CMLF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	WWMF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	CNL	Bq/y	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Kinectrics	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	3.42E+09	3.30E+09	2.35E+09	5.49E+09	2.93E+09	-	-	-
	DPWF's Fraction	*unitless*	N/A	N/A	N/A	N/A	N/A	-	-	-
Gross Beta/Gamma	Bruce A	Bq/y	9.96E+08	1.08E+09	1.20E+09	2.13E+09	7.66E+08	-	-	-
	Bruce B	Bq/y	1.42E+09	2.04E+09	2.55E+09	2.26E+09	2.26E+09	-	-	-
	CMLF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	WWMF	Bq/y	4.62E+08	2.84E+08	1.69E+08	7.08E+07	9.54E+07	-	-	-
	CNL	Bq/y	1.05E+07	2.56E+07	1.97E+07	4.52E+07	3.31E+07	2.97E+07	8.60E+06	8.18E+06
	Kinectrics	Bq/y	N/A	N/A	N/A	0.00E+00	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	2.89E+09	3.43E+09	3.94E+09	4.51E+09	3.15E+09	-	-	-
	DPWF's Fraction	*unitless*	3.63E-03	7.46E-03	5.00E-03	1.00E-02	1.05E-02	-	-	-

Radionuclide	Facility	Units	2016	2017	2018	2019	2020	2021	2022	2023
Gross Alpha	Bruce A	Bq/y	6.96E+04	<Ld	<Ld	<Ld	<Ld	-	-	-
	Bruce B	Bq/y	<Ld	<Ld	<Ld	<Ld	<Ld	-	-	-
	CMLF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	WWMF	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	CNL	Bq/y	8.98E+06	1.12E+07	1.18E+07	6.75E+06	8.34E+06	5.55E+06	5.70E+06	8.02E+06
	Kinectrics	Bq/y	N/A	N/A	N/A	N/A	N/A	-	-	-
	TOTAL (all facilities)	***Bq/y***	9.05E+06	1.12E+07	1.18E+07	6.75E+06	8.34E+06	-	-	-
	DPWF's Fraction	*unitless*	9.92E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	-	-	-

Notes:

N/A – Not Available
<Ld – less than detection limit

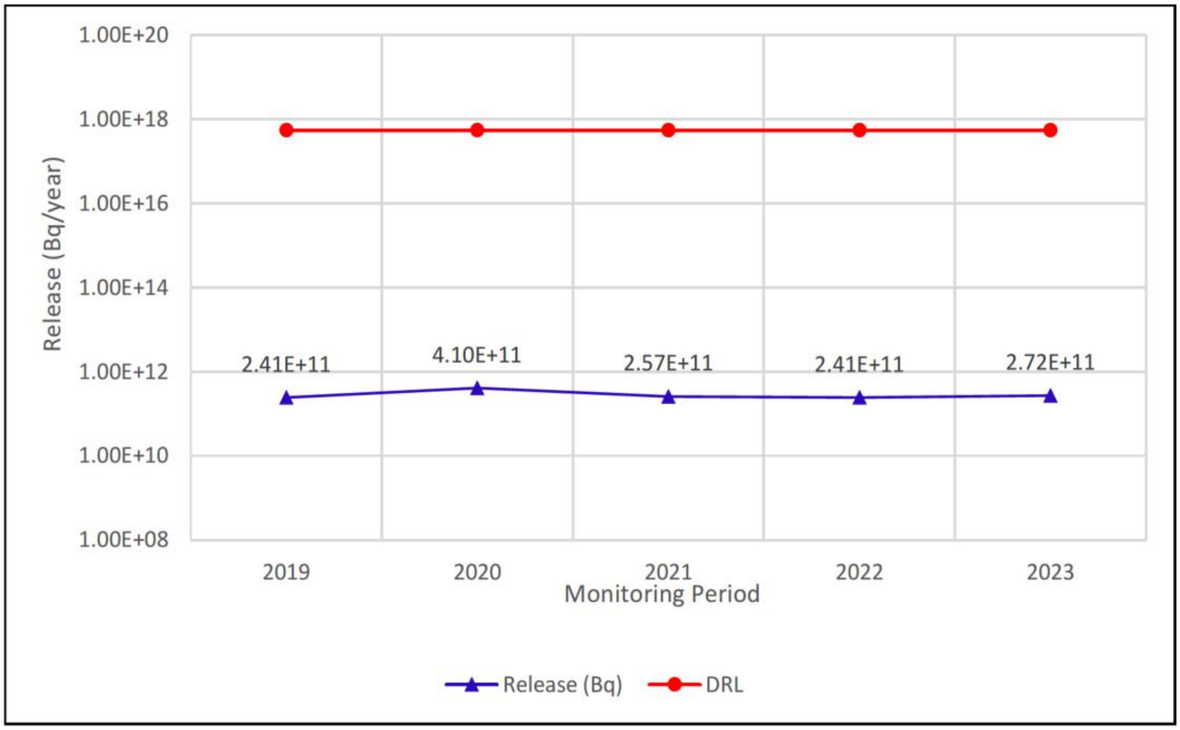


Figure 2-15 DPWF Airborne Release Trend for Tritium (CNL 2023c)

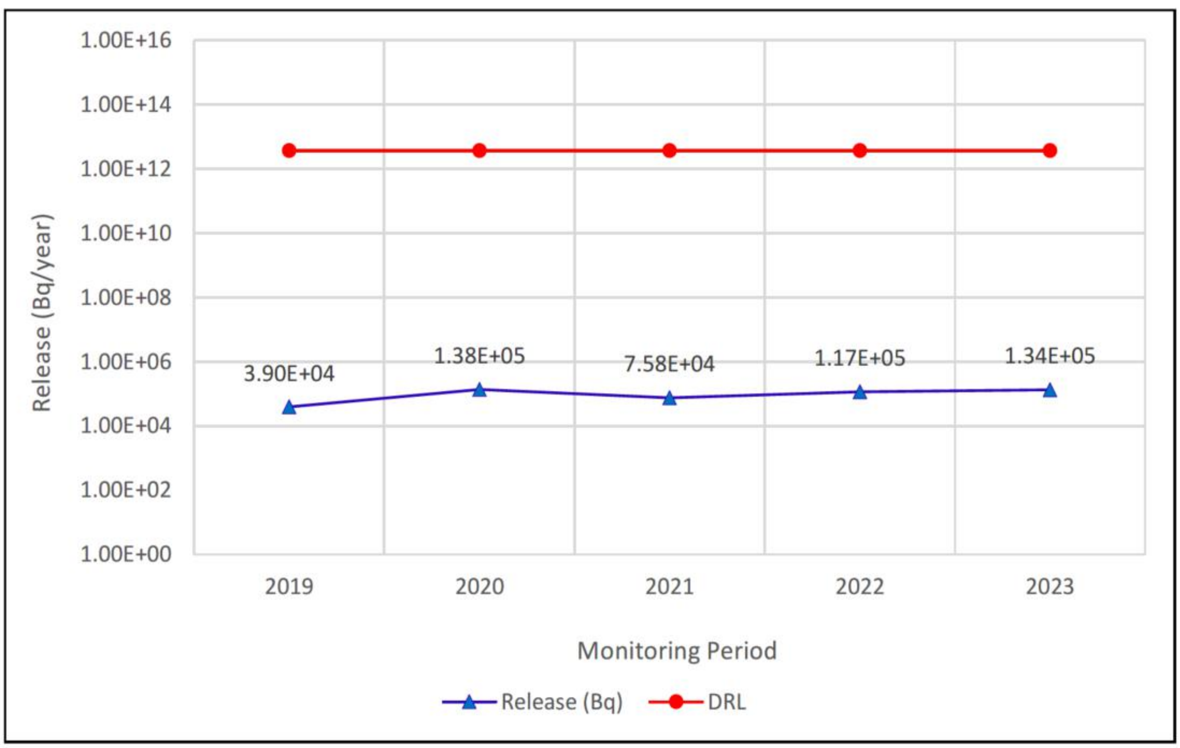


Figure 2-16 DPWF Airborne Release Trend for Gross Beta (CNL 2023c)

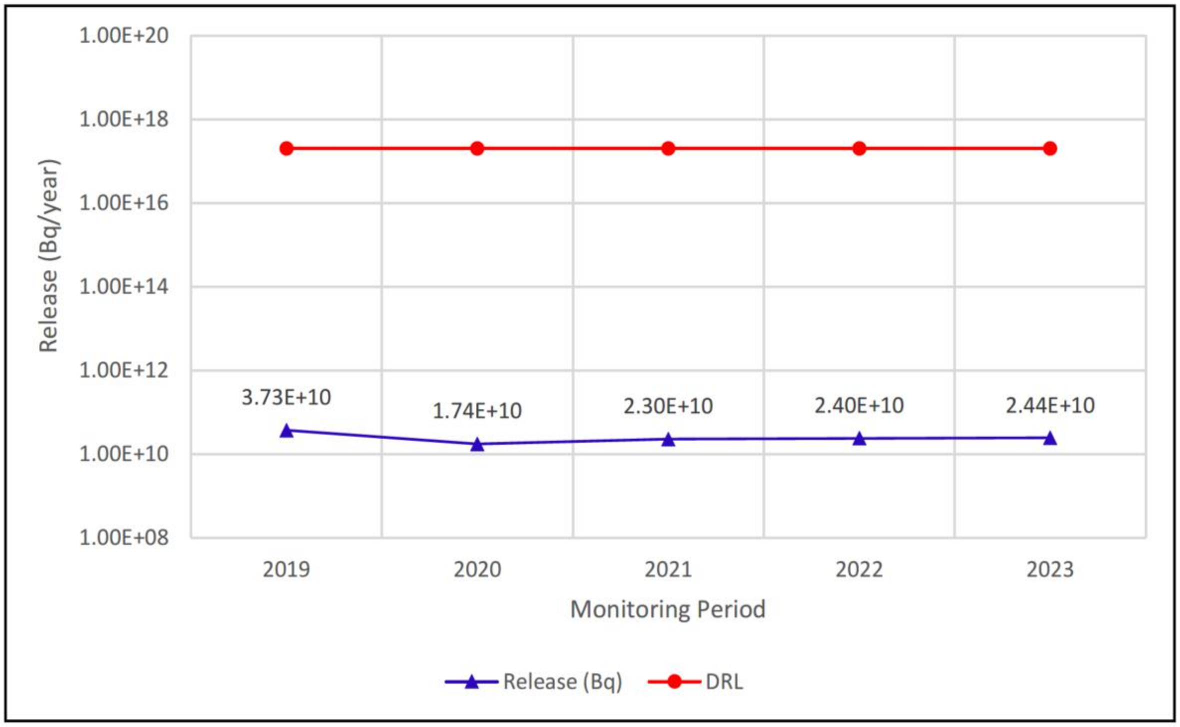


Figure 2-17 DPWF Waterborne Release Trend for Tritium (CNL 2023c)

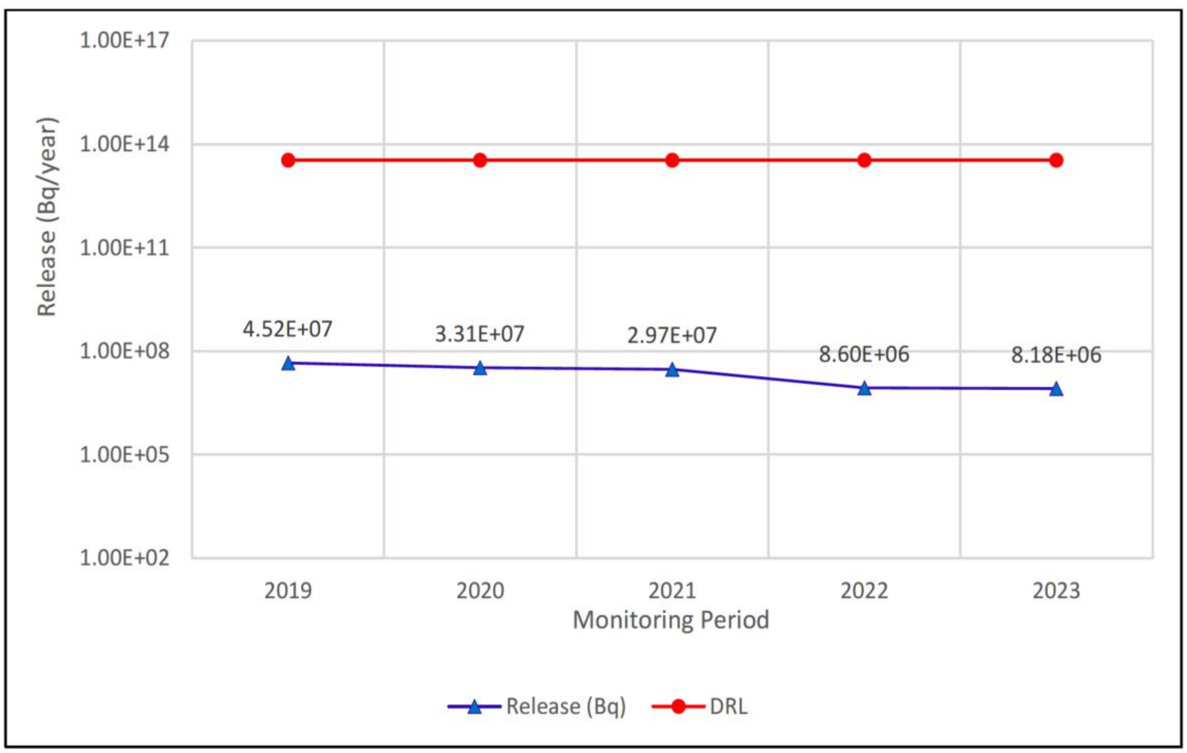


Figure 2-18 DPWF Waterborne Release Trend for Gross Beta (CNL 2023c)

2.6 Available Environmental Monitoring Data

Environmental data are generally available from 3 main sources:

1) BP's 2022 ERA (BP 2022);
2) DPWF studies, such as CNL's ACMRs and 2015 characterization study (CNL 2016); and,
3) BP's Environmental Protection Report for 2022 (BP 2023).

The following subsections discuss data from these main sources.

It is important to note that the DPWF site is surrounded by the BP site, and the BP site is much more complex. The DPWF site's emissions are also minor compared to BP's (see Table 2-4 and Table 2-5). Thus, any environmental concentrations measured in the vicinity of BP and the DPWF would implicitly reflect emissions from BP's facilities and the DPWF site. Environmental data (and in the case of the BP ERA (BP 2022), exposure point concentrations (EPCs)) outlined in BP (2022) and BP (2023) are therefore appropriate to use for the DPWF, and such data would conservatively bound any environmental concentrations originating from the DPWF's lesser emissions. Thus, this DPWF ERA is mainly based on results from the BP ERA (BP 2022).

2.6.1 Data from the BP ERA

The 2022 BP ERA used monitoring data from 2016 to 2020 and considered airborne and waterborne releases from the following facilities:

- Bruce A Nuclear Generating Station;
- Bruce B Nuclear Generating Station;
- Central Maintenance and Laundry Facility;
- OPG Western Waste Management Facility (WWMF);
- DPWF; and
- Kinectrics North Facility.

The BP ERA (BP 2022) contains a considerable amount of radiological and non-radiological data. Data are used in later subsections of this DPWF ERA.

2.6.2 Radionuclide and Non-Radiological Data from the DPWF

Groundwater Concentrations on the DPWF Site:

Measured groundwater concentration data are available for the DPWF. Sampling and analyses are performed as described in the DPWF's groundwater monitoring plan (CNL 2021c). Summaries are obtained from the DPWF's annual compliance reports.

DPWF groundwater sampling at 14 monitoring well locations was initiated in 2001 and was conducted three times in 2001, annually from 2002 to 2006, and periodically between 2008 and 2013. Monitoring results were reported to CNSC for the period 2001 to 2006. Reporting to the CNSC ceased in 2006 as monitoring indicated limited impacts on groundwater quality (CNL 2023a). The updated DPWF groundwater monitoring plan (CNL 2021c) recommends that groundwater sampling be conducted once every five (5) years, and so sampling was most recently conducted in the fall of 2022. Data are also available for groundwater in the inactive drainage system, from sampling performed in 2015 (CNL 2016).

Aside from groundwater, measurement data for surface water, air or soil are not available for the DPWF because the facility does not require an environmental monitoring program (CNL 2021a).

Drainage Water Data from CNL's 2015 Characterization Study:

In 2015, CNL sampled water from several points in the DPWF inactive drainage system, including Reactor Building sumps, outdoor stormwater catch basins, and a roadside drainage ditch. Samples were analyzed for a variety of radiological and non-radiological parameters, with the results documented in CNL (2016). The BP ERA (BP 2022) contains a considerable amount of radiological and non-radiological data. Data are used in later subsections of this DPWF ERA.

2.6.3 Radionuclide Data from Bruce Power's Environmental Protection Report

In 2023 BP published their Environmental Protection Report for 2022 (BP 2023). It is a key source of information on radionuclide concentrations in several environmental media. Data are used in later subsections of this DPWF ERA.

3.0 RADIOLOGICAL HUMAN HEALTH RISK ASSESSMENT

3.1 Problem Formulation and Conceptual Model

The objective of this radiological HHRA (DPWF HHRA) is to assess radiological risk from the DPWF to human receptors. The assessment is for current conditions and uses monitoring data from 2016 to 2020, as presented in the 2022 BP ERA (BP 2022).

The receptors, selection of contaminants of potential concern (COPCs), and exposure pathways to be assessed are presented below.

3.1.1 Receptors

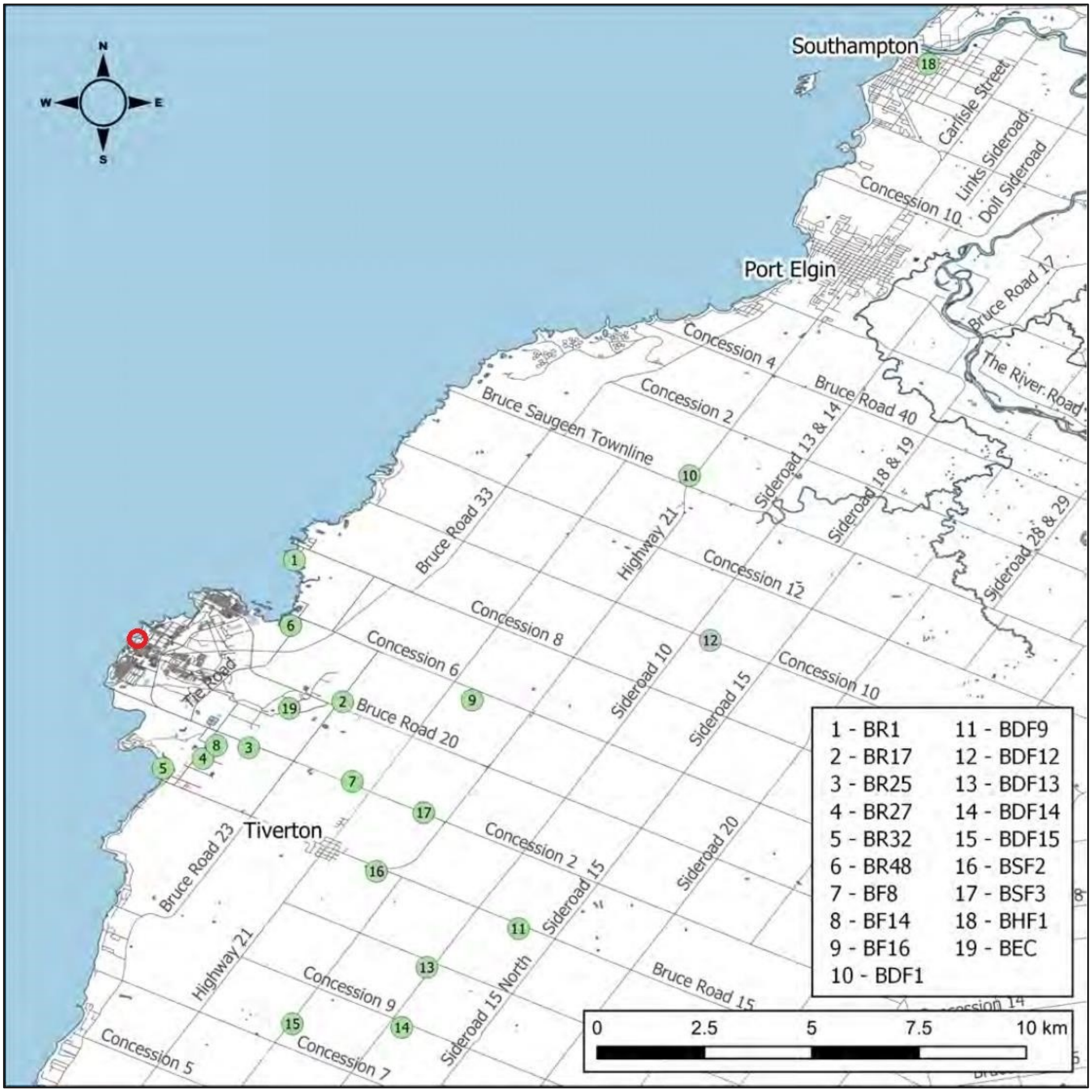
Human receptors for the present radiological DPWF HHRA were selected based on the receptors presented in the BP ERA (BP 2022), with consideration given to those noted in Athauda-Arachchige (2018). The BP radiological HHRA (BP 2022) mentions that its selection of human receptors was based on information such as, surrounding land usage, population distribution, meteorology, hydrology, water sources, water uses and food sources; information documented in BP's 2021 *Bruce Power Site Specific Survey Report* (BP 2021). From this information, the BP radiological HHRA (BP 2022) chose the following categories of representative receptors:

- Non-farm resident (BR);
- Farm resident (BF);
- Subsistence Farm Residents (previously called 'Mennonite farm resident' in the 2017 ERA) (BSF);
- Dairy farm resident (BDF);
- Hunter/fisher Resident (BHF); and,
- Bruce Eco-Industrial Park (BEC) worker.

The locations of these receptor groups are shown in Figure 3-1 below. They are located within 15 km of the BP site, with the exception of the hunter/fisherman group, which is located approximately 20 km north of the site (BP 2022). Each receptor group location includes three age categories as per CSA Standard N288.1-20: adult (16 to 70 years old), child (6 to 15 years old) and an infant (0 to 5 years old) except for the Bruce Eco-Industrial Park worker, who is assumed to be an adult (BP 2022).

Details for each receptor group are provided below (from BP 2022), following Figure 3-1.

It is important to note that on-site workers ***at the DPWF*** *are expected to be Nuclear Energy Workers*, which are covered under the facility's radiation protection program or health and safety program and are not assessed in the present HHRA, as per CSA N288.6-12 (BP 2022). The 2022 version of N288.6 (CSA 2022a) offers similar guidance.



Note: the approximate location of the DPWF site, within the BP Site, is indicated in red.

Figure 3-1 Human Receptor Locations for HHRA (radiological) (BP 2022)

Non-farm resident (BR):

Represents a typical, full-time resident in the area surrounding the BP site. They use grocery stores for a large portion of their food intake (BP 2022).

Farm resident (BF):

The farm resident is more likely to consume their own crop or livestock, but still use grocery stores for a portion of their food intake (BP 2022).

Subsistence Farm Residents (BSF):

This receptor was previously referred to as the Mennonite farm resident in the prior (2017) BP ERA. This receptor group is defined as an individual for whom over half of their diet is self-produced. Therefore, this group is representative of Mennonite/Amish farmers and other residents who depend predominantly on locally grown foodstuff. The subsistence farm resident obtains a larger portion of their food, milk, and water from local sources (BP 2022).

Dairy farm resident (BDF):

The dairy farm resident is assumed to consume some fresh milk from their own farm, and a slightly higher fraction of locally grown produce and livestock (BP 2022).

Hunter/Fisher Resident (BHF):

BP (2022) mentions that the hunter/fisher resident is defined as an individual who catches and consumes wild game and fish in significantly greater quantities than other residents. They are assumed to obtain all their fish and wild game from local sources and consume greater quantities of these foods than the average Canadian diet. For other food categories, some are sourced locally while the remainder is from grocery stores.

In this context, the hunter/fisher resident is representative of Indigenous populations. Bruce Power has conducted surveys of the Saugeen Ojibway Nation, Historic Saugeen Métis (HSM) and Métis Nation of Ontario (MNO) from 2019 – 2021. These surveys collected information on the lifestyles of local Indigenous groups, including dietary information, sources of food and water, and the use of wild flora for medicinal and ceremonial purposes. The data from these surveys has been used to establish intake rates and local intake fractions of fish, wild game, and other foodstuffs to ensure that the assessment is representative of the characteristics of Indigenous residents living near Site. Thus, the BP ERA (BP 2022) is informed by these surveys. The BP ERA (BP 2022) notes that the results of these surveys show that intake rates of wild game may be up to 24.3 times higher than the average Canadian diet, and intake rates of fish and shellfish may be up to 1.35 times higher than the average Canadian diet. Thus, in the BP ERA (BP 2022), the 95th percentile intake rates from CSA N288.1 were scaled by these factors. Intake rates for other food categories were bounded by the values in N288.1, therefore the N288.1 values are used.

Bruce Eco-Industrial Park (BEC) worker:

Represents workers at the industrial park. The assessment for a BEC worker represents occupational exposures (for non-Nuclear Energy Workers (non-NEWs)). It is assumed that the BEC worker does not also live at one of the other selected receptor locations, i.e., the BEC dose is independent of the other representative person doses.

Consideration of Seasonal/Park Users:

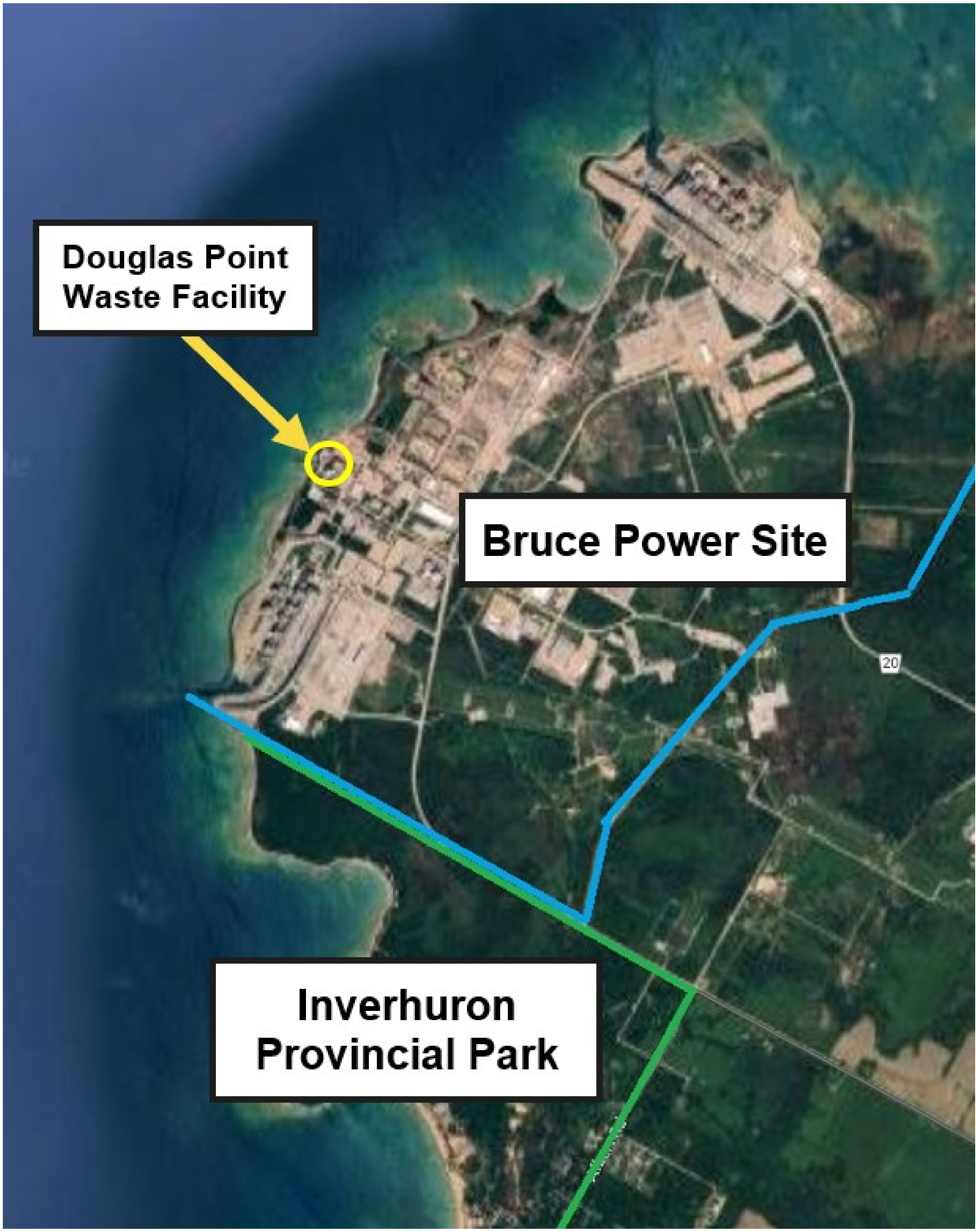
Given the proximity of parks to the BP site - namely, Inverhuron Provincial Park and MacGregor Point Provincial Park (see Figure 3-2 and Figure 3-3 below) - consideration was given to seasonal/park users. The closest park is Inverhuron Provincial Park. Although Inverhuron Provincial Park neighbours the BP site's southwestern boundary, the DPWF site is approximately 1.5 km from the nearest part of this boundary.

The exposure of a seasonal user or park receptor group would be bounded by exposure of the subsistence farm resident receptor group (BSF) and the resident receptor group (BR) located next to the BP site. This is the case because the subsistence farm resident depends predominantly on locally grown foodstuff. Therefore, their exposure to any contamination in fruit and vegetables is bounding. Similarly, the local resident – specifically receptor ID #5 (BR32) in Figure 3-1 above) - is exposed to similar pathways as the seasonal user or park user but is present in close proximity to the BP site boundary full time. Seasonal users or park users by definition would have less intake of local foods, and their time spent in the vicinity of the park will not be higher than local residents, who are present year around.

[redacted]

Note: Based on Google maps base image. All locations are approximate, for context only.

Figure 3-2 Approximate Locations of Nearby Parks



Note: Based on Google maps base image. All borders are approximated.

Figure 3-3 Approximate Locations of the BP Site, DPWF Site, and Inverhuron Provincial Park

3.1.2 Selection of Radiological COPCs for the Radiological HHRA

3.1.2.1 Radionuclides Relevant to the DPWF

According to Athauda-Arachchige (2018), the primary radionuclides associated with the radioactive materials present within the DPWF are:

- Reactor systems - Co-60, Fe-55, Ni-63, Zr-95, Cs-137, Eu-154, Eu-152.
- Intermediate level radioactive waste – Co-60, Sb-125, unknown (in radiological materials stored in the fuel transfer tunnel and empty fuel bundle flask (aluminum clad and lead filled)).

The Derived Release Limit (DRL) study for DPWF (CNL 2023b) calculated DRLs for the following radionuclides: C-14, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, HTO, Sb-125, Sr-90, and Am-241 for both airborne and liquid effluents (CNL 2023b).

The DPWF Effluent Monitoring Program (EMP) (CNL 2021a) prescribes that semi-annual waterborne effluent samples are to be collected and analyzed for gross beta activity, gross alpha activity and tritium oxide. For airborne emission monitoring, stack ventilation exhaust is analyzed for gross beta activity (one per fan run time period; weekly intervals when the exhaust runs continuously) and tritium oxide (one per fan run time period; weekly intervals when run continuously) (CNL 2021a).

3.1.2.2 Radiological COPCs Selected for the DPWF Radiological HHRA

The COPCs chosen for assessment in this DPWF HHRA were selected based on data from BP's annual environmental monitoring, as summarized in the BP ERA (BP 2022). These include:

- airborne radionuclide groups:
  - HTO;
  - Noble gases;
  - C-14;
  - Mixed fission product iodines;
  - Gross alpha particulates; and
  - Gross beta/gamma particulates.
- waterborne radionuclide groups:
  - HTO;
  - C-14;
  - Gross alpha;
  - Gross beta/gamma.

Table 3-1 compares the radionuclide groups assessed in the BP ERA (BP 2022) to those identified as being relevant to the DPWF. Table 3-1 shows that the COPCs assessed in the present HHRA encompass all of the individual radionuclides associated with DPWF, either as individuals (e.g., HTO, C-14) or as categories (e.g., mixed fission product iodines, gross beta/gamma or gross alpha). The BP ERA (BP 2022) also acknowledges the releases contributed by the DPWF and summarizes their annual release data in Tables 216 to 222.

Table 3-1 Summary of Radionuclide COPCs for the DPWF HHRA

Radionuclide COPCs for Present DPWF HHRA (Based on BP (2022) Data)	Radionuclides Associated with DPWF (Based on Athauda-Arachchige, 2018; CNL, 2023b; CNL, 2021a)
Airborne Releases	
HTO	HTO
Noble gases	N/A
C-14	C-14
Mixed fission product iodines (represented as I-131)	N/A
Gross alpha particulates (conservatively assumed to be Np-237)	Am-241
Gross beta/gamma particulates (conservatively represented using Co-60).	Co-60, Fe-55 (electron capture), Ni-63, Zr-95, Cs-137, Eu-154, Eu-152, Sb-125, Cs-134, Sr-90
Waterborne Releases	
HTO	HTO
C-14	N/A
Gross alpha particulates (conservatively assumed to be Pu-239)	Am-241
Gross beta/gamma particulates (conservatively represented using Co-60)	Co-60, Fe-55 (electron capture), Ni-63, Zr-95, Cs-137, Eu-154, Eu-152, Sb-125, Cs-134, Sr-90

Notes: N/A – Not measured/monitored at the DPWF for this effluent stream, but it is retained on the COPC list because it was assessed in the BP ERA, upon which the DPWF HHRA results are based.

3.1.2.3 *Examination of Available Radiological Environmental Data*

DPWF Inactive Drainage System Water - Radionuclides

CNL (2016) sampled water from the following locations within the DPWF site's drainage system (see Section 2.3.8.5 and Figure 2-6):

- Reactor Building D3 and D6 sumps,
- Catch basins 1, 2 and 5; and,
- The roadside drainage ditch

Table 3-2, reproduced from CNL (2016), presents measured radionuclide concentrations in these samples.

Table 3-2 Radionuclide Concentrations Measured in DPWF Drainage Water (CNL 2016)

		Douglas Point							
Sample ID		DP-D3	DP-D6	DP-D6d	DP-1CB	DP-2CB	DP-5CB	DP-FB	DP-RDD
QC Designation				Duplicate				Blank	
Date Sampled		10-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	11-Nov-15	10-Nov-15	10-Nov-15	10-Nov-15
Tritium (H-3)	Bq/mL	0.51	1.84	1.87	0.77	0.54	0.24	0.05	0.24
C-14	Bq/L	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37	<7.37
K-40	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cr-51	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mn-54	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-57	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Fe-59	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Co-60	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zn-65	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Se-75	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Nb-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Zr-95	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Mo-99	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Tc-99m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-103	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ru-106	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ag-110m	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Sb-125	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
I-131	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ba-133	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-134	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Cs-137	Bq/L	<1.75	<1.7	<1.7	<1.04	<1.8	<1.82	<1.73	<1.8
Ce-141	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ce-144	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-152x	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-154	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Eu-155	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Tl-208	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Bi-212	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-212	Bq/L	<2.74	<2.37	1.52	1.62	<2.71	<2.63	1.46	3.20
Bi-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pb-214	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ra-226	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Ac-228	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Pa-233	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Th-234	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Am-241	Bq/L	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA
Total Alpha	Bq/L	<0.41	**0.502**	<0.32	<0.39	<0.22	<0.18	<0.17	**0.636**
Total Beta	Bq/L	<0.40	0.403	0.627	<0.38	<0.38	<0.38	<0.38	<0.40

Note: Light grey shading: denotes detectable concentrations

Tritium was detected in all samples, ranging from 50 Bq/L (field blank) to 1,870 Bq/L (D6 sump, Reactor Building). For perspective these concentrations are less than the 7,000 Bq/L criterion for drinking water (GO 2003; HC 2022).

Total alpha activity ranged from <0.18 Bq/L (i.e., non-detect) (outdoor catch basin) up to 0.636 Bq/L (road site drainage ditch). Concentrations of Am-241, specifically, were less than the detection limit at all sample locations. For perspective, the maximum total alpha concentration (0.636 Bq/L) only slightly exceeds the 0.5 Bq/L criterion for drinking water (HC 2022).

Total beta activity ranged from <0.38 Bq/L (i.e., non-detect) (several locations) up to 0.627 Bq/L (D6 sump, Reactor Building). For perspective, the maximum value – 0.627 Bq/L – is less than the 1 Bq/L criterion for drinking water (HC 2022).

Gamma emitters, such Co-60, Cs-137 and Sr-90, had concentrations less than detection limits at all sample locations.

Note that water from the inactive drainage system is not used as potable water.

Surface Water (Lakes, Streams, Ponds) – Tritium, Gross Beta, Gross Gamma

BP (2023) indicates that surface water samples are collected from Lake Huron as well as several ponds and streams on the BP site. Ponds and streams would receive radionuclides from airborne releases whereas Lake Huron also receives waterborne effluents (from BP and from the DPWF). Sampling locations at and near the BP site are shown in Figure 3-4, whereas sampling locations in the region surrounding the BP site are shown in Figure 3-5. Lake water samples are also collected by OPG at 3 locations (Bancroft, Belleville and Cobourg) representing provincial background conditions.

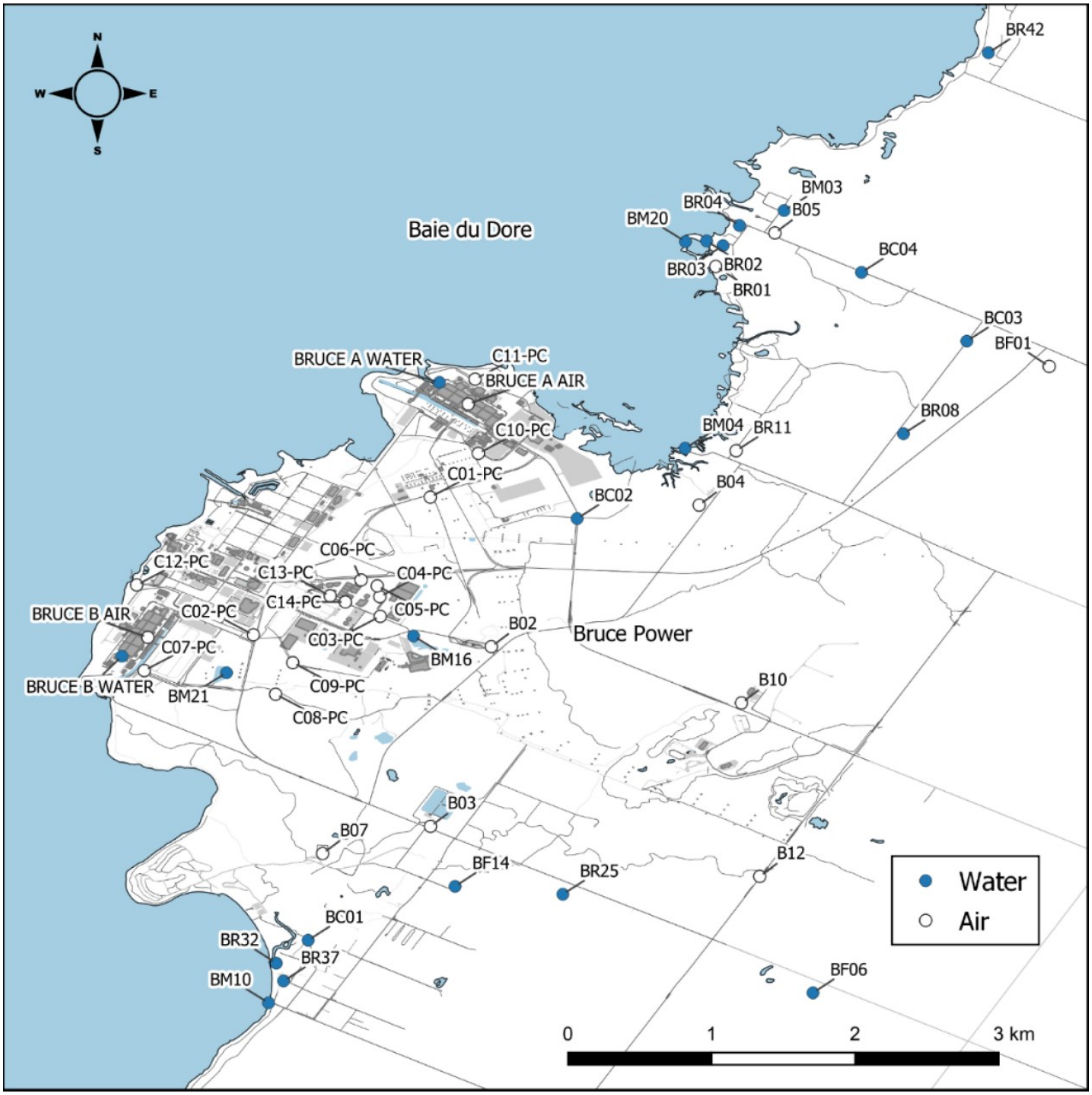


Figure 3-4 Air and Water Monitoring Locations On and Near the BP Site (BP 2023)

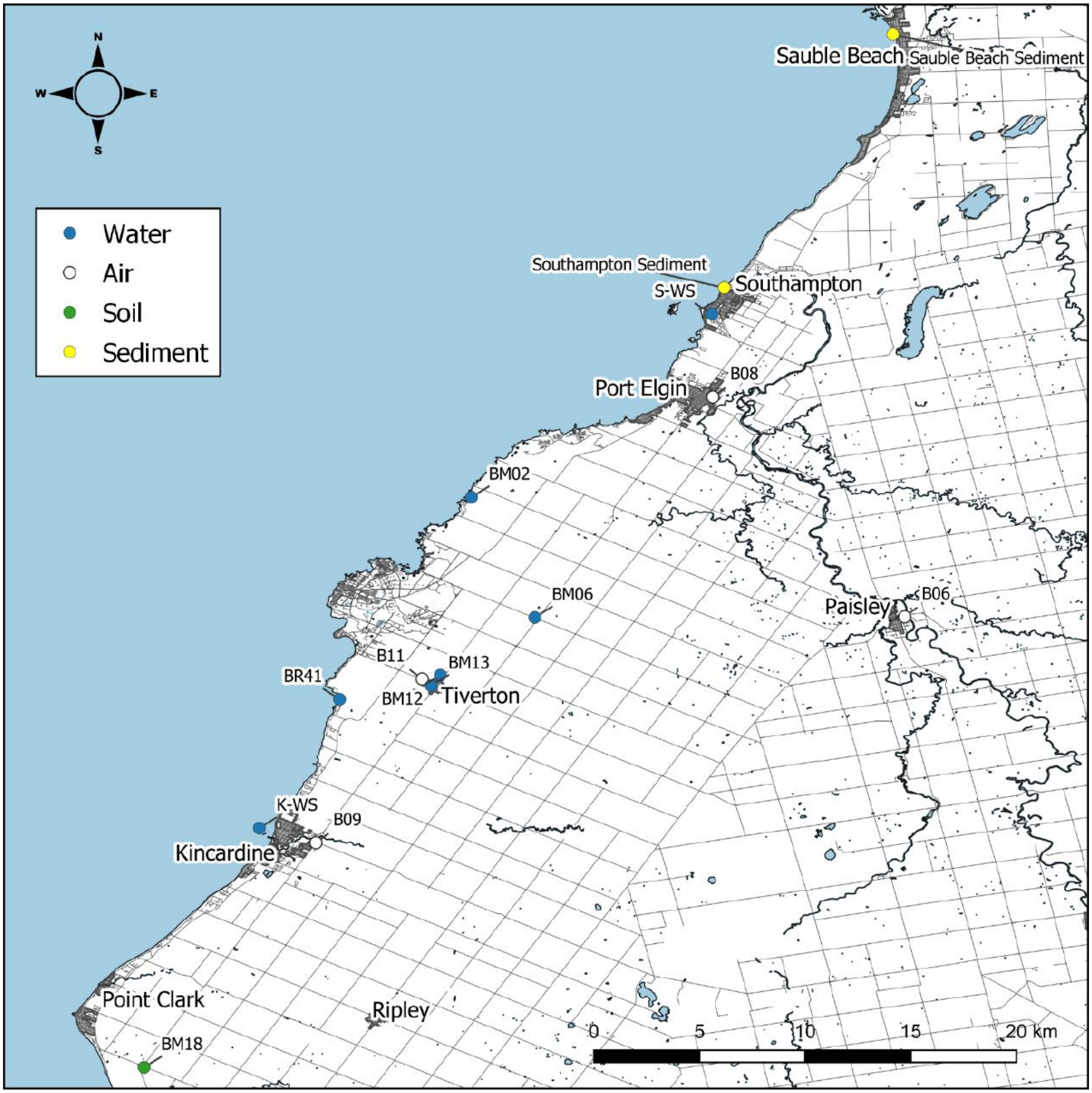


Figure 3-5 Air, Water, Soil and Sediment Monitoring Locations In the Region Surrounding the BP Site (BP 2023)

Table 3-3, reproduced from BP (2023), presents 2022 annual average tritium and gross beta concentrations in surface water. Figure 3-6 shows long term trends in annual average concentrations, from 2013 to 2022.

Table 3-3 2022 Annual Average Tritium and Gross Beta Concentrations in Lake Huron, Ponds, Streams and Background Lakes (BP 2023)

Location Type	Sample Location	Tritium Oxide (Bq/L)	Gross Beta (Bq/L)
On Site Pond	BM16-WL (B31 Pond)	1.84E+02	Not applicable
On Site Pond	BM21-WL (Former Sewage Lagoon)	5.69E+02	Not applicable
Indicator Stream	BC02-WC	1.43E+02	9.66E-02
Area Near Stream	BC01-WC	5.36E+01	1.09E-01
Area Near Stream	BC03-WC	1.05E+02	1.15E-01
Area Near Stream	BC04-WC	1.29E+02	8.46E-02
Indicator Lake	BM04-WL	1.63E+02	9.68E-02
Indicator Lake	BM04-WL duplicate	1.63E+02	9.05E-02
Area Near Lake	BM10-WL	9.88E+00	8.10E-02
Area Near Lake	BM20-WL	4.19E+01	7.05E-02
Background Lake	Bancroft (Clark Lake)	4.0E-01	4.6E-02
Background Lake	Belleville (Bay of Quinte)	1.3E+00	7.6E-02
Background Lake	Cobourg (Lake Ontario)	2.3E+00	1.0E-01

Notes:

- Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used
- Provincial background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used
- Bancroft, Belleville, and Cobourg are not sampled during winter months (Quarter 1 and 4)

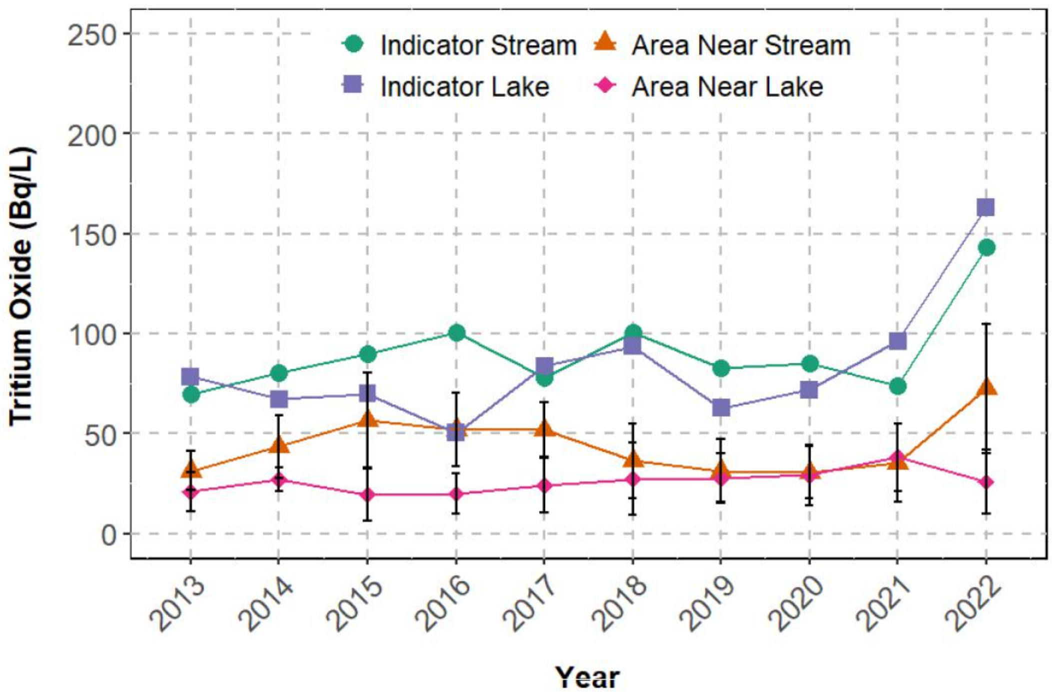


Figure 3-6 Annual Average Tritium Concentrations in Lake Huron and Streams, 2013 to 2022 (BP 2023)

BP (2023) mentions that gross gamma results (not included in the table or figure above) were less than or very close to the critical level, and indistinguishable from background. BP (2023) defines the critical level as follows: *"The critical level or decision threshold (Lc) is the calculated value based on background measurements, below which the net counts measured from the sample are indistinguishable from the background at the 95% probability level.".*

According to BP (2023), 2022 lake and stream water tritium concentrations generally decrease with distance from the BP site. All tritium concentrations are well below the 7,000 Bq/L criterion (GO 2003; HC 2022). Gross beta concentrations show little variation with distance from the BP site. Gross beta concentrations measured near the BP site are similar to those measured at the Cobourg (Lake Ontario) background location. All gross beta concentrations are below the CNSC guideline/screening level of 1 Bq/L (BP 2023), which is the same as the 1 Bq/L HC (2022) drinking water quality criterion for gross beta.

Tritium in Air

According to BP (2023), BP measures tritium oxide (HTO) air concentrations at 10 locations near the BP site and at 1 location (Nanticoke) representing background conditions. Table 3-4, reproduced from BP (2023), presents the annual average tritium concentration at each location. Figure 3-7 groups the stations and graphs their monthly average tritium concentrations (thus providing an indication of their variability). Stations B02, B03, and B04 are the closest to the DPWF; they are located near the BP site's southern property boundary. The highest annual average measured concentration among these 3 stations is 5.19 Bq/m^3. BP (2023) states that the tritium oxide concentrations measured in air near the BP site are well below the CNSC guideline/screening level of 340 Bq/m^3 (BP 2023).

Table 3-4 Annual Average Measured HTO Air Concentrations (BP 2023)

Location Type	Sample Location	Tritium Oxide (becquerels per cubic metre)
Indicator	B02-ST	3.66E+00
Indicator	B03-ST	2.85E+00
Indicator	B04-ST	5.19E+00
Indicator	**Average**	**3.92E+00**
Area Near	B05-ST	3.16E+00
Area Near	B07-ST	2.37E+00
Area Near	B10-ST	2.58E+00
Area Near	B11-ST	1.57E+00
Area Near	**Average**	**2.42E+00**
Area Far	B06-ST	2.43E-01
Area Far	B08-ST	4.36E-01
Area Far	B09-ST	3.26E-01
Area Far	**Average**	**3.35E-01**
Background	Nanticoke	4.48E-02

Notes:

- Sample count = 12 in all cases, except B02-ST sample count = 11.
- For calculation of averages the uncensored analytical result was used.

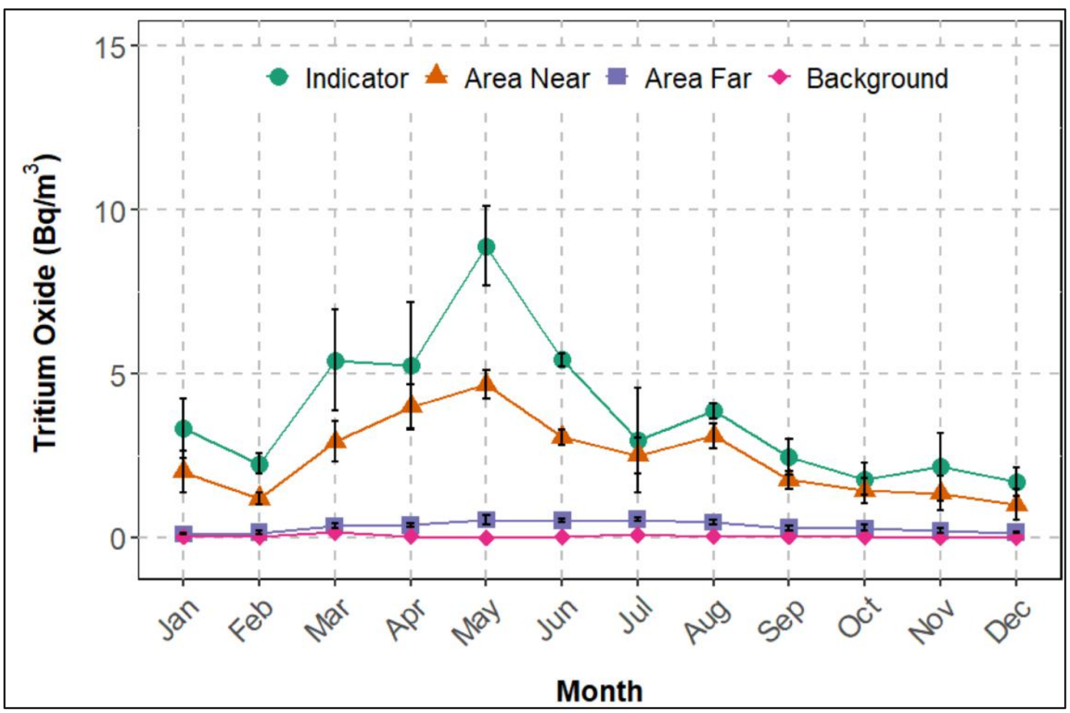


Figure 3-7 2022 Monthly Average HTO Air Concentrations (BP 2023)

C-14 in Air

According to BP (2023), concentrations of C-14 in air are measured at several locations (see Figure 3-4 and Figure 3-5):

- 8 sampling locations near the BP site;
- 1 duplicate sampler at B05 at Scott Point;
- 14 passive samplers on the BP site, situated around Bruce A, Bruce B and Ontario Power Generation Western Waste Management Facility; and,
- 5 samplers under the Provincial Environmental Monitoring Program, which the province uses to measure background levels (at Nanticoke).

Table 3-5 and Table 3-6, reproduced from BP (2023), present annual average C-14 concentrations at stations off the BP and on the BP site, respectively. Figure 3-8 groups the stations and graphs their quarterly average C-14 concentrations (thus providing an indication of their variability in 2022). Finally, Figure 3-9 shows long term trends in annual average C-14 concentrations from 2013 to 2022.

Station C12-PC is located near the shore, between the DPWF site and Bruce B. it is the closest location to the DPWF site. The 2022 annual average concentration at C12-PC was 421 Bq^{14}C/kgC. B03 and B05 are the closest *offsite* stations (i.e., off the BP Site and thus, offsite and farther from the DPWF site); the highest measured annual average concentration among them is 250 Bq^{14}C/kgC. Among stations representing background levels, the annual average background concentration is about 205 Bq^{14}C/kgC. These measurements indicate that C-14 concentrations in air *on* the BP site *near* the DPWF are higher than background levels, whereas concentrations off the Bruce Power site, but close to its property boundary, are only slightly higher than background levels.

Table 3-5 Stations off of the BP Site - Annual Average C-14 Air Concentrations (BP 2023)

Location Type	Sample Location	Carbon-14 ($Bq^{14}C/kgC$)
Indicator	B03-PC	2.30E+02
Area Near	B05-PC (#1)	2.37E+02
Area Near	B05-PC (#2)	2.50E+02
Area Near	B11-PC	2.32E+02
Area Near	BF01-PC	2.22E+02
Area Near	BF14-PC	2.38E+02
Area Near	BF23-PC	2.23E+02
Area Near	BR01-PC	2.50E+02
Area Near	BR11-PC	2.37E+02
Area Near	**Average**	**2.36E+02**
Background	Bancroft	1.96E+02
Background	Barrie	2.05E+02
Background	Lakefield	2.18E+02
Background	Nanticoke	2.05E+02
Background	Picton	2.02E+02
Background	**Average**	**2.05E+02**

Notes:
- Sample count = 4 for each location.
- For calculation of averages the uncensored analytical result was used.

Table 3-6 Stations on the BP Site - 2022 Annual Average C-14 Air Concentrations (BP 2023)

Location Type	Sample Location	Carbon-14 ($Bq^{14}C/kgC$)
On-Site	C01-PC	4.02E+02
On-Site	C02-PC	3.57E+02
On-Site	C03-PC	1.62E+04
On-Site	C04-PC	3.51E+03
On-Site	C05-PC	1.75E+03
On-Site	C06-PC	2.46E+03
On-Site	C07-PC	3.72E+02
On-Site	C08-PC	3.49E+02
On-Site	C09-PC	3.31E+02
On-Site	C10-PC	3.87E+02
On-Site	C11-PC	9.90E+02
On-Site	C12-PC	4.21E+02
On-Site	C13-PC	1.38E+03
On-Site	C14-PC	1.83E+03

Notes:
- Sample count = 4 for each location.
- For calculation of averages the uncensored analytical result was used.

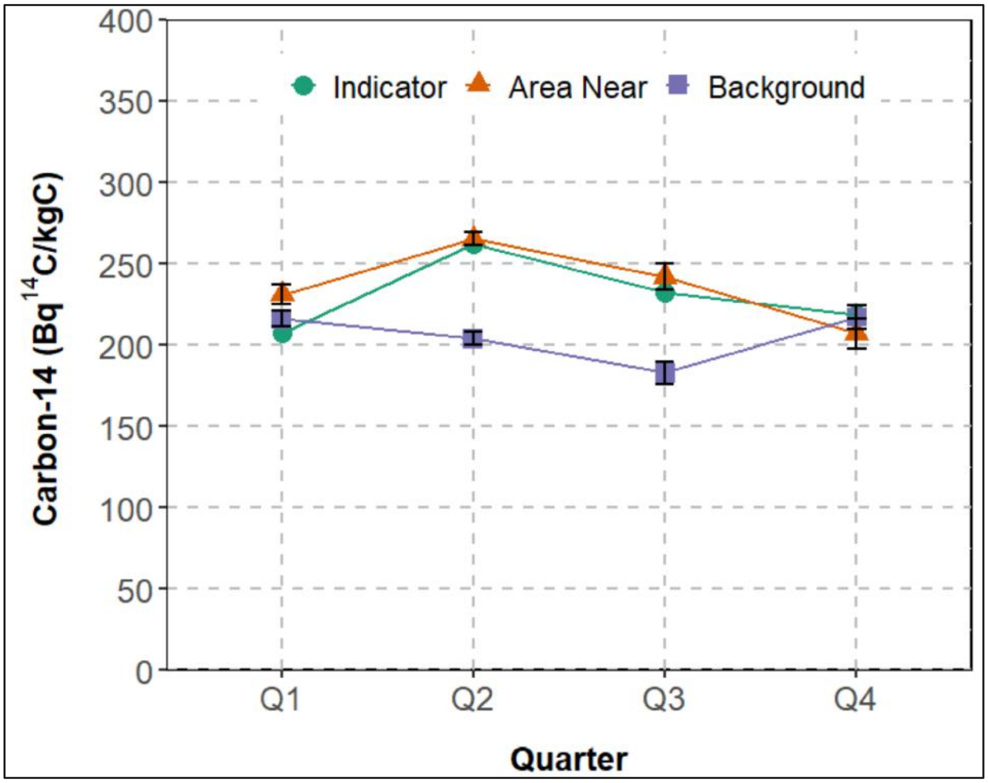


Figure 3-8 2022 Quarterly Average C-14 Air Concentrations (BP 2023)

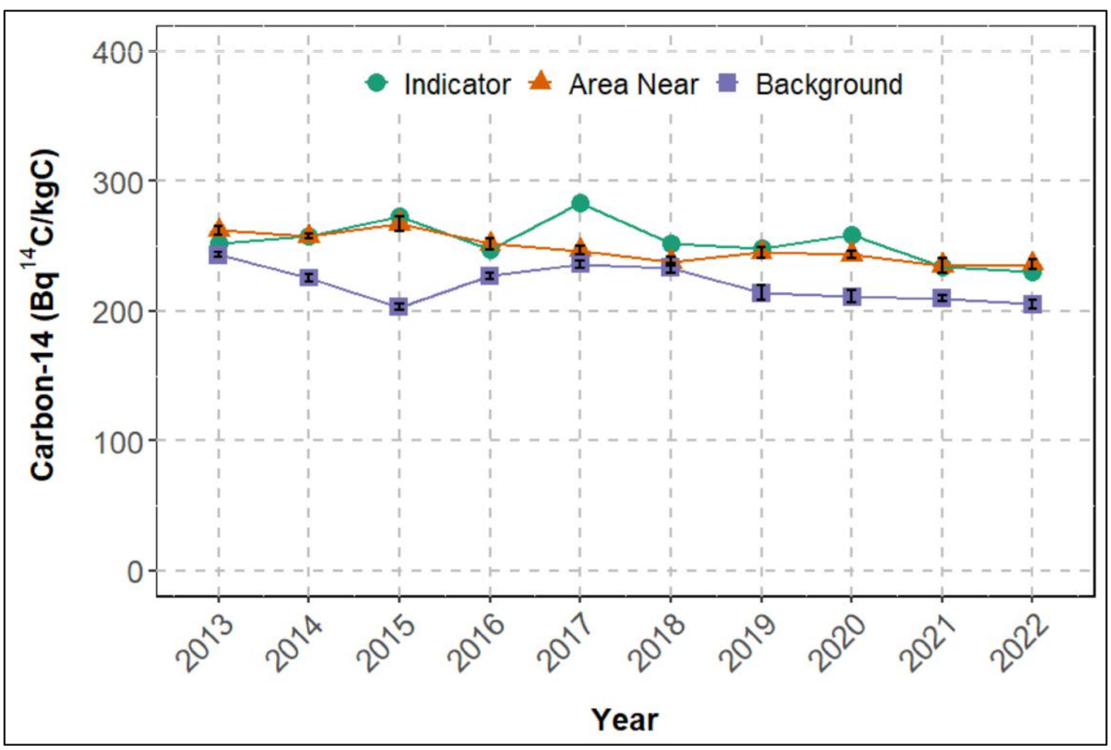


Figure 3-9 Annual Average C-14 Air Concentrations 2013 to 2022 (BP 2023)

Municipal Water from Water Supply and Treatment Plants (Offsite) – Tritium & Gross Beta

BP (2023) indicates that municipal drinking water is sampled at 2 water supply plants on Lake Huron: one in Southampton (~22 km northeast) of the BP site, and one in Kincardine (~15 km SSW of the BP site), plus several other plants representing background conditions (see Figure 3-4 and Figure 3-5).

Table 3-7, reproduced from BP (2023), presents annual average tritium and gross beta concentrations in drinking water at municipal water supply locations (including Southampton, Kincardine, and others representing background conditions). Figure 3-10 shows long term trends in annual average tritium concentrations in drinking water, from 2013 to 2022.

BP (2023) indicates that the 2022 annual average concentrations are well below the 7,000 Bq/L drinking water quality criterion (GO 2003; HC 2022), as well as BP's committed administrative level of 100 Bq/L. Gross beta results at the local water supply plants for 2022 (0.06 - 0.07 Bq/L) were similar to historical and provincial background results (0.04 - 0.11 Bq/L) and were well below the CNSC guideline/screening level of 1 Bq/L (BP 2023), which is the same as the 1 Bq/L HC (2022) drinking water quality criterion for gross beta.

Table 3-7 2022 Annual Average Tritium and Gross Beta Concentrations in Drinking Water at Municipal Water Supply Locations (BP 2023)

Location Type	Sample Location	Tritium Oxide (Bq/L)	Gross Beta (Bq/L)
Bruce Power	Kincardine	3.95E+00	6.23E-02
Bruce Power	Southampton	1.04E+01	6.66E-02
Background	Brockville (WSP)	3.0E+00	1.1E-01
Background	Burlington (WSP)	4.2E+00	1.0E-01
Background	Goderich (WSP)	1.8E+00	9.3E-02
Background	Kingston (WSP)	3.0E+00	1.0E-01
Background	Niagara Falls (WSP)	1.5E+00	9.6E-02
Background	Windsor	2.2E+00	7.9E-02
Background	St. Catherine's	1.1E+00	9.5E-02
Background	Thunder Bay	<Ld	4.3E-02
Background	North Bay	7.3E-01	6.5E-02
Background	Parry Sound	8.8E-01	5.6E-02

Notes:

- Bruce Power: For calculation of averages where the result was less than critical level (Lc), the uncensored analytical result was used. '<Lc' stated in table when all results were <Lc.
- Provincial background: For calculation of averages where the result was less than the minimum detection level (Ld), the uncensored analytical result was used. '<Ld' stated in table when all results were <Ld

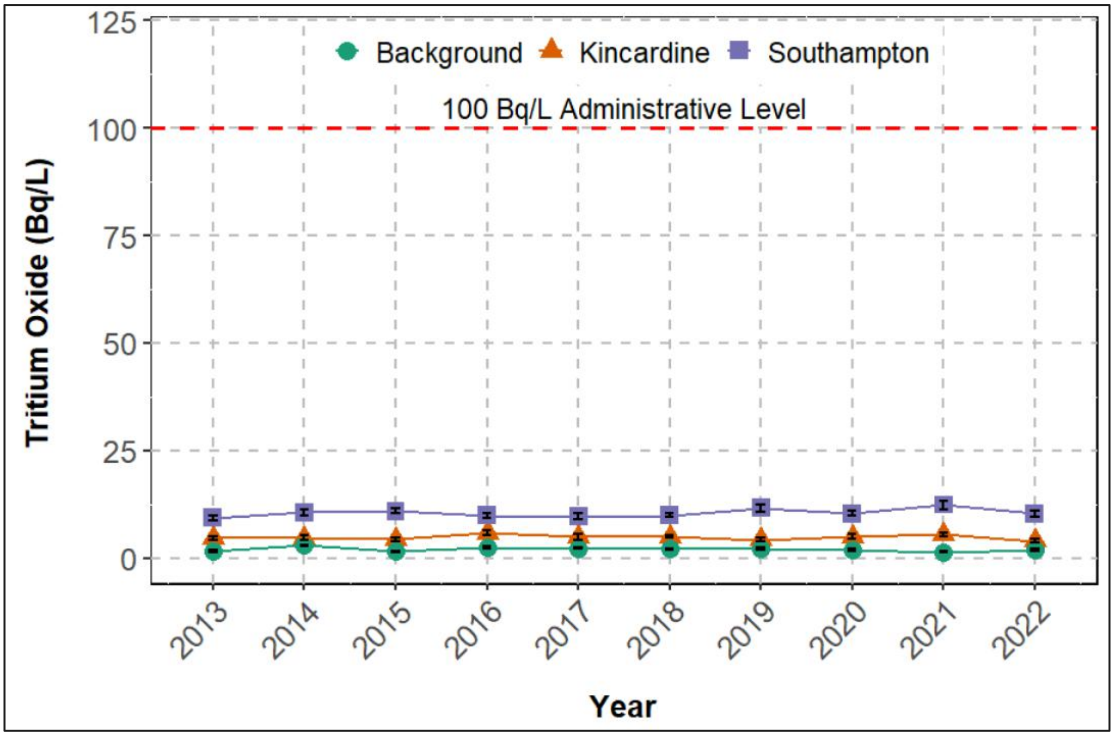


Figure 3-10 Annual Average Tritium Oxide Concentrations in Municipal Drinking Water at Water Supply Plants, 2013 to 2022 (BP 2023)

<u>Municipal and Residential Water from Wells (Offsite) – Tritium & Gross Beta</u>

BP (2023) indicates that drinking water from wells is collected from several locations (see Figure 3-4 and Figure 3-5):

- 4 municipal wells. One at Scott Point (BM03-WW), one at Underwood (BM06-WW) and two (2) at Tiverton (BM12-WW, BM13-WW);
- 7 deep residential wells;
- 6 shallow residential wells;
- 2 representative locations for gross beta and gross gamma analysis. One near Scott Point (BR02-WW) and one near Inverhuron (BR32-WW).

Table 3-8, reproduced from BP (2023), presents 2022 annual average tritium and gross beta concentrations in drinking water collected from these municipal and residential wells. Tritium concentrations at several wells are less than the critical level (discussed earlier – see surface water). When detectable, tritium concentrations were well below the 7,000 Bq/L drinking water criterion (GO 2003; HC 2022). According to BP (2023), the average gross beta result for BR02 and BR32 were slightly higher than the background locations but were only a fraction of the CNSC guideline/screening level of 1 Bq/L, which is the same as the 1 Bq/L HC (2022) drinking water criterion for gross beta. BP (2023) also states that gamma results were less than or very close to the critical level and indistinguishable from background.

Table 3-8 2022 Annual Average Tritium and Gross Beta Concentrations in Drinking Water From Municipal and Residential Wells Off of the BP Site (BP 2023)

Location Type	Sample Location	Tritium Oxide (Bq/L)	Gross Beta (Bq/L)
Municipal Well	BM03-WW	<Lc	Not Applicable
Municipal Well	BM06-WW	<Lc	Not Applicable
Municipal Well	BM12-WW	<Lc	Not Applicable
Municipal Well	BM13-WW	<Lc	Not Applicable
Residential Deep Well	BR01-WW	No sample	Not Applicable
Residential Deep Well	BR08-WW	3.84E-01	Not Applicable
Residential Deep Well	BR25-WW	<Lc	Not Applicable
Residential Deep Well	BF01-WW	1.22E-01	Not Applicable
Residential Deep Well	BF14-WW	<Lc	Not Applicable
Residential Deep Well	BF23-WW	<Lc	Not Applicable
Residential Deep Well	BM02-WW	No sample	Not Applicable
Residential Shallow Well	BR02-WW	<Lc	1.51E-01
Residential Shallow Well	BR03-WW	1.37E+02	Not Applicable
Residential Shallow Well	BR04-WW	<Lc	Not Applicable
Residential Shallow Well	BR41-WW	3.29E+01	Not Applicable
Residential Shallow Well	BR42-WW	4.69E+01	Not Applicable
Residential Shallow Well	BF06-WW	<Lc	Not Applicable
Residential Shallow Well	BR32-WW	1.44E+01	3.21E-01

Notes:

- Bruce Power: For calculation of averages where the result was less than critical level (Lc), the uncensored analytical result was used. '<Lc' stated in table when all results were <Lc.

Beach Sand

BP (2023) indicates that beach sand samples were collected in 2022 (locations are shown in Figure 3-4 and Figure 3-5). Table 3-9 presents the 2022 annual average concentrations of Co-60, Cs-134 and Cs-137 in beach sand samples collected near the BP site and from samples collected at Cobourg and Goderich, which represent background conditions.

Table 3-9 2022 Annual Average Radionuclide Concentrations in Beach Sand (BP 2023)

Location Type	Location	Cobalt-60 (Bq/kg)	Cesium-134 (Bq/kg)	Cesium-137 (Bq/kg)
Bruce Power	Area Near	<Lc	<Lc	1.01E+00
Background	Cobourg	<Ld	2.1E-01	2.5E-01
Background	Goderich	<Ld	1.8E-01	<Ld

Notes:

- Bruce Power - For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used. '<Lc' stated in table when the average was negative
- Provincial background –For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used. '<Ld' stated in table when all values were less than the detection level

For Co-60 and Cs-134, BP (2023) states that the annual average concentrations in beach sand collected from the "area near" location were less than corresponding critical levels, or indistinguishable from background, which has been the case for prior years as well.

For Cs-137, BP (2023) describes the concentration from the "area near" location as being consistently very low, marginally higher than the provincial background averages for Cobourg and Goderich, and well below the CNSC guideline/screening level for soil (58.6 Bq/kg dry weight) or sediment (37,300 Bq/kg dry weight).

Garden Soil (Off of the BP Site)

BP (2023) indicates that garden soil samples are collected once every 5 years (locations are shown in Figure 3-4 and Figure 3-5). The last year of collection was 2019, thus 2022 data are not available.

Aquatic Sediment (Off of the BP Site)

BP (2023) indicates that, like garden soil, aquatic sediment samples are collected once every 5 years (locations are shown in Figure 3-4 and Figure 3-5), with the last year of collection being 2019. Data from 2022 are not available.

External Gamma on the DPWF Site:

CNL monitors gamma levels at two locations on the DPWF site (CNL 2024):

1. On the spent fuel canisters; and,
2. Within the Reactor Building.

Figure 3-11, below, presents measured contact gamma dose rates (on the spent fuel storage containers) for the most recent 5-year period (2019 to 2023) (CNL 2024). CNL (2024) notes that the design dose rate limit on contact of the spent fuel storage canisters is 10 μSv/h, which is indicated by the red line in the figure; there have been no significant change in readings over time, and the dose rates are significantly less than the design dose rate limit of 10 μSv/h.

Gamma radiation is attenuated by air, such that gamma radiation levels attributable to even large sources can become negligible several hundred metres from the source. Thus, gamma dose rates measured near the spent fuel containers will further decrease with distance until reaching background levels.

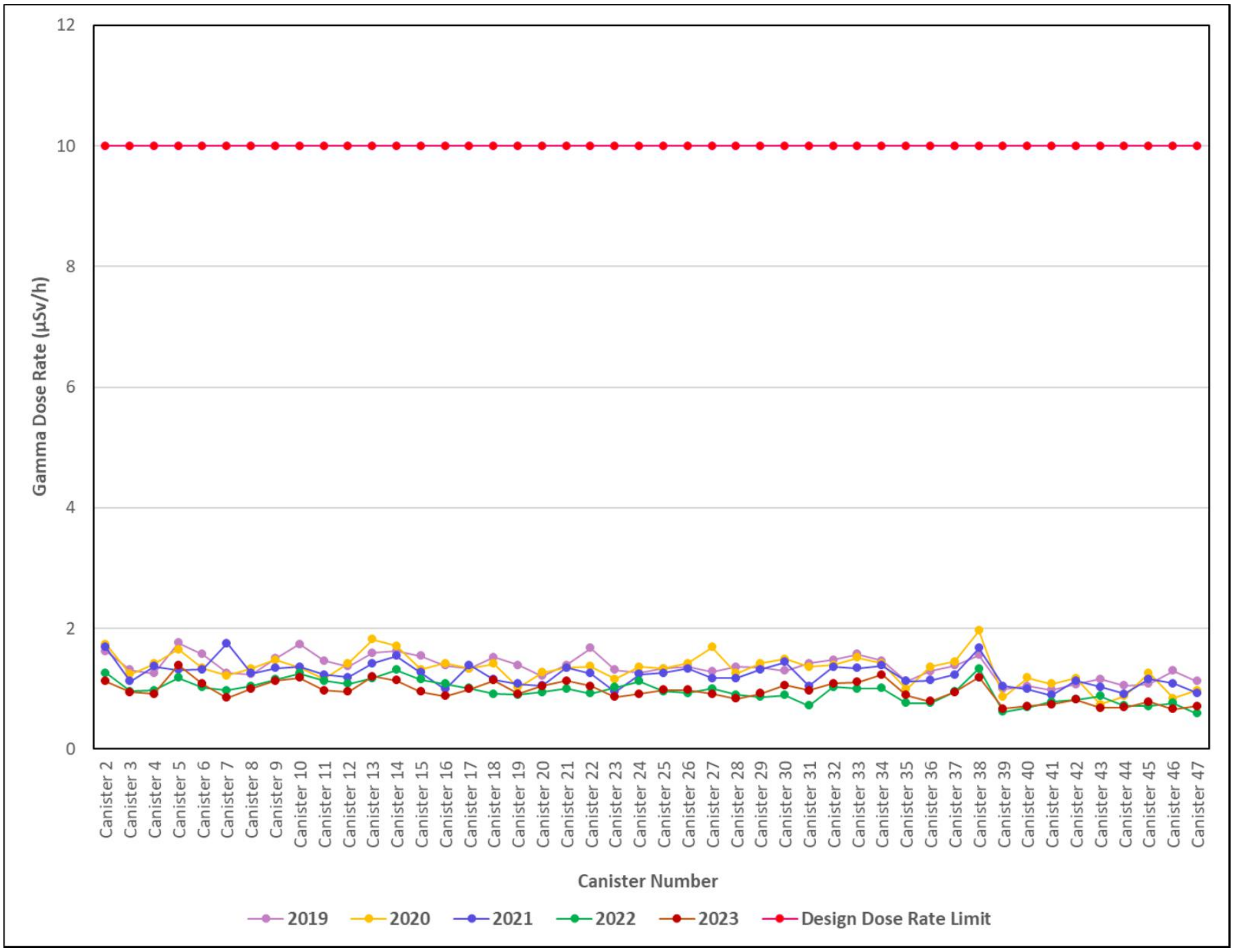


Figure 3-11 Contact Gamma Dose Rates on Spent Fuel Storage Containers (CNL 2024)

Figure 3-12, below, presents measured gamma dose rates within the Reactor Building for the most recent 5-year period (2019 to 2023) (CNL 2024). CNL (2024) mentions that dose rates are decreasing as expected due to radioactive decay.

The main source of gamma radiation in Reactor Building is the calandria and bioshield which are located at ground level. Annual surveys of the dousing tank (within the Reactor Building near the ceiling) have not indicated gamma radiation fields, and so gamma radiation is not expected to escape through the Reactor Building roof. The Administration Building and Turbine Building have undergone considerable decommissioning and no longer contain radiological sources. The Service Building has no radiological source capable of releasing gamma radiation that can penetrate through the roof or walls. Therefore, the Administration Building and Turbine Building are not expected to emit gamma radiation, and the gamma rates measured inside the Reactor Building are not expected to escape outside of the building.

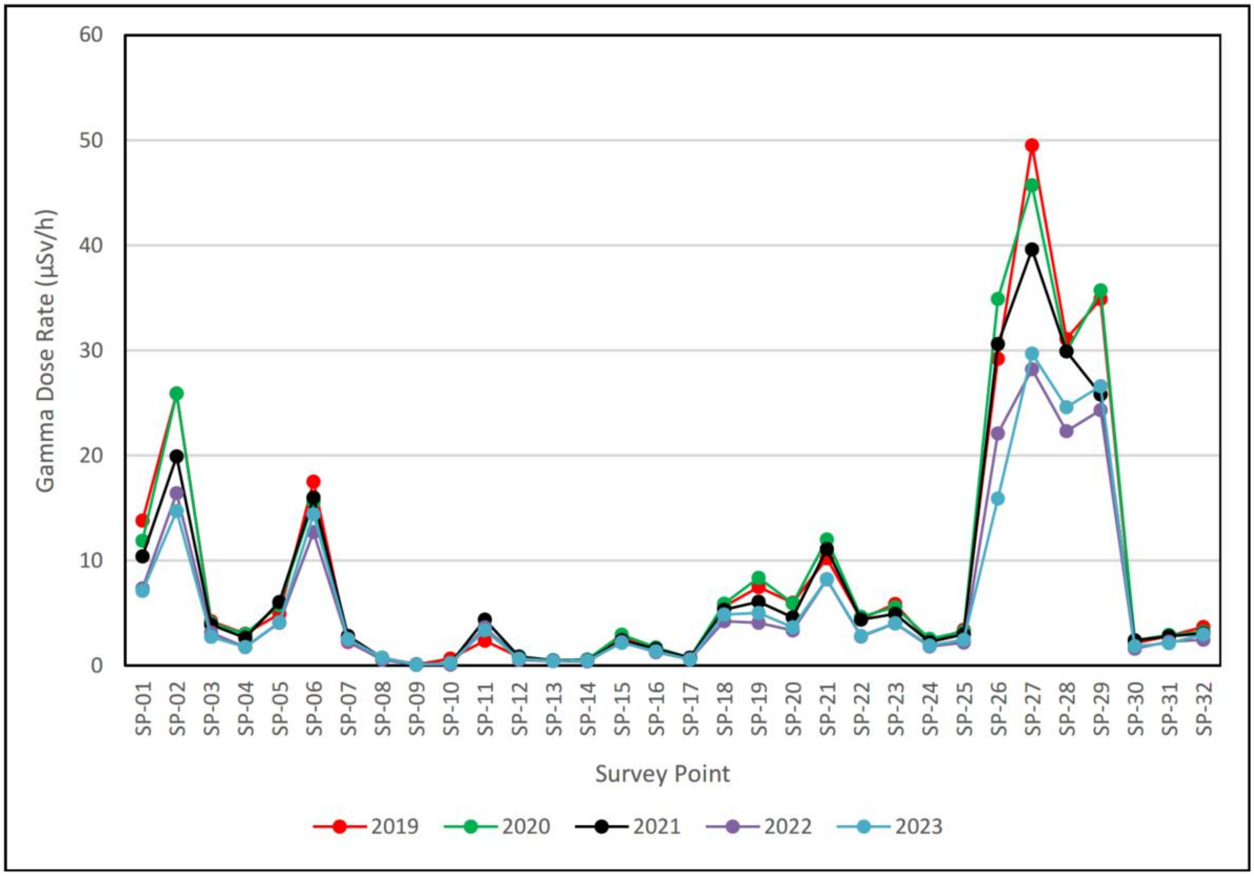


Figure 3-12 Gamma Dose Rates Within the Reactor Building (CNL 2024)

External Gamma Off of the DPWF Site:

According to BP (2023), BP measures ambient gamma levels in air at 10 monitoring stations, both on and off of the BP site. Monitoring also includes select locations that represent background conditions (shown on Figure 3-4 and Figure 3-5).

Table 3-10, reproduced from BP (2023), shows BP's gamma monitoring results for 2022. Figure 3-13, below, presents annual average gamma dose rates from 2013 to 2022. BP (2023) notes that: gamma rates have remained relatively constant from 2013 to 2022, BP and provincial background measurements show similar trends, and, gamma dose rates at the BP site are consistently below provincial background levels.

Table 3-10 2022 Annual External Gamma Dose Rate Measurements (BP 2023)

Location Type	Sample Location	Total Exposure Time (days)	Total Measured Dose in Air (μGy)	Annual Average Dose Rate in Air (ηGy/h)	Annualized Exposure (μGy)
Indicator	B02-TLD	380	493	54	474
Indicator	B03-TLD	379	463	51	446
Indicator	B04-TLD	380	407	45	391
Indicator	**Average**	**380**	**454**	**50**	**437**
Area Near	B05-TLD	379	413	45	398
Area Near	B07-TLD	379	410	45	395
Area Near	B10-TLD	380	538	59	517
Area Near	B11-TLD	379	509	56	491
Area Near	**Average**	**379**	**468**	**51**	**450**
Area Far	B06-TLD	379	417	46	402
Area Far	B08-TLD	379	401	44	386
Area Far	B09-TLD	379	394	43	380
Area Far	**Average**	**379**	**404**	**44**	**389**
Background	Bancroft	364	603	69	605
Background	Barrie	366	528	60	527
Background	Lakefield	364	545	62	547
Background	Niagara Falls	381	414	45	397
Background	North Bay	345	542	65	574
Background	Ottawa	368	389	44	386
Background	Thunder Bay	353	542	64	561
Background	Windsor	363	492	56	495
Background	**Average**	**363**	**507**	**58**	**511**

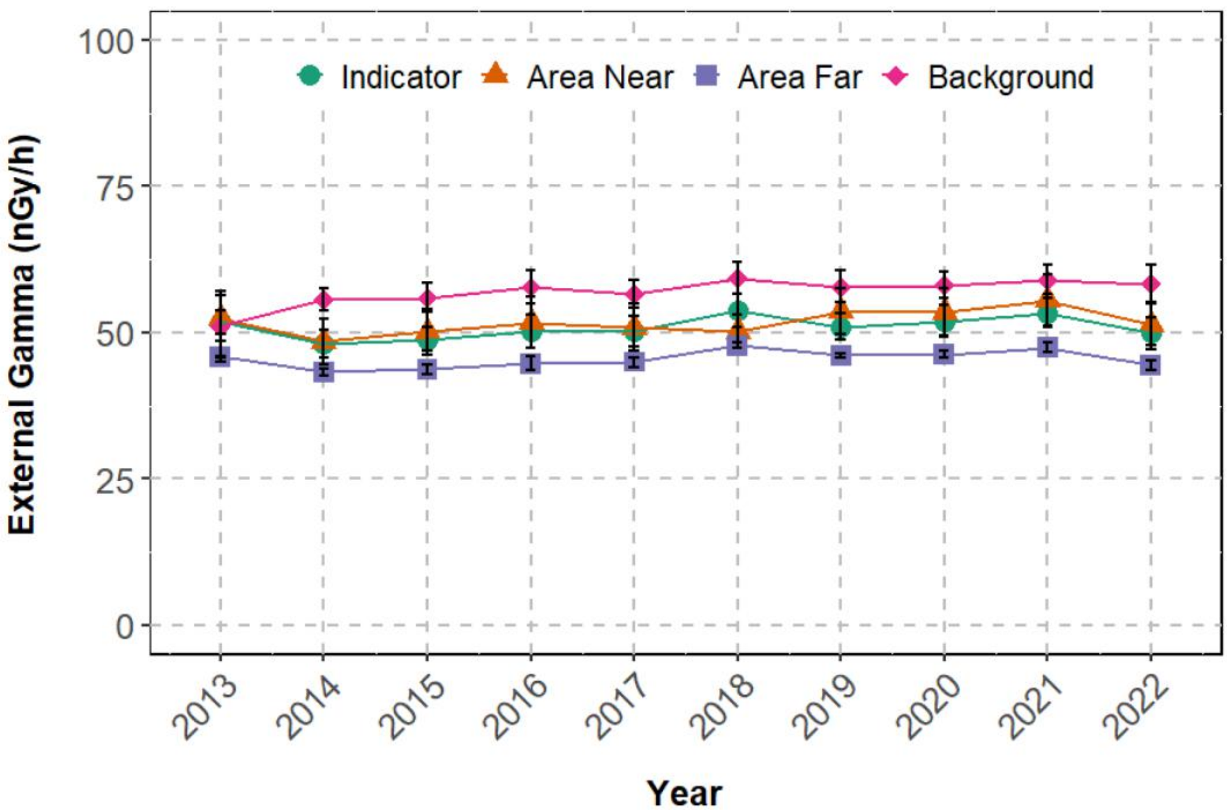


Figure 3-13 Annual Average External Gamma Dose Rates (2013 to 2022) (BP 2023)

3.1.2.4 Summary

DPWF Drainage Water (CNL 2016): The maximum tritium and total beta concentrations were less than their corresponding drinking water guideline values (GO 2003; HC 2022). The maximum total alpha concentration was slightly higher than its corresponding drinking water guideline value (GO 2003; HC 2022). Gamma emitters, such Co-60, Cs-137 and Sr-90, had concentrations less than detection limits. This drainage water is not used as a source of potable water, and once released into Lake Huron, would rapidly dilute even further. Data are from 2015.

Surface Water (Lakes, Streams and Ponds) (BP 2023): Annual average gross gamma concentrations were less than or very close to the critical level, and indistinguishable from background. Annual average tritium concentrations were below the corresponding drinking water guideline value (GO 2003; HC2022). Annual average gross beta concentrations were less than the CNSC guideline/screening level and less than the corresponding drinking water guideline value (HC 2022). Data are from 2022.

Municipal Water from Water Supply Plants off of the BP Site (BP 2023): Annual average tritium concentrations are less than the corresponding drinking water guideline value (GO 2003; HC 2022) (BP 2023). Annual average gross beta concentrations are similar to historical and provincial background levels (BP 2023). Data are from 2022.

Municipal and Residential Well Water off of the BP Site (BP 2023): When detectable, annual average tritium concentrations were less than the corresponding drinking water guideline value (GO 2003; HC 2022). Annual average gross beta concentrations at BR02 and BR32 were slightly higher than the background locations, but were only a fraction of the CNSC guideline/screening level (BP 2023), which is the same as the 1 Bq/L HC (2022) drinking water criterion. Gross gamma concentrations were less than or very close to the critical level, and indistinguishable from background. Data are from 2022.

Air (BP 2023): Annual average tritium oxide concentrations measured in air near the BP site are well below the CNSC guideline/screening level (BP 2023). Annual average C-14 concentrations measured on the BP site are higher than background, though concentrations measured off of the BP but near its boundary are only slightly higher than background (BP 2023). Data are from 2022.

Beach Sand Off of the BP Site (BP 2023): For Co-60 and Cs-134, annual average concentrations at the “area near” location were less than corresponding critical levels, or indistinguishable from background (BP 2023). For Cs-137, the concentration at the “area near” location was consistently very low, marginally higher than the average provincial background, and well below the CNSC guideline/screening level (BP 2023).

External Gamma on the DPWF Site (CNL 2024): CNL monitors gamma rates at the spent fuel storage area (contact dose rates) and inside of the Reactor Building. At the spent fuel storage area, contact gamma rates from 2019 to 2023 have been less than ~2 µSv/hr; there have been no significant change in gamma rates over time and the dose rates are less than the design dose rate limit of 10 µSv/h (CNL 2024). Gamma dose rates inside the Reactor Building are due to the calandria and bioshield, however this gamma radiation is not expected to escape through the building’s roof or exterior walls. This is confirmed by the fact that annual gamma surveys of the dousing tank, located near the ceiling, have not indicated any gamma radiation fields.

3.1.3 Exposure Pathways

Based on the descriptions in Section 2.2, the main radionuclide releases from the DPWF are as follows:

- Airborne effluent - discharged in batches (not continuously) via the Main Stack, which uses a HEPA filtration system (CNL 2021a); and,
- Liquid effluent - released to Lake Huron via the Main Outfall. Liquid releases are not continuous and are from the inactive drainage system, which conveys groundwater, stormwater, and floor drain water from non-contaminated zones (see Section 2.2.8.5).

Based on these releases, the following potential exposure pathways are considered relevant for human receptors (from Athauda-Arachchige 2018):

- Air inhalation;
- Air immersion;
- Surface water ingestion;
- Surface water immersion;
- Soil ingestion (incidental);
- Soil external (ground shine);
- Terrestrial animal ingestion;
- Terrestrial plant ingestion;
- Aquatic animal ingestion;
- Aquatic plant ingestion;
- Sediment ingestion (incidental);
- Sediment external;
- External gamma.

Groundwater on the DPWF and BP Sites

Groundwater on the DPWF site is not used (including groundwater collected in the sumps). There are also no public receptors on the DPWF site. Therefore, there is no pathway through which public receptors could be exposed to groundwater on the DPWF site. Similarly, as shown in Figure 3-1, there are no public receptors located within the BP site that surrounds the DPWF site. Thus, there is no pathway through which public receptors could be exposed to groundwater on the surrounding BP site.

3.1.4 Conceptual Site Model

The 2022 BP ERA used the "Integrated Model for the Probabilistic Assessment of Contamination Transport" to model and calculate the radiation dose to human receptors. It covers all the exposure pathways in accordance with N288.1, including those listed above (BP 2022). The transport of radioactive material through various environmental media and food chains also follows guidance from N288.1-20 (CSA 2020), as shown in Figure 3-14.

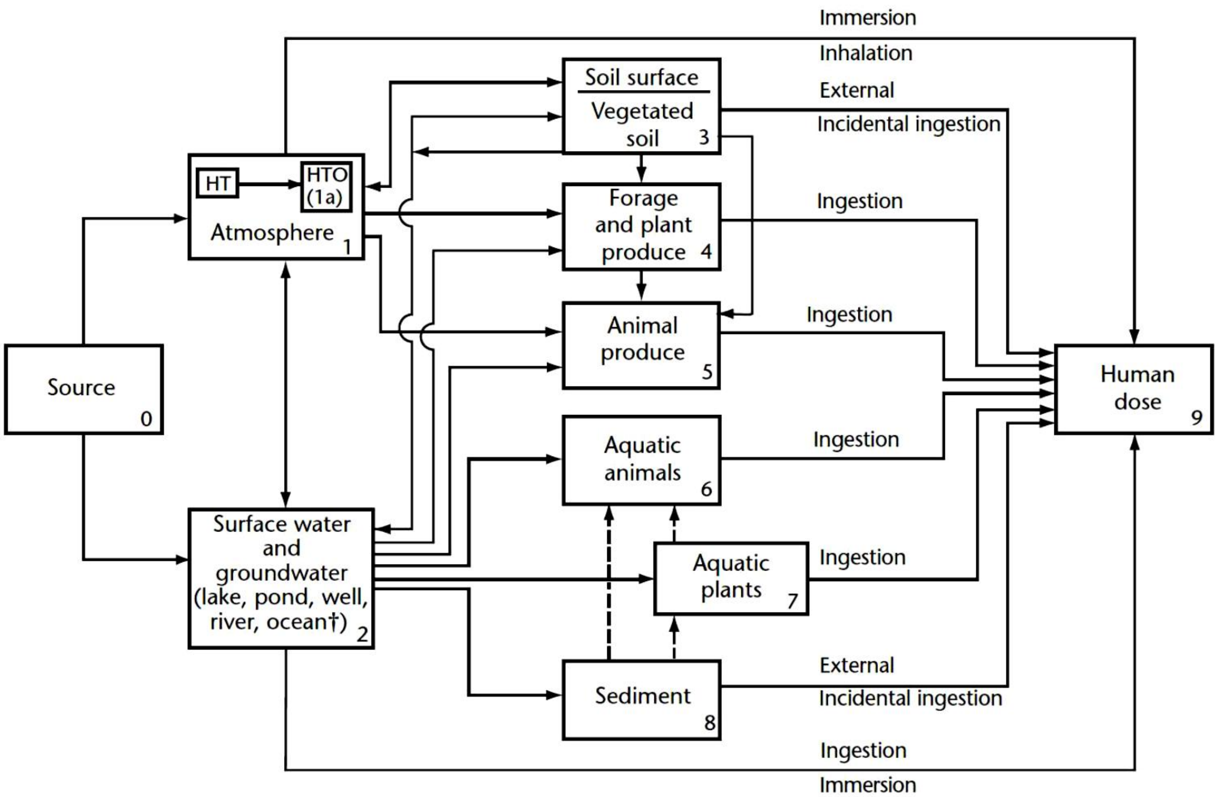


Figure 3-14 Human Health Conceptual Model (BP 2022)

3.2 Exposure Assessment

An assessment of radiological exposure to human receptors was carried out for the BP site, including the DPWF, as part of the BP ERA (BP 2022). Receptor characteristics, equations, and exposure parameters (e.g., DCs, inhalation rates, etc.) were obtained from CSA Standard N288.1 (CSA 2020). Additional site-specific information on water usage and dietary intake for local residents was obtained from the 2021 Site Specific Survey (BP 2021). As described below, the BP ERA exposure assessment bounds the exposure assessment of the DPWF site, as follows:

- **Receptors:** The receptors evaluated in the BP ERA (BP 2022) are the same as those selected for the DPWF, in terms of diet, lifestyle and location.
- **EPCs:** In the BP ERA (BP 2022), EPCs were calculated for both average (average of annual averages) and upper-range (i.e., maximum of annual averages) concentrations of radioactive material in the environment using monitoring data from 2016-2020. These radiological monitoring data were collected at locations that would also capture releases from the DPWF. The BP ERA (BP 2022) acknowledges that it implicitly accounts for the DPWF's influence: "*while CNL, OPG and*

Hydro One were not explicitly involved in the assessment, the influence of these facilities is implicitly included in the assessment, particularly for surface water, given that it is not practical to isolate any potential effects from the Site as a whole" (BP 2022). It is noted that radiological data for environmental media at background locations were also collected and the background-subtracted concentrations were used in the BP ERA to represent incremental exposure (BP 2022). Provincial background levels in environmental media were derived using data from several towns and cities across Ontario, including Thunder Bay, Sudbury, North Bay, Parry Sound, Ottawa, Bancroft, Brockville, Lakefield, Barrie, Goderich, Grand Bend, Orangeville, Cobourg, Belleville, Kingston, Toronto, Etobicoke, Burlington, Sarnia, London, St. Catherines, Niagara Falls, Nanticoke, and Windsor.

- **Radionuclides:** The BP ERA (BP 2022) was carried out based on data collected during BP's annual environmental monitoring. In some cases, environmental monitoring provides estimates of mixed fission product iodines, gross alpha and gross beta/gamma, rather than individual radionuclides, in air and surface water. Gross measurements represent the total summed activity concentration of all radionuclides present in the sample. As discussed in the selection of COPCs section, the COPCs considered in the BP ERA encompass all the individual radionuclides released by DPWF, either as individuals (e.g., HTO, C-14) or as categories (e.g., mixed fission product iodines, gross beta/gamma or gross alpha) (BP 2022).

Gamma Radiation:

Measured gamma dose rates were presented in Section 3.1.2.3. CNL monitors gamma levels at two locations on the DPWF site (CNL 2024): on the spent fuel canisters; and, within the Reactor Building.

Regarding the spent fuel containers, contact dose rate measurements from 2019 to 2023 indicate that contact dose rates are less than about 2 μSv/h, which is less than CNL's design dose rate limit of 10 μSv/hr.

Gamma dose rates inside the Reactor Building are due to the calandria and bioshield, however this gamma radiation is not expected to escape through the building's roof or exterior walls. This is confirmed by the fact that annual gamma surveys of the dousing tank, located near the ceiling, have not indicated any gamma radiation fields.

Gamma radiation is attenuated by air, such that gamma radiation levels attributable to even large sources can become negligible several hundred metres from the source. Thus, the gamma dose rates measured near the spent fuel containers will further decrease with distance until reaching background levels.

Members of the public do not have access to the DPWF site. The nearest public receptors would be located off the DPWF and BP sites. At such a distance the gamma dose rates from the spent fuel containers would decrease to negligible levels. Therefore, no unacceptable risk is expected to off-site public receptors from gamma radiation from the DPWF.

3.3 Effects Assessment

The radiological benchmark used for this radiological DPWF HHRA is 1 mSv per year, based on the effective dose limits in the Canadian Nuclear Safety Commission's (CNSC's) Radiation Protection Regulations (CNSC 2000) for the member of the public.

3.4 Risk Characterization

The radiological risk characterization carried out in the BP ERA (BP 2022) evaluates risk to off-site human receptors from exposure to radiological releases from the BP site, which includes the DPWF. As discussed in Section 3.2, the BP site releases assessed in the BP ERA included air and liquid emissions from DPWF, and the receptors and exposure pathways included those relevant to DPWF.

The BP ERA estimated that radiation doses from the entire BP site to human receptors (i.e., members of the public residing in the area surrounding the site) are less than 1% of the CNSC effective dose limit for a member of the public (1 mSv/y) and less than the 10 µSv/y *de minimis* value (i.e., the dose below which the effects to humans are considered to be negligible or insignificant). The most exposed human receptor was the adult in a subsistence farm (BSF3), located near the intersection of Hwy 21 and Concession Road 4. The calculated average annual dose for the adult is 2.52 µSv/y with an upper range value of 3.28 µSv/y (BP 2022). The largest dose contributors for this receptor are ingestion of local produce (41% from C-14 and 12% from HTO) and ingestion of terrestrial animal products (23% from C-14). The BP ERA draws the following conclusion (BP 2022):

> *With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., concentrations reported as less than a detection limit) addressed in a conservative manner, there is no radiological risk to human health for members of the public resulting from normal operations on the Site.*

As shown in Section 2.5, the DPWF is only a small portion (0.59%) of the BP site, and results from the BP ERA are considered to be bounding of exposure from the DPWF. Since the calculated dose rates are well below the dose criteria for the BP site as a whole, it can therefore be concluded that no unacceptable radiological risk is expected to human health for members of the public resulting from current conditions at the DPWF.

3.5 Uncertainty

Uncertainty Related to N288.6 and N288.1 Versions

Some uncertainty is introduced by the fact that, while this DPWF ERA is prepared following the 2022 version of N288.6, it relies on analyses performed in the BP ERA (BP 2022) which was prepared to the prior version of N288.6 (i.e., 2012) and the 2018 version of N288.1 (the 2018 version of N288.1 is Update 3 of the 2014 version). The scope of this ERA is commensurate with the scale and complexity of the very low environmental risks associated with the DPWF, as such, the differences in the versions of these standards are unlikely to have any significant impact on the ERA's conclusions.

Problem Formulation

Receptor selection relies on information from recent studies performed for the DPWF and BP sites. These were prepared following CNL and BP's quality control programs (respectively) and are considered to be of good quality and recent enough to capture current conditions at and surrounding the site. Therefore, no significant uncertainties are identified in receptor selection.

COPC selection relies on information from CNL's current EMP for the DPWF (CNL 2021), from BP (2022) which encompasses the DPWF, and from a CNL memo (i.e., Athauda-Arachchige 2018) discussing the relevant radionuclides for the DPWF. These reports were prepared recently and following CNL and BP's quality control programs (respectively). This supporting information is considered to be of good quality and to reflect current site conditions and operating activities. Nevertheless, the following uncertainties are acknowledged, most of which are uncertainties that the BP ERA (BP 2022) acknowledges of its own assessment:

- **Use of effluent and environmental data reported as less than a detection limit:**

  Some measurement values in this report, and in the BP (2022) assessment relied upon by this report, are reported at the detection limit, which is also sometimes referred to as the minimum detection limit. This creates an initial uncertainty in the use of the measured data, i.e., the true measured value is between zero and the detection limit. BP (2022) followed methods for dealing with values less than the limits of detection according to CSA N288.4. In the calculation of exposure and dose, the most conservative assumption is to assume that the concentration is equal to the detection limit. In several cases this assumption was used because it is conservative. Where possible, BP (2022) also incorporated uncensored data below the detection limit. Where censored data are taken from supporting CNL documents, the detection limit is noted (where possible) and the value was assumed to be equal to the detection limit.

- **Use of a single radionuclide to represent a group of radionuclides (resulting in conservative overestimates)**

  In several cases radioactivity in airborne and waterborne releases are reported as gross beta/gamma and gross alpha. In BP (2022) – and in this DPWF ERA by relying on BP (2022) – specific radionuclides are used to conservatively represent each category of particulates. For example, Co-60 is used to represent all beta/gamma emitters. Co-60 was selected because it has greater dose conversion coefficients for external exposure than other expected contaminants. The assumption that the entire activity of beta/gamma is solely comprised of Co-60 is conservative because it overestimates the radiation dose, particularly via external exposure pathways due to its relatively high energy gamma emission.

[redacted]

Exposure Assessment

Exposure assessment relies on the results of the BP ERA (BP 2022), which includes the influence of the DPWF. The radionuclides assessed in the BP ERA (BP 2022) encompass those relevant to the DPWF. BP (2022) acknowledges the following uncertainties:

- **The assumption that site survey data and generic exposure factors apply to all receptors considered in this assessment:**

  The BP ERA (BP 2022) relies on BP's site-specific survey data as the basis for characterizing off-site human receptors (resident, farmer, dairy farmer, subsistence farmer and hunter/fisher). The BP ERA (BP 2022) explains that residents of the same type were modeled as having common local intake fractions. The BP ERA (BP 2022) also mentions that all other exposure factors (e.g., dietary intake rates) were assumed to be common among all receptors. This introduces some uncertainty in the analysis, as the individual receptors are not being modeled exactly as they are in reality. However, the exposure factors used are conservative based on CSA N288.1 guidance and local site survey data. Therefore, the resulting exposure and radiation dose estimates are more likely to be conservative overestimates (BP 2022).

  The BP ERA (BP 2022) specifically notes that, for the hunter/fisher receptor, which is representative of Indigenous groups near the BP Site, intake rates for wild game and fish were previously assumed to be 95th percentile results from the First Nations Food, Nutrition, and Environmental Study (FNFNES). However, surveys undertaken by BP from 2019 to 2021 demonstrated that the FNFNES results were overly conservative and have provided specific intake rates and local intake fractions of fish, wild game, and other foodstuffs. The BP ERA (BP 2022) mentions that incorporating these site-specific (local) results reduces its uncertainty and ensures that the assessment is representative of the characteristics of Indigenous residents in the area surrounding Site (BP 2022).

- **The use of average, non-location-specific radionuclide concentrations for the majority of environmental media, and, the use of modelling to determine concentrations that are not measured (resulting in conservative overestimates):**

  The BP ERA (BP 2022) acknowledges that not every receptor location has associated measured values for all of the environmental media used in the model (i.e., the concentration of radionuclides in air, soil, water, sediment, livestock, produce, etc.). When environmental media have fewer sampling locations or lower sampling frequency (e.g., foodstuffs), the BP ERA (BP 2022) calculates an average concentration for the entire area and uses it for each receptor location, which can result in increased uncertainty for receptor locations further away from the measured location (BP 2022).

The BP ERA (2022) mentions that, in the cases where measurements are not taken as part of BP's environmental monitoring, or measurements in environmental media are either below detection limits or indistinguishable from background, BP used modelling to estimate the environmental transport of radionuclides from the release points at the BP Site to each receptor location. The BP ERA (BP 2022) reviewed the ratio of its modeled versus measured concentration of tritium in air and found that their modelled values are generally overestimates of the concentrations at receptor locations by approximately a factor of two, which is generally conservative (BP 2022).

The BP ERA (2022) also mentions that, for the hunter/fisher receptor, there is uncertainty associated with the location that wild game and fish are caught. To conservatively manage this uncertainty, the BP ERA (BP 2022) uses average values from the most bounding location (Baie du Doré) to calculate concentrations of radionuclides in fish, , and the concentrations in wild game are based on average measured concentrations in deer tissue from samples collected on or near the BP site (BP 2022).

Effects Assessment

This section presents the CNSC public dose limit; no significant uncertainties are identified.

Risk Characterization

Risk characterization (i.e., calculating dose rates to receptors and comparing to the dose limit) relies on the results of the BP ERA (BP 2022), which includes the influence of the DPWF. As mentioned above, the BP ERA (BP 2022) was prepared recently and following BP's quality control program, it is considered to be of good quality and to reflect current site conditions and operating activities.

The BP ERA (BP 2022) addresses its uncertainties by using conservative assumptions and parameter values. As such, it is likely that its dose results are conservative overestimations. This overestimation results in doses that are less than 1% of the CNSC dose limit for members of the public and less than the 10 μSv/y *de minimis* value, the dose below which the effects to humans are considered to be negligible or insignificant (BP 2022).

4.0 RADIOLOGICAL ECOLOGICAL RISK ASSESSMENT

4.1 Problem Formulation and Conceptual Model

The objective of this radiological ecological risk assessment (DPWF EcoRA) is to assess radiological risk from the DPWF to ecological receptors. The assessment is for current conditions and uses monitoring data from 2016 to 2020 as presented in the BP ERA (BP 2022). Physical stressors are considered in Section 6.0.

The receptors, selection of COPCs, and exposure pathways to be assessed are presented below.

4.1.1 Receptors

Since the DPWF site shares the same wider environmental surroundings as the BP site, the reference organisms that the BP ERA (BP 2022) developed to represent this environment also apply to the DPWF. Thus, this DPWF ERA relies on the BP ERA's (BP 2022) reference organisms.

In the BP ERA (BP 2022), reference organisms were used in the radiological ecological assessment to apply exposure parameters (e.g., concentration ratios (CRs) and dose coefficients (DCs)) that are assumed to generally apply to a given set of biota. The reference organisms selected are consistent with the Ecological Risk from Ionizing Contaminants Assessment and Management (ERICA) Tool (ERICA Consortium 2023), which is the source of parameters and dose coefficients used in the assessment. The list of reference organisms used as receptors is as follows (BP 2022):

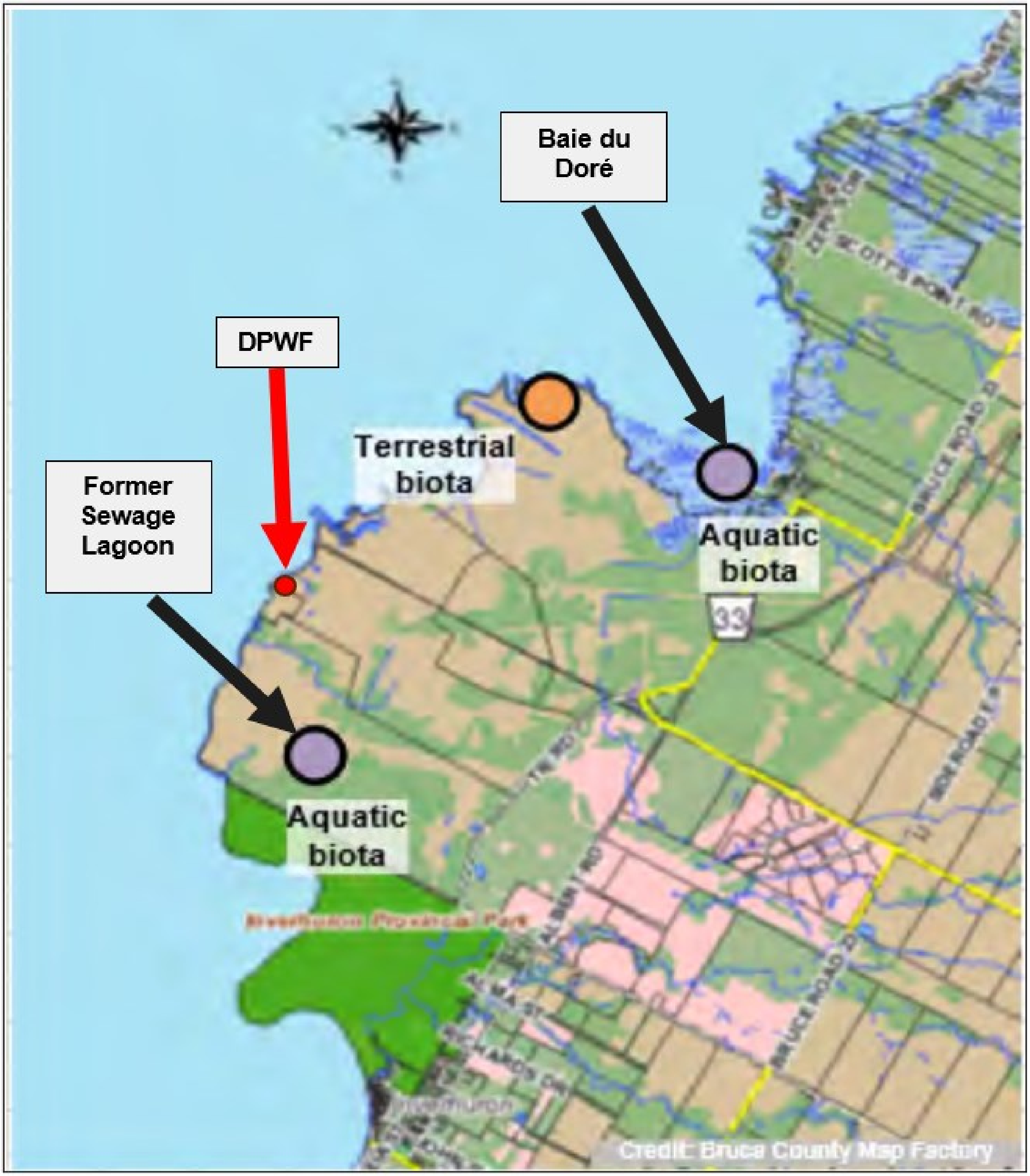
- Trees
- Grasses and Herbs
- Soil Invertebrates
- Small Mammal (conservatively represented by a small burrowing mammal assumed to spend 100% of its time underground, such as meadow vole)
- Large Mammal (represented by a deer)
- Bird (representative of all birds including those identified as SAR)
- Amphibian (representative of all amphibian and reptile including those identified as SAR)
- Aquatic plants (freshwater)
- Zooplankton
- Pelagic Invertebrates (freshwater)
- Benthic Invertebrates (freshwater)
- Benthic Fish (freshwater)
- Pelagic Fish (freshwater)

Figure 4-1, below, shows the locations chosen to assess ecological receptors in the BP ERA (BP 2022). The BP ERA (BP 2022) assumed that all terrestrial biota reside on-site, specifically, north of Bruce A. The BP ERA (BP 2022) chose this location because it is the location associated with the maximum measured on-site concentration of C-14 in air (excluding measurements from OPG's WWMF). This is a conservative selection. The only exception is large mammal (deer), for which the exposure assessment is based on opportunistic samples of deer collected near the Site (BP 2022). The BP ERA (BP 2022) assumed that aquatic biota reside in the Baie du Doré or the Former Sewage (commissioning waste) Lagoon (FSL). Despite being roughly 4 km from DPWF, Baie du Doré is the off-site location where the highest concentrations of tritium and gamma-emitting radionuclides are measured. Although pelagic fish do not consistently reside in Baie du Doré, benthic and pelagic fish are assumed to reside in Baie du Doré for the purpose of dose calculations to ensure the most conservative possible outcomes are presented. The FSL is included in the BP ERA (BP 2022) as an aquatic receptor location because it has higher tritium concentrations than Baie du Doré and has been identified as a fish habitat (BP 2022). However, the FSL is not relevant to the present DPWF EcoRA because there are no releases from the DPWF to the FSL. Therefore, Baie du Doré is the aquatic receptor location most relevant for this DPWF ERA.

Assessment and Measurement Endpoints

For the radiological EcoRA, the assessment endpoint is the same as that used in the BP ERA: "*protection of non-human biota from adverse effects on survival, growth, or reproduction, due to radiological contaminants"* (BP 2022). The absorbed radiation dose rate to non-human biota is the measurement endpoint used to determine radiological risk. Decision criteria in BP (2022) are based on established radiation dose benchmarks, such as those recommended in CSA N288.6-12 (CSA 2012), which are the same as those in CSA N288.6-22 (CSA 2022a).

Relevant SAR are represented among the reference organism groups used.



Notes:

Former Sewage Lagoon is not relevant to DPWF releases.

The location shown for the DPWF is approximate.

Figure 4-1 Ecological Receptor Locations (BP 2022)

4.1.2 Selection of Radiological COPCs for the Radiological EcoRA

4.1.2.1 Radionuclides Present at DPWF

According to Athauda-Arachchige (2018), the primary radionuclides associated with radioactive materials present within the DPWF, as relevant to ecological receptors, are:

For terrestrial biota:

- Tritium (H-3);
- C-14; and
- Cs-137.

For aquatic biota:

- Tritium (H-3);
- C-14;
- Co-60;
- Cs-134; and
- Cs-137.

4.1.2.2 COPCs Selected for the DPWF EcoRA

The COPCs for this DPWF EcoRA were selected based on data from BP's annual environmental monitoring, as summarized in the BP ERA (BP 2022).

In the BP ERA (BP 2022), the radionuclide groups selected for terrestrial biota are:

- Tritium (H-3);
- Noble gases;
- C-14;
- Cs-137 (representing gross beta/gamma radionuclides);
- Pu-239 (representing gross alpha radionuclides);
- I-131; and
- Noble gases.

The radionuclide groups considered for the aquatic biota in the BP ERA are (BP 2022):

- Tritiated water (HTO);
- Organically Bound Tritium (OBT);
- C-14;
- Cs-137 (representing gross beta/gamma radionuclides); and
- Pu-239 and Np-237 (representing gross alpha radionuclides).

Airborne and waterborne annual emissions data for the DPWF (and other facilities within the BP site) were presented earlier in Section 2.5. The information in Section 2.5 shows that the DPWF's emissions are generally a small fraction of BP's, and therefore, using the BP ERA's (BP 2022) exposure point concentrations implicitly accounts for the DPWF's contribution. The information in Section 2.5 also shows that the 2016-2020 emissions data used in the BP ERA (BP 2022) are still representative of more recent DPWF emissions (i.e., 2021 to 2023).

Table 4-1, below, compares the radionuclides chosen for this DPFW EcoRA (i.e., those assessed in the BP ERA (BP 2022)) to the radionuclides identified in Athauda-Arachchige (2018) as being relevant for the DPWF. Table 4-1 demonstrates that all relevant radionuclides identified by Athauda-Arachchige (2018) are encompassed by the radionuclide groups assessed in the BP ERA (BP 2022).

Table 4-1 Summary of Radionuclide COPCs for this DPWF EcoRA

Radionuclide COPC for Present DPWF EcoRA (Based on BP ERA Data (BP 2022))	Radionuclides Associated with DPWF (Based on Athauda-Arachchige, 2018)
Terrestrial Biota	
Tritium (H-3)	H-3
Noble Gases	N/A
C-14	C-14
I-131	N/A
Pu-239 (representing gross alpha radionuclides)	N/A
Cs-137 (representing gross beta/gamma radionuclides)	Cs-137
Aquatic Biota	
Tritiated water (HTO)	H-3
Organically bound tritium (OBT)	N/A
C-14	C-14
Pu-239 and Np-237 (representing gross alpha radionuclides)	N/A
Cs-137 (representing gross beta/gamma radionuclides)	Co-60, Cs-134, Cs-137 (representing any additional beta/gamma radionuclides)

Notes: N/A – Not measured/monitored at the DPWF for this effluent stream, but it is retained on the COPC list because it was assessed in the BP ERA, upon which the DPWF EcoRA results are based.

4.1.2.3 Examination of Available Radiological Environmental Data

Section 3.1.2.3 presented available data characterizing radionuclide concentrations in environmental media. Key information is summarized again here. Ecological receptors would not have direct access to groundwater, so data for that medium are not applicable to the radiological EcoRA.

DPWF Inactive Drainage System Water – Radionuclides (CNL 2016)

Tritium concentrations ranged from 50 Bq/L (outdoor catch basin) to 1,870 Bq/L (D6 sump, Reactor Building). It is important to note that ecological receptors would not have access to water in the Reactor Building sumps. For context, the No-Effect Concentration (NEC) for tritium in water is 12,600,000 Bq/L according to Chouhan *et al.*, (2009) or 9,000,000 Bq/L according to US DOE (2019).

Total alpha activity ranged from <0.18 Bq/L (i.e., non-detect) (outdoor catch basin) up to 0.636 Bq/L (outdoor road-side drainage ditch). Concentrations of Am-241 specifically, were less than the detection limit at all sample locations. For context, using Pu-239 as the representative alpha emitting radionuclide, the NEC for Pu-239 in water is 7 Bq/L, according to US DOE (2019).

Total beta activity ranged from about <0.38 Bq/L (i.e., non-detect) (outdoor catch basins and road-side ditch), up to 0.627 Bq/L (D6 sump within the Reactor Building). It is important to note that ecological receptors would not have access to water in the Reactor Building sumps. For context, using C-14 as the representative beta emitting radionuclide, the NEC for C-14 in freshwater is 8,450 Bq/L according to Chouhan *et al*., (2009).

Gamma emitters, such Co-60, Cs-137, Cs-134, had concentrations less than detection limits at all sample locations.

Surface Water (Lakes, Streams, Ponds) – Tritium, Gross Beta, Gross Gamma (BP 2023)

BP (2023) mentions that 2022 gross gamma results were less than or very close to the critical level, and indistinguishable from background.

Annual average tritium concentrations measured in lake water included 163 Bq/L near Baie du Doré (BM04), 9.8 Bq/L near Inverhuron (BM10), and 41.9 Bq/L near Hassenbach Bay (BM20) (see Figure 3-4 and Table 3-3). For context, as mentioned above, the NEC for tritium in water is 12,600,000 Bq/L according to Chouhan *et al*. (2009) or 9,000,000 Bq/L according to US DOE (2019).

Annual average gross beta concentrations measured near the BP site were found to be similar to those measured at the Cobourg (Lake Ontario) background location.

Beach Sand (BP 2023)

BP (2023) notes that for Co-60 and Cs-134, annual average concentrations at the “area near” location were less than corresponding critical levels, or indistinguishable from background. For Cs-137, the concentration at the “area near” location was consistently very low, marginally higher than the average provincial background.

External Gamma on the DPWF Site (CNL 2024):

Information characterizing external gamma dose rates was presented in Section 3.1.2.3. To summarize: CNL monitors gamma rates at the spent fuel storage area (contact dose rates) and inside of the Reactor Building.

At the spent fuel storage area, contact gamma rates from 2019 to 2023 have been less than ~2 µSv/hr; there have been no significant change in gamma rates over time and the dose rates are less than the design dose rate limit of 10 µSv/h (CNL 2024).

Gamma dose rates inside the Reactor Building are due to the calandria and bioshield, however this gamma radiation is not expected to escape through the building’s roof or exterior walls. This is confirmed by the fact that annual gamma surveys of the dousing tank, located near the ceiling, have not indicated any gamma radiation fields.

Exposure Pathways

As discussed in Section 3.1.3, the main radionuclide releases from the DPWF are from airborne releases from the Main Stack, and from liquid releases via the Main Outfall.

According to Athauda-Arachchige (2018), the relevant exposure pathways for the ecological receptors are (i) external exposure and (ii) internal consumption of contaminated foods. Physical stressors are considered in Section 6.0.

The external exposure pathways for terrestrial biota include:

- Air immersion (exposure from gaseous radionuclides in the air).
- Ground shine (exposure from radioactive particulate on the ground, primarily beta/gamma emitters such as Cs-137).
- Gamma radiation.

The external exposure pathways for aquatic biota include:

- Water immersion (primarily beta/gamma emitters such as Cs-137).
- Sediment external (exposure from radioactive particulate in sediment, primarily beta/gamma emitters such as Cs-137).

Internal exposure pathways for both terrestrial and aquatic biota are dominated by their food intakes, or water uptake for plants.

4.1.3 Conceptual Site Model

A conceptual site model outlining exposure pathways is shown in Figure 4-2 and Figure 4-3.

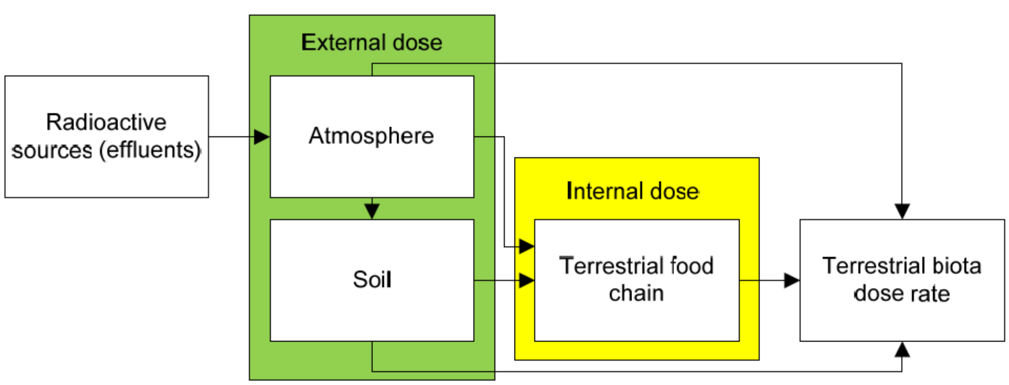


Figure 4-2 Exposure Pathways for Terrestrial Biota (BP 2022)

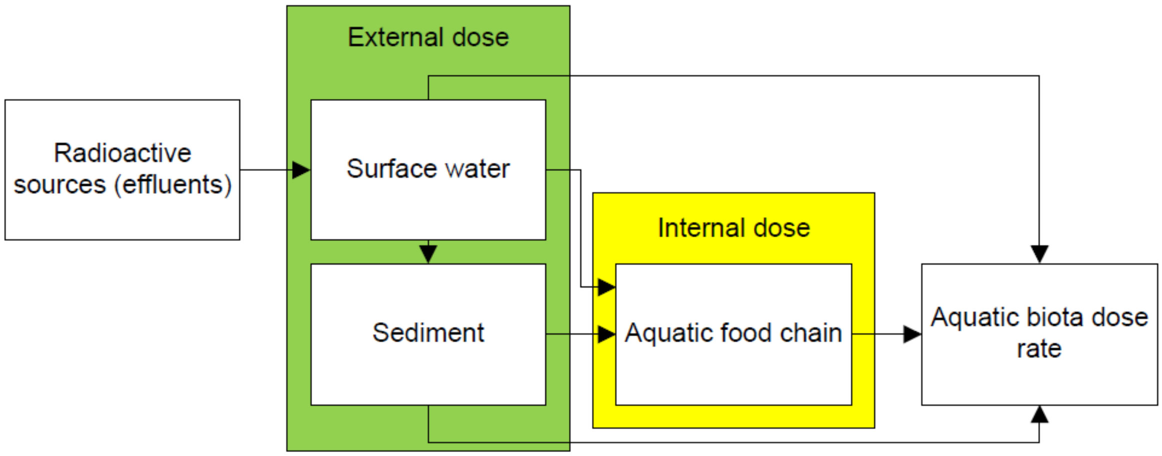


Figure 4-3 Exposure Pathways for Aquatic Biota (BP 2022)

4.2 Exposure Assessment

An assessment of radiological exposure to ecological receptors was carried out for the BP site, including DPWF, as part of the BP ERA (BP 2022). All CRs, DCs and occupancy factors in the BP ERA were obtained from the ERICA Tool and CSA Standard N288.1 (CSA 2017). The exposure assessment performed in BP (2022) follows the guidance and approach outlined in CSA N288.6-12 (CSA 2012). The results of the BP ERA bound the radiological exposure assessment of the DPWF, as follows:

- **Receptors:** The BP ERA selects and evaluates radiological risk to a set of reference organisms, which are expected to be representative of all the selected ecological receptors. For example, large mammal and small burrowing mammal are considered representative of the mammal receptors, including meadow vole, northern short-tailed shrew, red fox, muskrat, water shrew and American mink. Similarly, there is a bird receptor which is representative of birds such as mourning dove, American woodcock, short-eared owl, green-winged teal, spotted sandpiper, and belted kingfisher. The reference organisms considered in the BP ERA encompass those applicable to the present ERA for DPWF.
- **Receptor locations:** In the BP ERA, receptors are placed at the location(s) of maximum radionuclide concentrations:
  - Terrestrial biota are assumed to reside on the Site, specifically north of Bruce A, where the highest on-site concentrations of C-14 in air are measured, excluding locations in the immediate vicinity of the WWMF, which are excluded from this ERA and from the BP ERA but are assessed in OPG's 2021 WWMF ERA (EcoMetrix 2021). Also, the BP ERA's exposure assessment for large mammal (deer) is based on opportunistic samples of deer collected near the Site.
  - For aquatic biota, receptors were placed in the Baie du Doré (off-site) and the FSL (on-site), although FSL is not applicable to Douglas Point. This ensures that the exposure assessed bounds any actual exposure within the BP site, including from the DPWF.

- **EPCs:** In the BP ERA (BP 2022), all exposure point concentrations were taken or derived from data collected as part of radiological environmental monitoring. This included measured tissue concentrations for deer as well as pelagic and benthic fish, and on-site measurements of gamma-emitting radionuclides in soil. Air measurements were taken at locations across the BP site, including near DPWF. Surface water, sediment and fish measurements were taken from Lake Huron, Stream C, including Baie du Doré. Surface water measurements were also taken at FSL (on-site), although FSL is not applicable to Douglas Point. These measurements are expected to encompass all releases from the BP site, including from DPWF. It is noted that background-subtracted concentrations were used in the BP ERA; this is representative of incremental exposure (BP 2022).

- **COPCs:** As discussed in Section 4.1.2, the radiological COPCs considered in the BP ERA include all the individual radionuclides released by DPWF, either as individuals (e.g., HTO, C-14) or as categories (e.g., gross beta/gamma or gross alpha) for both terrestrial and aquatic biota. Among the beta/gamma-emitting radionuclides of Co-60, Cs-134 and Cs-137, only Cs-137 has been measured above detection limits in on-site soil, and sediment and fish samples in and around the Site. As a result, Cs-137 was chosen as the sole beta/gamma-emitting radionuclide for the EcoRA. The representative radionuclides for gross alpha radionuclides were selected based on the limiting (lowest) DRL calculations for both Bruce A and Bruce B and are represented by the selection of Np-237 and Pu-239 as representative alpha radionuclides.

Gamma Radiation:

Information characterizing external gamma dose rates was presented in Section 3.1.2.3. Nesting has not been observed near the spent fuel canisters. The main on-site biota that could potentially be exposed to gamma radiation are birds, namely sea gulls. CNL staff have periodically observed sea gulls nesting near the Reactor Building and Service Building, however no birds nest in the spent fuel storage canister area where outdoor gamma rates are measured.

Gamma radiation is attenuated by air, such that gamma radiation levels attributable to even large sources can become negligible several hundred metres from the source. Thus, gamma dose rates measured near the spent fuel containers will further decrease with distance until reaching background levels.

Based on the above, no unacceptable risk is expected to on-site or off-site ecological receptors from gamma radiation from the DPWF.

4.3 Effects Assessment

For ecological receptors, radiation dose benchmarks for quantitative effects assessment follow United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) (UNSCEAR 2008), consistent with N288.6-22 (CSA 2022a). These values are:

- 100 µGy/h (or 2.4 mGy/d) for terrestrial biota;
- 400 µGy/h (or 9.6 mGy/d) for aquatic biota.

Environment Canada/Health Canada (EC/HC 2003) also has a proposed benchmark for fish (0.5 mGy/d), which is approximately 20 times lower. This benchmark is used specifically for risk characterization for benthic and pelagic fish (BP 2022).

4.4 Risk Characterization

The radiological risk characterization carried out in the BP ERA (BP 2022) evaluates risk to on-site and off-site ecological receptors from exposure to radiological releases from the BP site. As discussed in Section 4.2, the BP site releases included air and liquid emissions from DPWF, and the receptors and exposure pathways included those relevant to DPWF.

The BP ERA (BP 2022) estimates that radiation doses from the entire BP site to ecological receptors are all below the dose limits, as follows:

- Terrestrial Biota – the highest calculated dose rate is to small mammals which is still much less than the corresponding benchmark (0.1%). Dose rates to all other terrestrial biota are even lower, less than 0.1% of their corresponding benchmarks;
- Aquatic Biota (Baie du Doré) – for all aquatic biota, calculated dose rates were a small fraction of their corresponding benchmark values. The highest calculated dose rate was to benthic invertebrates (2.09E-04 mGy/d), which is 0.002% of the corresponding benchmark. Dose rates to benthic and pelagic fish are less than 0.001% of the EC/HC (2003) benchmark.

Risk results do not separately evaluate biota that are identified as SAR (some species in the amphibian and bird categories). There is no clear guidance on the use of radiological benchmarks for the assessment of SAR. For non-radiological contaminants, ecological species are assessed at the individual level by using the No-Observed-Adverse-Effect-Level (NOAEL) benchmark over the Lowest-Observed-Adverse-Effect-Level (LOAEL) benchmark (for birds/mammals). When a NOAEL is not available, a factor of 10 is usually applied to the LOAEL to calculate a corresponding NOAEL (Sample *et al*. 1996). A similar methodology could be applied to the radiological benchmarks to assess at the individual as opposed to the population level, by dividing the benchmark by a factor of 10. As the estimated doses for bird and amphibian are both below 10% of the benchmark, dose rates for SAR would remain below the adjusted benchmark if a safety factor of 10 was applied.

The BP ERA concluded that there is no unacceptable radiological risk to non-human biota (both terrestrial and aquatic) resulting from normal operations on the BP site (BP 2022). Since the BP ERA calculations are considered to be bounding of exposure to releases from the DPWF, it can therefore be concluded that there is no unacceptable radiological risk to ecological receptors resulting from current conditions at DPWF. Furthermore, as discussed in Section 3.4, based on data from Appendix J of the BP ERA, releases from the DPWF are typically a small percentage of releases from the entire BP site. In air, the DPWF contributes less than 1% of the total from the BP site. In water, the contribution from the DPWF is a greater percentage of the total. However, since the calculated dose rates are well below the dose criteria for the BP site as a whole, it can therefore be concluded that no unacceptable radiological risk is expected to non-human biota resulting from current conditions at DPWF.

Gamma Radiation:

As outlined in Section 4.2, no unacceptable risk is expected to on-site or off-site ecological receptors from gamma radiation from the DPWF.

4.5 Uncertainty

Uncertainty Related to N288.6 and N288.1 Versions

This uncertainty is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

Problem Formulation

Receptor selection relies on information from BP (2022) (which encompasses the DPWF) to identify reference organisms. BP (2022) was prepared following BP's quality control programs and is considered to be of good quality and recent enough to capture current conditions at and surrounding the site. Therefore, no significant uncertainties are identified in receptor selection.

COPC selection relies on information from CNL's current EMP for the DPWF (CNL 2021a), from BP (2022) which encompasses the DPWF, and from a CNL memo (i.e., Athauda-Arachchige 2018) discussing the relevant radionuclides for the DPWF. These reports were prepared recently and following CNL and BP's quality control programs (respectively). This supporting information is considered to be of good quality and to reflect current conditions and operating activities.

The main sources of uncertainty in problem formulation are as follows (based on the discussions in BP 2022):

- **Use of effluent and environmental data reported as less than a detection limit:**

  This uncertainty, and how it is addressed, is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

- **Use of a single radionuclide to represent a group of radionuclides (resulting in conservative overestimates):**

  The BP ERA (BP 2022) acknowledges that among the beta/gamma-emitting radionuclides of Co-60, Cs-134 and Cs-137, only Cs-137 has been measured above detection limits in soil in on the BP site, and in sediment and fish samples in and around the BP site (BP 2022). As a result, the BP ERA (BP 2022) uses Cs-137 to represent beta/gamma-emitting radionuclides for the BP (2022) EcoRA.

  The BP ERA (BP 2022) selected the representative radionuclides for gross alpha based on the limiting (lowest) DRL calculations for both Bruce A and Bruce B. BP also conducted a literature review of alpha dosimetry in non-human biota to validate the selection of specific representative alpha radionuclides for the EcoRA. From this, it was determined that CR among potential representative alpha radionuclides vary significantly for different radionuclide-biota pairs. Other parameters (e.g., dose coefficients) were identified as being less variable, and were represented by the selection of Np-237 and Pu-239 as representative alpha radionuclides. Therefore, the calculation approach was modified such that the greatest CR value among all potential alpha radionuclides was used for evaluating alpha dose to each species. The BP ERA (BP 2022) concluded that this approach represents conservative management of uncertainty associated with the selection of representative alpha-emitting radionuclides (BP 2022).

Section 4.1.2 of this DPWF ERA compares radionuclides and shows how the BP ERA's radionuclide selection appropriately captures all radionuclides relevant to the DPWF.

Exposure Assessment

Exposure assessment relies on the results of the BP ERA (BP 2022), which includes the influence of the DPWF. The radionuclides assessed in the BP ERA (BP 2022) encompass those relevant to the DPWF.

The main sources of uncertainty in the BP (2022) radiological exposure assessment for ecological receptors are as follows:

- **Use of effluent and environmental data reported as less than a detection limit:**

  This uncertainty, and how it is addressed, is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

- **The use of modelling to determine concentrations that are not measured (resulting in conservative overestimates):**

  This uncertainty, and how it is addressed, is applicable to both the radiological HHRA and radiological EcoRA. See Section 3.5 for discussion.

- **Use of 100% occupancy factors for biota with no available measurements of tissue concentrations (resulting in conservative overestimates):**

  In the BP ERA (BP 2022), all terrestrial and aquatic biota were assumed to be exposed to the maximum radionuclide concentrations found on or near the BP site, for the entire year – unless measurements of radioactivity in tissue were incorporated (e.g., deer and fish). The BP ERA (BP 2022) notes that this is a very conservative assumption, given the migratory nature of these species and that their home range size is much larger than the spatial area where the maximum radionuclide concentrations are observed. The conservatism of this approach is evidenced by the dose rate to fish in Baie du Doré and deer killed in the vicinity of the site, for which measured tissue concentrations are used, resulting in significantly lower tissue concentrations than those conservatively estimated based on CRs and constant exposure to maximum concentrations (BP 2022). A small number of tissue measurements are available for other species (e.g., beaver, coyote) which similarly show that measured tissue concentrations are less than calculated tissue concentrations (BP 2022).

- **The use of generic CRs for reference organisms to quantify the uptake of radionuclides through the food chain:**

  This assessment, by relying on BP (2022), makes use of CRs to relate the concentration of radionuclides present in the environment to the concentration of radionuclides present in biota tissue, for the purposes of calculating internal dose. The BP ERA (BP 2022) mentions that, consistent with the recommendations of CSA N288.6 (CSA 2022a), CSA N288.1 (CSA 2020) and the ERICA Tool, generic CRs were used given that site-specific CRs are not available. The use of generic CRs for representative species provides an approximate relationship between environmental and tissue concentrations but does not consider any special food-chain relationships that may exist (BP 2022).

The BP ERA (BP 2022) mentions that, aside from measured radioactivity in deer tissue, measurements of C-14 in air and C-137 in soil were incorporated into the exposure assessment for terrestrial biota. For all other radionuclide concentrations, CRs were used in the dose rate calculations, which generally results in a more conservative assessment (BP 2022).

Effects Assessment

Benchmarks are based on effects to non-human biota correlating to the following endpoints: morbidity, mortality or reproduction. The BP ERA (BP 2022) acknowledges that since the specific dose rate associated with each effect can vary by an order of magnitude, there is a large degree of uncertainty in the benchmarks.

Table 4-2, reproduced from the BP ERA (BP 2022), presents the radiological benchmarks mentioned in CSA N288.6 (CSA 2022a). The UNSCEAR benchmarks - which are recommended by N288.6 - are at the lower bounds of the range of potential dose rates that may lead to adverse effects to non-human biota and are therefore deemed to be conservative (BP 2022). The BP ERA (BP 2022) notes that the EC/HC (2003) benchmark for fish is considerably lower than the UNSCEAR benchmark for aquatic biota, therefore, the benchmarks chosen in the BP ERA (2022) – and in this DPWF ERA by relying on the BP ERA - are those from UNSCEAR *with* the EC/HC (2003) benchmark specifically for fish. This is a conservative approach.

Table 4-2 Comparison of Radiological Effects Benchmarks in CSA N288.6 (BP 2022)

Organization	Biota	Dose Rate (mGy/d)
United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 2008) *(recommended by CSA N288.6 (CSA 2022a))*	Terrestrial	2.4
	Aquatic	9.6
Advisory Committee on Radiation Protection (ACRP 2022)	All	3
Environment Canada and Health Canada (EC/HC 2003)	Invertebrates	5.4
	Fish	0.5
	All others	2.7

The BP ERA (BP 2022) acknowledges an additional uncertainty in the radiological effects assessment, which is organisms' sensitivity to radiation at early life stages. The BP ERA (BP 2022) mentions that while it is generally acknowledged that species have a greater radio-sensitivity during early life stages, current radiological benchmarks for non-human biota do not explicitly account for this. However, as outlined in the BP ERA's (BP 2022) exposure assessment, a benthic invertebrate representative receptor could also represent exposure of pelagic fish larva and insects.

Risk Characterization

Risk characterization (i.e., calculating dose rates for reference organisms and comparing to dose rate criteria) relies on the results of the BP ERA (BP 2022), which includes the influence of the DPWF. As mentioned above, the BP ERA (BP 2022) was prepared recently and following BP's quality control program, it is considered to be of good quality and to reflect current conditions (both on-site and off-site) and operations.

The BP ERA (BP 2022) addresses its uncertainties by using conservative assumptions and parameter values. This means the results are likely an overestimate of dose and risk. This overestimation based on conservative assumptions still results in dose results that are much less than corresponding benchmarks.

5.0 HUMAN HEALTH RISK ASSESSMENT FOR CHEMICALS AND PHYSICAL STRESSORS

5.1 Problem Formulation and Conceptual Model

The objective of this non-radiological DPWF HHRA is to assess non-radiological risk from the DPWF, to human receptors. The assessment is for current conditions and uses information from the 2022 BP ERA (BP 2022).

The receptors, selection of COPCs, and exposure pathways to be assessed are presented below.

5.1.1 Receptors

It is important to note that, as discussed in the next Section (Section 5.1.2), no chemical COPCs were retained for further analysis. Therefore, detailed receptor mapping is not warranted. Nevertheless, the following summary of potential receptors is provided for completeness.

It is important to note that the only people expected to be present on-site for extended periods of time are those that are workers. The health and safety of on-site workers is regulated, and there are a number of health and safety programs/protocols in place for the Site. Additionally, as described in CSA Standard N288.6-22 (CSA 2022a), assessment of on-site workers is not typically incorporated into risk assessments under the Standard. Strict compliance with all applicable occupational health and safety protocols was assumed and as a result, on-site workers were not assessed in the HHRA.

Human receptors for the present non-radiological DPWF HHRA were selected based on the non-radiological HHRA receptors presented in the BP ERA (BP 2022), with consideration also given to those mentioned in Athauda-Arachchige (2018). The BP non-radiological HHRA (BP 2022) mentions that its human receptors were selected based on the known current and likely future uses of the site (BP site) and its surrounding area, as described in BP's 2021 *Bruce Power Site Specific Survey Report* (BP 2021), and that they remain unchanged from the prior iteration of the BP ERA completed in 2017.

It is important to note that the BP ERA (BP 2022) excludes visitors to the OPG-operated lands from its assessment; this DPWF ERA similarly excludes such visitors from assessment.

- **Members of Indigenous communities:**

  The nearest Indigenous communities are:

  - Chippewas of Saugeen First Nation Reserve No. 29, located adjacent to the community of Southampton on the shoreline of Lake Huron approximately 25 km from the BP site); and,
  - Chippewas of Nawash Unceded First Nation Cape Crocker Reserve No. 27, located on the north side of Colpoy's Bay and the east shore (Georgian Bay) of the Bruce Peninsula north of the town of Wiarton, approximately 70 km from the BP site.

Members of the Metis Nation of Ontario (MNO) and the HSM may also reside in the area around the site.

[redacted]

- **Local residents:**

  Local residents include people who live at the nearest homes, including farms and cottages if they are used year-round. These residents include:

  - non-farm residents;
  - farm residents;
  - subsistence farm residents; and
  - dairy farm residents.

  Potential pathways of exposure considered in the HHRA include inhalation of ambient air (represented in the BP ERA (BP 2022) by air concentrations calculated at the BP site property boundary), consumption of drinking water (represented by shallow residential wells or treated water from local municipal supplies), and direct contact with surface water (represented by offshore surface water at Lake Huron including off the Bruce A and Bruce B discharges).

- **Seasonal Users:**

  The BP ERA (BP 2022) also identifies seasonal cottagers and campers at nearby parks. There are provincial parks located along the shores of Lake Huron, including Inverhuron Provincial Park that borders the BP site to the south. Potential pathways of exposure considered for seasonal users include inhalation of ambient air (represented in the BP ERA (BP 2022) by calculated ambient air concentrations at the BP site property boundary), consumption of drinking water (represented by shallow residential wells or treated water from local municipal supplies), and direct contact with surface water (represented by off-shore surface water at Lake Huron including off the Bruce A and Bruce B discharges), while swimming in recreational areas along Lake Huron.

- **Bruce Eco-industrial Centre Workers**

  In the BP ERA (BP 2022), this receptor group includes people who work at the Bruce Eco-Industrial Park and are nearby off-site workers. The BP ERA (BP 2022) indicates that their exposure is bounded by the other receptors listed above and therefore was not considered further (BP 2022).

5.1.2 Selection of Chemical COPCs for Non-Radiological HHRA

Based on the hazardous substances present at the DPWF, Athauda-Arachchige (2018) identifies the following chemicals as potential COPCs for this DPWF HHRA:

- Lead;
- Mercury; and,
- Polychlorinated Biphenyls (PCBs).

CNL (2021a) considered the potential presence of these materials and concluded that there are no significant non-radiological hazardous contaminant source terms in the remaining DPWF buildings. Lead-based paint is present, as are lead blocks in the Reactor Building. Mercury may be present in instrumentation switches, and PCBs may be present in light ballasts (CNL 2021a). Given their forms, it is unlikely that these chemicals would be released in significant quantities.

In addition, based on environmental concentrations in surface water (which is the main pathway of exposure for human receptors), Athauda-Arachchige (2018) identifies the following chemicals as potential COPCs in Lake Huron:

- Phosphorus: only a concern from an algal growth perspective;
- Aluminum;
- Mercury; and,
- Morpholine.

The BP ERA conducted a chemical screening for its HHRA in which contaminant concentrations across the BP site, including lead, mercury, PCBs, phosphorus, aluminum, mercury and morpholine, were compared to screening criteria. Based on maximum BP site-wide environmental concentrations, which encompass DPWF concentrations:

- **Air:** the BP ERA (BP 2022) identified no hazardous chemical COPCs in air. As noted above, under normal operations, the chemicals relevant to the DPWF (i.e., lead, mercury and PCBs) have negligible airborne releases due to their waste forms. CNL shares DPWF annual monitoring data with BP with the understanding that it is factored into BP's ERAs.

- **Soil:** As noted above, under normal operations, the chemicals relevant to the DPWF (i.e., lead, mercury and PCBs) have negligible airborne releases (and subsequent deposition to soil) due to their waste forms. Therefore, there are no pathways that lead to offsite soil contamination by these COPCs.

In the BP ERA (BP 2022), potential human receptor exposure to hazardous chemical COPCs from the BP site, in offsite soil (i.e., soil beyond the BP site, and thus also beyond the DPWF site), was not retained for further assessment.

- **DPWF Inactive Drainage System Water:** The DPWF's inactive drainage system is described in Section 2.3.8.5. It collects drainage water from roof drains, catch basins, roadside drainage ditches, and building foundation drains. CNL (2016) sampled water from three outdoor catch basins, a road-side drainage ditch, and 2 of the Reactor Building's foundation drainage sumps (D3 and D6) and sent the samples for chemical analysis. Results are as follows:

  - **Mercury** was non-detect in all samples, using a detection limit of 5 ng/L.

  - **Lead** was non-detect in all but one sample, using a detection limit of 0.004 mg/L. The one sample with detectable concentrations (0.014 mg/L) was from outdoor catch basin 1, which drains the parking lots. Lead detected in this drainage water is most likely from the parking lot.

  - **PCBs** were non-detect in all samples, using a detection limit of <0.1 μg/L.

  - **Morpholine** is not produced by the DPWF because the DPWF has no process effluent. There is no indication that morpholine would be present in the DPWF's only liquid releases, which are of water from the inactive drainage system.

  - **Phosphorus** concentrations were non-detect (<0.019 mg/L) in the D3 and D6 Reactor Building sumps and road-side drainage ditch. Phosphorus concentrations in the 3 outdoor catch basins ranged from 0.047 mg/L to 0.3 mg/L. These concentrations are less than the 97.5th percent Ontario background concentration of 7.97 mg/L (OMOE 2011).

  - **Aluminum** concentrations in the D3 and D6 sumps (Reactor Building) ranged from 0.039 to 0.031 mg/L. Aluminum concentrations in the 3 outdoor catch basins were to 0.155 mg/L, 2.65 mg/L, and 4.17 mg/L. The concentration in the road-side drainage ditch was 0.044 mg/L. For context, the HC (2021) drinking water criterion for aluminum is 2.9 mg/L, and the CCME (1987) water quality guideline for protection of agriculture is 5 mg/L. All but the one catch basin sample are less than the drinking water criterion, though water from this drainage system is not used as potable water.

  It is important to note that drainage effluent is not directly accessed by human receptors. And furthermore, concentrations in drainage effluent would be further diluted once the drainage water discharges to Lake Huron.

- **Surface Water (Lake Huron):** Maximum measured concentrations of lead and aluminum among Lake Huron samples were less than their corresponding benchmark values (BP 2022).

Morpholine was not detected in Lake Huron surface water samples using a detection limit of 0.004 mg/L which is equal to the corresponding benchmark value (BP 2022).

Mercury was not detected in any Lake Huron surface water samples using a detection limit of 0.1 µg/L, which is less than corresponding HHRA benchmark values. Mercury has not been detected since 2017 (BP 2022).

Regarding phosphorus, concentrations exceeding the benchmark value (>20 µg/L; based on avoiding nuisance algae issues) were only detected in December 2018 and October 2020. Studies along the Lake Huron shoreline have identified that agricultural land uses are a significant source of phosphorus to Lake Huron (BP 2022). BP (2022) notes that BP's discharges from the past 5 years have met their environmental compliance approval objective, supporting the rationale that phosphorus concentrations are not due to releases from the BP or DPWF sites.

Lake Huron surface water samples were not analyzed for PCBs, however, as mentioned above, in 2015 CNL sampled water from the DPWF's inactive drainage system and analyzed the samples for PCBs. PCBs were non-detect in all samples, using a detection limit of 0.1 µg/L (CNL 2016).

Therefore, none of the chemical COPCs relevant to the DPWF were screened-in for surface water in relation to recreational use by humans (i.e., incidental ingestion and dermal contact with surface water while swimming).

- **Groundwater on the DPWF Site:** On site groundwater - i.e., groundwater on the *DPWF site* - is not used as a potable water source (CNL 2023c). As outlined earlier, human receptors for the HHRA are located off of the DPWF site, upgradient in terms of the general direction of groundwater flow. Therefore, there is no exposure pathway through which off-site human public receptors would come into contact with on-site groundwater.

- **Offsite Groundwater (Shallow Drinking Water Wells):**
    - *Groundwater off of the DPWF site but within the BP site:* The BP ERA (BP 2022) mentions that this groundwater is not used as a potable source for the on-site worker receptors assessed in that ERA. The BP ERA (BP 2022) also mentions that there is no complete exposure pathway by which human receptors may come into contact with this groundwater.

    - *Groundwater beyond the BP site:* Lead, mercury and PCBs were not identified in off-site shallow residential drinking water wells, or in local drinking water treatment plants (BP 2022). It is important to note that the general direction of groundwater flow is from the site toward Lake Huron, whereas offsite human receptors are located further upgradient from the BP site. Also, as noted above, under normal operations, chemicals relevant to the DPWF (i.e., lead, mercury and PCBs) are unlikely to have significant airborne releases (and subsequent deposition to soil and transport into groundwater) due to their waste forms.

Therefore, based on the screening above, none of the chemical contaminants relevant to the DPWF (i.e., lead, mercury, PCBs, phosphorus, aluminum, and morpholine) are retained for further analysis. Diesel is discussed separately below.

Diesel:

In follow-up to strong petroleum odours noted during recent decommissioning-related excavation work in the DPWF's former tank storage area, CNL arranged for a Phase 2 Environmental Site Assessment to be completed (CNL 2023a). This is a paved area next to the storage area of the Turbine Building which historically contained 3 diesel underground storage tanks which were emptied and removed approximately 30 years ago. There were no documented spills in this area.

The study included borehole and groundwater monitoring well installation, sampling of soil and groundwater, and laboratory analysis for petroleum hydrocarbon related contaminants (WSP 2023).

Figure 5-1 shows the locations of boreholes, monitoring wells, soil samples, and groundwater samples. Figure 5-2 shows soil analysis results. Figure 5-3 shows groundwater analysis results.

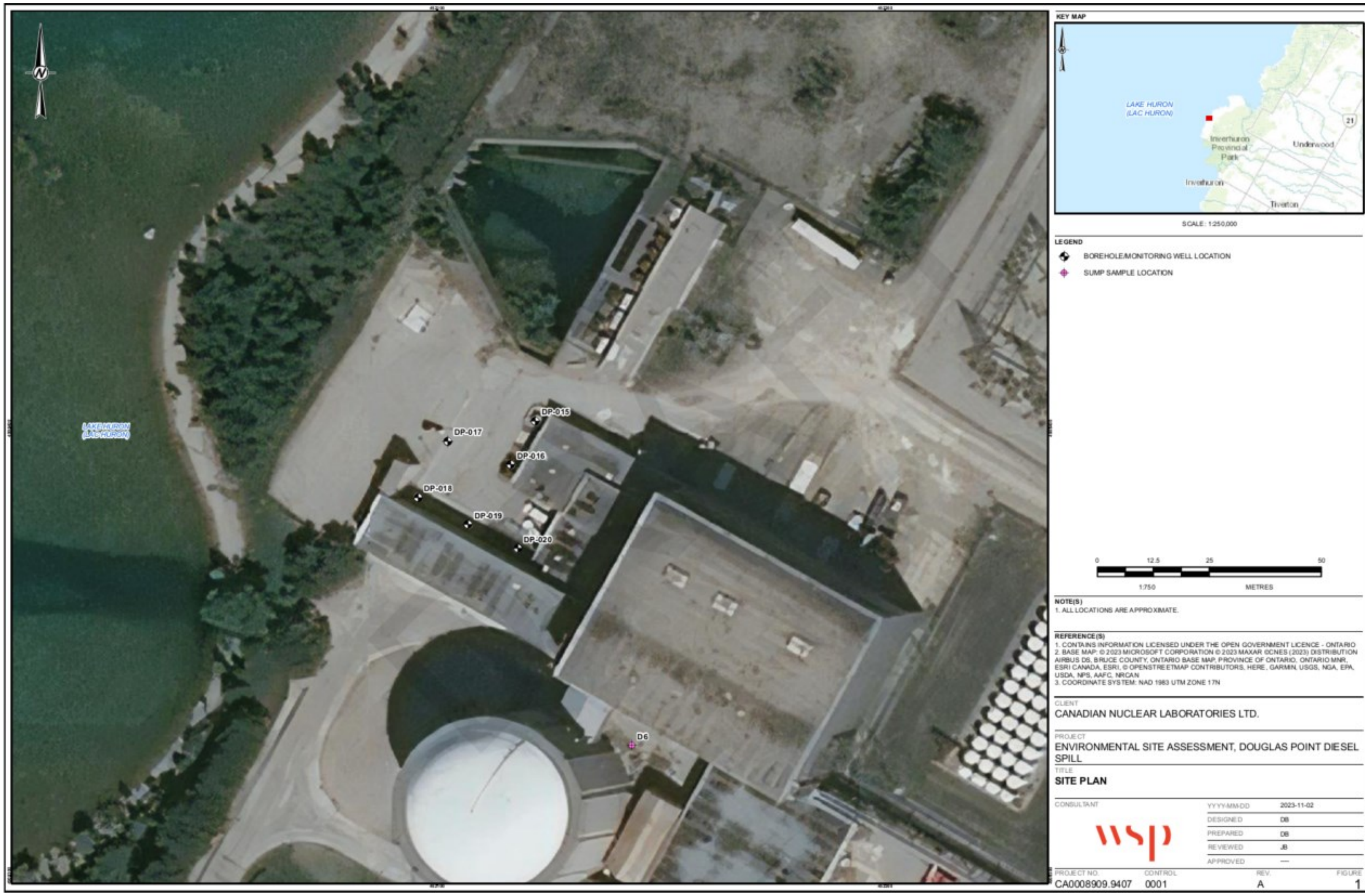


Figure 5-1 Borehole, Monitoring Wells, and Sump Sample Locations (WSP 2023)

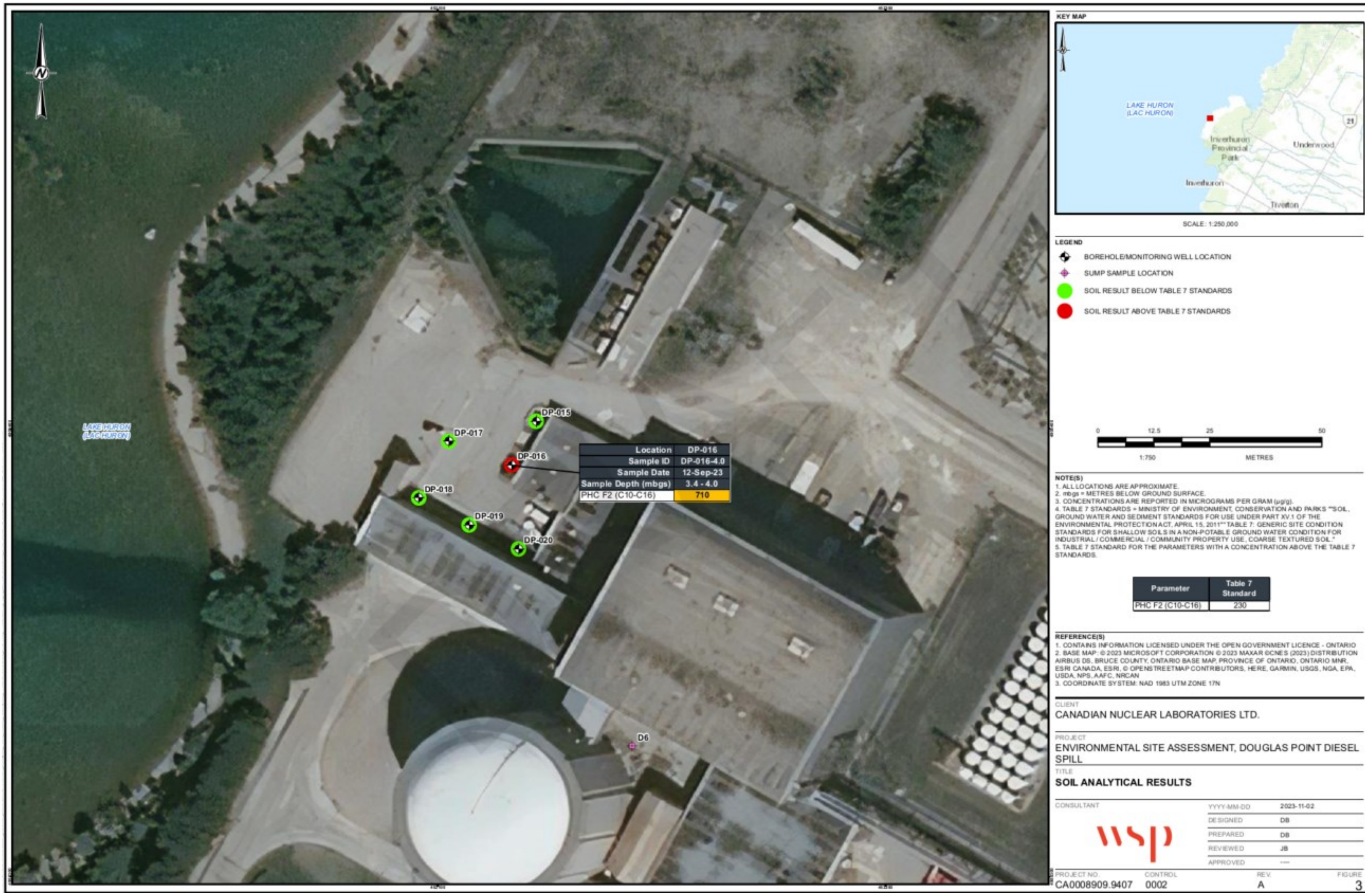


Figure 5-2 Soil Analytical Results (WSP 2023)

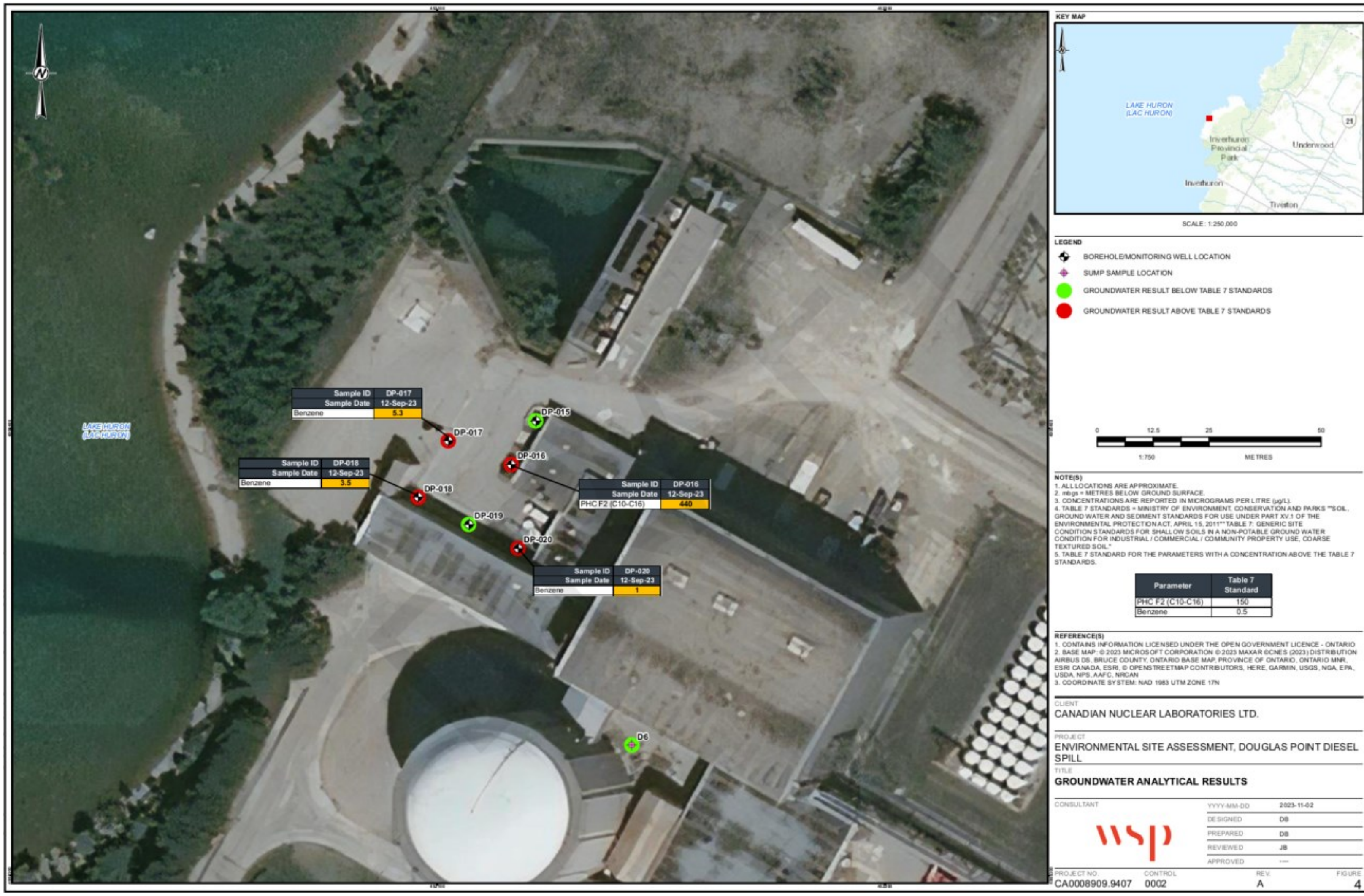


Figure 5-3 Groundwater Analytical Results (WSP 2023)

As outlined in WSP (2023), a total of eight (8) soil samples were obtained and analyzed for PHCs: 2 at DP-015, 2 at DP-016, and one at each of DP-017 through DP-020. As shown in Figure 5-2, only one (1) soil sample from location DP-016 (specifically, DP-016-4.0) indicated a petroleum hydrocarbon (PHC) F2 (C10-C16) concentration of 710 µg/g which exceeds the Ontario Ministry of the Environment, Conservation and Parks (MECP) Table 7 guideline value of 230 µg/g (MECP 2011). All other soil samples had concentrations less than corresponding guideline values (WSP 2023).

As outlined in WSP (2023), a total of seven (7) groundwater samples were obtained and analyzed for PHCs: one from each of DP-015 through DP-020, and one (D6) from a nearby sump. As shown in Figure 5-3, one groundwater sample (DP-016) indicated a PHC F2 (C10-C16) concentration of 440 µg/L which exceeds the MECP Table 7 guideline value of 150 µg/L, and 3 samples (DP-017, DP-018, and DP-020) indicated benzene concentrations of 5.3 µg/L, 3.5 µg/L, and 1 µg/L (respectively), which exceed the MECP Table 7 guideline value of 0.5 µg/L.

WSP (2023) concluded that the impact has been delineated both laterally and vertically in soil and groundwater to the north, south and west, and is assumed not to extend to the east. WSP (2023) also mentions that there is no indication of the impacts migrating with groundwater, and that PHC impacts appear to be stable and can remain in place until building demolition. Decontamination of soil is planned during CNL's final site decommissioning. It is important to note that this area of contaminated soil is relatively small compared to the size of the DPWF site and is located beneath a paved area adjacent to a building; it is therefore inaccessible to receptors.

Physical Stressors:

With respect to physical stressors, noise was the only physical stressor identified for human receptors, for the entire BP site (BP 2022).

5.1.3 Exposure Pathways

Since all chemical contaminants were "screened out" (see Section 5.1.2), no unacceptable risk to human health is expected due to releases of chemical contaminants from the DPWF. Hazard quotients and risk calculations are not warranted. As noted in Section 6.2.5 of N288.6-22 (CSA 2022a), the goal of the screening process is to identify contaminants and physical stressors that are relevant to the facility and operations and that require further quantitative evaluation, and these are referred to as COPCs. Since no COPCs were identified, further quantification is not required for the chemical contaminants.

Physical Stressors – Noise:

With respect to physical stressors, exposure to facility noise could be considered a potential pathway for this DPWF HHRA. Noise is discussed further in Section 5.4.2.

5.1.4 Conceptual Site Model

As discussed in Section 5.1.2, no non-radiological contaminants were retained for further analysis in the HHRA. Since all contaminants were “screened out”, no unacceptable risk to human health is expected due to releases of chemical contaminants from the DPWF. However, for completeness, Figure 5-4 presents the BP (2022) non-radiological HHRA conceptual site model for the BP site (which encompasses the DPWF).

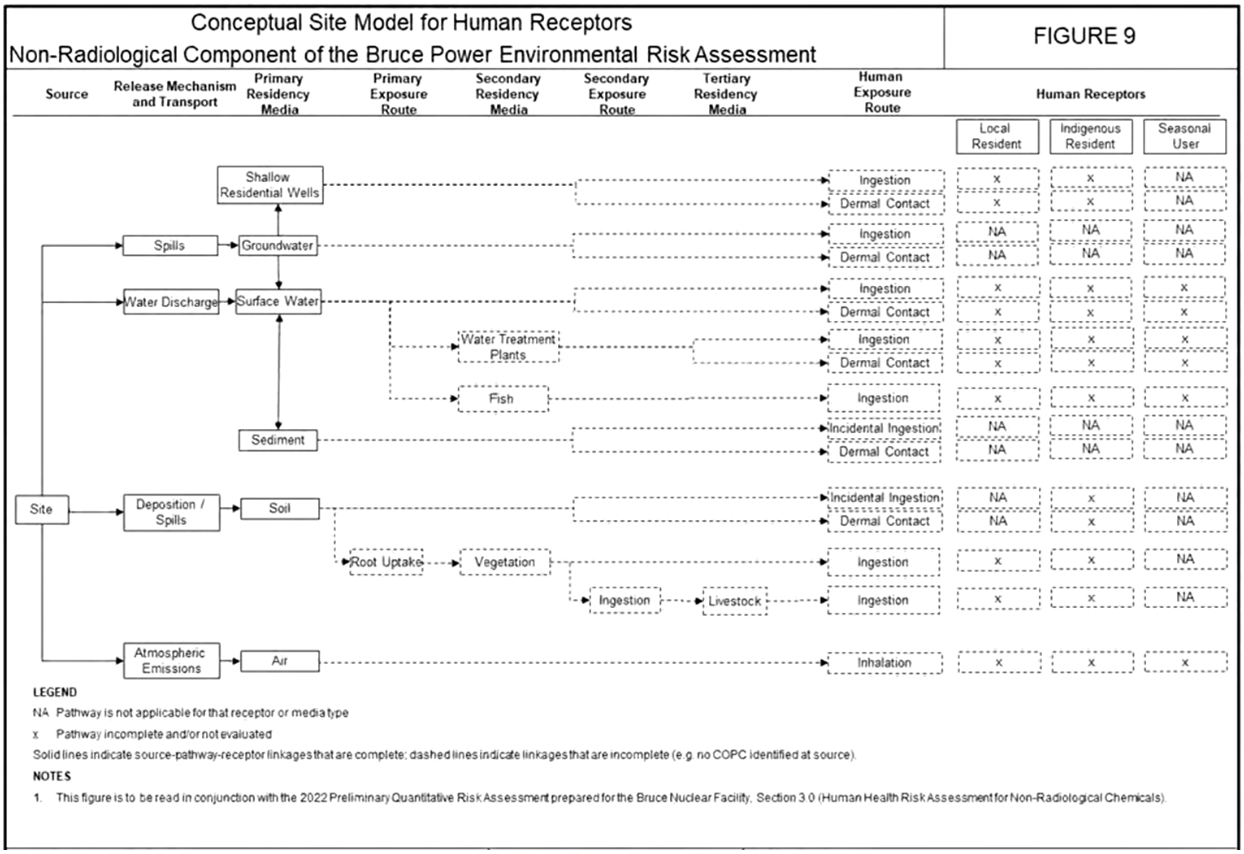


Figure 5-4 BP (2022) Non-Radiological HHRA Conceptual Site Model for the BP Site

5.2 Exposure Assessment

As outlined in Section 5.1.2, none of the chemicals identified by Athauda-Arachchige (2018) as being relevant to the DPWF site were retained as COPCs in relevant environmental media. Thus, no unacceptable risk to human health is expected due to releases of chemical contaminants from the DPWF. Exposure assessment is not required for the chemical contaminants.

5.3 Toxicity Assessment

As outlined in Section 5.1.2, none of the chemicals identified by Athauda-Arachchige (2018) as being relevant to the DPWF site were retained as COPCs in relevant environmental media. Thus, no unacceptable risk to human health is expected due to releases of chemical contaminants from the DPWF. Toxicity assessment is not required for the chemical contaminants.

5.4 Risk Characterization

5.4.1 Chemical

As outlined in Section 5.1.2, none of the chemicals identified by Athauda-Arachchige (2018) as being relevant to the DPWF were retained as COPCs. Concentration data assessed in the BP ERA's (BP 2022) screening include the influence of the DPWF; therefore, the screening results are also applicable. Since all chemical contaminants associated with the DPWF were screened out, no unacceptable risk is expected to human health of public receptors from exposure to contaminants related to current operations and conditions at the DPWF.

Regarding diesel contamination, CNL has followed up via a study documented in WSP (2023). WSP (2023) concluded that the diesel impact has been delineated both laterally and vertically in soil and groundwater to the north, south and west, and is assumed not to extend to the east. WSP (2023) also mentions that there is no indication of the impacts migrating with groundwater, and that PHC impacts appear to be stable and can remain in place until building demolition. Decontamination of soil is planned during CNL's final site decommissioning. It is important to note that this area of contaminated soil is relatively small compared to the size of the DPWF site and is located beneath a paved area adjacent to a building; it is therefore inaccessible to receptors.

5.4.2 Physical Stressors

The BP ERA (BP 2022) includes an assessment of noise impacts of the site (encompassing the DPWF's noise emissions). Noise investigation studies have been conducted annually from 2015 to 2020. From 2020 to 2019 a variety of sound mitigations were implemented at the BP site. Results from the most recent noise investigation (2020) indicate that natural sounds were typically dominant. The BP site was faintly audible when background sound was lower. During periods where the contribution of background sound was at a minimum, the sound levels at Lake Street (the main concerned receptor location) and within Inverhuron

Provincial Park were as low as 22 to 24 dBA, which is well within the applicable MECP criterion of 40 dBA. Given that DPWF is a small portion of the BP site, this result is bounding, and shows that noise from DPWF will not result in unacceptable risk to human health.

5.5 Uncertainty

Uncertainty Related to N288.6 and N288.1 Versions

This uncertainty is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

Problem Formulation

Receptors

Receptor selection relies on information from recent studies performed for the DPWF (i.e., Athauda-Arachchige 2018) and BP sites (i.e., BP 2022). These were prepared following CNL and BP's quality control programs (respectively) and are considered to be of good quality and recent enough to capture current conditions at and surrounding the site. The BP ERA (BP 2022) incorporates information from site-specific surveys in its selection of human receptors. Therefore, no significant uncertainties are identified in human receptor selection.

COPC Selection

COPC selection relies on information from CNL's current EMP for the DPWF (CNL 2021a), from the BP ERA (BP 2022) which encompasses the DPWF, and from a CNL memo (i.e., Athauda-Arachchige 2018) discussing the hazardous chemicals relevant to the DPWF. These studies were prepared recently and following CNL and BP's quality control programs (respectively). This supporting information is considered to be of good quality and to reflect current site conditions and operating activities. Section 5.1.2 outlines how each hazardous chemical relevant to the DPWF is addressed by the BP ERA (BP 2022). Therefore, no significant uncertainties are identified in COPC selection.

Sump and Drainage Data

Some minor uncertainty exists due to the limited number of measurements in groundwater from the sumps and drainage system: all available data are from a single measurement campaign performed in 2015. However, it is important to note that there have been no significant changes to facility operations or releases since that time. Also, any activities undertaken since then would be decommissioning activities resulting in a net *reduction* of hazardous materials on site. Given this, and the waste forms of lead, mercury, and PCBs (see Section 5.1.2), there is little reason to believe that concentrations of lead, mercury, and PCBs in releases would have notably increased in the past 9 years. Nevertheless, this may introduce minor uncertainty.

Soil Data

Some minor uncertainty is introduced by relying on the BP ERA's (BP 2022) non-radiological soil data, specifically regarding the *locations* from which non-radiological soil data are available. The BP ERA's (BP

2022) soil data are compiled from numerous sampling locations across the BP site, though the soil sampling location nearest to the DPWF site is BPS-04-16, which is approximately 1 km away. However, as discussed earlier, the waste forms of the DPWF's relevant contaminants (lead in shielding blocks, mercury in instrumentation switches, and PCBs in some ballasts) mean that these compounds would have negligible airborne releases, thus the concentrations of these contaminants in soil that are attributable to the DPWF are also likely to be negligible. Also, members of the public do not have access to the DPWF site, thus the only human receptors on the DPWF site are workers who are covered under CNL's health and safety program and would have limited exposure pathways to soil. Nevertheless, this does introduce some minor uncertainty.

Detection Limits

Some uncertainty is introduced through the use of effluent and environmental data reported as less than a detection limit. This uncertainty, and how it is addressed, is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

Exposure Assessment

Since all contaminants were screened out in Section 5.1.2, exposure assessment calculations were not required for the DPWF. No significant uncertainties are identified.

Toxicity Assessment

Since all contaminants were screened out in Section 5.1.2, no toxicity assessment was required for the DPWF. No significant uncertainties are identified.

Risk Characterization

Since all contaminants were screened out in Section 5.1.2, risk calculations were not required for the DPWF. No significant uncertainties are identified.

Regarding noise as a physical stressor, although noise monitoring has not been conducted on the DPWF specifically, noise monitoring has been completed for the surrounding BP site as discussed earlier. The DPWF is a small fraction of the size of the BP site, and current activities at the DPWF do not involve significant noise sources. Therefore, the absence of noise monitoring at the DPWF site is not considered to be a significant uncertainty.

6.0 ECOLOGICAL RISK ASSESSMENT FOR CHEMICALS AND PHYSICAL STRESSORS

6.1 Problem Formulation and Conceptual Model

The objective of the non-radiological DPWF EcoRA is to assess risk to ecological receptors from exposure to chemicals and physical stressors. The assessment is for current conditions and uses monitoring data from 2017 to 2021 for air, groundwater, surface water, sediment, and drinking water as presented in the 2022 BP ERA (BP 2022), which includes data from DPWF. The BP ERA (BP 2022) soil assessment relies on historical and recent data (i.e., data from 2000 to 2021) to account for updated assessment criteria not available for the 2017 ERA.

The receptors, selection of COPCs, and exposure pathways to be assessed are presented below.

6.1.1 Receptors

Athauda-Arachchige (2018) provides a list of suggested aquatic and terrestrial ecological receptors selected for the DPWF. The receptors were selected based on criteria similar to those outlined in CEAA (2012) guidance on selection of valued components. These include species and habitats observed at the DPWF; representation of all major plant and animal groups, and multiple trophic levels; consideration of cultural or socio-economic significance; conservation status. The list of receptors is presented below and it is consistent with the ecological receptors assessed in the BP ERA. For birds, mammals, amphibians, reptiles, and fish, a limited number of species were selected to be representative of various feeding guilds within the receptor group (BP 2022). All potential SAR were assessed in the EcoRA with surrogate species of the same feeding guild, with the exception of the following (BP 2022):

- Species whose primary diet consists of aerial insects which would result in negligible exposures to COPCs. These species include the eastern small-footed myotis, little brown myotis, northern myotis, tri-coloured bat, bank swallow, barn swallow and chimney swift.

- Aerial invertebrate species: Monarch and Yellow-banded bumble bee. These species are primarily exposed through ingestion of plants that may have bioaccumulated COPCs in soil rather than direct soil contact. There is a lack of toxicological data and receptor characteristics to evaluate exposures for aerial invertebrates, and the assessment of soil invertebrates is considered protective of these species.

The list of receptors is as follows:

- **Terrestrial Receptors**
  - Terrestrial Plants (surrogate for all relevant plant SAR)
  - Soil Invertebrates
  - Mammals
    - Meadow vole
    - Northern short-tailed shrew
    - White-tailed Deer
    - Red Fox
  - Birds
    - Mourning dove (surrogate for red-headed woodpecker SAR)
    - American woodcock (surrogate for several SAR: Bobolink, Eastern meadowlark, Eastern whip-poor-will, Canada warbler, Eastern wood-pewee, Grasshopper sparrow, and Wood thrush)
    - Short-eared owl (surrogate for Common nighthawk and Peregrin Falcon SAR)
  - Reptiles and Amphibians
    - Common Gartersnake (surrogate for all relevant terrestrial snake SAR)
    - Wood Frog

- **Semi-Aquatic Receptors**
  - Mammals
    - Muskrat
    - American Mink
  - Birds
    - Green-winged Teal
    - Spotted Sandpiper
    - Belted Kingfisher (surrogate for several SAR: Bald eagle, Horned grebe, Least bittern)
  - Reptiles
    - Snapping Turtle (surrogate for all relevant turtle SAR)
    - Northern Water Snake (surrogate for all relevant aquatic snake SAR)

- **Aquatic Receptors**
  - Aquatic plants
  - Zooplankton
  - Benthic Invertebrates
  - Amphibians (embryonic and larval life stages)
    - Bullfrog
  - Fish
    - Lake Whitefish
    - Lake Sturgeon
    - Whitefish
    - Cisco (*Coregoninae*)
    - Cyprind sp.
    - Northern Pike
    - Walleye
    - Salmon Sp.
    - Rainbow Trout
    - Brook Trout
    - Yellow Perch
    - Cisco (*Coregonus artedi*)

- Muskellunge
- Bass
- Lake trout
- Lake Herring
- Burbot
- Bullhead
- Channel Catfish
- Smallmouth Bass
- Largemouth Bass
- Brown Trout
- White Sucker
- Carp
- Smelt
- Chub

It is important to note that the DPWF has no process intake and the only liquid effluent is of precipitation and groundwater captured by the sump systems (see Section 2.2.8.5). Therefore, physical stressors such as impingement, entrainment, thermal effects, and physical effects of cooling water discharges do not apply to the DPWF.

<u>*Assessment and Measurement Endpoints*</u>

For the non-radiological EcoRA, the assessment endpoint is the same as that used in the BP ERA: *"protection of non-human biota from adverse effects on survival, growth, or reproduction, due to chemical contaminants"* (BP 2022).

In general, for receptors that are immobile or are immersed in an environmental medium (e.g., plants, fish, soil organisms, etc.) the measurement endpoint is comparison of concentrations in the relevant environmental medium to literature-derived toxicological benchmarks which are protective of deleterious effects on survival, growth, development, or reproduction (BP 2022). Otherwise (e.g., for wildlife), the measurement endpoint is comparison of modeled dietary doses to literature-derived toxicity reference values which are protective of deleterious effects on survival, growth, development, or reproduction (BP 2022).

SAR, however, are assessed at the individual level rather than the population level. This involves the use of more protective toxicological benchmarks than those used to assess non-SAR receptors at the population level.

6.1.2 Selection of Chemical COPCs for the Non-Radiological EcoRA

As discussed in Section 5.1.2, based on the hazardous substances present at the DPWF, Athauda-Arachchige (2018) identifies the following chemicals as potential COPCs:

- Lead;
- Mercury; and,
- PCBs.

CNL (2021a) considered the potential presence of these materials and concluded that there are no significant non-radiological hazardous contaminant source terms in the building. Lead-based paint is present, as are lead blocks in the Reactor Building. Mercury may be present in instrumentation switches, and PCBs may be present in light ballasts (CNL 2021a). Given their waste forms, it is likely that airborne releases of lead, mercury and PCBs are negligible.

In addition, based on environmental concentrations in surface water (which is the main pathway of exposure for human receptors), Athauda-Arachchige (2018) identifies the following chemicals as potential COPCs in Lake Huron:

- Phosphorus: only a concern from an algal growth perspective;
- Aluminum;
- Mercury; and,
- Morpholine.

Based on environmental concentrations assessed in the BP ERA (BP 2022):

- **Air:** Following BP (2022), for ecological receptors, inhalation exposure is not assessed and thus COPCs in air are not examined. The Canadian Council of Ministers of the Environment (CCME) has noted that inhalation is likely to be a minor route of exposure for ecological receptors and thus will contribute little to potential risks to the receptors (BP 2022). Respirable particles (i.e., greater than 5 µm) are most likely ingested as a result of mucociliary clearance rather than being inhaled (BP 2022). At equal exposure concentrations, it has been determined that inhalation of contaminants associated with dust particles is expected to contribute less than 0.1% of total risk compared to oral exposure to wildlife (BP 2022). As such, inhalation exposure is expected to be minimal, if not negligible, in comparison to the oral route of exposure. Toxicological benchmarks for exposure by inhalation are also limited for ecological receptors. Finally, as mentioned above, it is likely that airborne releases of lead, mercury and PCBs are negligible due to their waste forms.

- **Soil:** Soil primarily receives contaminants from airborne releases, and as mentioned above, it is likely that the DPWF's airborne releases of lead, mercury and PCBs are negligible.

- **DPWF Inactive Drainage System Water:** The DPWF's inactive drainage system is described in Section 2.3.8.5. It collects drainage water from roof drains, catch basins, roadside drainage ditches, and building foundation drains. As mentioned earlier, CNL (2016) sampled water from three outdoor catch basins, a road-side drainage ditch, and 2 of the Reactor Building's foundation drainage sumps (D3 and D6) and sent the samples for chemical analysis. Results are as follows:

  - **Mercury** was non-detect in all samples, using a detection limit of 5 ng/L. This is less than the CCME water quality guideline for protection of aquatic life (26 ng/L) (CCME 2003).

  - **Lead** was non-detect in all but one sample, using a detection limit of 0.004 mg/L. The one sample with detectable concentrations (0.014 mg/L) was from outdoor catch basin 1, which drains the parking lots. Lead detected in this drainage water is most likely from the parking lot.

  - **PCBs** were non-detect in all samples, using a detection limit of 0.1 µg/L. This is less than the OMOE (2011) Ontario groundwater background value of 0.2 µg/L.
  - **Morpholine** is not produced by the DPWF because the DPWF has no process effluent. There is no indication that morpholine would be present in the DPWF's only liquid releases, which are of water from the inactive drainage system.

- **Phosphorus** concentrations were non-detect (<0.019 mg/L) in the D3 and D6 Reactor Building sumps and road-side drainage ditch. Phosphorus concentrations in the 3 outdoor catch basins ranged from 0.047 mg/L to 0.3 mg/L. These concentrations are less than the 97.5th percent Ontario background concentration of 7.97 mg/L (OMOE 2011).

- **Aluminum** concentrations in the D3 and D6 sumps (Reactor Building) ranged from 0.039 to 0.031 mg/L. Aluminum concentrations in the 3 outdoor catch basins were to 0.155 mg/L, 2.65 mg/L, and 4.17 mg/L. The concentration in the road-side drainage ditch was 0.044 mg/L. CNL (2016) attributes the concentrations measured in outdoor catch basins to vehicle and parking lot runoff.

It is important to note that drainage effluent in the D3 and D6 sumps is not accessible to ecological receptors. It is also unlikely that ecological receptors would gain access to water in the catch basins.

It is also important to note that the concentrations measured in the inactive drainage system would be further diluted once the drainage water discharges to Lake Huron.

- **Surface water (Lake Huron):** BP (2022) categorizes surface water data into 3 groups based on the types of locations the data represent. These include: offsite water courses (e.g., Lake Huron nearshore environment); on-site water courses (e.g., Stream C); and, on-site drainage features (e.g., B16 Pond). Of these, only off-site water courses – representing Lake Huron – are relevant to DPWF liquid releases because DPWF's liquid releases discharge via the inactive drainage system to Lake Huron.

Figure 6-1 shows the locations of Lake Huron surface water sampling locations.

Lead: The maximum measured concentration of lead among Lake Huron samples was less than the corresponding benchmark value.

Aluminum: The maximum measured concentration of aluminum among Lake Huron samples was less than the corresponding benchmark value.

Morpholine: Morpholine was not detected in Lake Huron surface water samples using a detection limit of 0.004 mg/L which is equal to the corresponding benchmark value.

Mercury: Mercury was not detected in any Lake Huron surface water samples using a detection limit of 0.1 µg/L. This detection limit is greater than the CCME mercury benchmark of 0.026 µg/L. However, as outlined in BP (2022), mercury has not been detected since 2017 and was not retained as a COPC in surface water. Due to a lack of detection, mercury was not retained as COPCs in surface water for the 2022 BP ERA. Also, as mentioned earlier, mercury was measured directly in the DPWF's inactive drainage system and all measurements were non-detect using detection limit of 5 ng/L (CNL 2016).

Phosphorus: Concentrations exceeding the benchmark value (>20 µg/L) were only detected in December 2018 and October 2020. BP (2022) notes that studies along the Lake Huron shoreline have identified that agricultural land uses are a significant source of phosphorus to Lake Huron. BP (2022) notes that BP's discharges from the past 5 years have met their emissions objectives, further supporting the rationale that phosphorus concentrations are not due to releases from the BP and DPWF sites. Also, as mentioned earlier, phosphorus was measured directly in the DPWF's liquid effluent (i.e., captured GW) and the maximum measured concentration was less than its corresponding criterion (CNL 2016).

PCBs: Lake Huron surface water samples were not analyzed for PCBs; however, as mentioned earlier, PCBs were measured directly in the DPWF's inactive drainage system and all measurements were non-detect using detection limit of 0.1 µg/L (CNL 2016).

Therefore, none of the chemicals relevant to the DPWF or identified by Athauda-Arachchige (2018) are retained as surface water COPCs for this DPWF EcoRA.

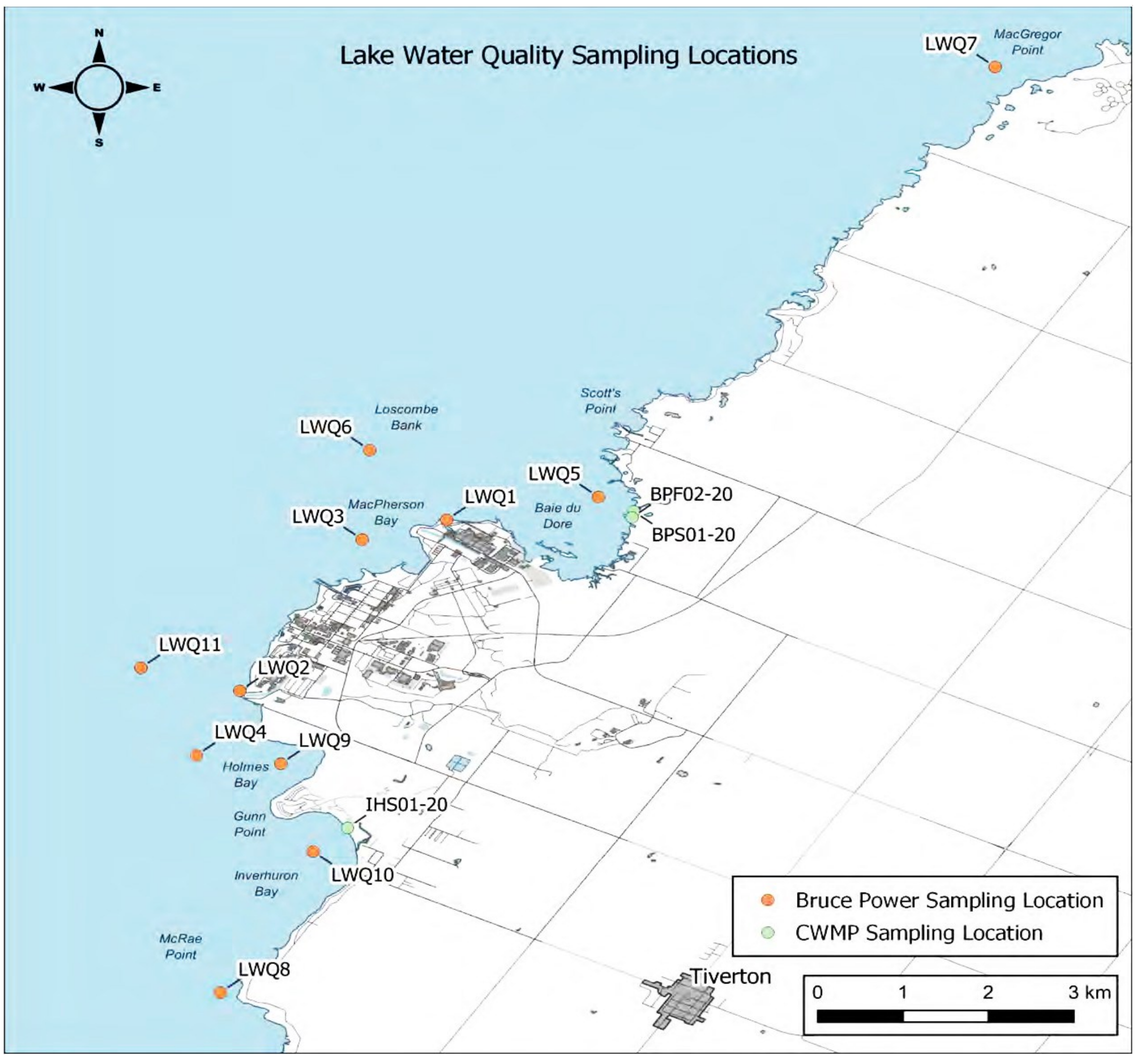


Figure 6-1 Lake Huron Surface Water Sampling Locations (BP 2022)

- **Groundwater On the DPWF Site:** Groundwater on the DPWF site is inaccessible to ecological receptors. On-site groundwater that is captured and drained by the DPWF's inactive drainage system is discussed separately, above.

- **Off-Site Groundwater on the Surrounding BP Site:** Groundwater data in the BP EcoRA (BP 2022) focus on areas of the BP site that represent viable ecological habitat, or areas that are *adjacent to* areas that represent viable ecological habitat. Data collected from areas that are used for active industrial operations, with no adjacent ecological habitat, were not considered. Also, only shallow groundwater (i.e., groundwater that was less than 1.5 meters below ground surface (mbgs)) from on-site groundwater monitoring wells was retained for further consideration in the BP (2022) EcoRA, and only with respect to potential root uptake by terrestrial plants.

  After screening (which included lead), BP (2022) identified no COPCs for groundwater on the BP site. For mercury and PCBs, in 2015, CNL (2016) sampled groundwater at 6 points along the DPWF inactive drainage system and analyzed the samples for lead, mercury, and PCBs (and other analytes). For mercury, all samples were non-detect using a detection limit of 5 ng/L. For PCBs, all samples were non-detect using a detection limit of 0.1 µg/L. CNL (2021c) considered the results from CNL (2016) and concluded that the only sign of non-radiological contamination in the DPWF drainage system was road salt contamination (elevated concentrations of conductivity, chloride and sodium).

  Therefore, lead, mercury and PCBs are not identified as COPCs in off-site groundwater. Based on these results, potential shallow root uptake is not retained for further assessment. Groundwater as an environmental medium does not warrant further assessment in this DPWF EcoRA.

- **Sediment:** Similar to surface water, BP (2022) categorizes sediment data into 3 groups based on the types of locations the data represent. These include: offsite water courses (e.g., Lake Huron nearshore environment); on-site water courses (e.g., Stream C); and, on-site drainage features (e.g., B16 Pond). Of these, only off-site water courses – representing Lake Huron – are relevant to DPWF liquid releases because DPWF's liquid releases discharge via the inactive drainage system to Lake Huron.

  Offsite sediment concentration data in BP (2022) represent several locations including Sauble Beach, Inverhuron, Bruce A discharge channel, Baie du Doré, and others. For lead and aluminum, maximum measured concentrations are less than the lowest corresponding benchmark values. For mercury, all samples were non-detect using a detection limit of 0.05 µg/g, which is lower than the corresponding CCME benchmark value.

  Concentration data for PCBs are unavailable for lake sediment locations. They are available for onsite waterbodies (i.e., Stream C), however the DPWF's drainage system discharge to Lake Huron not Stream C. Nevertheless, all sediment samples from Stream C were non-detect using a detection limit of 0.03 µg/g which is lower than the CCME benchmark value. Also, as mentioned above, CNL (2016) measured PCB concentrations directly in DPWF effluent and all measurements were non-detect using a detection limit of 0.1 µg/L. Thus, offshore sediment locations are unlikely to contain PCBs from DPWF effluent.

Based on this information, no COPCs relevant to the DPWF have been identified in offshore (Lake Huron) sediment. Sediment as an environmental medium does not warrant further assessment in this DPWF EcoRA.

Diesel

Diesel was discussed earlier in Section 5.1.2. Decontamination of soil is planned during CNL's final site decommissioning. It is important to note that the area of PHC contaminated soil is relatively small compared to the size of the DPWF site and is located beneath a paved area adjacent to a building; it is therefore inaccessible to receptors.

6.1.3 Exposure Pathways

Athauda-Arachchige (2018) suggests the following chemical exposure pathways for the various ecological receptors and they are consistent with those considered in the BP ERA (BP 2022).

For mammals and birds (as appropriate):

- Inhalation of soil dust (assumed to be negligible (BP 2022));
- Ingestion of soil;
- Dermal contact with soil (assumed to be negligible (BP 2022));
- Ingestion of terrestrial plants;
- Ingestion of soil invertebrates;
- Ingestion of prey;
- Ingestion of surface water;
- Dermal contact with surface water (assumed to be negligible (BP 2022));
- Ingestion of fish;
- Ingestion of sediment;
- Dermal contact with sediment (assumed to be negligible (BP 2022));
- Ingestion of aquatic plants;
- Ingestion of benthic invertebrates;
- Ingestion of groundwater (not considered a complete exposure pathway in BP (2022));
- Dermal contact with groundwater (not considered a complete exposure pathway in BP (2022)).

For terrestrial plants and soil invertebrates:

- Direct contact with soil;
- Direct contact with groundwater.

For reptiles and amphibians receptors (as appropriate):

- Ingestion of soil;
- Ingestion of terrestrial plants and small mammals;
- Ingestion of aquatic plants, invertebrates and fish;
- Ingestion of surface water.

For aquatic receptors (as appropriate):

- Direct contact with surface water;
- Direct contact with sediment;
- Ingestion of surface water;
- Ingestion of aquatic plants, invertebrates and fish.

Physical Stressors

Ecological receptors at the BP site could be exposed to physical stressors such as:

- noise;
- physical effects of cooling water discharges;
- thermal effects;
- fish impingement and entrainment;
- habitat alteration;
- bird strikes and vehicle-wildlife collisions.

However, it is important to note that the DPWF has no process intake and the only liquid effluent is of precipitation and groundwater captured by the sump systems (see Section 2.2.8.5). Therefore, physical stressors such as impingement, entrainment, thermal effects, and physical effects of cooling water discharges do not apply to the DPWF.

Noise, habitat alteration, bird strikes, and vehicle-wildlife collisions are potentially relevant and are discussed further in Section 6.4.2.

6.1.4 Conceptual Site Model

As discussed in Section 6.1.2, no non-radiological contaminants were retained for further analysis in the EcoRA. Since all contaminants were “screened out”, there is no unacceptable risk to ecological receptors expected due to releases of chemical contaminants from the DPWF. However, for completeness, Figure 6-2 and Figure 6-3 present the BP (2022) non-radiological EcoRA conceptual site models for the BP site (which encompasses the DPWF).

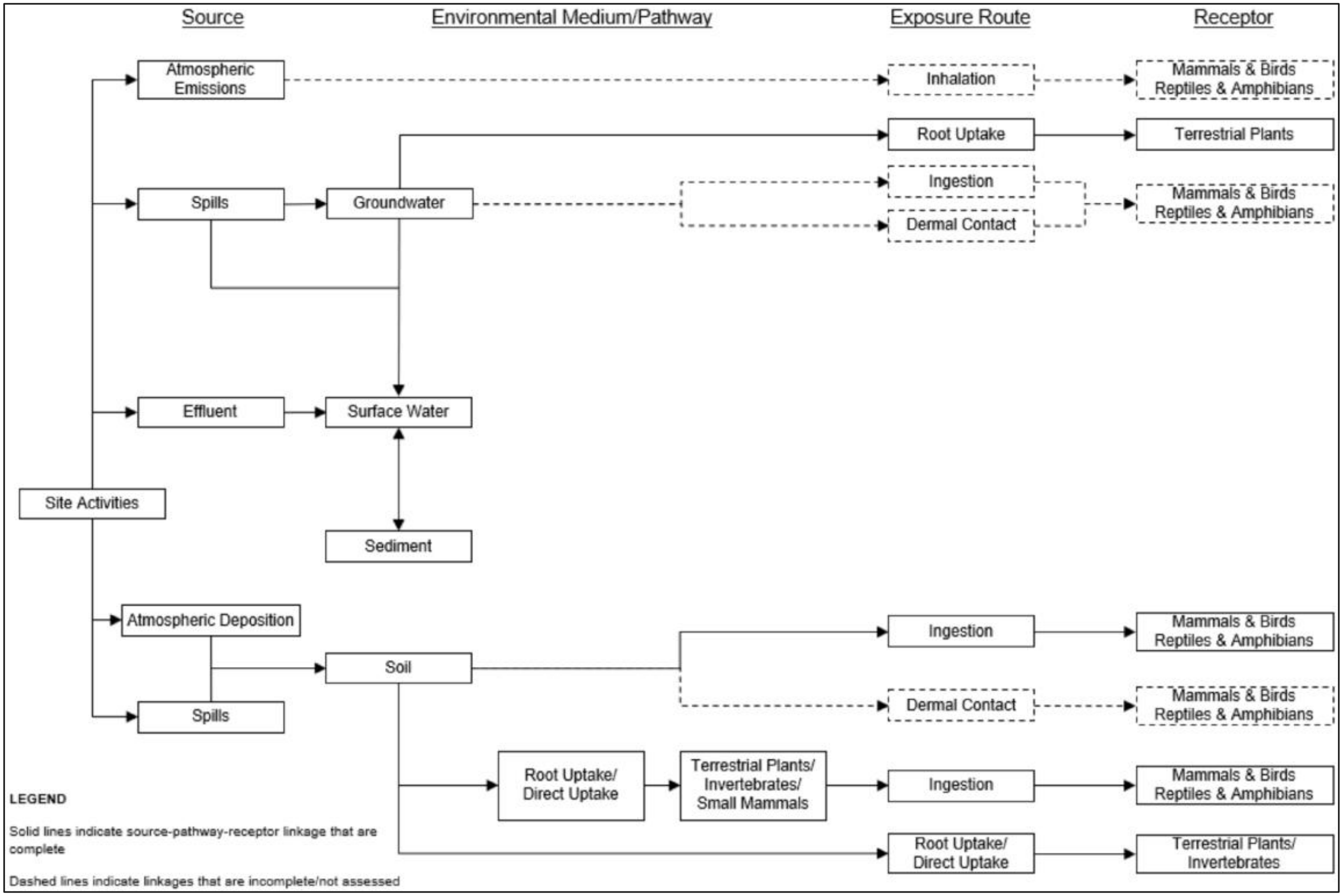


Figure 6-2 Non-Radiological EcoRA Conceptual Site Model for Terrestrial Receptors (BP 2022)

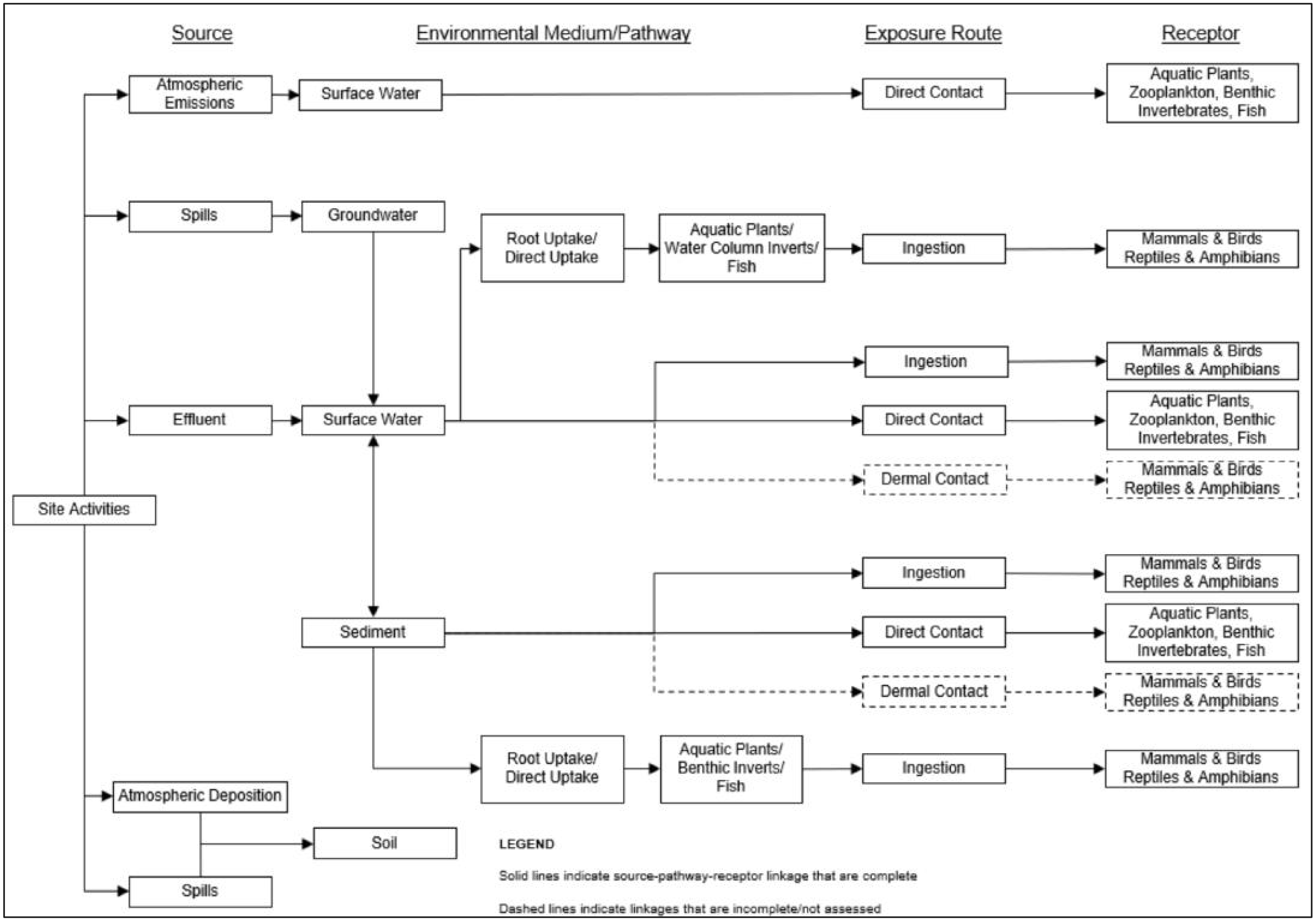


Figure 6-3 Non-Radiological EcoRA Conceptual Site Model for Aquatic Receptors (BP 2022)

6.2 Exposure Assessment

As outlined in Section 6.1.2, none of the chemicals identified by Athauda-Arachchige (2018) as being relevant to the DPWF site were retained as COPCs in relevant environmental media. Therefore, further quantitative assessment is not warranted in this DPWF EcoRA.

Nevertheless, an assessment of ecological receptor exposure to chemicals is available for the BP site, including DPWF, in the BP ERA (BP 2022). The exposure calculations performed in BP (2022) follow the guidance in CSA N288.6-12 (CSA 2012). As discussed in Section 3.2, the BP ERA exposure assessment is expected to encompass the exposure assessment of the DPWF.

6.3 Toxicity Assessment

As outlined in Section 6.1.2, none of the chemicals identified by Athauda-Arachchige (2018) as being relevant to the DPWF site were retained as COPCs in relevant environmental media. Therefore, toxicity assessment is not warranted in this DPWF EcoRA.

6.4 Risk Characterization

6.4.1 Chemical

As outlined in Section 6.1.2, none of the chemicals identified by Athauda-Arachchige (2018) as being relevant to the DPWF were retained as COPCs. Concentration data assessed in the BP ERA's (BP 2022) screening include the influence of the DPWF; therefore, the screening results are also applicable. Since all chemical contaminants associated with the DPWF were screened out, no unacceptable risk is expected to ecological receptors from exposure to contaminants related to current operations and conditions at the DPWF.

Regarding diesel contamination, CNL has followed up via a Phase 2 Environmental Site Assessment documented in WSP (2023). WSP (2023) concluded that the diesel impact has been delineated both laterally and vertically in soil and groundwater to the north, south and west, and is assumed not to extend to the east. WSP (2023) also mentions that there is no indication of the impacts migrating with groundwater, and that PHC impacts appear to be stable and can remain in place until building demolition. Decontamination of soil is planned during CNL's final site decommissioning. It is important to note that this area of contaminated soil is relatively small compared to the size of the DPWF site and is located beneath a paved area adjacent to a building; it is therefore inaccessible to receptors.

6.4.2 Physical Stressors

Noise

As discussed in BP (2022), for ecological receptors, no noise benchmarks are available from federal or provincial regulatory agencies, including the U.S. Environment Protection Agency, and the scientific literature focusses on behavioural adaptations to elevated noise levels (e.g., avoidance) rather than health effects. The Government of Canada's recommendations to reduce risks to migratory birds indicates that consideration of increased setbacks from the nests of migratory birds with significant sources of disturbance, including noise exceeding 10dB above ambient noise levels and noise greater than about 50 dB. Measured noise levels are below the level of significant disturbance. Due to the lack of benchmarks, noise effects on wildlife are not quantitatively assessed (BP 2022).

It is important to note that the DPWF site is a small portion of the BP site and generally contributes little to overall noise levels at the BP site.

CNL also considers potential noise emissions during its decommissioning planning processes and develops work programs accordingly. If work planning identifies activities with the potential to have significant noise emissions, CNL would consider appropriate prevention and mitigation measures.

Habitat Alteration

As shown in Figure 2-13 (ELC) the DPWF is classified as industrial land in active use. As indicated in Figure 2-14 (vegetation communities) and Figure 2-2 (aerial photo), site vegetation is limited to a small patch of manicured lawn. The DPWF site is a small portion of the overall BP site, offers little if any habitat, and has not experienced any substantial changes. Therefore, habitat alteration is negligible.

Bird Strikes

BP commenced bird strike surveys in late spring of 2017 as part of environmental monitoring. The survey focuses on 3 buildings which have considerable amounts of glass windows/exterior panels, since these structures could potentially have heightened collision risk. Four years of bird building collision monitoring resulted in only eight recorded bird carcasses between the three monitored buildings. The eight recorded species are forest associates, which may reflect the presence of woodlots in proximity to the buildings. Survey results indicate that there is no unacceptable risk to the local bird populations from bird strikes on site buildings (BP 2022). This is assumed to apply to the DPWF as well, and is supported by: the fact that DPWF site staff have not observed notable bird strike fatalities; buildings on the DPWF site do not have significant amounts of glass windows or exterior panels, and the DPWF site is not located next to forested areas.

Vehicle-Wildlife Collisions

As outlined in BP (2022), the level of wildlife mortality observed on the BP site is consistent with the level observed across the province of Ontario. Ontario reports approximately 14,000 large herbivore (mainly deer) collisions annually on provincial roads and highways but the real number of wildlife vehicle collisions is likely much higher, with 24,000 collisions with vertebrates recorded on a 31 km stretch of the Thousand Islands Parkway in Eastern Ontario over only 5 months in 2008. With approximately 190,000 km of roads in Ontario, this represents 0.07 large herbivore collisions per kilometer of road and 774 vertebrate collisions per kilometer of road. From 2017 to 2021, BP surveys recorded a total of 3 deer collisions and 392 vertebrate collisions over approximately 35 km of roads surveyed for vehicle wildlife collisions. This results in an annual average of 0.017 large herbivore collisions per kilometer of road and 2.24 vertebrate collisions per kilometer of road, well below reported data for public roads in Ontario. Therefore, there is no differential mortality occurring due to these stressors related to the operation of the BP site compared to other industrial and residential locations across Ontario (BP 2022).

The DPWF is a very small portion within the larger BP site and has a similarly small contribution to vehicle traffic on the BP site.

6.5 Uncertainty

Uncertainty Related to N288.6 and N288.1 Versions

This uncertainty is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

Problem Formulation

Receptor selection relies on information from recent studies performed for the DPWF (i.e., Athauda-Arachchige 2018) and BP sites (i.e., BP 2022). These were prepared following CNL and BP's quality control programs (respectively) and are considered to be of good quality and recent enough to capture current conditions at and surrounding the site. BP (2022) incorporates information from site-specific wildlife inventory surveys in its selection of ecological receptors. Therefore, no significant uncertainties are identified in ecological receptor selection.

COPC selection relies on information from CNL's current EMP for the DPWF (CNL 2021a), from BP (2022) which encompasses the DPWF, and from a CNL memo (i.e., Athauda-Arachchige 2018) discussing the hazardous chemicals relevant to the DPWF. These studies were prepared recently and following CNL and BP's quality control programs (respectively). This supporting information is considered to be of good quality and to reflect current site conditions and operating activities. Section 6.1.2 outlines how each hazardous chemical relevant to the DPWF is addressed by the BP ERA (BP 2022). Therefore, no significant uncertainties are identified in COPC selection.

As discussed in Section 6.1.2, some uncertainty is introduced by not directly assessing COPC concentrations in air and subsequent uptake from inhalation. However, Section 6.1.2 also outlines that - for ecological receptors - uptake via inhalation is minor compared to other intake routes (namely ingestion), and that soil (which receives COPCs deposited from air) is directly assessed. Therefore, this uncertainty is considered to be adequately addressed.

As mentioned in Section 5.5, some uncertainty exists because there are no non-radiological COPC concentration measurements in on-site soil (i.e., soil on the DPWF site). However, soil primarily receives contaminants from airborne releases, and as mentioned above, rationale was provided for why airborne releases of lead, mercury and PCBs are likely to be negligible. In addition, the area considered to be potentially suitable ecological habitat is very limited (i.e., the small grassy area to the South of the Reactor and Service buildings) and comprehensive characterization of the soil surrounding the facility will be planned as part of CNL's Environmental Remediation process.

As mentioned in Section 5.5, some uncertainty exists due to the limited number of non-radiological COPC measurements in groundwater from the sumps and effluent system. This applies to the EcoRA as well as the HHRA. See discussion of this uncertainty in Section 5.5.

Some minor uncertainty exists due to the fact that there are no non-radiological COPC concentration measurements in sediment *at the DPWF*, though measured sediment concentrations are available for most non-radiological COPCs *at other locations in Lake Huron*. Sediment could be impacted by COPCs in surface water, however, as outlined in Section 6.1.2, none of the chemicals relevant to the DPWF were retained as surface water COPCs for this EcoRA, and, existing sediment data indicate that concentrations are less than corresponding benchmarks at their respective locations. Furthermore, due to the highly energetic environment offshore of the site (BP 2022) it would not be feasible to sample sediment affected solely by the DPWF.

Lastly, some uncertainty is introduced through the use of effluent and environmental data reported as less than a detection limit. This uncertainty, and how it is addressed, is applicable to the radiological and non-radiological HHRA and EcoRA. See Section 3.5 for discussion.

Exposure Assessment

Since all contaminants relevant to the DPWF were screened out in Section 6.1.2, exposure assessment calculations were not required for the DPWF. No significant uncertainties are identified.

Toxicity Assessment

Since all contaminants relevant to the DPWF were screened out in Section 6.1.2, no toxicity assessment was required for the DPWF. No significant uncertainties are identified.

Risk Characterization

Since all contaminants were screened out in Section 6.1.2, risk calculations are not required for the DPWF. No significant uncertainties are identified.

There is some minor uncertainty in the evaluation of noise as a physical stressor due to the lack of benchmark values for wildlife. However, noise monitoring conducted in 2019 indicated that the sounds of nature and resident activities were dominant at Lake Street and within Inverhuron Provincial Park (BP 2022). Noise monitoring conducted in 2020 indicated that natural sounds were typically dominant (BP 2022). These results imply that offsite noise levels are at or near natural background levels. Furthermore, the DPWF is a small fraction of the BP site, and current activities at the DPWF do not involve significant noise sources. Therefore, the absence of noise benchmarks for ecological receptors is unlikely to influence the EcoRA's conclusions regarding noise, and therefore is not considered to be a significant uncertainty.

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Table 7-1 summarizes the conclusions of this report.

Table 7-1 Summary of Conclusions

Radiological HHRA:	Radiological EcoRA:
No unacceptable radiological risk is expected to human health of members of the public resulting from current conditions at the DPWF.	No unacceptable radiological risk is expected to non-human biota resulting from current conditions at the DPWF.
Chemical (Non-Radiological) HHRA:	**Chemical (Non-Radiological) EcoRA:**
No unacceptable risk is expected to human health of public receptors from exposure to contaminants, or physical stressors, related to current operations and conditions at the DPWF. Regarding diesel, CNL has followed-up with a Phase 2 Environmental Site Assessment and remediation is planned.	No unacceptable risk is expected to ecological receptors from exposure to contaminants, or physical stressors, related to current operations and conditions at the DPWF. Regarding diesel, CNL has followed-up with a Phase 2 Environmental Site Assessment and remediation is planned.

Under current conditions, based on the data available for the DPWF and surrounding area, no unacceptable risk is expected to human or non-human biota, from exposure to radiological or non-radiological contaminants or from physical stressors related to the DPWF.

As mentioned in Section 5.1.2, follow-up on soil diesel decontamination is planned as part of final site decommissioning.

7.2 Cumulative Effects

CNSC REGDOC 2.9.1 describes cumulative effects as those that are “likely to result from the designated project in combination with other physical activities that have been or will be carried out.” For this ERA, a cumulative effects assessment would involve exposing the receptors not only to emissions from DPWF, but also to emissions from the entire BP site that could be occurring at the same time. This is a scenario that has been characterized in the BP ERA (BP 2022). As discussed earlier in this ERA, the BP ERA calculations are based on receptors, COPCs and exposure pathways that encompass exposure to any releases from the entire BP site (which bounds the DPWF). The BP ERA results are therefore reflective of cumulative effects.

As demonstrated in Sections 3 and 5, the BP ERA concludes that there are no unacceptable risks to human health for members of the public resulting from exposure to radionuclides, chemicals or physical stressors under current conditions at the BP site, including DPWF. Also, for the COPCs that are associated with DPWF, the BP ERA concludes that there are no unacceptable risks to ecological receptors resulting from exposure to radionuclides, chemicals or physical stressors under current conditions at the BP site, including DPWF (as presented in Sections 4 and 6). Therefore, no additional assessment of cumulative effects is required.

Based on the available information, no mitigation measures are recommended at this time.

7.3 Risk-Based Recommendations

The following risk-based recommendations have been developed to resolve data gaps and address uncertainties in this ERA. Any detailed plans required to execute follow-up activities will be documented outside of this ERA and additional data collected as a result of the implementation of these plans will be considered in the next iteration of the ERA, as applicable.

Diesel Contamination

As mentioned in Section 5.1.2, CNL has followed-up with a Phase 2 Environmental Site Assessment and future work to address soil diesel decontamination is planned as part of final site decommissioning.

Measured Soil Concentration Data for the DPWF Site

Regarding the uncertainty associated with the non-radiological (chemical) EcoRA; the waste forms of the DPWF's relevant contaminants (lead in shielding blocks, mercury in instrumentation switches, and PCBs in some ballasts) mean that these compounds would have negligible airborne releases, thus the concentrations of these contaminants in soil that are attributable to the DPWF are also likely to be negligible. In addition, the area considered to be potentially suitable ecological habitat is very limited (i.e., the small grassy area to the South of the Reactor and Service buildings). Comprehensive characterization of the soil surrounding the facility will be planned as part of CNL's Environmental Remediation process and results will be incorporated into the ERA, where applicable, when available.

Versions of CSA Standards

As mentioned in Section 3.5, some uncertainty is introduced by the fact that, while this DPWF ERA is prepared following the 2022 version of N288.6, it relies on analyses performed in the BP ERA (BP 2022) which was prepared to the prior version of N288.6 (i.e., 2012), and the 2018 version of N288.1 (the 2018 version of N288.1 is Update 3 of the 2014 version). The scope of this ERA is commensurate with the scale and complexity of the very low environmental risks associated with the DPWF, as such, the differences in the versions of these standards are unlikely to have any significant impact on the ERA's conclusion of no unacceptable risk to human or non-human biota, from exposure to radiological or non-radiological contaminants or from physical stressors related to the DPWF.

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9.0 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

Section 10 of CSA N288.6-22 (CSA 2022a) outlines the QA and Quality Control (QC) requirements of an ERA. CSA (2022) describes QA and QC activities as follows:

> *"Quality assurance (QA) activities are performed to monitor, document and control the quality of the ERA process (e.g., planning, data gathering, data management, data analysis, report preparationand record keeping) on a continual basis."*
>
> *"Quality control (QC) activities comprise those activities that specifically monitor and control discrete laboratory and field tasks."*

It is important to note that no field or laboratory tasks were undertaken for this ERA. This ERA relies on facility descriptions, media concentrations, measured dose, receptor descriptions, and other information from various technical documents (as referenced).

The Arcadis Quality System, which is described below, was implemented in the preparation of this ERA.

9.1 Quality Assurance and Quality Control (QA/QC) Applied to the ERA Program

The Arcadis Quality System has been certified to the ISO 9001:2015 standard.

Arcadis is a strong believer in the importance of internal QA/QC mechanisms. Arcadis has an internal Corporate Quality Manual developed as part of the QA Program for executing studies and projects detailing key components and actions. The QA Program assures Arcadis and its clients of the high-quality deliverable that is being produced.

The QA Program provides a framework for a planned and disciplined consideration of all the factors that influence the quality of the work undertaken from the early stage of project initiation, to project execution and project close-out. The QA Program follows ISO 9001:2015 requirements and includes requirements for documentation, management responsibility, resource management, employee training, product realization and monitoring. This is achieved by developing standard operating procedures, assigning responsibilities and establishing appropriate document control. Arcadis' ISO 9001:2015 certificate is presented in Figure 9-1 below.

DNV

MANAGEMENT SYSTEM CERTIFICATE

Certificate no.: C583590

Initial certification date: 26 May, 2015 (by different Certification body)

Valid: 26 May, 2024 – 25 May, 2027

This is to certify that the management system of

Arcadis Canada Inc.

8133 Warden Ave, Unit 300, Markham, ON, Canada

has been found to conform to the Quality Management System standard:

ISO 9001:2015

This certificate is valid for the following scope:

Environmental Services to the Nuclear Fuel Cycle for Projects and at Project Sites including Evaluation and Restoration, Strategic Environmental Consulting, Environmental Planning, Construction and Water Services.

Place and date:
Katy, TX, 11 March, 2024

For the issuing office:
DNV - Business Assurance
1400 Ravello Drive, Katy, TX, 77449-5164, USA

Sherif Mekkawy
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.

ACCREDITED UNIT: DNV Business Assurance USA Inc., 1400 Ravello Drive, Katy, TX, 77449, USA - TEL: +1 281-396-1000. www.dnv.com

Figure 9-1 Arcadis Certificate of Conformance to ISO 9001:2015

Operating procedures provide standards against which performance and progress are measured. Responsibility assignment ensures that there is accountability for all project activities and document control procedures ensure project records are systematically archived, easily retrievable and in a standard and consistent format. The QA/QC Program is an integral part of Project Management.

The Quality System adopted for this project included the following major actions:

- Project Management Tracking Form:
    - Identify and document client requirements;
    - Define project work plans;
    - Identify deliverables and quality assurance/review requirements;
    - Identify and track project change requests; and
    - Document internal review and acceptance of deliverables.

- Internal Review of Project Work:
    - Review by senior staff and all appropriate technical experts of preliminary or draft product or other work completed; and
    - Revision of preliminary or draft product or other work completed based on results on internal review.

- Client Review of Project Work:
    - Client Review (or delegated contractor) of preliminary or draft product or other work completed; and
    - Revision and finalization of product or completion of work.

- Signatures on Final Reports:
    - Person responsible for preparing the report; and
    - Project director responsible for approving the report.

All changes to the work plan, methodology, and scope of the project were subject to approval by the Client.

The quality-sensitive elements applicable to this project, and how they are accomplished, are indicated below:

a) **Data Gathering** (i.e., extraction of relevant information from technical documents): Qualified Arcadis staff were involved in the selection and evaluation of data, in collaboration with CNL.

b) **Data Analysis** (e.g., COPC screening)**:** Data analysis was performed by qualified staff and underwent internal review.

c) **Report Preparation** (including addressing and incorporating review comments): Reports were prepared by qualified staff and underwent internal review as well as review by CNL staff knowledgeable of the DPWF.

d) Record keeping: With respect to document control, the project made use of:
    - A standardized file-naming structure;
    - Centralized file storage on the secure server; and,
    - Signoff sheets for deliverables prior to transmission.

Appendix A

Concordance Table

APPENDIX A – Concordance Table

This ERA was prepared in accordance with the requirements of CSA Standard N288.6-22: *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills* (CSA 2022a). The following table presents how the sections of the present ERA align with the ERA contents suggested in CSA N288.6-22 (CSA 2022a). Clauses 0 to 3 have not been included because they do not contain requirements. To remain brief, section numbers (and their topics) have been included rather than reproducing complete text from the standard. See N288.6-22 (CSA 2022a) for the full text.

Table A-1: Concordance Table for CSA N288.6-22 - Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills

Section #	Topic	CSA N288.6-22 Requirement	Douglas Point ERA Section
4 4.1	**Environmental risk assessment objectives and report format** Environmental risk assessment objectives	As described in Clause 0.1.1, an ERA of a nuclear facility is a systematic process used to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors, including the magnitude and extent of the potential effects associated with the facility. The objectives of an ERA are to evaluate the risk to relevant human and non-human biota receptors resulting from exposure to contaminants and stressors related to a site and its activities, and to recommend further action or assessment based on the results.	Goals, Objectives and Scope (1.2)
4.2	Environmental risk assessment report format	See details in CSA N288.6-22	Organization of Report (1.3)
5 5.1	**Environmental risk assessment framework, tiers, and timelines** Framework	The framework for an ERA at a nuclear facility should encompass the following technical components: (a) problem formulation; (b) exposure assessment; (c) toxicity/effects assessment; and (d) risk characterization.	Organization of Report (1.3), and TOC for more details
5.2	Tiers of assessment	See details in CSA N288.6-22	Goals, Objectives and Scope (1.2)
5.3	Risk assessment updates	See details in CSA N288.6-22	ERA Goals, Objectives and Scope (1.2)
6 6.1	**Human health risk assessments** General	Clause 6 outlines the recommended components of HHRAs involving both non-radiological and radiological contaminants and physical stressors. HHRAs comprise the following components: (a) problem formulation; (b) exposure assessment; (c) toxicity assessment; and (d) risk characterization.	See below

Section #	Topic	CSA N288.6-22 Requirement	Douglas Point ERA Section
6.2	Problem formulation	See details in CSA N288.6-22	HHRA Problem Formulation (3.1 – Radiological HHRA 5.1 – Non-radiological HHRA)
6.3	Exposure assessment	See details in CSA N288.6-22	HHRA Exposure Assessment (3.2 and 5.2)
6.4	Toxicity assessment	See details in CSA N288.6-22	HHRA Effects / Toxicity Assessments (3.3 and 5.3)
6.5	Risk characterization	See details in CSA N288.6-22	HHRA Risk Characterization (3.4 and 5.4)
7 7.1	**Ecological risk assessments** General	Clause 7 outlines the recommended components of EcoRAs for contaminants and physical stressors. All EcoRAs, irrespective of the tier of assessment, comprise the following components: (a) problem formulation; (b) exposure assessment; (c) effects assessment; and (d) risk characterization.	See below
7.2	Problem formulation	See details in CSA N288.6-22	EcoRA Problem Formulation (4.1 – Radiological EcoRA 6.1 – Non-Radiological EcoRA)
7.3	Exposure assessment	See details in CSA N288.6-22	EcoRA Exposure Assessment (4.2 and 6.2)
7.4	Effects assessment	See details in CSA N288.6-22	EcoRA Effects / Toxicity Assessments (4.3 and 6.3)
7.5	Risk characterization	See details in CSA N288.6-22	EcoRA Risk Characterization (4.4 and 6.4)
8 8.1	**Evaluation of uncertainty** General	Clause 8 provides guidance on methods for evaluating uncertainty that are applicable to both HHRAs and EcoRAs. For each stage of the risk assessment (i.e., problem formulation, exposure assessment, toxicity/effects assessment, and risk characterization) the important uncertainties shall be evaluated qualitatively or semi-quantitatively and discussed in the ERA report.	See below

Section #	Topic	CSA N288.6-22 Requirement	Douglas Point ERA Section
8.2	Identifying and evaluating uncertainty	See details in CSA N288.6-22	Radiological HHRA – Uncertainties (3.5) Radiological EcoRA – Uncertainties (4.5) Non-Radiological HHRA – Uncertainties (5.5) Non-Radiological EcoRA – Uncertainties (6.5)
8.3	Probabilistic risk assessment	See details in CSA N288.6-22	Not in scope - not required for this ERA.
9 9.1	**Risk-based recommendations** General	Risk-based recommendations are an important outcome of an ERA and are useful for the development of risk management and/or remediation plans and for EMP optimization. Risk-based recommendations should be based on the results of the HHRA and the EcoRA.	Conclusions and Recommendations (7.0)
9.2	Recommendations for monitoring	ERA results might identify new or previously unidentified environmental issues or identify the need to study an environmental issue further. Alternatively, an ERA might indicate that some existing monitoring activities are unnecessary. As such, if appropriate, the ERA should recommend any changes to the monitoring program that are needed to focus the program and reduce uncertainties. Thus, the risk assessment results provide feedback into the EMP.	Conclusions and Recommendations (7.0)
9.3	Recommendations for risk management or remediation	See details in CSA N288.6-22	Conclusions and Recommendations (7.0)
10 10.1	**Quality assurance and quality control** -	Quality assurance (QA) activities are performed to monitor, document, and control the quality of the ERA process (e.g., planning, data gathering, data management, data analysis, report preparation, and record keeping) on a continual basis.	Quality Assurance and Quality Control (9.0)

Section #	Topic	CSA N288.6-22 Requirement	Douglas Point ERA Section
10.2	-	All aspects of the ERA process shall have appropriate QA and QC. QA/QC requirements for the ERA should be specified prior to conducting the ERA. The QA/QC requirements should be established to verify that the ERA is adequately addressing environmental issues and producing accurate results, and to identify any deficiencies requiring corrective action.	See Clause 10.1 above
10.3	-	Any data used in the ERA process that have been collected as part of the EMP should meet the data quality specifications outlined in the EMP.	See Clause 10.1 above
11 11.1	**Periodic review of the ERA** -	See details in CSA N288.6-22	See below
11.2	-	The information identified in Clause 11.1 should be used to plan the update to the ERA so that the update addresses current issues using current environmental data and current science.	ERA Goals, Objectives and Scope (1.2)
11.3	-	The EMP should also be reviewed on a five-year cycle (as specified in CSA N288.4), following completion of an updated ERA to ensure that environmental monitoring is addressing the data needs identified in the latest ERA	ERA Goals, Objectives and Scope (1.2)

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