2022 Environmental Protection Report

Bruce Power

B-REP-07000-00015

Master Created: 24Apr2023 12:49

PUBLIC

ENVIRONMENTAL PROTECTION REPORT 2022

B-REP-07000-00015

Rev 000

May 1, 2023

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Master Created: 24Apr2023 12:49

ABSTRACT OF PRESENT REVISION:

ACKNOWLEDGEMENT

Bruce Power appreciates the support of the local residents, businesses and communities surrounding the Bruce Power site who voluntarily take part in the environmental monitoring programs. Results from air monitoring equipment placed throughout the communities and local sample results from fish, honey, eggs, beef, poultry, grains, fruits, vegetables, animal feed and water help confirm a representative dose to public result.

EXECUTIVE SUMMARY

The purpose of this report is to fulfill regulatory requirements on environmental protection in accordance with Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating Licence for Bruce Nuclear Generating Stations A and B Licence number 18:02/2028 [R-1] and Canadian Nuclear Safety Commission Regulatory Document REGDOC 3.1.1 Reporting Requirements for Nuclear Power Plants [R-2].

International Organization for Standardization 14001, Environmental Management Systems Standard provides organizations the framework to improve environmental performance and protect the environment. Bruce Power had a successful re-registration audit in 2020 to acquire re-certification to the International Organization for Standardization 14001 standard [R-3], and underwent a successful surveillance audit in 2022. More details are described in section 9.0.

The Canadian Standards Association N288 series of Standards and Guidelines provide overall direction on environmental management and protection for nuclear facilities and several are a requirement of the operating licence for the facility. Bruce Power has implemented the Canadian Standards Association N288 standards as per requirements of the Licence Condition Handbook [R-4].

Site Location

The Site is located on the eastern shore of Lake Huron near Tiverton, Ontario within the traditional lands and treaty territory of the people of the Saugeen Ojibway Nation, which includes the Chippewas of Nawash and Saugeen First Nations. Bruce Power is dedicated to honouring Indigenous history and culture and is committed to moving forward in the spirit of reconciliation and respect with the Saugeen Ojibway Nation, Georgian Bay Métis Nation of Ontario and the Historic Saugeen Métis, and to leading by example in this community and industry.

During the 2018 licence renewal process, Bruce Power presented their commitment to working with Saugeen Ojibway Nation, Métis Nation of Ontario and Historic Saugeen Métis in a manner that best suits their communities, to enhance involvement in environmental monitoring. Recognizing that every community has a unique set of interests, in 2022 we worked with each community to further these commitments. Progress in environmental monitoring over the course of the year included:

- Saugeen Ojibway Nation's Coastal Waters Monitoring Program continued for the fourth consecutive year. Results from this program are used in conjunction with environmental monitoring results in the 2022 Environmental Risk Assessment to better understand the near shore environment of Lake Huron over a larger spatial scale.

- Bruce Power in conjunction with the Council of the Great Lakes Region and Climate Risk Institute worked alongside each of the local Indigenous communities (Saugeen Ojibway Nation, Métis Nation of Ontario and Historic Saugeen Métis) to develop a Climate Change Risk Assessment and story map unique to each community taking into account specific habitats and species of particular interests within each community.

- Bruce Power engaged the Indigenous communities on the results of the 2022 Environmental Risk Assessment prior to its completion allowing for dialogue and opportunity to address any concerns prior to the completion of the report.

- Historic Saugeen Métis, Bruce Power, the Intergovernmental Panel on Climate Change, University of Waterloo and the Nuclear Innovation Institute worked collaboratively to conduct research on Fairy Lake to determine the quality of the lake and measures on how the quality can be improved.

Bruce Power continues to build and develop our dialogue on environmental items of interest with indigenous Nations and Communities. Sharing and insights have strengthened our approach and have led to synergies for growth and partnership for continued environmental protections.

Dose to Public

Each year Bruce Power gathers information in order to calculate the radiological dose to representative persons living near the Site. This includes meteorological data, analysis of local environmental media and Site radiological emissions and effluents that include all utilities near or within the Bruce Power Site boundary. Following the methodology outlined in Canadian Standards Association N288.1 and using an environmental transfer model, a dose is calculated for each representative person at three age classes – adult, child and infant. A representative person is determined using the lifestyle characteristics identified in the Site Specific Survey and is defined as an individual who receives a dose that is representative of the most highly exposed individuals in the population. The most limiting result, or highest calculated dose, is used as the annual dose to public and is published annually in this report.

For the thirty-first consecutive year, Bruce Power's contribution to the annual dose of a member of the public is less than the lower threshold for significance (less than 10 microsieverts per year) and is considered *de minimus*. The maximum dose associated with Bruce Power operations in 2022 was obtained for the Bruce Subsistence Farmer (BSF2) Infant who received 2.4 microsieverts per year. All other representative persons have a lower dose. This maximum dose is a small fraction of a percent of the legal limit of 1,000 microsieverts per year.

Representative Person	Committed Effective Dose	Percentage of Legal Limit
BSF2 Infant	2.4 microsieverts per year	0.24%

Community Investment and Sustainability

Bruce Power is dedicated to supporting environmental stewardship and awareness throughout the local communities and in the greater Ontario region. Our Environment and Sustainability Fund distributes $400,000 annually to local environmental projects and partnerships with a focus on Grey, Bruce, and Huron counties. The funding is aimed at initiatives related to conservation, carbon emissions reduction, as well as environmental education, awareness, and research. In 2022, Bruce Power's Environment and Sustainability Fund partnerships included:

- Supporting the development of Zero Emission Vehicle infrastructure with Plug'n Drive, a non-profit organization committed to accelerating electric vehicle adoption to maximize their environmental and economic benefits.

- Supporting the Lake Huron Coastal Centre's Coast Watchers, a citizen science program that engages citizens in the monitoring and protection of the Lake Huron coast. Data collected by this program is shared with partnering organizations and government agencies.

In addition, Bruce Power remains committed to seeking ways to reduce the environmental impact of our operations, while aligning support with provincial, national, and global sustainability goals. Following our commitment to Net Zero (Greenhouse Gas emissions) by 2027, Bruce Power released a 2027 Net Zero Strategy, outlining the emissions reduction, substitution and offsetting actions that will be undertaken to achieve our targets. Bruce Power met emissions reduction targets in 2022 and continues to work on the implementation of onsite operational initiatives and is partnering with local carbon sequestration and offset projects to support further reductions. Bruce Power is also in the process of developing a Nuclear Carbon Offset Protocol, in partnership with GHD Group Limited.

Our sustainability program and reporting are based on Environmental, Social and Governance principles, aligning with global standards and best practices. In 2022, Bruce Power received a Low Risk Environmental, Social and Governance Risk Rating by the third-party Environmental, Social and Governance rating agency Morningstar Sustainalytics, with strong and improving Environmental, Social and Governance performance year over year.

Environmental Risk Assessment

An Environmental Risk Assessment was prepared following the guidance of Canadian Standards Association N288.6-12 which defines an Environmental Risk Assessment as a systematic process used to identify, quantify, and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors (human and non-human biota), including the magnitude and extent of the potential effects associated with a facility [R-5]. The 2022 Environmental Risk Assessment found that operation of the Site has not resulted in adverse effects on human health or nearby residents or visitors due to exposure to radiological or conventional substances. There were no adverse effects on ecological receptors due to exposure to radiological substances. Risks to ecological receptors from exposure to conventional substances were limited to specific areas on site and are detailed in 4.1. Where risks have the potential to be elevated, follow-up monitoring at specific locations was recommended. Implementation of follow-up recommendations is in progress in preparation for the submission of the next Environmental Risk Assessment in June of 2027.

Environmental Monitoring

Bruce Power's Environmental Protection Program is built upon an integrated monitoring approach that strives to understand environmental impact, verify environmental protection, and continuously improve by driving strategic research and innovation through collaborations with industry and community. The environmental monitoring program is designed to meet the requirements of Canadian Standards Association N288.4-10 [R-5]. This consists of both radiological environmental monitoring program, which is used to characterize dose to public annually, and non-radiological (conventional) environmental monitoring program. Together, environmental monitoring and assessment verifies that emissions and effluents as a result of site operations have a minimal impact on the surroundings. Environmental safety and responsibility are woven into all aspects of the company's nuclear safety culture, and Bruce Power commits to meet or exceed all relevant legal and voluntary environmental requirements. The company holds itself accountable to prevent pollution through strong management of emissions, effluents, and waste, and it implements robust spill mitigation measures in order to provide effective containment and control of contaminants.

Radiological Environmental Monitoring

The Radiological Environmental Monitoring program establishes a database of radiological activity measured in the environment near Bruce Power and determines the contribution of overall radiation dose to members of the public as a consequence of the radiological releases from normal operations on Site. The radiological environmental monitoring data implicitly reflects the influence of releases from all Bruce Power licensed facilities as well as facilities within or adjacent to the Bruce Power Site boundary that are owned by other parties. The program involves the annual collection and analysis of environmental media for radionuclides specific to nuclear power generation. The program design is based on risk and is informed by a radionuclide and exposure pathways analysis. Monitoring locations are conservatively selected to be representative of locations of exposure of representative persons and also based on practical considerations, including the availability of samples and participation of local residents and farmers. Sampling locations are grouped by proximity to site and these groups include indicator, area near and area far locations. Generally, radionuclide concentrations decrease with distance from site and all levels result in a *de minimus* dose. In 2022, as stated above, the maximum dose associated with Bruce Power operations was obtained for the BSF2 Infant who received 2.4 microsieverts per year which is less than the lower threshold for significance (less than 10 microsieverts per year).

Conventional Environmental Monitoring

The Conventional Environmental Monitoring Program monitors for conventional (non-radiological) contaminants, physical stressors, potential biological effects and pathways for both human and non-human biota. Bruce Power has a strong water quality monitoring program that continues to verify that effluent and emissions as well as physical stressors as a result of facility operations have little-to-no effect on the surrounding waterbody, and that Bruce Power has effective containment and effluent control measures in place. Fish impingement and entrainment losses in 2022 were consistent with prior years and well below the maximum loss permitted in Bruce Power's Fisheries Act Authorization. Fish offsetting activities continued as planned in 2022, with monitoring in the Saugeen River in the vicinity of the former Truax Dam as per Bruce Power's Offsetting Plan. This year's results from the Before-After Control-Impact study in fish production demonstrate that a statistically significant offset in fish biomass and production has occurred in the main stem of the Saugeen River, as well as one upstream tributary (Otter Creek). Thermal monitoring in Lake Huron also continued in 2022, with results used for ongoing verification for thermal risk assessment to address both the Ministry of Environment, Conservation and Parks environmental compliance approval conditions and analysis for the Environmental Risk Assessment. Long term biological effects monitoring of local wildlife populations continues to demonstrate a diverse and abundant community including amphibians, reptiles, birds, waterfowl and fish.

Groundwater Protection

The Bruce Power Groundwater Protection Program is aligned with Canadian Standards Association N288.7-15, Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills. The program is designed in consideration of a conceptual site model to achieve the overall groundwater protection goal to protect the quality and quantity of groundwater by minimizing the interactions with the environment from activities associated with Bruce Power thereby allowing the effective management of groundwater as a resource. The groundwater goals are achieved through the setting of objectives which were developed through a systematic planning process and form the basis of program performance monitoring. Performance against program objectives is evaluated at least annually which allows for continuous program improvements.

All groundwater objectives were achieved in 2022.

Effluent Monitoring

Results of the Effluent Monitoring program demonstrate that all conventional and radiological effluents (waterborne and airborne) are, and continue to be, well below regulatory limits.

Radiological Emissions and Effluent Monitoring

In 2022, all radiological releases continued to remain well below the Derived Release Limits. Bruce Power has several engineered barriers in place, where possible, to minimize radionuclides released to the environment and keep airborne emissions and waterborne effluent as low as reasonably achievable. These barriers in addition to systematic monitoring, trending and investigation of emissions and effluent, as required, assists Bruce Power in minimizing releases and ensuring they remain well below regulatory limits.

Conventional Effluent Monitoring

Air emissions and water effluents are controlled to meet regulatory requirements and to minimize impacts to protect the natural environment. Emissions and effluents are discharged according to specific licenses, permits, and regulations under (but not limited to) the Environmental Protection Act [R-6] and the Ontario Water Resources Act [R-7]. Bruce Power performs extensive modelling and monitoring of its emissions and effluent to ensure that releases occur within acceptable limits and environmental impact are minimized.

Waste Management

Bruce Power complies with all waste regulations and requirements of the relevant federal, provincial, and municipal authorities. Further, Bruce Power has taken an active role for many years to reduce all forms of waste: from an environmental and financial standpoint waste reduction is good for our company and the community in which we reside. Our philosophy employs a whole life-cycle approach in that we reduce waste at the consumer level, generate less waste at the company level, find opportunities to reuse products (on-site, off-site donations, or auction), and implement recycling programs that are available in the ever-changing recycling market. Wherever its fate, each waste stream generated at Bruce Power is processed and disposed of in a safe and environmentally responsible manner.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to fulfill regulatory requirements on environmental protection in accordance with Licence Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating Licence Bruce Nuclear Generating Stations A and B 18:02/2028 [R-8] and the Canadian Nuclear Safety Commission Regulatory Document REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants, Section 3.5 [R-2]. This report meets the content, timing and reporting requirements of REGDOC-3.1.1 [R-2].

1.2 Regulatory Requirements

1.2.1 Licence Requirements

Power Reactor Operating Licence Bruce Nuclear Generating Stations A and B 18:02/2028 [R-8] and the associated Licence Condition Handbook [R-9], has Section 3.3 Reporting Requirements that require Bruce Power to notify and report in accordance with Canadian Nuclear Safety Commission regulatory document REGDOC-3.1.1, version 2 [R-2]. Environmental Protection is one safety control area which covers programs that identify, control, and monitor all releases of radiological, non-radiological and hazardous substances, and monitors the effects on the environment from the operation of facilities or as the result of licensed activities.

The environmental protection report is submitted annually to the Canadian Nuclear Safety Commission and contains information as required by REGDOC-3.1.1, version 2 section 3.5 [R-2] posted publicly a, Publications – Bruce Power.

Federal and provincial regulations require licensees to monitor and report on the characteristics of airborne and waterborne effluent. Licensees are required to comply with any statutes, regulations, licences, or permits that govern the operation of the nuclear facility or licensed activity. The release of hazardous substances is regulated by both the Ontario Ministry of the Environment Conservation and Parks and Environment and Climate Change Canada through various acts and regulations, as well as by the Canadian Nuclear Safety Commission.

If the licensee is required to submit annual reports to other government departments concerning their environmental protection program, that show the results of the effluent/emission and environmental monitoring programs, sending a copy of the report to the Canadian Nuclear Safety Commission is acceptable. This satisfies the Canadian Nuclear Safety Commission’s requirement for oversight of the Bruce Power environmental monitoring program.

1.2.2 Environmental Protection Program

Bruce Power complies with federal regulations, programs, and standards which protect human health and the environment under the *Nuclear Safety and Control Act* [R-10]. The key elements are listed below:

- The *General Nuclear Safety and Control Regulations* [R-11] require every licensee to take all reasonable precautions to protect the environment and to control release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity.
- The *Class 1 Nuclear Facilities Regulations* [R-12] set out environmental protection requirements that must be met.
- The *Radiation Protection Regulations* [R-13] prescribe radiation dose limits for the general public of 1 millisieverts (1000 microsieverts) per calendar year.
- Power Reactor Operating Licence 18.02/2028, Nuclear Reactor Operating Licence Bruce Nuclear Generating Stations A and B[R-8].

The Canadian Nuclear Safety Commission, when considering relicensing, has an obligation through the *Nuclear Safety and Control Act* [R-10] to consider whether an applicant will make adequate provision for the protection of the environment and the health and safety of people as outlined in REGDOC 2.9.1 Environmental Protection Policies, Programs and Procedures [R-14]. As a result, the Canadian Standards Association N288 standards are implemented through requirements set out in the License Condition Handbook [R-9].

REGDOC-2.9.1 [R-14] outlines the requirements needed for an environmental protection program consistent with the environmental management system standard, International Organization for Standardization 14001, Environmental Management System. Bruce Power's BP-PROG-00.02, Environmental Management [R-15] implements this environmental protection program.

1.2.2.1 Canadian Standards Association N288 Series

The Canadian Standards Association N288 standards are part of a series of guidelines and standards on environmental management of nuclear facilities. Bruce Power will continue to strive to be industry best and implement newer versions of the Canadian Standards Association N288 series of environmental standards as they become available.

Bruce Power has implemented the following Canadian Standards Association standards that are relevant to the Canadian Nuclear Safety Commission's regulatory framework for environmental compliance:

- Canadian Standards Association N288.1-14 (Update 3), Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities [R-16];
- Canadian Standards Association N288.4-10, Environmental Monitoring Program at Class 1 nuclear facilities and uranium mines and mills [R-5];
- Canadian Standards Association N288.5-11, Effluent monitoring programs at Class 1 nuclear facilities and uranium mines and mills [R-17];
- Canadian Standards Association N288.6-12, Environmental Risk Assessments at Class 1 nuclear facilities and uranium mines and mills [R-18]; and
- Canadian Standards Association N288.7-15, Groundwater Protection Programs at Class 1 nuclear facilities and uranium mines and mills [R-19].
- Canadian Standards Association N288.8-17, Establishing and implementing action levels for releases to the environment from nuclear facilities [R-20].

Bruce Power is working towards implementing, N288.1-20, Guidelines for modelling radionuclide environmental transport, fate, and exposure associated with the normal operation of nuclear facilities by Q4 2023 [R-21].

Bruce power has also proactively implemented N288.0-22, Environmental management of nuclear facilities: Common requirements of the Canadian Standards Association N288 series of Standards. This standard is required to be implemented when moving to the new versions (2022 onwards) of the N288 standards.

Bruce Power is following the guidance provided in Canadian Standards Association N288.9-18, Guideline for design of fish impingement and entrainment programs at nuclear facilities [R-22] to enhance the fish impingement and entrainment programs and Canadian Standards Association N288.3.4-13, Performance testing of nuclear air-cleaning systems at nuclear facilities [R-23].

1.2.2.2 Environmental Management System (International Organization for Standardization 14001 Standard)

International Organization for Standardization 14001 [R-3] specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance. The standard is used to manage its environmental responsibilities in a systematic manner that contributes to environmental sustainability and ensures environmental protection.

In 2022, Bruce Power had a successful surveillance audit to confirm that Bruce Power operates an Environmental Management System compliant with the requirements of International Organization for Standardization 14001:2015 [R-3]. The current certification is valid for three years (2020-2023).

The Bruce Power environmental management system program oversees the planning, implementation, and operation of integrated activities, with a focus on minimizing the potential adverse impact of Bruce Power operations on the environment. This includes ensuring the Bruce Power's Environmental Safety Program as defined by BP-PROG-00.02, Environmental Management [R-15], conforms to the International Organization for Standardization 14001 standard for Environmental Management System [R-3], environmental compliance obligations applicable to Bruce Power and the commitments made in the Environmental Policy.

Environment & Sustainability Policy

The Environmental Policy was updated in 2021 to the Environment & Sustainability Policy to enhance the description of sustainability principles, address work in strategic research and innovation, and to demonstrate our commitment of meeting or exceeding requirements. The Environment & Sustainability Policy establishes guiding principles and environmental expectations for employees and those working on behalf of Bruce Power. The Environmental Policy reflects the commitment of Bruce Power to protect the environment and states that you can count on Bruce Power to:

- Ingrain a healthy nuclear safety culture which promotes nuclear safety, radiological safety, industrial safety and environmental safety and sustainability;
- Commit to excellence by meeting or exceeding all relevant legal and voluntary requirements to which Bruce Power subscribes;
- Understand our environmental impact and verify environmental protection through monitoring the environment, collaborating with industry and the community, and driving related strategic research and innovation;
- Focus on continuous improvement by adopting applicable industry best practices and requirements of International Organization for Standardization 14001;
- Ensure our business decisions support the application and practice of sustainability principles by protecting, conserving, and restoring our resources through energy conservation, reducing water consumption, supporting waste diversion, and considering product life cycle in our Supply Chain;
- Hold ourselves accountable to prevent pollution through robust management of emissions, effluents and waste, as well as implementation of spill mitigation measures;

- Promote environmental stewardship and awareness at work, in the community, and across Ontario;

- Uphold the trust of the community through open and transparent communication with partners, Indigenous communities, and stakeholders on environmental interests;

- Play a leading role in keeping the air clean and fighting climate change; supporting emissions reductions strategies to achieve a Net Zero Canada by 2050; adopting ambitious net reduction strategies for Bruce Power to achieve Net Zero (Greenhouse Gas); and

- Support partners, communities and organizations to drive innovations and projects to offset and sequester carbon in a real and tangible way.

2.0 BACKGROUND

The Site is located in the Municipality of Kincardine on the eastern shore of Lake Huron within Bruce County. The Municipality of Kincardine is comprised of the town of Kincardine and several small villages and towns including Inverhuron and Tiverton. The area is a popular tourist destination with many cottages and holiday parks attracting visitors from across Ontario, Canada and the United States. The next closest municipality to the Site is the Town of Saugeen Shores, which is approximately 25 kilometres from the Site. The Town of Saugeen Shores includes Southampton and Port Elgin.

Bruce County can be broadly split into three sections: (i) the Bruce Peninsula, part of the Niagara Escarpment, (ii) the Lakeshore that includes a number of sandy beaches and fresh water, and (iii) the Interior Region, also known as the “breadbasket” which has a strong history of farming and agriculture. Bruce County has economic strengths in many sectors including tourism, agriculture and energy. The 2021 Census showed a population of 12,268 people in the Municipality of Kincardine (an increase of 7.7% from 2016) and a population of 15,908 in the Town of Saugeen Shores (an increase of 16% from 2016), which includes Southampton and Port Elgin. Both municipalities are in Bruce County, which has a total population of 73,396 (an increase of 7.7% from 2016).

2.1 Bruce Power Site

Bruce Power has been safely operating the Bruce Nuclear Facility (referred to as the “Site” herein) located near Tiverton, Ontario since May 2001. The Site is located on the east shore of Lake Huron about 18 kilometres north of Kincardine. The Site includes Bruce Nuclear Generating Station A (Bruce A) and Bruce Nuclear Generating Station B (Bruce B), which each comprise four CANDU reactors, as well as ancillary facilities. The Site also encompasses lands currently occupied by Ontario Power Generation, Canadian Nuclear Laboratories Douglas Point and Hydro One.

Currently, six of the eight reactors are operational, and the facility also includes radioactive waste storage among other supporting facilities. Unit 6 at Bruce B is undergoing Major Component Replacement and Major Component Replacement for Unit 3 at Bruce A commenced in March 2023.

2.1.1 Ontario Power Generation Land and Facilities

The Western Waste Management Facility is owned and operated by Ontario Power Generation. It is located centrally on the Bruce site and is designated for the management of radioactive waste and licensed for such use by the Canadian Nuclear Safety Commission. This 19-hectare facility contains the Low and Intermediate Level Waste storage area and the used fuel dry storage area [R-24].

The objectives of the Western Waste Management Facility are to provide safe material handling (receipt, transfers, and retrieval), treatment, and storage of radioactive materials produced at nuclear generating stations and other facilities currently or previously operated by Ontario Power Generation or its predecessor, Ontario Hydro. This facility also provides safe storage of Bruce Power’s used fuel in Dry Storage Containers until it can be transported to an alternative long term used fuel storage or disposal facility. The used fuel dry storage area is a security protected area located northeast of the Low and Intermediate Level Waste storage area and consists of Dry Storage Containers processing and storage buildings [R-25].

The Low and Intermediate Level Waste portion of the facility consists of various structures such as the Amenities Building, Waste Volume Reduction Building, Transportation Package Maintenance Building, low level and intermediate level waste storage buildings, quadricells, in ground containers, trenches, and tile holes. These structures are primarily used for processing of low-level waste and storage of Low and Intermediate Level Waste from Onatrio Power Generation’s Pickering and Darlington Nuclear Generating Stations as well as Bruce Power operations.

2.1.1.1 Ontario Power Generation Western Waste Management Facility

The Ontario Power Generation Western Waste Management Facility operates under a Waste Facility Operating Licence (WFOL-W4-314.00 2027) [R-56] and monitors emissions in accordance with Ontario Power Generation’s N-STD-OP-0031 Monitoring of Nuclear and Hazardous Substances in Effluents [R-57]. N-STD-OP-0031 establishes the minimum standards for monitoring airborne and waterborne releases for Ontario Power Generation nuclear facilities in accordance with Canadian Standards Association N288.5 [R-19]. The effluent monitoring program ensures emissions are maintained well below the Derived Release Limits established in the Licence Condition Handbook (LCH-W4-314.00 2027) [R-58] and provides for early detection of potential adverse trends. The effluent monitoring results are reported quarterly to the Canadian Nuclear Safety Commission by Ontario Power Generation. The effluent monitoring program is reviewed and updated as necessary to ensure it is inclusive of changing site conditions (e.g., expansions and aging management), historic performance, updated standards and industry best practices.

The efficacy of the effluent monitoring program is also assessed by the Western Waste Management Facility specific Environmental Risk Assessment process and the Environmental Monitoring Program. The Environmental Risk Assessment and Environmental Monitoring Program are completed in accordance with Canadian Standards Association N288.6 and N288.4 [R-20] [R-6]. The Environmental Risk Assessment [R-59] is updated at a minimum of once every five years and the Environmental Monitoring Program is reviewed annually.

The most recent Environmental Risk Assessment update was completed in 2021 [R-59]. The conclusions of the Environmental Risk Assessment and the Environmental Monitoring Program indicate that there are no adverse effects to human health or to the local community level ecology from the operation of the Western Waste Management Facility [R-60]. The Environmental Risk Assessment and Annual Environmental Monitoring Program reports are available to the public on Ontario Power Generation's website at www.opg.com/reporting/regulatory-reporting/.

2.1.2 Canadian Nuclear Laboratories Lands and Facilities

The Douglas Point Waste Facility is operated by Canadian Nuclear Laboratories and is located on the Bruce Nuclear Power Development Site. Douglas Point, which operated between 1966 and 1984, was the prototype commercial-scale Canada Deuterium Uranium (CANDU) nuclear power plant. With full operation commencing in 1968, the Douglas Point Generating Station supplied 220 Megawatts to the Ontario grid over the next 16 years. Eventually a decision was made to shut down Douglas Point rather than undertake the refurbishment of the pressure tubes that was required for continued operation. While the Douglas Point facility structures remain in place today, the reactor has been permanently shut down since 1984. Used fuel from the reactor is stored in dry storage modules at the facility. Decommissioning of the Douglas Point Facility is progressing with a 2070 timeline for completion. The decommissioning plans for the coming years include the dismantling of non-nuclear buildings and nuclear support buildings. The reactor and its building are anticipated to be decommissioned after 2030.

In 2020, the facility was in Phase 2 of decommissioning, known as “Storage with Surveillance” [R-25] [R-26]. In 2021, the Canadian Nuclear Safety Commission amended the decommissioning licence to allow Canadian Nuclear Laboratories to begin Phase 3 of five-phase process of decommissioning activities.

2.1.3 Hydro One Lands and Facilities

Hydro One owns and operates a number of assets within Bruce Site. These include, but are not limited to, office and workshops for maintenance, switchyards at Bruce A and Bruce B, switching stations and transformer stations, and transmission corridors [R-26].

2.2 Kinectrics' Ontario Nuclear Services Facility

Kinectrics' Ontario Nuclear Services Facility (previously known as K.I. North Facility) is located in Tiverton, Ontario, approximately 3 kilometres from the Bruce Site. The site has an approximate footprint of 16.66 hectares and houses one building with an approximate footprint of 3440 square metres. The facility functions as a radioactive workspace to decontaminate and refurbish large nuclear reactor tools and equipment used during reactor maintenance outages [R-27].

Kinectrics carries out effluent monitoring activities on both airborne tritium releases through exhaust stacks and on liquid releases to sewer, following Kinectrics' effluent monitoring procedures. Specifically:

- Kinectrics' Waste Nuclear Substance Licence requires releases to air to be monitored for tritium only at Kinectrics' Ontario Nuclear Services Facility, since particulates are caught in pre-filters and High Efficiency Particulate Air filters prior to exhaust. Tritium releases through exhaust stacks are continuously sampled, and analysis of the samples is conducted weekly [R-27].

- Potentially active wastewater is temporarily stored in collection tanks and sampled and analyzed prior to release. If any radiological or chemical contaminant is found to be above administrative control levels, which are set below the Waste Nuclear Substance Licence limits, then the tank contents are filtered through two charcoal filters and then re-analyzed. All releases are maintained below the Waste Nuclear Substance Licence limits [R-27]. The processes at Kinectrics' Ontario Nuclear Services Facility produce very small volumes of liquid waste, hence discharge to the environment is not required often (less than once per year).

2.3 Canadian Nuclear Safety Commission, Independent Environmental Monitoring Program

The Canadian Nuclear Safety Commission has implemented its Independent Environmental Monitoring Program to verify that the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to, the Canadian Nuclear Safety Commission's ongoing compliance verification program. The Independent Environmental Monitoring Program involves taking samples from publicly accessible areas around the facilities and measuring and analyzing the amount of radioactive and hazardous substances in those samples. Canadian Nuclear Safety Commission staff collect the samples and send them to the Canadian Nuclear Safety Commission's state-of-the-art laboratory for testing and analysis. Since the implementation of the Independent Environmental Monitoring Program, the area outside of the Bruce Nuclear Generating Station perimeter was sampled in 2013, 2015, 2016 and 2019. [R-28]

The sampling plans focus on measuring concentrations of contaminants in the environment at publicly accessible locations such as parks, residential communities and beaches, and in areas of interest identified in Environmental Risk Assessments. Samples may be taken for air, water, soil, sediment, vegetation, and some food, such as meat and produce.

The Canadian Nuclear Safety Commission has also conducted a large study to look at radiation exposure and the incidence of cancer around Ontario nuclear generating sites, including the Bruce Power site. This study concluded that doses to the public were well below levels of natural background radiation and that people who live near nuclear generating sites have no excess cancer risk and are as healthy as the rest of Canada’s general population [R-29].

2.3.1 2019 Independent Environmental Monitoring Program Results

The 2019 Independent Environmental Monitoring Program sampling plan for the Bruce Nuclear Generating Station focused on nuclear and hazardous contaminants. This differs from Independent Environmental Monitoring Program sampling plans in 2013, 2015 and 2016 which focused only on nuclear contaminants. A site-specific sampling plan was developed based on Bruce Power’s approved environmental monitoring program and the Canadian Nuclear Safety Commission’s regulatory experience with the site. The Métis Nation of Ontario, Saugeen Ojibway Nation and Historic Saugeen Métis also collaborated with the Canadian Nuclear Safety Commission by providing valuable information about locations and species of interest for sampling, and by participating in the collection of samples. It is a priority for the Canadian Nuclear Safety Commission to ensure that Independent Environmental Monitoring Program sampling reflects traditional Indigenous land use, values and knowledge, where possible, so that Independent Environmental Monitoring Program results are meaningful to the communities [R-28].

In all years, samples were collected in publicly accessible areas outside the Bruce Nuclear Generating Station site perimeter and included samples of air, water, soil, sediment, vegetation and food, such as meat and produce from local farms.

In 2019, the radioactivity measured in air, water, sediment, soil and vegetation samples, as well as in samples of meat, fish, milk and produce was below guidelines and Canadian Nuclear Safety Commission screening levels. These results are similar to those in 2013, 2015 and 2016. Canadian Nuclear Safety Commission screening levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 millisieverts per year. No health impacts are expected at this dose level.

The levels of hazardous (non-radiological) contaminants measured in water and sediment were below applicable guidelines. All samples were within the range of licensees’ data based on their recent Environmental Risk Assessments, and below the toxicity data available, indicating that potential effects to the environment are low.

2.3.2 Independent Environmental Monitoring Program Conclusions

Independent Environmental Monitoring Program results from 2013, 2015, 2016 and 2019 indicate that the public and the environment around the Bruce Nuclear Generating Station are protected, and there are no expected health impacts. These results are consistent with the results submitted by Bruce Power, demonstrating that the licensee's environmental protection program protects the health and safety of the people and the environment [R-28]. Independent Environmental Monitoring Program samples were taken in 2022, however results have not been reported to date.

2.4 Local Indigenous Communities

The Site lies within the traditional lands and treaty territory of the Saugeen Ojibway Nation. Bruce Power is dedicated to honouring Indigenous history and culture and is committed to moving forward in the spirit of reconciliation and respect with the Saugeen Ojibway Nation, Georgian Bay Métis Nation of Ontario and the Historic Saugeen Métis and to leading by example in this community and industry. Métis people living near the Site may be represented by either the Historic Saugeen Métis or the Métis Nation of Ontario.

2.4.1 Saugeen Ojibway Nation

The Saugeen Ojibway Nation is comprised of the Chippewas of Nawash Unceded First Nation and the Chippewas of Saugeen First Nation. They are Aboriginal peoples of the Grey and Bruce region, which they know as Anishnaabekiing. Their traditional territory includes the lands and waters that surround the Site. The Saugeen Ojibway Nation has two main on-reserve communities which are located approximately 30 kilometres (Chippewas of Saugeen First Nation Reserve No. 29) and 80 kilometres north of the Site (Neyaashiinigmiing Reserve No. 27). The Saugeen Ojibway Nation also has two hunting ground reserves that are located approximately 115 kilometres north of the Site. The Saugeen Ojibway Nation's traditional territory is identified in Figure 1.

Figure 1 - Saugeen Ojibway Traditional Territory [R-30]

The Saugeen Ojibway Nation describes their asserted and established Aboriginal and treaty rights as follows:

"Saugeen Ojibway Nation has asserted and proven Aboriginal and Treaty rights throughout its Traditional Territory and continues to rely on this Territory for its economic, cultural, and spiritual survival. The Saugeen Ojibway Nation Territory, including its large reserves, is also the basis of significant and growing commercial fishing and tourism economies. Saugeen Ojibway Nation asserts its Aboriginal and Treaty rights entitle its members to be sustained by the lands, waters and resources of their Traditional Territory. Saugeen Ojibway Nation has the right to protect and preserve its Traditional Territory to ensure that it will be able to sustain its future generations. Saugeen Ojibway Nation asserts that its rights include, but are not limited to:

- The right to continue to be a distinct people living within their Traditional Territory;
- The right to maintain their culture, language and way of life;
- The right to be sustained by the lands, waters and resources of their Traditional Territory;
- The right to the exclusive use and occupation of their communal lands;
- The right to continued use of all of their Traditional Territory;
- The right to harvest for sustenance, cultural and livelihood purposes;
- The right to be meaningfully involved in decisions that will affect their Traditional Territory so that they can protect their way of life for many generations to come; and
- The right to be the stewards of their Traditional Territory.

Saugeen Ojibway Nation has a proven and exclusive Aboriginal and Treaty Right to a commercial fishery in the waters of Georgian Bay and Lake Huron, within Saugeen Ojibway Nation Territory. Members of Saugeen Ojibway Nation and their ancestors have been fishing these waters for sustenance and as the basis of trade and commerce for many hundreds of generations, and they continue to do so today. This fact has been recognized by the courts and by the Crown. While Lake Whitefish have significant cultural and economic significance to Saugeen Ojibway Nation - and have consequently been discussed at length in past proceedings and in these submissions - Saugeen Ojibway Nation's fishing rights are not species specific and include the right to harvest all species of fish" [R-31][R-32].

2.4.2 Historic Saugeen Métis

The Historic Saugeen Métis is a self-governing Métis community at the mouth of the Saugeen River in Southampton, Ontario. The Historic Saugeen Métis are an independent, rights bearing community that began with the arrival of trader Pierre Piché in the Saugeen territory in 1818. Its members have historically hunted, fished, traded, and lived in the traditional Saugeen territory since the early 1800s and assert harvesting rights based on the R. v. Powley decision of the Supreme Court of Canada. The Historic Saugeen Métis became independent and self-governing in 2008 and left the Métis Nation of Ontario in or around 2009. This Métis community is one of the formally organized Métis communities in Ontario that is not represented by the Métis Nation of Ontario. Its office is found in Southampton. According to the Historic Saugeen Métis website, the Historic Saugeen Métis [R-33]: "…are a distinctive Aboriginal community descended from unions between our European traders and Indian women. We are the Lake Huron watershed Métis with a unique Métis history and culture that lived, fished, hunted, trapped, and harvested the lands and waters of the Bruce Peninsula, the Lake Huron proper shoreline and its watersheds, their traditional Métis territory.

The Historic Saugeen Métis traded in a regional network since the early 1800s as far as the north shore of Lake Huron and have kinship with the Wikwemikong First Nations community and Killarney Métis community. The geographic scope of the contemporary community is described as covering over 275 kilometres of shoreline from Tobermory and south of Goderich, and includes the counties of Bruce, Grey, and Huron. Upon the decline of the fur trade in the early 1820s, Métis families from the Northwest joined these early Métis at Goderich. The community traded in a cohesive regional trading network that extended from the Upper Detroit River system to the northern shoreline of Lake Huron, to the historic Métis community of Killarney, creating kinship along the network from Detroit to Killarney."

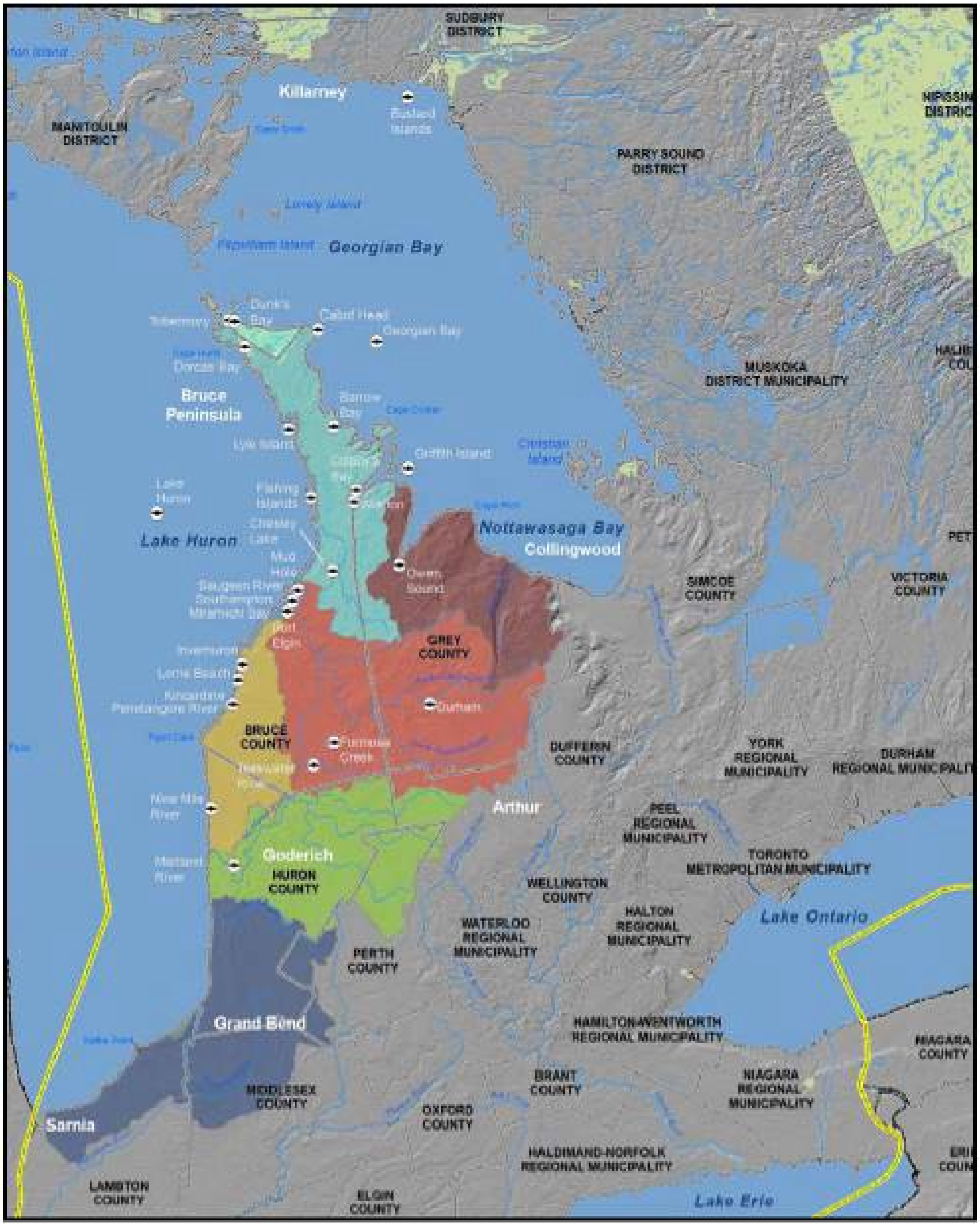


Figure 2 – Traditional Fish Harvesting Locations of the Historic Saugeen Métis [R-34]

2.4.3 Métis Nation of Ontario

The Métis Nation of Ontario was established in 1993 “as a representative organization with the objective to protect, assert, and support the distinct culture, traditions, economic wellbeing, and Métis constitutional rights embodied in the *Constitution Act*, 1982, Section 35, within the Métis Homelands of Ontario” [R-35]. The Métis Nation of Ontario has 29 community councils across Ontario, which represents regional rights bearing Métis communities. Three of these councils (Moon River Metis Council, Georgian Bay Metis Council, and the Great Lakes Metis Council) represent a regional right bearing community defined as the Georgian Bay Traditional Harvesting Territory, Figure 3 - Métis Nation of Ontario Traditional Harvesting Map [R-35], which includes the area surrounding the Site (Region 7). These three councils (collectively known as “Georgian Bay Regional Consultation Committee”) are distinct from the Historic Saugeen Métis which are no longer part of the Métis Nation of Ontario. The Métis Nation of Ontario and the Georgian Bay Regional Consultation Committee assert that their people exercise Aboriginal rights throughout the territory surrounding the Site. This includes hunting, fishing, trapping, gathering, sugaring, wood harvesting, use of sacred and communal sites, and use of water as described in the Métis Nation of Ontario’s Oral Presentation to the Canadian Nuclear Safety Commission in the public hearing for Bruce Power’s application to renew its operating licence in 2015: “The Métis Nation of Ontario and their Regional Consultation Committee assert that their people exercise Aboriginal rights throughout the territory surrounding the Bruce site, including, among other things, hunting, fishing (food and commercial), trapping (food and commercial), gathering, sugaring, wood harvesting, use of sacred and communal sites (i.e., incidental cabins, family group assembly locations etc.) and use of water. These rights are protected under the *Constitution Act*, 1982, section 35, as existing Aboriginal rights that have not been extinguished by the Crown by way of treaty or other means. Métis peoples live in, harvest throughout and extensively rely on their traditional territories for their individual and community’s wellbeing” [R-35].

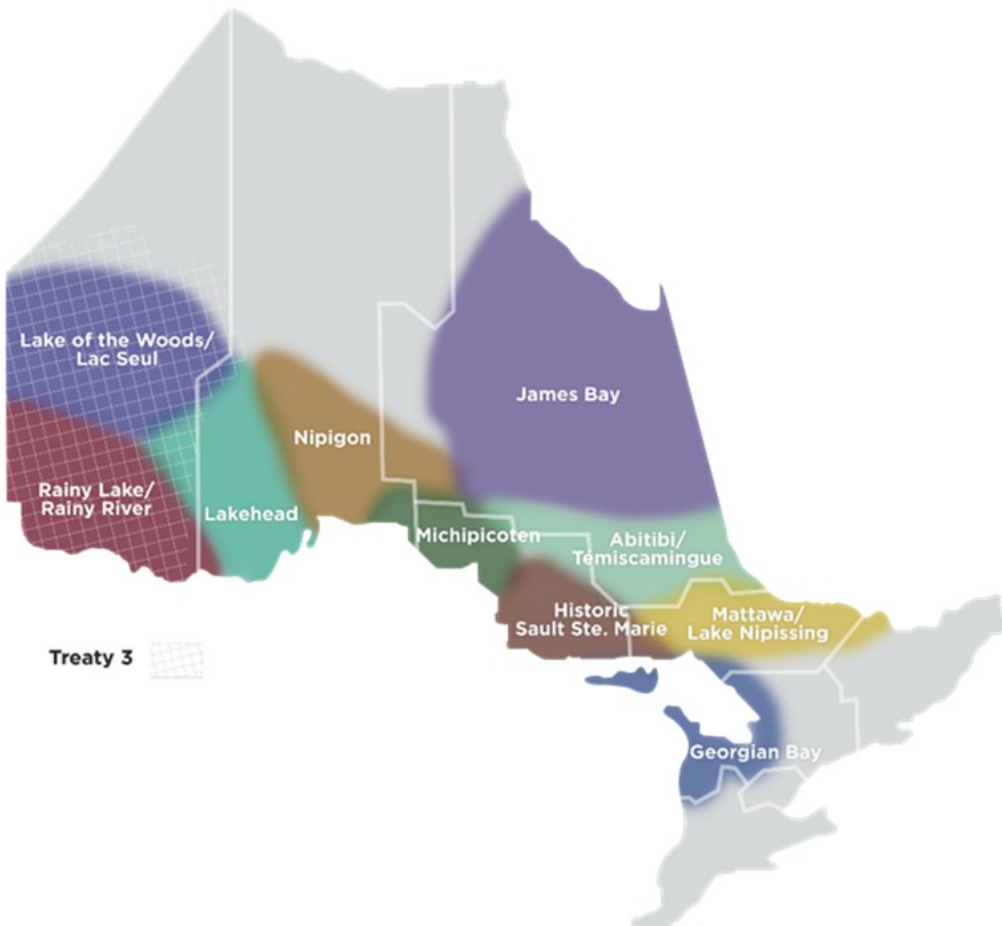


Figure 3 - Métis Nation of Ontario Traditional Harvesting Map [R-35]

2.5 Bruce Power's Community Engagement

Bruce Power has a long history of engaging and supporting local communities surrounding the Site. Bruce Power's values guide its conduct, decision-making and relationships both on the Site and in the community. To Bruce Power, living its values means conducting business ethically, respectfully, safely and with professionalism. Bruce Power's Code of Conduct is based upon these corporate values and sets a high standard of personal and professional integrity and behavioural expectations for everyone. It provides detailed information, guidelines, and references to other policies and resources that will help the company's employees make the right choices on a daily basis. Bruce Power's engagement with local communities and Indigenous groups is supported by its Public Disclosure Protocol, its

Indigenous Relations Policy, and its relationship/engagement agreements with the three Indigenous groups.

2.5.1 Community Investment and Sustainability

Corporate Social Responsibility is a core value at Bruce Power. Bruce Power's Community Investment fund has grown over the years and currently supports an annual giving of upwards of $2 million a year through five funding streams: Community Investment and Sponsorship, Environment and Sustainability, Indigenous Community Investment, Gifts in Kind and Tripartite. Bruce Power's Environment and Sustainability Fund saw the distribution of $400,000 amongst sponsorship, long-term partnerships, and events in 2022. Established in 2015, the Environment and Sustainability fund focuses allocation of resources to initiatives in the areas of:

- Environmental conservation and restoration
- Energy efficiency and carbon emission reduction
- Climate change mitigation and resilience
- Environmental education, awareness, and research

Priority is given to those initiatives within the Grey, Bruce and Huron counties given the Bruce Power's site location.

Bruce Power is committed to environmental protection in all areas of our business and to continually seeking ways of minimizing the environmental impact of our operations, while supporting provincial, national, and global sustainability goals. In 2021, Bruce Power announced our commitment to achieve Net Zero greenhouse gas emissions from its site operations by 2027. In 2022, Bruce Power released its 2027 Net Zero Strategy, outlining the emissions reduction, substitution and offsetting actions that will be undertaken to achieve these targets. Bruce Power met its emission reduction targets in 2022 and continues to implement operational initiatives to support further reductions. Initiatives include interior and exterior lighting upgrades, improvements to site building efficiency, and fleet efficiency efforts such as the addition of electric and hybrid vehicles and the optimization of our fleet size. In addition, through a Net Zero partnership with the Nuclear Innovation Institute, Bruce Power is supporting carbon-offset projects in our local communities, including The Alternative Land Use Services New Acre Project. Selected as part of the Carbon Offset Coalition and funded by the Carbon Offset Accelerator Fund, the project involves 600 acres of nature-based projects on agricultural land across Bruce and Grey counties that result in carbon sequestering opportunities and the protection and enhancement of local ecosystems. Carbon offsets generated from this project will help to support Bruce Power's Net Zero 2027 commitment. To help support other industries in meeting their emission reduction goals, Bruce Power is also developing a Nuclear Carbon Offset Protocol, in partnership with GHD Group Limited. This protocol will be based on new incremental nuclear output being accredited for an avoided emissions benefit.

Bruce Power's sustainability program is based on Environmental, Social and Governance principles, integrating a quantitative and formalized approach in communicating our performance in our reports, and aiming to align with global standards and best practices. The oversight and endorsement of initiatives to integrate Environmental, Social and Governance monitoring and goals into Bruce Power's long-term business strategy is undertaken by the leadership-level Environment and Sustainability Oversight Committee that was established in 2020.

In 2022, Bruce Power received a Low Risk Environmental, Social and Governance Risk Rating by the third-party Environmental, Social and Governance rating agency Morningstar Sustainalytics, with strong and improving Environmental, Social and Governance performance year over year. The latest Risk Rating ranked Bruce Power a spot in the top 3 within its sub-industry on a global scale and in the top three per cent in the utilities industry covered by Morningstar Sustainalytics. Bruce Power drives for continued improvement in our Environmental, Social and Governance efforts and sustainable business practices based on feedback from these third-party assessments.

More information on our sustainability program can be found in Bruce Power's 2022 Sustainability Report, including our 2021 sustainability performance metrics. Our next report including our 2022 performance metrics will be published in June 2023.

2.5.2 Life Extension Program and Major Component Replacement

In December 2015, Bruce Power reached an agreement with the Independent Electricity System Operator to advance a long-term investment program to refurbish its nuclear fleet and secure the site's operation until 2064.

The Life-Extension Program started planning activities on January 1, 2016, and involves the gradual replacement of older systems in the company's eight reactor units during routine maintenance outages.

As part of the Life-Extension Program, Bruce Power is carrying out an intensive Major Component Replacement Project. The Major Component Replacement Project activities began in January 2020 and focuses on the replacement of key primary side components in Units 3 to 8, including steam generators, pressure tubes, calandria tubes and feeder tubes.

Minor modifications were completed for existing environmental compliance approvals as required. These were within the operational flexibility of the environmental compliance approval and did not impact the environmental limits for effluent. As of March 2023, there were no environmental infractions related to the Life Extension Program or Major Component Replacement. Environment personnel continue to perform as key stakeholders in Life Extension and Major Component Replacement projects, providing document reviews and feedback throughout all stages of planning and execution. The Environment staff conduct routine field walk downs and observations; ensuring oversight on activities which have the potential to impact the environment and providing timely guidance on mitigation measures where appropriate.

Environmental management plans are created to manage potential environmental risks and mitigation strategies related to the larger project scopes of work. The Environmental Management Plans are developed to provide project execution vendors with key information regarding the environmental aspects of the activities covered in their scope of work, including conventional and radiological emissions, waste, and spills. The Environmental Management Plans also provide the execution owner with awareness on items such as regulatory requirements and event reporting expectation. For the remainder of smaller scope planned evolutions, an Environmental Management Plan may not be appropriate but Environmental Impact Workflows are utilized to perform an environmental impact assessment of the activity. Environmental Impact Workflows prompt for a description of the activity being performed and contain a series of questions which allows for environment personnel to then assess the risk and provide relevant guidance to ensure any potential environmental risk the activity poses are appropriately managed and mitigated.

Over the course of 2021 and 2022, many projects related milestones were completed with minimal environmental impact as anticipated in the 2017 Predictive Environmental Risk Assessment. Following breaker open on January 17, 2020, Unit 6 was safely taken into a defueled guaranteed shutdown state and the lead in vault work completed. Crews then drained and dried the Moderator and Primary Heat Transport systems. The removal series of work started in 2020 and by the end of 2021, the upper and lower feeders had been removed as well as the pressure tubes and calandria tubes. The eight steam generators were also removed, and new steam generators installed in 2021. Then in 2022 the installation series of work began for the feeders, pressure tubes and calandria tubes. The Moderator system was refilled with no impacts to the environment. Systems will continue to be returned to service in 2023 and the unit brought back into operation in Q4 2023.

Construction and refurbishment of buildings has continued with preparations for Major Component Replacement Unit 3 at Bruce A including a material handling building to support transfer of materials from the un-zoned area into Unit 3, refurbishment of spaces at Bruce A for offices for additional personnel, an Auxiliary Guardhouse for Bruce A, and the completion of construction trailers for the crane pad.

Environment assessment and guidance is integrated throughout all the projects related to Major Component Replacement; starting at the planning stage and continuing through to execution to ensure that Environmental Management Plan and Environmental Impact Workflows guidance and requirements are adhered to. As the execution of Unit 6 Major Component Replacement progresses, planning and preparation for the start of Unit 3 Major Component Replacement in March 2023 is nearing completion while ensuring that previous experience and lessons learned are being incorporated.

3.0 DOSE TO PUBLIC

Canadians are regularly exposed to ionizing radiation as part of their everyday lives [R-36] [R-37] [R-38]. This is partly due to exposure to naturally occurring cosmic radiation from the sun and stars and from terrestrial radiation from radioactive materials (e.g., uranium, thorium, and radium) that naturally exist in soil and rocks. Radon is a naturally occurring radioactive gas that is produced by the earth's crust and is present in the air. A variety of foods contain natural sources of radiation including potatoes, carrots, bananas, milk and red meats. The effective dose from natural radiation in Canada is estimated to be 1,800 microsieverts per year [R-37]. Other locations in the world have higher exposure rates, for example, the Kerala Coast in India has an annual effective dose of 12,500 microsieverts per year [R-37].

In addition to these sources, human activities also contribute to overall radiation exposure, such as air travel, smoking and medical or clinical services such as x-ray machines and CT scanners. For example, a cross country flight (20 microsieverts), tobacco and smoke detectors (100 microsieverts), a dental (5 microsieverts) or chest (100 microsieverts) x-ray, or a CT scan (7,000 uSv) adds to a person's overall radiation dose [R-39].

Living near a nuclear power plant also contributes to annual dose as radionuclides associated with CANDU reactors are released to the environment as part of normal operation. These discharges to air and water are heavily regulated in Canada and limits are imposed to ensure levels are safe to workers, the public and the environment. The annual dose limit for a member of the public is 1,000 microsieverts per year [R-40]. As part of the regulatory requirements, Bruce Power must calculate and report its contribution to radiological exposure dose to members of the public on an annual basis.

The annual doses are calculated using the computer software IMPACT following the methodology described in Canadian Standards Association N288.1 [R-21]. The approach uses a radionuclide transport and exposure pathways model that incorporates concentrations of radionuclides measured in environmental media, human characteristics specific to local behaviors and lifestyles, site specific meteorological data, as well as facility characteristics and radiological release information. The details are described in the sections below, however the overall outcome for 2022 is provided here.

For the thirty-first consecutive year, Bruce Power's contribution to the annual dose of a member of the public is less than the lower threshold for significance (<10 microsieverts per year) and is considered *de minimus* [R-41]. The representative person's dose associated with Bruce Power operations in 2022, who is calculated to have the maximum, is the BSF2 Infant who received 2.4 microsieverts per year (Table 1). All other representative persons have a lower dose. This maximum dose is a fraction of a percent of the legal dose limit of 1,000 microsieverts per year.

Table 1 - 2022 Maximum Representative Person's Dose

Maximum Representative Person	Committed Effective Dose	Percentage of Legal Limit
BSF2 Infant	2.4 microsieverts per year	0.24%

The contribution of each radionuclide or radionuclide group to the 2022 radiological dose for the maximally exposed representative person is shown in Table 2 and Figure 4. Consistent with previous years, most of the radiological dose is from two radionuclides (carbon-14 = 54%, tritium oxide = 40%). Exposure pathways to these radionuclides are predominantly ingestion of local food sources as well as air inhalation and immersion.

Table 2 - 2022 Radiological Dose by Contaminant for Representative Persons Group BSF2 Infant

	Carbon-14	Cobalt-60	Cesium-134	Cesium-137	Tritium Oxide	Iodine, mixed fission products	Noble Gases	Total
Dose (μSv/y)	1.3E00	9.7E-03	1.2E-02	1.1E-02	9.6E-01	2.7E-04	1.1E-01	2.4E+00
Percentage	54%	0%	0%	1%	40%	0%	5%	100%

Note:

1. BSF2 is Subsistence Farmer 2

2. Tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce, and animal products

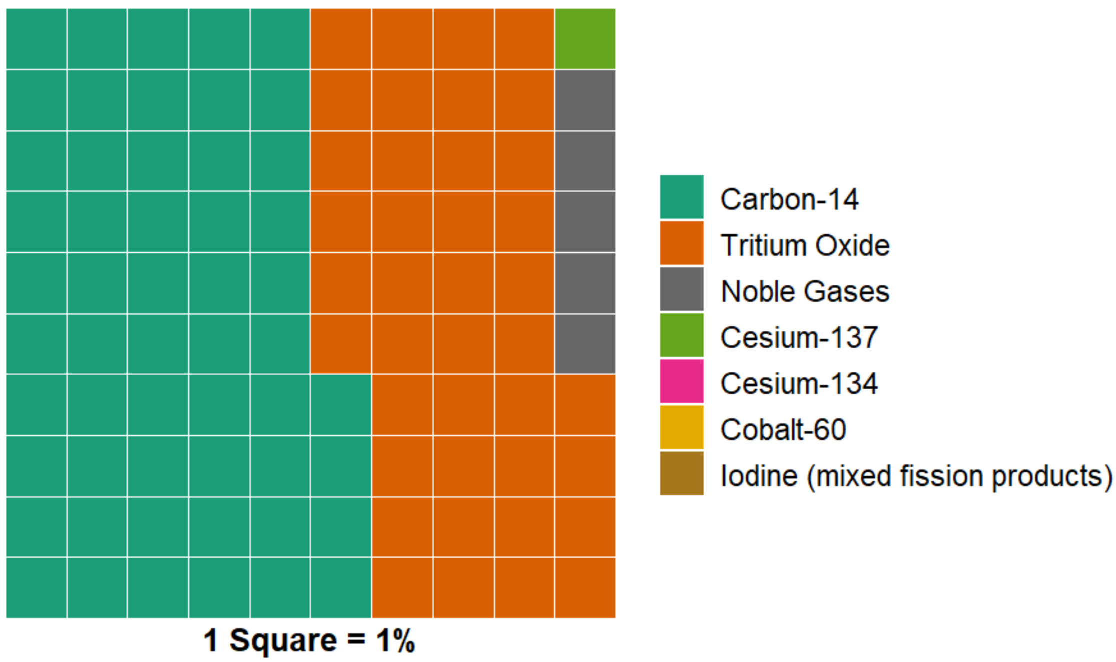


Figure 4 - 2022 Radiological Dose by Contaminant for Representative Persons Group BSF2 Infant

3.1 Historical Dose to Public

The additional contribution on the annual radiation dose to members of the public from Bruce Power Site activities has been below the level of significance (less than 10 microsieverts per year) for 31 consecutive years. The annual maximum dose for the last ten years is shown in Figure 5. Although the value fluctuates based on operational or maintenance activities that occur (e.g. preparations in advance of the vacuum building outage in 2015), the outcome is only a small fraction of a percent of the legal limit of 1,000 microsieverts per year. It is also a small contribution to the annual dose experienced from natural radiation in Canada (1,800 microsieverts per year) [R-37]. The calculation of public dose demonstrates that the radiological emissions from the Bruce Power Site have an extremely small impact on public dose.

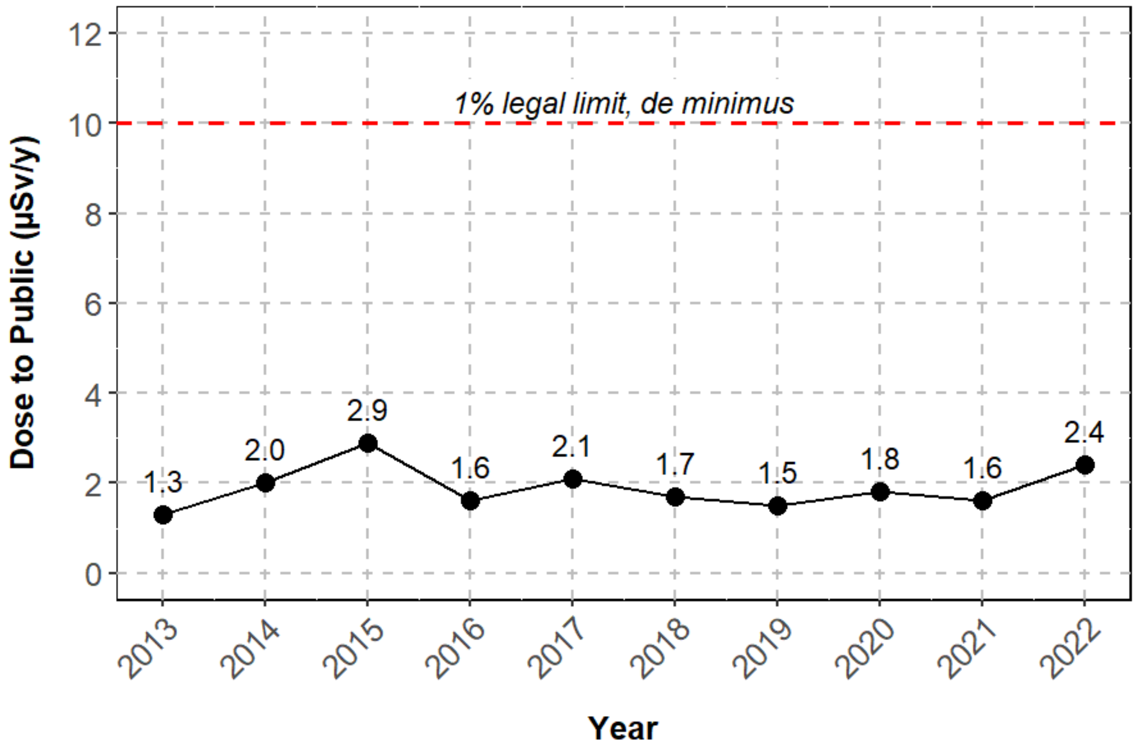


Figure 5 - Historical Dose to Public Over Time (Dose Limit 1000 microsieverts per year)

3.2 2022 Dose to Public

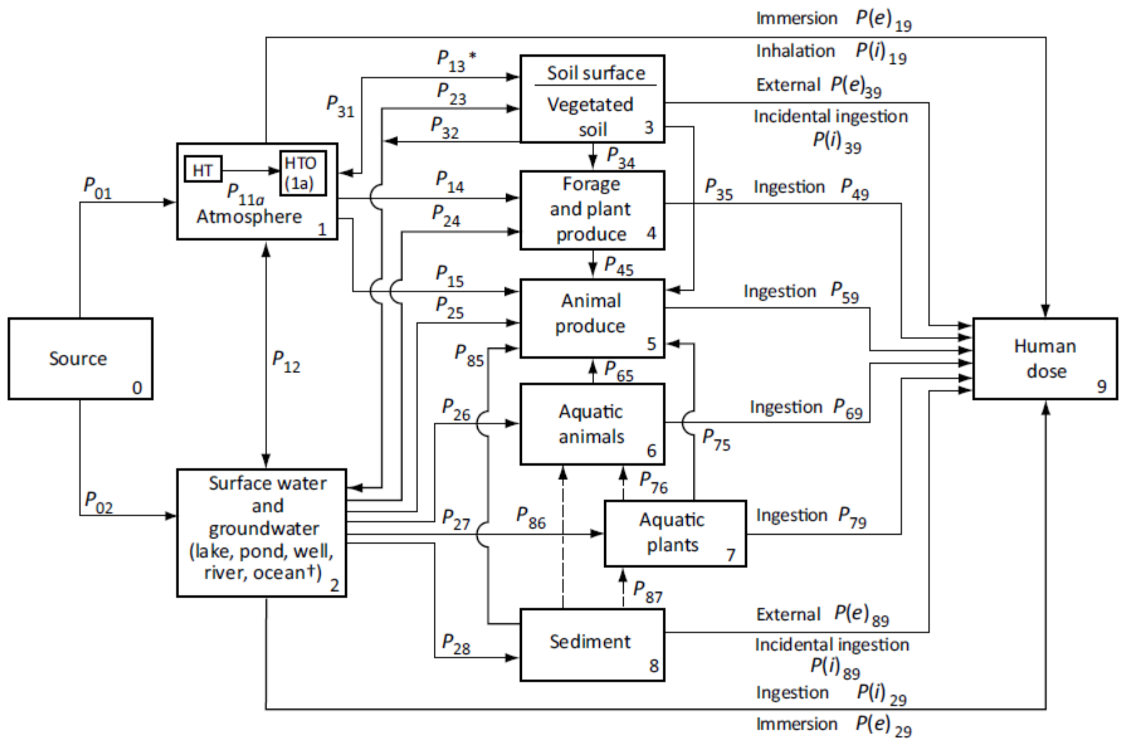
3.2.1 Methodology

Living near the Bruce Power Site results in an additional radiation dose to members of the public due to radiological releases to the environment as part of normal operation. The additional contribution to a person's overall dose is calculated each year and provided in this report.

The following information is required for calculating the public dose:

- Annual radiological airborne emission and waterborne effluent data from all licensed activities on or adjacent to the Bruce Power Site (Section 5.1)
- Annual Radiological Environmental Monitoring data (Section 6.1)
- Annual meteorological data (Section 3.2.2)
- Characteristics of the Representative Persons (Section 3.2.4)

The methodology used to calculate annual public dose from normal operations at CANDU nuclear power stations is described in Canadian Standards Association N288.1 [R-21]. A radionuclide transport and exposure pathways model is used which relies on an array of mathematical equations that describe the transfer of radioactive materials through the environment, as depicted in Figure 6 [R-21]. This pathways model may be likened to a food web that is specific to the local area and population. For example, one pathway could be of a radiological contaminant (e.g., tritiated water) released to the air that is deposited on a field and taken up by the plants. Dairy cattle may eat these plants, which may impact the cow's milk that is ingested by a child. These elaborate networks are set up in computer software called IMPACT, which is the acronym for Integrated Model for the Probabilistic Assessment of Contaminant Transport. IMPACT is a customizable tool that allows the user to assess the transport and fate of a contaminant through a user-specified environment. All of these exposure pathways are summed together in order to quantify the overall human exposure (i.e., dose). Canadian Standards Association N288.1 provides the transport and exposure factors for each step, as well as default values for human and site characteristics, which are refined for the local area based on the Site Specific Survey and annual meteorological data [R-21].



* *Includes transfer factors P_{13area}, P_{13mass}, and P_{13spw}.*

† *For ocean water, pathways P_{23}, P_{24}, P_{25}, and $P(i)_{29}$ are not used.*

Notes:

1) *The broken lines represent pathways that are not explicitly considered in the model or are considered only in special circumstances.*
2) *Factors include multiple transfers where appropriate.*

Figure 6 - Environmental Transfer Model (Extracted from Canadian Standards Association N288.1)

Measured concentrations of radiological contaminants in environmental monitoring data are used in calculating dose. The data is verified, and the background is subtracted before being entered into the IMPACT model by a third-party independent contractor. All data undergoes a quality assurance and quality control review prior to the dose calculation. For some radionuclide and media combinations, concentrations are below the limit of detection of the measuring equipment and thus may inhibit the ability to measure the desired radionuclide. In cases where monitoring data are not available for a particular exposure media, the available environmental monitoring data are used to calculate or define the missing radionuclide concentrations in the intermediate media as far along the exposure pathway (i.e., food chain) as possible. If no data is available for any media along a specified exposure pathway, transport modelling and emissions or effluent data (either atmospheric or aqueous) are used to define the radionuclide concentrations in the exposure media.

The exposure pathways used in the model for each of the radionuclides that contribute significantly to dose, based on sample medium, are shown in Table 3. The dose contributions from each of these exposure pathways are summed to give a total overall dose for each of the representative persons and age groups (i.e., infant, child, and adult). These three age groups are used to refine exposure based on diet and lifestyle differences. The maximum result is taken as the "dose to public" for the year, with all others having a lower dose. As per the *Radiation Protection Regulations SOR/2000-203*, the public radiation dose limit for a year is 1000 microsieverts (100 millirem) [R-40].

Table 3 - Radionuclides Measured as Part of Radiological Environmental Monitoring

Radionuclide	Sample Medium	Exposure Pathway
Tritium oxide	Air	Inhalation (includes skin absorption)
Tritium oxide	Water (drinking water, surface water, well water)	Ingestion
Tritium oxide	Water (precipitation, groundwater)	Ingestion
Tritium oxide	Plants (fruits, vegetables, grains)	Ingestion
Tritium oxide	Animals (meat, milk, honey)	Ingestion
Tritium oxide	Fish	Ingestion
Carbon-14	Air	Inhalation, External
Carbon-14	Plants (fruits, vegetables, grains)	Ingestion
Carbon-14	Animals (meat, milk, honey, eggs)	Ingestion
Carbon-14	Fish	Ingestion
Gamma	Air	Inhalation, External
Gamma	Water (surface water)	Ingestion
Gamma	Animals (meat, honey)	Ingestion
Gamma	Fish	Ingestion
Gamma	Sediment	External
Gamma	Soil	External
Gross Beta	Water (drinking water, surface water, well water, precipitation)	Ingestion
Iodine-131	Site emissions	Air inhalation, Air external Terrestrial animals (ingestion)
Iodine-131	Milk	Ingestion
Noble Gases (half-life of days)	Air	Air External
Organic bound tritium	Fish	Ingestion

There are uncertainties inherent in radiological effluent and emissions monitoring, Radiological Environmental Monitoring, and the dose estimates derived from them. The uncertainty of Bruce Power radiological releases has been estimated, and minimum uncertainties have been characterized as a percentage of weekly airborne emissions or per-batch or monthly waterborne emissions, as applicable. Uncertainty estimates vary for each stack and radionuclide but are generally about 5 – 25% for stacks that contribute most significantly to total airborne emissions. The uncertainty estimates for radiological liquid emissions range from about 5% to 50% for each active liquid waste batch release of tritium and gross gamma respectively, and around 5 to 15% for monthly releases of carbon-14 and gross alpha. While these uncertainties in radiological effluent and emissions reporting are noted, they have a limited effect on uncertainties in the dose results. Data from the Radiological Environmental Monitoring Program is used wherever available to provide actual concentrations of radionuclides in environmental media, which reduces the dependence on effluent and emissions data and its associated uncertainty. This approach is in alignment with recommendations of Canadian Standards Association N288.4 to use measured versus modelled concentrations where possible to achieve more precise dose estimates [R-5]. The uncertainties associated with radiological environmental monitoring data are dependent on each specific analysis method and measurement result. In this report, annual averages are presented, and the associated uncertainty is represented by error bars on the figures.

The overall uncertainties associated with public dose estimates have been characterized by a CANDU Owners Group study [R-42]. This study concluded that dose estimates based on environmental measures for important exposure pathways, such as Bruce Power's annual dose calculation, tend to have uncertainties on the order of ± 30%. Bruce Power's annual radiological emissions and effluent continue to remain well below Derived Release Limits with annual dose to public remaining very low *(de minimus*).2022

3.2.1.1 2022 Dose Calculations

For 2022, the basic set-up of the IMPACT model, in terms of transfer parameters and environmental variables, is identical to that used in 2021, as well as in the most recent Environmental Risk Assessment and Derived Release Limit updates. The general physiological characteristics of the representative persons (e.g., inhalation rates, water ingestion rates, food intake rates) were the mean values taken from Canadian Standards Association N288.1 [R-21].

The fractions of ingested foodstuffs that originate from local sources (e.g., backyard gardens or local farm markets) are based in part on the results of the most recent Site-Specific Survey (Section 3.2.3). The net percentage contribution of each specific food type (e.g., fruits or beef) to each major category of consumption (i.e., total plant product or animal product) is based on both the local fraction and the generic intake rates. Local percentage of food intake from local sources and rates of intake used are provided in APPENDIX A:

The emissions and effluents that were directly considered in the dose calculation process include tritium oxide, carbon-14, noble gases, and radio-iodines. For the purpose of public dose calculations, it is assumed that iodine emissions are in the form of mixed fission products, assumed to be present in a ratio associated with a state of secular equilibrium (i.e., other radionuclides from iodine-131 to iodine-135 are assumed to be present). The dose calculation process assumes that all iodine is iodine-131 for longer duration pathways (i.e., anything related to sediment or soil partitioning, or bio-uptake), but for shorter duration pathways (i.e., air inhalation or immersion, lake water immersion or ingestion) the full release is equivalent to iodine-mixed fission products. In modeling the environmental transport and partitioning of radio-iodines, there is assumed to be no isotopic discrimination, and that iodine-mixed fission products behave the same as iodine-131.

In 2018, it was decided *a priori* to assume that all reported beta/gamma emissions and effluents were cobalt-60, consistent with the approach applied in the Environmental Risk Assessment [R-43]. This assumption has been shown to be conservative, very likely over-stating the actual dose that could be associated with Bruce Power emissions and effluents. It should be noted that doses for cesiums-134 and cesium-137 are still calculated where direct environmental measures of those radionuclides are available through the Radiological Environmental Monitoring Program. For alpha emitters, it has been determined in past analysis, including the Environmental Risk Assessment that alpha emitters are released at rates which lead to public doses that are negligible. For this reason, alpha emissions are not included in the dose calculation process.

In 2022, the approach taken when Radiological Environmental Monitoring data included values that were less than the associated detection limit or critical level, those values were taken as reported. For example, in the calculation of local or background averages where some measured values were reported as less than critical level or detection limit, the uncensored analytical results were used in the calculation. In most cases, the resulting doses are slightly more conservative (i.e., higher) in using this approach.

For 2022 dose calculations [R-44], the following conservative measures were taken to address unavailable data or measured values being lower than background:

- No milk sample was available for locations BDF12 and BDF13. The average results for the milk samples collected from the nearest dairy farm that is closer to the sources of emissions (i.e., BDF15 for BDF13 and BDF1 for BDF12) was applied for these locations.
- For deep residential wells, the activity level of tritium oxide in all samples collected in 2022 was reported to be less than the critical level. In this specific case, the critical level itself was assigned, with adjustment for background, as the representative value for tritium oxide in all deep residential wells. The public dose associated with tritium oxide in deep residential wells is in the order of 0.01 microsieverts per year or less.
- The activity level of carbon-14 in some local samples of food products (e.g., honey, eggs, poultry, milk, fish, vegetables, and grains) collected was lower than the

corresponding activity in background samples. To quantify the carbon-14 activity in these media, the environmental transport models in IMPACT were invoked.

- The measured activity of beta/gamma emitters (i.e., cobalt-60, cesium-134 and cesium-137) in local samples of some media was lower than background. As in the case of carbon-14, the environmental transport models in IMPACT were invoked.
- No beef samples were available in 2022. Milk concentrations were used as a surrogate for meat, since the dairy cow is expected to be most similar to beef cows in various aspects that might affect exposure and uptake of radionuclides.

3.2.2 Meteorological Data

Meteorological data are required in order to calculate doses to the public resulting from the operation of nuclear facilities on the Bruce Power site. Specifically, the processed meteorological data in the format of Triple Joint Frequency are required as inputs to the computer code IMPACT for public dose calculations. The calculation of joint frequency data used by Bruce Power meets the requirements described in Clause 6.1.4 of Canadian Standards Association N288.1-20 [R-21].

There are two meteorological towers at the Bruce Power site: one 50-metre on-site tower and one 10-metre off-site tower. These towers were installed in 1990 at specific locations to ensure that the meteorological measurements are representative of local atmospheric conditions experienced, and to better account for how emissions are conveyed inland.

In order to be used for calculating the Triple Joint Frequency, the annual data collection must be 90% complete as per Clause 4.3.2.6 of Canadian Standards Association N288.2-19 [R-45]. In 2020, both the on-site and off-site meteorological towers were upgraded to improve data availability. At both locations the monitoring equipment were replaced and have battery back-up capabilities, and the dataloggers and software were upgraded. The data availability analysis results for the two meteorological towers for 2022 is shown in Table 4. There was a lightning strike on the 50-metre tower in September 2022, which took the logger offline for a few weeks.

Table 4 - Summary of Data Availability for 2022

Data Source	Available Records	Total Records Planned	Record Availability (%)
10-metre Tower	8461	8760	97
50-metre Tower	7996	8760	91

The data availability in the 2022 raw meteorological data met the 90% data availability requirement and were used to calculate the Double Joint Frequency and Triple Joint Frequency for the Site [R-46]. The methodology for obtaining the Double Joint Frequency and Triple Joint Frequency, as well as the results for the 50-metre tower is provided in APPENDIX B:.

3.2.3 Site Survey

The Site Specific Survey Report includes a collection of information on the local population and the environment surrounding Bruce Power. The report is used to support a number of site programs, such as calculation of Derived Released Limits of radiological environmental releases, Emergency Preparedness, the Radiological Environmental Monitoring Program, Safety Reports and license renewal. The Site Specific Survey is updated typically every five years to reflect recent changes to the area surrounding the Bruce Power site.

The survey report includes meteorology, land usage, population distribution, water usage, agriculture, recreational activities and food sources in the area. In addition, information on daycare centres, before and after school programs, long term care homes, school boards, and recreational parks located within 20 kilometres of the Bruce Power site are documented. The diet and lifestyle data collected is used to identify groups of people with similar characteristics to develop or refine the "representative persons" (see Section 3.2.4). These unique groups are used for dose to public calculations as per Canadian Standards Association N288.1 [R-21].

The Site Specific Survey Report was updated in 2021 and focused on refining the characteristics of the hunter/fisher receptor to better reflect the behaviours and practices of local First Nations and Métis groups. Diet surveys were co-developed and completed in 2019-2021 by members of Saugeen Ojibway Nation, Metis Nation of Ontario and Historic Saugeen Metis. An independent third party reviewed and then consolidated the individual results to update the hunter/fisher receptor characteristics with the most conservative parameters. This ensures that the dose calculation is representative of the local population. The updated hunter/fisher receptor has been used for all dose calculations since 2021, including the 2022 Environmental Risk Assessment.

The 2021 Site Specific Survey is in the process of being revised to incorporate the 2021 Census data from Statistics Canada. The census includes population and agricultural data specific to the local area.

3.2.4 Representative Persons

Doses received by individual members of the public as a result of a given radionuclide release vary depending on factors such as proximity to the release, dietary and behavioral habits, age and metabolism, and variations in the environment [R-21]. A homogenous group of individuals with the same exposure factors may be grouped together, where the individual that receives the highest dose within that group is considered the representative person of that group. Each representative person is broken down into three age classes (i.e. infant, child, adult) in order to account for different diets, breathing rates and dose coefficients.

The Site Specific Survey Report provides the information needed to refine the standard human characteristics provided in Canadian Standards Association N288.1 to include local environmental and lifestyle information. This includes details like where people live in relation to Bruce Power, where a person's drinking water comes from, how much local food a person consumes and how much time is spent outdoors.

The following categories of representative persons have been identified based on distinct lifestyle and proximity to the Site:

- **Non-farm resident** - The non-farm resident is considered the typical, full-time resident in the area surrounding the Site. They get a large portion of their food from grocery stores.
- **Farm resident** - 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.
- **Subsistence farm resident** - The subsistence farm resident gets a larger portion of their food, milk and water from local sources, and over half of their diet is self-produced.
- **Dairy farm resident** - 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.
- **Bruce Eco Industrial Park worker** - For consistency with previous studies, the Bruce Eco Industrial Park worker is referred to as a Bruce Energy Centre worker, which corresponds to the former name of the facility. The assessment for a Bruce Energy Centre worker represents occupational exposures at a location near the facility. It is assumed that the Bruce Energy Centre worker does not also live at one of the other selected receptor locations, i.e., the Bruce Energy Centre worker dose is independent of the other representative person doses.
- **Hunter/Fisher** - The hunter/fisher resident represents individuals who may catch and consume wild game and fish in significantly greater quantities than other residents. They are assumed to obtain all of 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 is sourced locally while the remainder is from grocery stores. The characteristics of this resident have been developed based on surveys of the Saugeen Ojibway Nation, Historic Saugeen Métis, and the Métis Nation of Ontario undertaken from 2019 to 2021.

A total of 19 representative persons were selected, each comprised of an adult (16 to 70 years old), child (6 to 15 years old), and infant (0 to 5 years old) [R-21], except for the Bruce Eco Industrial park worker, who is assumed to be an adult. All representative persons were chosen based on proximity to the Site (i.e., all locations are within 15 kilometres from the Site), with the exception of the hunter/fisher resident, who is located approximately 20 kilometres north of the site. A description of the representative persons by group name is provided in Table 5 and the locations are shown on Figure 7.

Table 5 - Description of Representative Persons

Group Name	General Characteristics and Location of Group
BR1	Non-farm resident, lakeshore at Scott Point (Located to the northeast of Bruce A at a distance of approximately 2 kilometres and northeast of Bruce B at a distance of approximately 5 kilometres)
BR17	Non-farm resident, inland (Located to the southeast of Bruce A at a distance of approximately 4 kilometres and east of Bruce B at a distance of approximately 5 kilometres)
BR25	Non-farm resident, inland (Located to the south of Bruce A at a distance of approximately 5 kilometres and to the southeast of Bruce B at a distance of approximately 4 kilometres)
BR27	Non-farm resident, inland, trailer park (Located to the south of Bruce A at a distance of approximately 5 kilometres and to the southeast of Bruce B at a distance of approximately 3 kilometres)
BR32	Non-farm resident, lakeshore (Located to the south of Bruce A in Inverhuron at a distance of approximately 6 kilometres and to the south of Bruce B in Inverhuron at a distance of approximately 3 kilometres)
BR48	Non-farm resident, inland (Located to the southeast of Bruce A near Baie du Doré at a distance of approximately 2 kilometres and to the east of Bruce B near Baie du Doré at a distance of approximately 3 kilometres)
BF8	Agricultural, farm resident (Located to the south of Bruce A at a distance of approximately 8 kilometres and to the southeast of Bruce B at a distance of approximately 7 kilometres)
BF14	Agricultural, farm resident (Located to the south of Bruce A at a distance of approximately 5 kilometres and to the southeast of Bruce B at a distance of approximately 3 kilometres)
BF16	Agricultural, farm resident (Located to the southeast of Bruce A at a distance of approximately 7 kilometres and to the east of Bruce B at a distance of approximately 8 kilometres)
BSF2	Agricultural, subsistence farm resident (Located to the southeast of Bruce A at a distance of approximately 9 kilometres and to the southeast of Bruce B at a distance of approximately 9 kilometres)

Group Name	General Characteristics and Location of Group
BSF3	Agricultural, subsistence farm resident (Located to the southeast of Bruce A at a distance of approximately 8 kilometres and to the southeast of Bruce B at a distance of approximately 8 kilometres)
BHF1	Generic hunter/fisher resident (Located approximately 20 kilometres north of the Site in Southampton)
BDF1	Agricultural, dairy farm resident (Located to the northeast of Bruce A at a distance of approximately 11 kilometres and to the northeast of Bruce B at a distance of approximately 14 kilometres)
BDF9	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 kilometres and to the southeast of Bruce B at a distance of approximately 12 kilometres)
BDF12	Agricultural, dairy farm resident (Located to the east of Bruce A at a distance of approximately 13 kilometres and to the northeast of Bruce B at a distance of approximately 15 kilometres)
BDF13	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 kilometres and to the southeast of Bruce B at a distance of approximately 12 kilometres)
BDF14	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 14 kilometres and to the southeast of Bruce B at a distance of approximately 13 kilometres)
BDF15	Agricultural, dairy farm resident (Located to the southeast of Bruce A at a distance of approximately 13 kilometres and to the southeast of Bruce B at a distance of approximately 12 kilometres)
BEC	Worker in Bruce Energy Centre (Located to the southeast of Bruce A at a distance of approximately 4 kilometres and to the east of Bruce B at a distance of approximately 4 kilometres)

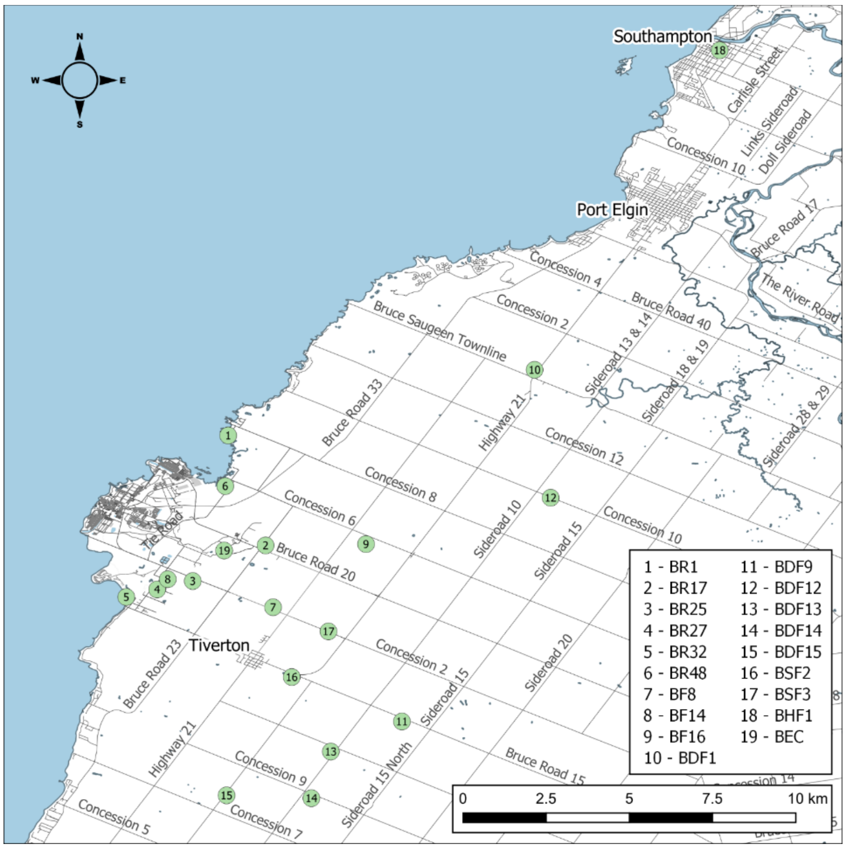


Figure 7 - Representative Person Locations

3.2.5 Dose Results and Interpretation

The maximum dose to a member of the public in 2022 was obtained for the subsistence farmer BSF2 infant with a value of 2.4 microsieverts per year [R-44] and remains well below the public dose limit of 1000 microsieverts per year [R-40]. This is an increase of about 56% compared to the maximum dose calculated in 2021 (1.6 microsieverts per year) for the same representative group (i.e., subsistence farmer). The calculated dose for this BSF group has been the highest of all groups for all but one year (2019) since this group was added in 2012.

In 2022, the doses calculated for the subsistence farmer group at both locations (BSF2 and BSF3) were in the range of 2.1 to 2.4 microsieverts per year. The average dose for the subsistence farmer group was 77% higher than the average dose for all other groups. Doses to the various representative locations and age classes of the dairy farm (BDF) group and also farm (BF) group range from 1.0 to 1.6 microsievert per year. The doses calculated for the non-farming resident (BR) group at various locations in close proximity to Bruce Power range from about 1.0 to 2.1 microsieverts per year. This is higher than doses determined for the non-farm resident groups in recent years. The child at location BR48 is the only receptor other than members of the SF group to receive a dose in excess of 2 microsieverts per year. The doses calculated for members of the hunter-fisher (BHF) group near Southampton were between 0.3 and 0.4 microsieverts per year, and 6% lower on average than doses calculated for 2021. The 2022 doses for the BHF group are the lowest reported since the group was first included in the dose calculation process in 2017. The BEC Adult had the lowest calculated dose with 0.1 microsieverts per year. Annual doses calculated for 2022 for all representative groups and age classes are provided in APPENDIX C:.

A substantial majority (79 to 85%) of the total dose to the BSF group is associated with food ingestion, which simply reflects the relatively high rate of local food consumption by members of this group. For other farm-based groups (BF and BDF), local food consumption also accounts for a significant percentage (57% and 64%, respectively) of total dose for the same reason. For most of the non-farm residential groups, the dose associated with food ingestion averages 42% of total dose, which is consistent with doses for this group in recent years, and notably lower than doses for farm-associated groups.

Aside from food consumption, direct exposure to radionuclides in air via inhalation and immersion is the only other significant contributor to total dose, accounting for about 32% of total dose for farm-based groups (BDF, BF, BSF) and 55% for the residential (BR) group. Overall, exposure pathways associated with emissions to atmosphere accounted for an average of 98% of total public dose. These general patterns are consistent with the patterns observed for the past decade.

The main contributing radionuclides to the limiting dose (BSF2 Infant) are carbon-14 at ~55 % of total dose and tritium oxide at ~39% of total dose. Overall, carbon-14 and tritium oxide (including organically bound tritium) combined account for an average of about 88% of the total dose for all groups of representative persons that have been considered in 2022. This dominance of carbon-14 and tritium oxide as contributors to total dose in 2022 is consistent with the findings of public dose calculations over the past decade. Noble gases and cesium-137 were the only other radionuclide group to consistently contribute more than 1% of public dose.

The increase in public dose in 2022 relative to 2021 is associated with increases in dose from carbon-14 and tritium oxide. For both radionuclides, the trend in dose reflects the trend in both emissions and measures in the environment. Measures of tritium oxide in air and food products were notably higher in 2022 at most representative locations. For carbon-14, activity in air also exhibited an increase at most locations. For food products, there was no clear increase in representative measures of carbon-14 activity, despite the clear increase in atmospheric activity. In many instances, representative activity levels of carbon-14 in plant produce actually declined in 2022 compared to 2021. This largely reflects the fact that the representative values from 2021 were based on model estimates of radionuclide activity. This model estimation was triggered by the fact that background carbon-14 activity was greater than local measures in 2021. In such cases, the dose calculation procedure calls for the activation of IMPACT transport models, which tend to be conservative. In 2022, the background carbon-14 activity in almost all animal products was higher than local measures, invoking conservative model estimation for this food group. For the limiting representative person (BSF2 infant), the carbon-14 dose from ingestion of plant products declined slightly from 2021 to 2022, while the animal ingestion dose for carbon-14 increased several-fold to account for almost 30% of total dose. This illustrates the general sensitivity of the dose calculation process to the variability of background measures of carbon-14 in the environment, particularly in plant and animal food products. Overall, the carbon-14 values used in the dose calculation process for 2022 are deemed to be conservative and representative.

Overall, the calculation of public dose demonstrates that the radiological emissions and effluents from Bruce Power facilities have an extremely small public dose impact. The maximum public dose associated with Bruce Power operations in 2022 (i.e., 2.4 microsieverts per year for the BSF2 infant) is still only a fraction of a percent of the legal limit (i.e., 1,000 microsieverts per year) [R-40] and of the average Canadian background dose (i.e., 1,800 microsieverts per year) [R-37]. It is also well below the *de minimus* threshold of 10 microsieverts per year and is considered negligible [R-41].

4.0 ENVIRONMENTAL RISK ASSESSMENT

The Environmental Risk Assessment fulfills the environmental protection requirements under the *Nuclear Safety and Control Act* [R-47]. The *Canadian Impact Assessment Act* [R-48] does not apply. An important area of focus related to the Environmental Risk Assessment is public and Indigenous engagement. The Environmental Risk Assessment process is meant to provide an on-going analysis of a company's interaction with the environment. Completion of an update to the Environmental Risk Assessment on a 5-year cycle is supported by annual environmental protection reports and both documents are subject to in-depth regulatory review.

One of the benefits of updating the Environmental Risk Assessment is the regular check in points with regulators and the public every 5 years on an ongoing basis. This gives all parties an opportunity to contribute, identify concerns and incorporate new studies or advances in science as per N288.6 guidance [R-49]. This process allows for the identification of emerging trends and identifies any new risks that may arise, which is an enhancement from past assessment processes. Indigenous communities and other members of the public will continue to participate in and provide feedback on the Environmental Risk Assessment.

4.1 Results of the 2022 Environmental Risk Assessment

An updated retrospective and predictive Environmental Risk Assessment was prepared following the guidance of Canadian Standards Association N288.6-12 in 2022 [R-43][R-50]. Review of the 2022 Environmental Risk Assessment by the Canadian Nuclear Safety Commission and Environment and Climate Change Canada concluded that the report is consistent with the overall methodology and complies with all the applicable requirements of Canadian Standards Association N288.6-12 [R-51]. The potential risk from physical stressors and from radiological and non-radiological releases to the environment were found to be generally low to negligible.

The cumulative environmental effects of multiple stressors are not directly assessed in the 2022 Environmental Risk Assessment. Bruce Power acknowledges the need to address the cumulative environmental effect of multiple stressors when and where it is warranted. The science behind the determination of cumulative effects is at its infancy: there is no consensus on a definition of "cumulative impact" and assessment methods are largely absent. Understanding cumulative impacts to a system first begins by evaluating its individual stressors. Bruce Power has done this and none of the individual stressors poses an unreasonable risk to the environment. As a result, it is unlikely that the combination of single stressors with low to no risk will result in a cumulative impact or approach an unreasonable risk. Over forty years of operations of the Bruce site and continued monitoring and assessment has provided empirical evidence of little to no risk to the local environment.

4.1.1 Indigenous Engagement

The results of the 2022 Environmental Risk Assessment were shared with Saugeen Ojibway Nation, Métis Nation of Ontario, and Historic Saugeen Métis prior to the submission of the Environmental Risk Assessment to the Canadian Nuclear Safety Commission. Based on the review of the past Bruce Power-specific concerns raised by Indigenous communities, all technical considerations within the construct of the Canadian Standards Association N288.6 framework have been dispositioned and those related to the Environmental Risk Assessment have been highlighted within the text. Bruce Power is committed to ongoing engagement, consultation, and communication with Saugeen Ojibway Nation, Métis Nation of Ontario, and Historic Saugeen Métis in accordance with Bruce Power's Indigenous Relations Policy, Protocol, and Relationship Agreements with the communities and regulatory requirements.

4.1.2 Conventional Risk Assessment

The non-radiological human health risk assessment evaluated the potential for health risks for members of the public residing in the area surrounding the Site, including recreational users. The potential for health risks due to non-radiological chemicals and physical stressors were negligible considering normal operations at the Site.

Data considered in the conventional ecological risk assessment is available for review at: https://wsp-shinyapps.shinyapps.io/ERA_screening_tables/ and included groundwater, soil, surface water and sediment data from locations on the Bruce Power site as shown in Figure 8.

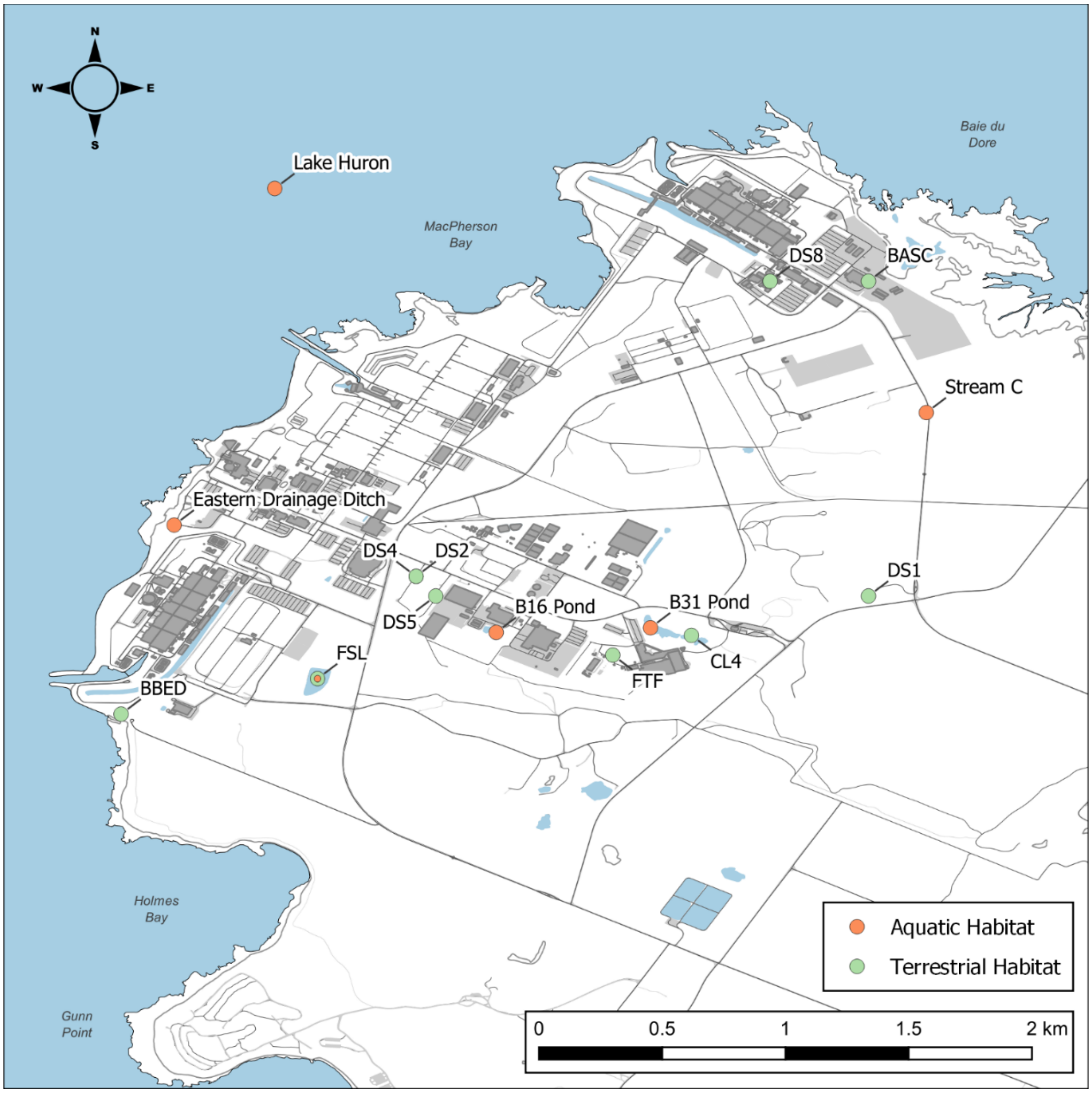


Figure 8 - Areas Assessed in the Conventional Ecological Risk Assessment

The conventional ecological risk assessment identified potential risks to terrestrial ecological receptors at Construction Landfill #4, Fire Training Facility, Distribution Station #1 and at five general soil sampling sites, to semi-aquatic receptors at Eastern Drainage Ditch and to aquatic receptors in Lake Huron, Former Sewage Lagoon, B31 Pond and Eastern Drainage Ditch (Table 6). The conservative nature of the methodology used to assess risks due to conventional contaminants in the ecological risk assessment results in the identification of areas of potential risk but does not necessarily indicate a current risk to receptors. Additional follow-up monitoring is required to refine the risk assessment.

Table 6 - Summary of Conventional Ecological Risk Assessment Conclusions and Recommendations

Area	**Media Assessed**	**Conclusions**	**Recommendations**
Terrestrial			
Construction Landfill #4	Soil	Hazard Quotients above 1 for terrestrial wildlife from zinc and high molecular weight polycyclic aromatic hydrocarbons.	Further work should characterize the extent of zinc impacts around Construction Landfill #4 collected in 2016 and polycyclic aromatic hydrocarbons impacts around site CL4-9 collected in 2000 to affirm potential risks because these were the only locations that exceeded the Construction Landfill #4. Further work should characterize the current acid base extractable concentrations at site CL4-9 collected in 2000 to confirm if they remain chemicals of potential concern in the absence of risk-based criteria.
Fire Training Facility	Soil	Hazard Quotients above 1 for plants and soil invertebrates from light total petroleum hydrocarbons.	Further work should characterize the current Petroleum Hydrocarbon (PHC) concentrations around historically contaminated areas within surface soil to affirm potential risks. Further work should characterize the current acetone and acid base extractable concentrations at site FTF-12 collected in 2000 to confirm if they remain chemicals of potential concern in absence of risk-based criteria.
Distribution Station #1	Soil	Hazard Quotients above 1 for plants and soil invertebrates from light total petroleum hydrocarbons.	Further work should characterize the current petroleum hydrocarbons concentrations around historically contaminated areas within surface soil to affirm potential risks.
General Surface Soil Samples (BPS and SS series)	Soil	Hazard Quotients above 1 for plans and soil invertebrates from boron (hot water soluble), selenium and petroleum hydrocarbons (fraction 2 and 3). Hazard Quotients above 1 for terrestrial	Further work should delineate the extent of metal impacts in surface soil around sites BPS-04-07 and SS6 and the extent of petroleum hydrocarbons impacts around sites BPS-07-07 and BPS-01-07 to affirm potential risks because these were the only locations that exceeded the site-specific target level. Further work should delineate strontium impacts around sites BPS-01-07 and BPS-02-07 to confirm if strontium remains a chemical of potential concern in absence of risk-based criteria.

Area	Media Assessed	Conclusions	Recommendations
		wildlife from lead and selenium.	
Aquatic			
Lake Huron shoreline and nearshore habitat	Surface Water	Hazard Quotients above 1 for aquatic communities from zinc.	Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program. Analysis of dissolved organic carbon required to derive site-specific toxicological benchmark for zinc.
Former Sewage Lagoon	Sediment	Hazard Quotients above 1 for aquatic communities from petroleum hydrocarbon.	Further work should delineate petroleum hydrocarbon impacts; total organic carbon should be assessed to derive a site-specific toxicological benchmark.
Former Sewage Lagoon	Surface Water	Hazard Quotients above 1 for aquatic communities from copper and zinc.	Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program. Analysis of dissolved organic carbon required to derive site-specific toxicological benchmark for zinc.
B31 Pond	Surface Water	Hazard Quotients above 1 for aquatic communities from copper.	Additional sampling events required to affirm potential risks as per updates to the environmental monitoring program.
Distal Eastern Drainage Ditch	Sediment	Hazard Quotients above 1 for aquatic communities from petroleum hydrocarbon fraction 3. Hazard Quotients above 1 for insectivorous, semi-aquatic wildlife from vanadium.	Further work should delineate petroleum hydrocarbon impacts; total organic carbon should be assessed to derive a site-specific toxicological benchmark. Further work should delineate vanadium impacts and measure chemical of potential concern concentration in benthos.

4.1.3 Radiological Risk Assessment

The radiation doses to members of the public residing in the area surrounding the Site are less than 1% of the Canadian Nuclear Safety Commission effective dose limit for a member of the public (1 millisievert per year) [R-52]. 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.

The radiation dose rates to non-human biota residing on or near the Site are less than 1% of the applicable United Nations Scientific Committee on the Effects of Atomic Radiation benchmark value [R-53]. With a hazard quotient of less than 0.01, and with many of the uncertainties in the assessment (e.g., occupancy factors and ingestion parameters) addressed in a conservative manner, there is no radiological risk to non-human biota resulting from normal operations on the Site.

In addition to assessing the overall risk to humans and non-human biota, this report examined the specific contributions of each radionuclide and exposure pathway to the total radiation dose. This analysis of relative risk provides information for the design of the radiological environmental monitoring program.

4.1.4 Physical Stressor Assessment

The assessment of the physical effects of the noise, cooling water intake and discharge, and habitat alteration has shown no unreasonable risk to human or ecological receptors.

Bruce Power has completed a comprehensive quantitative thermal risk assessment with substantial methodological improvements over past thermal risk assessments. These improvements have included the full incorporation of thermal modelling data, modelled thermal benchmarks for cold water fish species and assessment of all species and life stages present in the nearshore area. A pilot method of presenting daily maximum temperature data and overlays of fish species and life stage benchmark exceedances for improved visualization can be accessed at: https://wsp-shinyapps.shinyapps.io/ERA_temperature/. The thermal risk assessment assessed a low risk to several mainly cold and cool water species and life stages located in the Local Study Area:

3. Lake Trout, Lake Whitefish, Round Whitefish, Walleye and Brown Bullhead eggs
4. Larval Deepwater Sculpin, Lake Whitefish and Walleye
5. Growth stage for Rainbow Trout, Chinook Salmon, Lake Whitefish, Walleye, Gizzard Shad and Yellow Perch
6. Parent Smallmouth Bass and Brown Bullhead.

Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected.

No benchmarks for fish impingement or entrainment are available from federal or provincial authorities that can be used to assess the environmental risk. Effect thresholds are dependent on sufficient knowledge of the population including natural variability. Bruce Power obtained a

Fisheries Act Authorization from Fisheries and Oceans Canada in 2019 [R-54] that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time.

Monitoring and assessment of impingement and entrainment and thermal effluents over time (in prior environmental assessments and environmental risk assessments) continues to verify no unreasonable risk to the natural environment because of these physical stressors. Extensive monitoring to verify these conclusions, coupled with comprehensive assessments that utilize best practices to characterize risk, have resulted in the conclusion that further mitigation is not warranted at this time. This conclusion is substantiated by the measured fish loss (non-significant) and lack of change in the predicted temperature differential from operations.

The design and use of existing mitigation technologies has been implemented to minimize impingement and entrainment and thermal impacts to the greatest extent possible. The Bruce Power site location, situated on the Douglas Point headland, was strategically picked because of its high energy zone with access to cold, deep water. The headland juts into Lake Huron providing a natural feature for dispersion of thermal effluent and the shoreline location itself is naturally low in diversity of fish species due to high wave action and winter ice movement. In 2020, Bruce Power submitted an assessment of feasible mitigation measures for thermal effluent and impingement and entrainment effects at the Bruce Power site [R-55]. This assessment of feasible mitigation measures for reduction of impingement and entrainment and thermal effluents identified the most feasible options for reduction of Impingement and Entrainment and thermal effluent as Variable Speed Drives and velocity cap modifications (i.e., light or sound deterrents). The results of the 2020 assessment of feasible mitigation measures are integrated into the 2022 Environmental Risk Assessment and any changes to mitigation technologies will be integrated into future Environmental Risk Assessments. Given the overall low impact of thermal effluent, impingement and entrainment on aquatic biota in Lake Huron, no additional mitigation measures will be actively implemented at the present time [R-56]. The update of the assessment of feasible mitigation measures within the Environmental Risk Assessment on a 5-year cycle provides a continual surveillance of potential mitigation measures in the event of operational changes or that continued monitoring of thermal effluent, impingement and entrainment show a significant increase in environmental impact to aquatic biota.

Bruce Power continues to be engaged in understanding the impacts from climate change predictions and considering how they may affect future operations and the local environment. Bruce Power has prepared an assessment of the potential effects of climate change on water temperatures by 2054 to 2074 [R-57]. The impact of Bruce Power operations in terms of thermal effluent will remain unchanged under all climate change scenarios. This means that the temperature changes driven by thermal effluent from Bruce Power operations in the local study area will not change as Lake Huron temperatures increase. The absolute temperature in the local study area is predicted to increase proportionately to the temperature increase in other nearshore areas of Lake Huron by 1-2 degrees Celsius. As climate change prediction models become more advanced and/or the ambient conditions change, the Environmental Risk Assessment will be updated to determine if and how such changes impact the operation of Bruce Power's facilities and, if required, assess the feasibility of mitigation measures.

4.1.5 Predictive Effects Assessment

Over the past 20 years Bruce Power has gained a significant amount of experience in the restart and refurbishment of its CANDU reactors. Overall, as outlined in Appendix D [R-50] of the 2022 Environmental Risk Assessment report, potential environmental effects of planned future activities are anticipated to be similar to those associated with the existing operations. Therefore, the existing environmental monitoring programs will be retained as required to confirm predictions and be reported through the annual environmental monitoring program findings. During life extension and major component replacement activities, Bruce Power's environmental management programs will be maintained.

Future site activities including Lutetium-177 production, life extension and major component replacement activities were evaluated for potential interactions with the environment. The preliminary assessment screened these interactions to assess whether the current operational conditions were bounding. Where this was not considered to be the case, a predicted bounding condition was developed and screened against accepted values for the protection of human health and the environment. In all cases, the current conditions were considered bounding, or the predicted conditions were screened as being acceptable.

The environmental effects and interactions that were discussed in this report are continually evaluated throughout the major component replacement planning stages through involvement of the Environment Department as a stakeholder in the design process and planning of major component replacement activities. Environmental management plans are implemented and executed as required for major component replacement activities.

All activities at the Bruce Power site, including major component replacement activities, will continue to be executed in a manner that ensures continual protection of human health and the environment, in accordance with applicable operating licences, codes and standards.

4.1.6 Conclusions

The Environmental Risk Assessment demonstrates that the operation of the Bruce Nuclear Facility has not resulted in adverse effects on human health of nearby residents or visitors or on non-human biota because of exposure to physical stressors or to radiological or conventional substances.

The baseline radiation doses to members of the public residing in the area surrounding the Site as calculated based on current operational conditions are less than 1% of the Canadian

Nuclear Safety Commission effective dose limit for a member of the public of 1 millisieverts per year. There is no radiological risk to human health for members of the public resulting from normal operations on the Site. The human health risk assessment for conventional contaminants identified no unreasonable risk for people using the land around the Site for recreational or residential/agricultural uses.

The radiation doses to non-human biota residing on or near the Site are less than 1% of the applicable United Nations Scientific Committee on the Effects of Atomic Radiation benchmark value. There is no radiological risk to non-human biota resulting from normal operations on the Site. The conventional ecological risk assessment identified potential risks to terrestrial ecological receptors at Construction Landfill #4, Fire Training Facility, Distribution Station #1 and at five general soil sampling sites, to semi-aquatic receptors at Eastern Drainage Ditch and to aquatic receptors in Lake Huron, Former Sewage Lagoon, B31 Pond and Eastern Drainage Ditch. Additional follow-up monitoring will be completed to refine these potential risks.

For thermal effluent, a low risk to some mainly cold and cool water species and life stages located in the Local Study Area was assessed during the thermal risk assessment process. Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected. For impingement and entrainment, Bruce Power has a Fisheries Act Authorization from Fisheries and Oceans Canada that permits continued operation with the requirement to meet specific conditions related to impingement and entrainment, including offsetting that is intended to provide complete compensation for the fish losses incurred through impingement and entrainment. Using this construct, fish losses from impingement and entrainment are compensated for by fisheries offsets, resulting in a no net loss over time. For other physical stressors, the assessment of the physical effects of noise, cooling water discharge and habitat alteration has shown no unreasonable risk to human or ecological receptors.

As the current operational conditions are demonstrated to be bounding of future activities, the 2022 Environmental Risk Assessment is, therefore, shown to be bounding of proposed future activities. There is no additional radiological or non-radiological risk to human or non-human biota resulting from anticipated future activities.

4.1.7 Preparation of the 2027 Environmental Risk Assessment

Table 7 described the progress on the recommendations listed in the conclusion of the 2022 Environmental Risk Assessment. The plan and progress towards the recommendations will be updated annually in this report.

Table 7 - Plan and Progress of Recommendations in the 2022 Environmental Risk Assessment

Recommendation in the 2022 Environmental Risk Assessment	Plan and Progress
Bruce Power will continue to engage with Saugeen Ojibway Nation, Métis Nation of Ontario and Historic Saugeen Métis to support climate change research that is relevant to each community.	This engagement is ongoing through regular and ad hoc meetings.
Bruce Power will continue to support the Coastal Waters Environmental Monitoring Program. This program was jointly developed between Bruce Power and Saugeen Ojibway Nation and aims to enhance the existing body of knowledge being compiled through Bruce Power's routine Environmental Monitoring.	Bruce Power is continuing to support the Coastal Waters Environmental Monitoring Program and Bruce Power will continue to integrate results into relevant environmental assessments.
As a follow up to the submission of the Assessment of Feasible Mitigation Measures report [R-56], updates to the risk assessment for Impingement and Entrainment and thermal effluent will continue to include an assessment of the need for mitigation measures and an update on any progress to mitigation measure implementation, if applicable.	Assessment of feasible mitigation measures continues and results will be incorporated as needed into: • Bruce A and B environmental compliance approvals; • Fisheries Act Authorization application; • Thermal risk assessments; and, • Projects on site that impacts thermal effluent and water taking, including Project 2030.
Bruce Power is required to complete entrainment monitoring and offset projects as part of the conditions of the Fisheries Act Authorization [R-54] and will continue to engage with Saugeen Ojibway Nation, Métis Nation of Ontario and Historic Saugeen Métis to communicate the results of the entrainment monitoring and to select and complete these offset projects.	Implementation of the Fisheries Act Authorization is ongoing. A pilot entrainment monitoring program is planned in 2023 and will be reported in the 2023 environmental protection report. Engagement with all three of the local Indigenous nations and communities is ongoing through regular and ad hoc meetings.
For the conventional ecological risk assessment, Bruce Power will complete follow up monitoring as recommended in Table 6 to refine the assessment of risk in the 2027 Environmental Risk Assessment. Results of follow up monitoring will be reported annually in the environmental protection reports and compared to the site-specific target levels calculated in the 2022 Environmental Risk Assessment.	Follow-up monitoring is being planned and results of completed monitoring will be reported annually in this report and compared to the site-specific target levels calculated in the 2022 Environmental Risk Assessment. No follow-up monitoring was completed during the 2022 calendar year.

Recommendation in the 2022 Environmental Risk Assessment	Plan and Progress
Based on the results of the 2022 conventional ecological risk assessment and the lack of ongoing industrial activity at the following locations, soil sampling will be discontinued at the Bruce A Storage Compound, the Bruce B Empty Drum Laydown Area, Former Sewage Lagoon and at Distribution Stations #2/4/5/8. Sediment and surface water monitoring at the B16 pond will be discontinued. Groundwater monitoring at the shallow (less than 1.5 metres) wells at the Former Sewage Lagoon and the Bruce A Storage Compound will be discontinued given the lack of Contaminants of Potential Concern. The need for additional monitoring will be determined by the Groundwater Protection Program in alignment with Canadian Standard Association N288.7 15 [R-19].	Sampling of environmental media at the specified locations has been discontinued.
Effluent and environmental data reported as less than a detection limit is a source of uncertainty in the radiological Environmental Risk Assessment. Uncensored data below the detection limit is now recorded and used where possible for environmental monitoring data. In some cases, the critical level is conservatively used as an upper bound of contaminant concentration. For effluent/emissions monitoring data, Bruce Power is in the process of completing the required work to report uncensored data and critical level information for all radiological analyses. This uncensored data and critical level information will then be used in routine reporting. The use of uncensored data and critical level information for effluent and emissions data will represent a refinement of the Environmental Risk Assessment dose calculations. However, most of the Human Health Risk Assessment dose calculations are based on measurements in environmental media and are not dependent on effluent/emissions data. As a result, increasing the accuracy of reported emissions will have a small effect on reported doses and on the outcomes of the radiological Human and Ecological Risk Assessments.	Changes to the management of uncensored data are in progress. Once available, this information will be integrated into the 2027 Environmental Risk Assessment.
From the Ecological Risk Assessment, additional measurements of radionuclides in on site waterbodies have confirmed that the Former Sewage Lagoon is the bounding exposure	Follow-up monitoring is planned and results of completed monitoring will be reported annually in

Recommendation in the 2022 Environmental Risk Assessment	Plan and Progress
location. Doses to non-human biota remain far below benchmark values, therefore additional refinement of dose calculations is not required. Continued monitoring of radionuclides in water and sediment at the Former Sewage Lagoon is recommended. This may include characterization of Carbon-14 in surface water to refine concentrations that were calculated based on modelling.	this report. No follow-up monitoring was completed during the 2022 calendar year.
Monitoring for impingement will continue. Bruce Power will also complete entrainment monitoring and offset projects as part of the conditions of the Fisheries Act Authorization [R-54].	Impingement monitoring continues and is reported in Section 6.2.2.1. A pilot entrainment monitoring program is planned in 2023 and will be reported in the 2023 Environmental Protection Report. Offset projects are ongoing and are reported in Section 6.2.2.
In response to the low risk posed by thermal effluent to several fish species, Bruce Power will continue to execute year-round thermal monitoring through logger deployments and thermal modelling work to monitor the risk posed by thermal effluent in the Local Study Area. Thermal logger deployments at depths over 10 metres will be discontinued during the winter period starting in the fall of 2022. Deployments at 3 metres, 5 metres and 10 metres depths will continue. Bluetooth technology for data loggers is being trialed to help improve retrieval of temperature loggers at shallow depths (≤10 metres). Deep locations (>10 metres) are difficult to retrieve in the spring, resulting in more field days and additional exposure of field personnel to health and safety concerns because of searching for and pulling these deep locations from the lake bottom. Over the winter period, the Thermal Risk Assessment considers only Lake Whitefish and Round Whitefish eggs at depths of 4 to 10 metres and Lake Trout eggs at depths of over 12 metres. For Lake Trout eggs, the only species and life stage assessed over the winter period at depths greater than 10 metres, thermal exceedances occur equitably at both reference and Local Study Area sites early in the incubation period; therefore, deployment and retrieval of temperature loggers	Thermal monitoring deployments at depth over 10 metres have been discontinued. Thermal loggers were deployed in the Fall of 2022 at depths of 3m, 5 metres and 10 metres across the Local Study Area. Bluetooth technology for data loggers was used for some data loggers in the 2022 Spring and Fall thermal monitoring deployments. While these loggers improved ease of data download, there was no ability to read the loggers from the water surface. Use of Bluetooth loggers will not help enhance retrieval of thermal monitoring locations.

Recommendation in the 2022 Environmental Risk Assessment	Plan and Progress
over the winter period at depths greater than 10 metres is not contributing to the assessment of thermal effects. The Local Study Area Remapping Tool generates daily temperatures for 8,815 nodes at the surface and 8,815 nodes at the bottom over the entire Thermal Risk Assessment period. Daily average and daily maximum temperatures from the Local Study Area Remapping Tool can be used in the same manner as measured temperature values in the Thermal Risk Assessment process. For the 2022 Thermal Risk Assessment, the tool was used to increase the spatial assessment of the extent of thermal exceedances for Lake Whitefish eggs, Round Whitefish eggs and Lake Trout eggs. In the 2027 Thermal Risk Assessment, temperatures used for Hazard Quotient calculations for Lake Trout eggs will be generated using the Local Study Area Remapping Tool. Temperatures used for Hazard Quotient calculations for Lake and Round Whitefish eggs will also be completed using the Local Study Area Remapping Tool and available measured data.	
Continued monitoring and assessment of impingement and entrainment and thermal effects will occur as per the established regulatory framework. This iterative assessment will also include ongoing Indigenous engagement and working to embed Indigenous values as was done throughout the mitigation measures assessment report. A reevaluation of risks and basis for decisions surrounding mitigation measure will be reported in subsequent Environmental Risk Assessments. Bruce Power will provide an update on the progress of the use of intake water flow flexibility (i.e., variable speed drives) engineering work and on current research related to the effects of sound and light on fish species relevant to the Local Study Area in the 2027 Environmental Risk Assessment.	Assessment of impingement and entrainment and thermal effluent continues and results will be incorporated as needed into: Bruce A and B environmental compliance approvals; Fisheries Act Authorization application; Thermal risk assessments; and, Projects on site that impacts thermal effluent and water taking, including Project 2030
Although no significant impact on the environment is expected from Lutetium-177 production, Bruce Power will collect data to verify and confirm that changes in atmospheric emissions are negligible.	Radiological emissions on site are reported in Section 5.1.

Recommendation in the 2022 Environmental Risk Assessment	Plan and Progress
During commissioning of the Isotope Production System and for a limited period thereafter, the particulate filters from the stack monitor will be analyzed for the presence of Ytterbium-175, Ytterbium -177 and Lutetium -177 in the gaseous effluents. Bruce Power will review the additional monitoring data to validate the assumptions presented in the predictive Environmental Risk Assessment.	
With the successful execution of a large portion of the higher risk Life Extension and Major Component Replacement activities for Unit 6, including the draining of systems and the removal of components, no substantial changes to baseline radiological and conventional emissions and effluents are expected to occur during Life Extension and Major Component Replacement. As the current operational conditions are demonstrated to be bounding of future activities, including Major Component Replacement activities, the 2022 Environmental Risk Assessment is, therefore, shown to be bounding of the proposed activities. The need to evaluate for monitoring related to Gas Bubble Trauma at the completion of the Life Extension Program will be carried to the 2027 Environmental Risk Assessment. No specific recommendations are required.	The impacts of Project 2030 are being evaluated and will be incorporated into the 2027 Environmental Risk Assessment and into a gap analysis, if deemed necessary. An Environmental Management Plan will be used to evaluate the impacts of Project 2030 on all environmental aspects.

In addition to the recommendations listed in Table 7 above, the Canadian Nuclear Safety Commission and Environment and Climate Change Canada have reviewed the 2022 Environmental Risk Assessment. Preparation of formal correspondence to respond to technical comments is underway. At the present time, the following recommendations will be implemented for the 2027 Environmental Risk Assessment:

- Regular wildlife turtle and bird surveys of on-site permanent drainage features will continue at the frequency dictated by the environmental monitoring program. Bruce Power will consider follow-up monitoring of benthic invertebrate communities in the nearshore area of Lake Huron, the discharge channels, and the addition of a reference site location if such monitoring is deemed necessary through the environmental monitoring program. Results will be included in future iterations of the annual Environmental Protection Report and in the 2027 Environmental Risk Assessment to provide additional context for risk characterization. An enhanced description of the permanent drainage features on site will be added to the 2027 Environmental Risk Assessment.

- Analysis of selenium and vanadium in sediment samples collected from the Eastern Drainage Ditch and the Former Sewage Lagoon and of pH from surface water at the Former Sewage Lagoon will continue during routine monitoring. Lake Huron surface water sampling will include antimony, barium, molybdenum, selenium, uranium, and vanadium as part of routine sampling. A discussion of the potential cumulative effects from project activities on phosphorus in effluent will be included in the 2027 environmental risk assessment. All sampling will be included in future iterations of the Annual Environmental Protection Report and assessed in the 2027 Environmental Risk Assessment.

- As completed for the 2022 Environmental Risk Assessment, future Environmental Risk Assessments will include a review of available Toxicity Reference Values for all Chemicals of Potential Concern. An interactive interface will be considered to facilitate regulator and stakeholder review of the screening process, similar to the one piloted for the 2022 Environmental Risk Assessment (https://wsp-shinyapps.shinyapps.io/ERA_screening_tables/).

- A map of the Lake Huron fishing Zone 1 will be included in the Impingement and Entrainment section.

- In the 2027 Thermal Risk Assessment, several changes will be made:

    - All available thermal monitoring data from April 1, 2021 to March 31, 2026 will be incorporated.

    - Validation results for the MIKE3 Huron Hydrothermal model will be presented for two years.

    - The Local Study Area Remapping Tool, thermal modelling improvements, calibration and validation efforts will be briefly discussed within the methodology section of the 2027 thermal risk assessment.

    - The spatial extent of thermal benchmark exceedances and hatch advance for Lake Whitefish eggs will be compared between operational and non-operational scenarios and with reference sites to enhance the risk characterization. This will provide additional context as to the spatial extent of exceedances within the Local Study Area.

    - Reference site selection criteria will be explicitly stated for all reference sites.

- An interactive interface for thermal risk assessment data will be considered, similar to the one prepared as a pilot for regulators and stakeholders for the 2022 Thermal Risk Assessment (https://wsp-shinyapps.shinyapps.io/ERA_temperature/).

- A discussion of the potential cumulative effects from project activities on phosphorus levels in Lake Huron will be included.

- Bruce Power will consider contributing funding and/or in-kind contributions to future projects to characterize the Habitat Productivity Index for Lake Huron run by external organizations. Bruce Power will not be initiating projects to characterize Habitat Productivity Index in Lake Huron based on the current Fisheries Act Authorization conditions.

- Bruce Power will consider posting a public plain language summary in addition to the posting of an accessible version of the report. Information will be provided regarding risk terminology, the quality assurance processes for the site-specific survey, and the periodic review process for the Environmental Risk Assessment. Bruce Power will also continue to list the changes made with each Environmental Risk Assessment update, including changes made to reach compliance with Canadian Standards Association N288.6-22.

5.0 EMISSIONS AND EFFLUENT MONITORING

Bruce Power's Environmental Protection Program is built upon an integrated monitoring approach that drives to understand environmental impact, verify environmental protection, and continuously improve by driving strategic research and innovation through collaborations with industry and community. Environmental safety and responsibility are woven into all aspects of the company's nuclear safety culture, and Bruce Power commits to meet or exceed all relevant legal and voluntary environmental requirements. The company holds itself accountable to prevent pollution through strong management of emissions, effluents, and waste and implements robust spill mitigation measures in order to provide effective containment and control of contaminants. To demonstrate environmental protection, Bruce Power performs extensive monitoring and modelling of radiological and conventional contaminants.

Air emissions and water effluents are controlled and regulated, and releases occur in a manner that minimizes environmental impact. Bruce Power's radiological and conventional environmental monitoring programs are designed to continuously verify that environmental protection is being maintained and that these releases have minimal impact on the surroundings. The programs are based on Canadian Standards Association N288.5, Canadian Nuclear Safety Commission REGDOC-2.9.1 [R-16], and reporting requirements in Canadian Nuclear Safety Commission REGDOC-3.1.1 [R-2].

Environmental protection is achieved by fulfilling key program objectives:

- Demonstrate compliance with all applicable environmental compliance obligations, Licence conditions and the Environmental Policy;
- Protect the quality of the natural environment and quantity of natural resources by minimizing interactions with the environment associated with site activities, allowing for effective environmental protection;
- To ensure there are monitoring and control measures to prevent or minimize the release of nuclear and/or hazardous substances directly or indirectly to the environment by design and operation of structures, systems and components;
- To have in place environmental monitoring to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to identify when and where;
- To protect human and ecological health that may be affected by the release of contaminants or physical stressors into the environment arising from the facility;
- Support business decisions to drive environmental protection, sustainability principles and the Environmental, Social and Governance strategy;
- Maintain strong engagement and collaboration with stakeholders, community members and Indigenous communities.

The results of the radiological and conventional emissions and effluent monitoring programs demonstrate that the environmental impact of Bruce Power operations remains very low and the emissions and effluent controls in place are effective at meeting the key program objectives.

5.1 Radiological Emissions and Effluent Monitoring Programs

Bruce Power monitors its radiological airborne emissions and waterborne effluent to ensure that releases are occurring within acceptable limits and remain As Low As Reasonably Achievable (ALARA). Radiological emissions and effluent monitoring data is reported to the Canadian Nuclear Safety Commission quarterly and is compared to internal administrative levels in addition to regulatory levels and limits. If abnormal conditions are identified, investigations are undertaken, and appropriate corrective actions are applied.

Radiological emissions and effluent monitoring results feed into the larger Environmental Protection framework to ensure the public and the environment are always protected. Data from the radiological emissions and effluent monitoring program are utilized in conjunction with Radiological Environmental Monitoring measurements to support radiation dose assessments and complete a comprehensive Environmental Risk Assessment in accordance with Canadian Standards Association N288.6 [R-18].

The objectives of the Bruce Power radiological emission and effluent monitoring program are to:

a) demonstrate compliance with authorized release limits (Derived Release Limits) and other regulatory requirements;

b) demonstrate adherence to internal objectives and targets set on release amounts, for the purposes of emissions and effluent control;

c) confirm the adequacy of controls on releases from the source;

d) provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring;

e) provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear substances released from the facility; and,

f) provide data which, when combined with the results of environmental monitoring, can be used to test, verify, or refine models used in Environmental Risk Assessments and dose assessments, and incorporate recommendations into program design.

Radionuclides in airborne emissions and waterborne effluents are monitored, as applicable, at Bruce Power facilities including Bruce A, Bruce B, Central Maintenance Facility, and the Central Storage Facility. Other facilities located on-site that monitor for airborne and waterborne radionuclides, as applicable, include Canadian Nuclear Laboratories, Ontario Power Generation's Western Waste Management Facility, and Kinectrics' Ontario Nuclear Services Facility. Descriptions of the radiological emissions and effluent programs for these facilities can be found in section 2.0.

5.1.1 Bruce Power Facilities (Bruce A, Bruce B, Central Maintenance Facility, Central Storage Facility)

Monitoring of radiological emissions and effluents from Bruce A, Bruce B, the Central Maintenance Facility, and the Central Storage Facility occurs within the Bruce Power framework for control of radioactive emissions and effluents and includes the monitoring systems operating and quality assurance requirements. Airborne radiological emissions are monitored from applicable stacks within each facility for tritium, carbon-14, radioiodine (^{131}I), noble gasses, gross beta/gamma, and gross alpha. Waterborne radiological effluents are monitored at applicable release points for tritium, carbon-14, gross alpha, and gross beta/gamma.

All airborne emissions and waterborne effluents at Bruce Power remain well below the Derived Release Limits (DRLs), which are regulatory limits developed using Canadian

Standards Association Standard N288.1[R-58], and based on a public dose limit of 1 millisievert per year as mandated by the Canadian Nuclear Safety Commission (*Radiation Protection Regulations*, *SOR/2000-203*) [R-59]. Bruce Power operates well below Derived Release Limits to ensure that members of the public and the environment are protected. Environmental Action Levels, developed in accordance with Canadian Standards Association Standard N288.8, are established at Bruce Power and are used as a precautionary measure to provide early warning of any actual or potential loss(es) of control of the Environmental Protection Program [R-60]. These levels are not an indication of risk to the public or environment as they represent a very small fraction of the Derived Release Limit (typically less than 1% of the Derived Release Limit) with annual dose to public remaining low (*de minimus)*. Bruce Power controls radiological emissions as low as reasonably achievable, by taking action to investigate causes of elevated emissions and effluents and initiating mitigating actions, when necessary.

On December 31, 2021, Bruce Power implemented new Derived Release Limits and Environmental Action Levels, in accordance with Canadian Standards Association N288.1-14 Update 3 and Canadian Standards Association N288.8-17. Changes to the Derived Release Limits were minor in nature, but the revised Environmental Action Levels are much lower than previous ones. In the past, Environmental Action Levels were applied to the whole station and were equivalent to 10% of the Derived Release Limit. The updated Environmental Action Levels are specific to each radionuclide and pathway of release and are based on the upper bound of historical normal releases.

5.1.2 Air

5.1.2.1 2022 Radiological Airborne Emissions Results

Through Bruce Power's normal operation and outage maintenance activities, airborne radiological emissions are released to the environment. These airborne emissions are primarily monitored through exhaust stacks and are well below regulatory limits (Derived Release Limits). Radiological airborne emissions typically originate from reactor systems such as the main moderator and heat transport systems and their auxiliary systems (e.g. purification). Airborne emissions can fluctuate during planned and unplanned activities; however, monitoring systems are in place to capture this variability. Planned activities that may result in temporary elevated emissions include controlled removal of defect fuel bundles from the reactor core, moderator cover gas purges to keep chemistry parameters within specifications, and increased outage days where maintenance work is performed on reactor systems to support equipment health and continued safe operation. Other causes of elevated emissions can include equipment deficiencies such as stack filter by-pass, resin exhaustion in ion-exchange purification systems, and boiler tube leaks that cause increased emissions through feedwater venting.

Bruce Power has several engineered barriers in place to minimize the release of radionuclides to the environment and keep releases as low as reasonably achievable (ALARA). These barriers include High Efficiency Particulate Air (HEPA) filters and High Efficiency Carbon Air

(HECA) filters to remove airborne radioiodine and particulates. Testing of Bruce Power's stack filters is conducted annually by a third-party vendor to assess and assure their removal efficiency. Additional barriers include moderator and heat transport purification systems designed to remove radionuclides, and moderator confinement and vault vapour recovery systems which reduce airborne tritium releases. Together, these engineered barriers along with systematic monitoring and investigation of emissions above normal operating levels ensures Bruce Power minimizes emissions to levels that are as low as reasonably achievable (ALARA). At all times, Bruce Power operations are designed to minimize emissions below internal administrative levels and Environmental Action Levels (Canadian Nuclear Safety Commission reportable levels), which ensures emissions remain well below regulatory Derived Release Limits.

The 2022 radiological airborne emission results for all licensed facilities onsite are shown in Table 8 [R-61]–[R-63]. This includes annual results of tritium, noble gases, radioiodine (^{131}I), carbon-14, particulate alpha, and particulate beta and gamma. Bruce Power provides emission results to the Canadian Nuclear Safety Commission in quarterly reports in accordance with the Power Reactor Operating Licence. Bruce Power's radiological airborne emissions continue to remain well below regulatory limits (Derived Release Limits) as shown in Table 9 which displays Bruce Power's annual emissions as a percentage of the Derived Release Limit. In February 2022, Bruce A experienced two weeks of elevated radioiodine emissions above the new Environmental Action Level as a result of a required removal of defect fuel (see section 5.1.2.3). Although the radioiodine emissions over this two-week period were greater than historical emissions, they were still well below the Derived Release Limit and the total annual dose to public remained low (*de minimus*).

Table 8 - Annual Radiological Airborne Emissions for 2022

Sample Source	**Tritium Oxide** (becquerels per year)	**Noble Gas** (becquerels – mega electron volts per year)	**Iodine-131** (becquerels per year)	**Particulate Beta/Gamma** (becquerels per year)	**Particulate Gross Alpha** (becquerels per year)	**Carbon-14** (becquerels per year)
Bruce A	1.7E+15	8.1E+13	6.8E+08	2.6E+06	2.1E+04	2.5E+12
Bruce B	3.7E+14	4.1E+13	4.0E+06	6.3E+06	7.5E+04	8.6E+11
Central Maintenance Facility	3.2E+09	N/A	0.0E+00	0.0E+00	4.4E+02	N/A
Central Storage Facility	1.4E+11	N/A	N/A	0.0E+00	N/A	N/A
Ontario Power Generation Western Waste Management Facility	1.42E+13	N/A	5.21E+03	0.00E+00	N/A	5.20E+09
Canadian Nuclear Laboratories Douglas Point Waste Facility	2.41E+11	N/A	N/A	1.17E+05	N/A	N/A
Kinectrics' Ontario Nuclear Services Facility	2.2E+11	N/A	N/A	N/A	N/A	N/A
Total	2.1E+15	1.2E+14	6.8E+08	9.1E+06	9.6E+04	3.4E+12

Note: Particulate beta/gamma results – Bruce A and Bruce B and the Canadian Nuclear Laboratories Douglas Point Waste Facility perform beta analysis, and the Central Maintenance Facility, Central Storage Facility and Ontario Power Generation Western Waste Management Facility utilize gamma scan results. Naturally occurring radionuclide material detected in the gamma scan analysis is not included in the summation of releases and are not reported.

Table 9 - Annual Radiological Airborne Emissions for 2022 as a Percentage of the Derived Release Limit

Radionuclide/ Radionuclide Group	Units	Bruce A	Bruce B	Central Maintenance Facility	Central Storage Facility
Tritium Oxide	Percent Derived Release Limit	5.1E-01	4.7E-02	1.0E-06	3.3E-05
Noble Gas	Percent Derived Release Limit	5.3E-02	1.1E-02	N/A	N/A
Iodine-131	Percent Derived Release Limit	1.9E-02	1.0E-04	0.0E+00	N/A
Particulate Beta/Gamma	Percent Derived Release Limit	4.1E-04	4.6E-04	0.0E+00	0.0E+00
Particulate Gross Alpha	Percent Derived Release Limit	7.9E-06	1.1E-05	1.3E-07	N/A
Carbon-14	Percent Derived Release Limit	1.1E-01	2.1E-02	N/A	N/A

5.1.2.2 Air Emission Monitoring of Lutetium-177 Production

In January 2022, Bruce Power began production of lutetium-177, a medical isotope used in targeted radionuclide therapy to treat neuroendocrine tumours and prostate cancer. The lutetium-177 produced at Bruce B will be used in cancer treatments around the world to precisely target malignant cancer cells without damaging surrounding healthy tissues.

Commissioning of the new isotope production system in Unit 7 began in January 2022 and became operational on October 24, 2022. Although no changes to radiological emission levels are expected from this isotope production system, temporary monitoring of lutetium-177, ytterbium-175 and ytterbium-177 is occurring at Bruce B. No airborne emissions from these radionuclides have been identified to-date. Due to the nature of the decay products associated with the production of lutetium-177, particles will either quickly decay to negligible activity or be filtered out by High Efficiency Particulate Air (HEPA) filters prior to release resulting in negligible emissions. Although it is expected to have a negligible impact on emissions, any radiological emissions produced from the lutetium-177 isotope production system would be detected by the existing stack monitoring systems already in place and reported to the Canadian Nuclear Safety Commission via regular reporting. No waterborne effluent is produced from the lutetium-177 isotope production system.

5.1.2.3 Historical Radiological Airborne Emission Results

Figure 9 through Figure 11 below provide an overview of historical annual airborne radiological emissions at Bruce A and Bruce B.

Historical airborne tritium emissions are provided in Figure 9. Airborne tritium is a principal radionuclide associated with dose to the public. Tritium emissions from Bruce B in 2022 were similar to previous years; however airborne emissions from Bruce A increased in 2021 and 2022. In December 2021 and January 2022, tritium emission increases were experienced at Bruce A due to a moderator pump seal leak that occurred on Unit 1 and was contained within the station inside the confinement rooms. To maintain radiological safety and minimize radiological dose to workers it was important to purge the air from the moderator pump room (within confinement) to contaminated exhaust prior to initiating cleanup activities. Although this activity caused elevated airborne releases of tritium, the impact to the dose to public remained very low.

In May 2022, Bruce A completed its Vacuum Building Outage to support Bruce Power's continued safe and reliable operation. Tritium emissions during full station outages can be temporarily elevated as multiple Unit reactor systems are purged to support Vacuum Building Outage activities. Additionally in 2022 at Bruce A, equipment challenges and planned maintenance activities (primarily in Unit 3 and Unit 4) impacted availability of the moderator confinement vapour recovery and vault vapour recovery systems. Reduced availability of this equipment due to replacement part availability caused increased tritium emissions exiting the exhaust stacks. An emphasis was placed on improving equipment reliability and performance of these systems and repairs were completed in the first quarter of 2023. Although tritium emissions at Bruce A were elevated above historical emissions, they were well below regulatory limits with dose to public remaining *de minimus*.

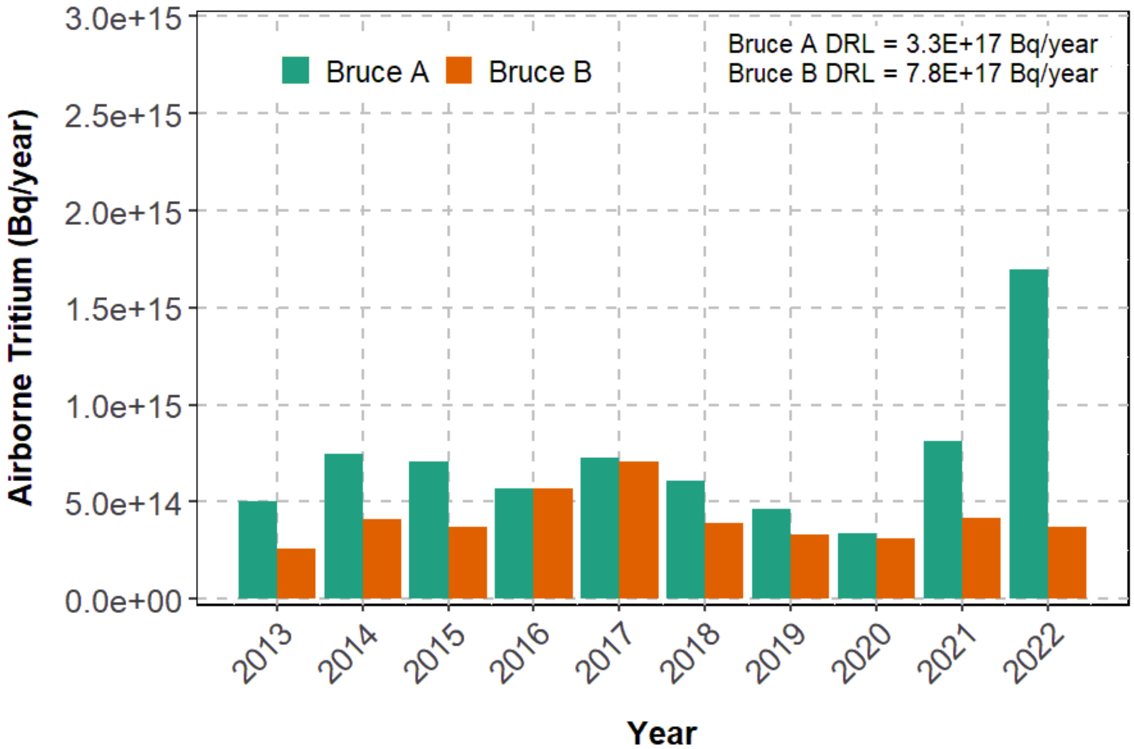


Figure 9 - Historical Airborne Tritium Emissions

Figure 10 displays the historical trend of airborne carbon-14 emissions. In 2022, carbon-14 emissions remained low at Bruce B, with an increase at Bruce A compared to previous years (2016 to 2021). This increase is attributed to confinement room purges and moderator cover gas purging in support of maintenance activities, system chemistry specifications (moderator cover gas) and multiple and simultaneous outages, including the Vacuum Building Outage, as well as fueling ahead activities in preparation for Unit 3's Major Component Replacement.

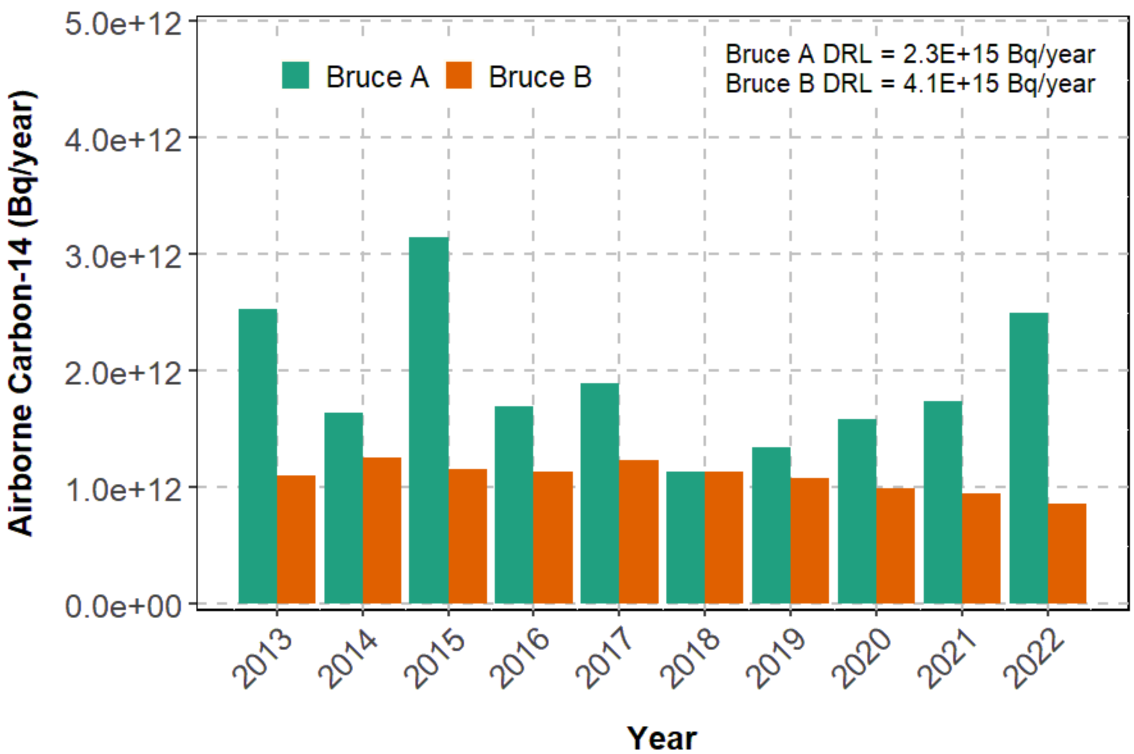


Figure 10 - Historical Airborne Carbon-14 Emissions

The majority of airborne iodine emissions are captured by the High Efficiency Carbon Air (HECA) filters, which are tested on an annual basis to determine efficiency and maintain equipment reliability. Many stack monitoring results for iodine are less than the Limit of Detection. To prevent producing an over-conservative number, as of 2016 results that were below the Limit of Detection were stated as such during routine reporting and results greater than Limit of Detection were included in the summation of iodine to provide a more representative value. A majority of iodine emissions at both Bruce A and B are below the Limit of Detection.

Figure 11 details the historical trend in radioiodine airborne emissions over the last 10 years. Iodine in air is a radiological emission associated with dose to the public. Radioiodine emissions from Bruce B in 2022 were similar to prior years and remained very low. An increase in iodine emissions at Bruce A in 2014 was caused by debris in the heat transport system following return to service of Units 1 and 2, which resulted in fuel defects and associated releases of iodine when the defect fuel was removed from the reactor. Bruce A experienced a similar increase in iodine emissions for two weeks in 2022 caused by removal of defect fuel on February 2nd, 2022. The radioiodine emissions during this period were above Bruce A's Environmental Action Level. Investigation into this event was completed and the primary causes of the elevated radioiodine emissions were determined to be: (1) insufficient filtration of the off-gassing Service Area Rehearsal Facility drum that collects heat transport water from the fueling machine when defect fuel is discharged to the Primary Irradiated Fuel Bay, (2) degraded condition of the Irradiated Fuel Bay High Efficiency Carbon Air filters, and (3) dampers that prevented iodine from being captured by the exhausted high efficiency carbon air filter beds. Corrective actions were put in place to prevent re-occurrence of this event. The High Efficiency Carbon Air filter beds were replaced, and an increased focus was placed on the filter maintenance and testing program. Although the iodine emissions in February 2022 were above the Environmental Action Level and reported to the Canadian Safety Nuclear Commission, all emissions during this time and for the remainder of the year were well below Bruce Power's Derived Release Limit and the dose to public for 2022 remained *de minimus*.

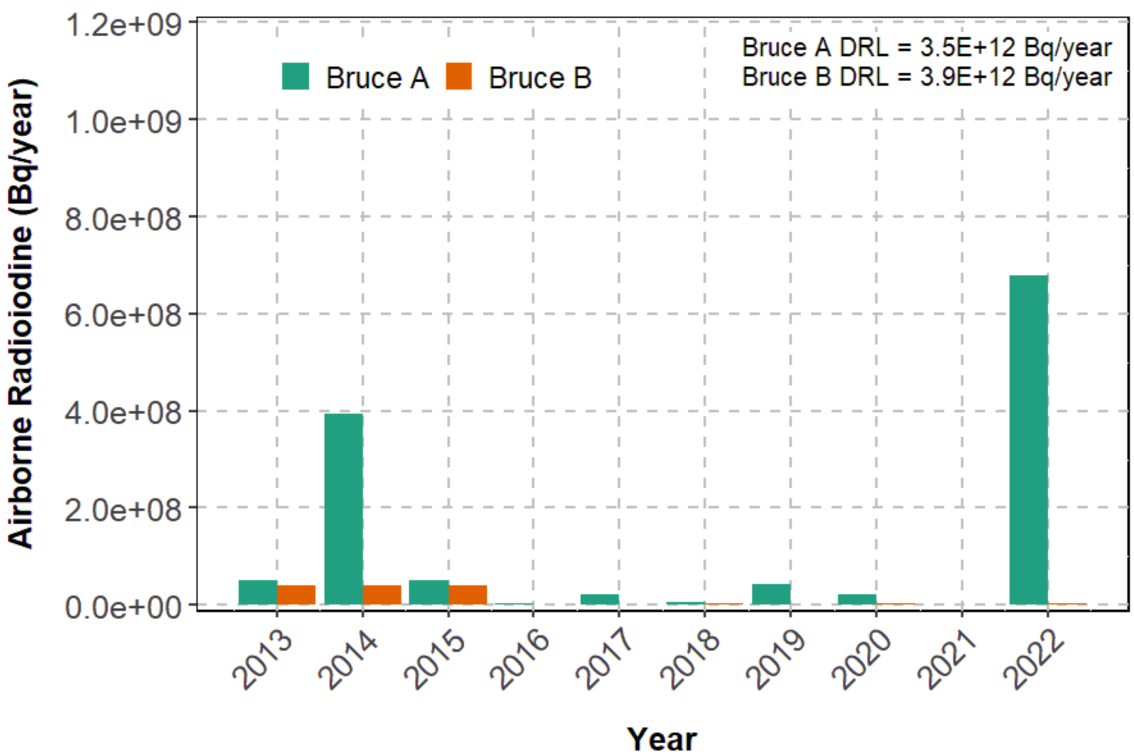


Figure 11 - Historical Radioiodine Emissions in Air

5.1.3 Water

5.1.3.1 2022 Radiological Waterborne Effluent Results

Waterborne radiological effluent, produced during Bruce Power's normal operation and outage activities, remained well below regulatory limits in 2022. Waterborne effluent is monitored through release pathways that include Active Liquid Waste, feedwater discharges and foundation drainage. Ultimately, these effluent streams are discharged to Lake Huron via the Condenser Cooling Water Duct. Radiological waterborne effluent typically originates within reactor systems such as the moderator and heat transport systems and their auxiliary systems (e.g., purification).

The largest contributor to waterborne radiological effluent is the Active Liquid Waste system. Water in this system is collected in tanks and re-circulated to allow time for short-lived radionuclides to decay. Reverse osmosis and filtration systems are also used to remove radioactive particulate. Prior to release, the contents of each tank are analyzed to ensure established discharge criteria are met.

Waterborne effluent loading can fluctuate depending on planned and unplanned activities that are taking place. Unplanned events that may result in higher radionuclide concentrations in effluent include equipment challenges such as moderator or primary heat transport upgraders being out of service, delays in offsite processing (de-tritiation) of heavy water (D_2O), purification resin exhaustion, and boiler tube leaks. Planned activities for which effluent fluctuations may occur include scheduled fuel bundle defect removals from the reactor, increased spent resin transfers, controlled discharges from collection and recovery systems and increased outage days where maintenance work is performed on reactor systems to support equipment health and continued safe operation.

Bruce Power has several barriers in place to minimize waterborne radionuclides from being released to the environment. These barriers include moderator and heat transport purification to remove waterborne radionuclides from reactor systems, heavy water in light water (D_2O in H_2O) leak detection to provide early indication of a heavy water leak or boiler tube leak, and heavy water (D_2O) supply and inventory systems to maximize the capture of heavy water (D_2O) for re-use. These barriers, in conjunction with applying the As Low As Reasonably Achievable (ALARA) principle, routine monitoring and initiating investigations when effluent levels are above normal operating levels, assists Bruce Power in minimizing effluent and ensuring effluent remains well below regulatory limits.

Bruce A, Bruce B, Canadian Nuclear Laboratories, and Kinectrics' Ontario Nuclear Services Facility monitor for waterborne radionuclides (as applicable). Annual results of waterborne radionuclides including tritium, carbon-14, particulate alpha, beta and gamma from these facilities are presented in Table 10 [R-61]–[R-63]**.** Bruce Power reports quarterly to the Canadian Nuclear Safety Commission results of radiological waterborne effluents in accordance with the Power Reactor Operating Licence. These totals include tritium releases from foundation drainage sump discharges. In 2022, Bruce Power's radiological waterborne effluents were well below regulatory limits as shown in Table 11 - Annual Radiological Waterborne Effluent Results for 2022 as a Percentage of the Derived Release Limit as well as below associated reportable Environmental Action Levels.

There are no direct waterborne radiological effluent releases to the environment from the Central Maintenance Facility or Central Storage Facility. All radiological waterborne releases from these buildings are directed to Bruce A's Active Liquid Waste management system for processing and are included in the waterborne effluent total for that facility.

Starting January 2021, monitoring of discharge from the Western Waste Management Facility's Sample Stations system surface (stormwater) and subsurface (groundwater) streams was transitioned from the effluent monitoring program to Canadian Standards Association N288.6, *Environmental risk assessments at Class I nuclear facilities and uranium mines and mills*, and Canadian Standards Association N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*, respectively [R-49], [R-64]. This change was based on the absence of releases of effluent into the stormwater system—other than the deposition of airborne emissions via precipitation. The monitoring and reporting of these airborne emissions are already managed under the airborne effluent monitoring programs and not reported separately as waterborne effluent [R-61].

Table 10 - Annual Waterborne (Aqueous) Radiological Effluent Results for 2022

Radionuclide/ Radionuclide Group	Units	Bruce A	Bruce B	Canadian Nuclear Laboratories Douglas Point Waste Facility	Kinectrics' Ontario Nuclear Services Facility	Total
Tritium Oxide	becquerels per year	2.8E+14	5.7E+14	2.40E+10	N/A	8.5E+14
Carbon-14	becquerels per year	6.9E+08	9.0E+08	N/A	N/A	1.6E+09
Gross Gamma	becquerels per year	1.7E+09	1.5E+09	N/A	N/A	3.2E+09
Gross Beta	becquerels per year	N/A	N/A	8.60E+06	N/A	8.6E+06
Gross Alpha	becquerels per year	Below Limit of Detection	Below Limit of Detection	5.70E+06	N/A	5.7E+06

Note: There were no waterborne emissions in 2022 for Kinectrics' Ontario Nuclear Services Facility

Table 11 - Annual Radiological Waterborne Effluent Results for 2022 as a Percentage of the Derived Release Limit

Radionuclide/ Radionuclide Group	Units	Bruce A	Bruce B
Tritium Oxide	% Derived Release Limit	3.3E-02	7.6E-01
Carbon-14	% Derived Release Limit	6.9E-04	4.3E-04
Gross Gamma	% Derived Release Limit	5.8E-02	2.4E-02
Gross Alpha	% Derived Release Limit	0.0E+00	0.0E+00

5.1.3.2 Historical Radiological Waterborne Effluent Results

The figures below (Figure 12 through Figure 14) provide historical annual releases of waterborne radiological effluent at Bruce A and Bruce B.

Figure 12 details the historical trend in waterborne tritium. Tritium in water is a minor contributor to the overall dose to the public. Waterborne tritium effluent at Bruce B has a consistently higher baseline compared to Bruce A due to a design configuration with the Moderator Confinement Vapour Recovery condensate being directed to the Active Liquid Waste System. Bruce A waterborne tritium effluent remained relatively stable in 2022 with Bruce B waterborne tritium decreasing to similar historical levels compared to 2021. In 2021, an increase in effluent was primarily attributed to a leaking motorized valve in the Unit 8 Emergency Coolant Injection (ECI) U loop which was identified and repaired in November. Unit 5 at Bruce B had been experiencing a minor ongoing boiler tube leak since 2017. The leak rate was monitored regularly and remained controlled well within acceptable values allowing continued operation until it was repaired in Bruce B’s planned Unit 5 outage ending April 2022. All effluent was well below regulatory limits with dose to public remaining *de minimus*.

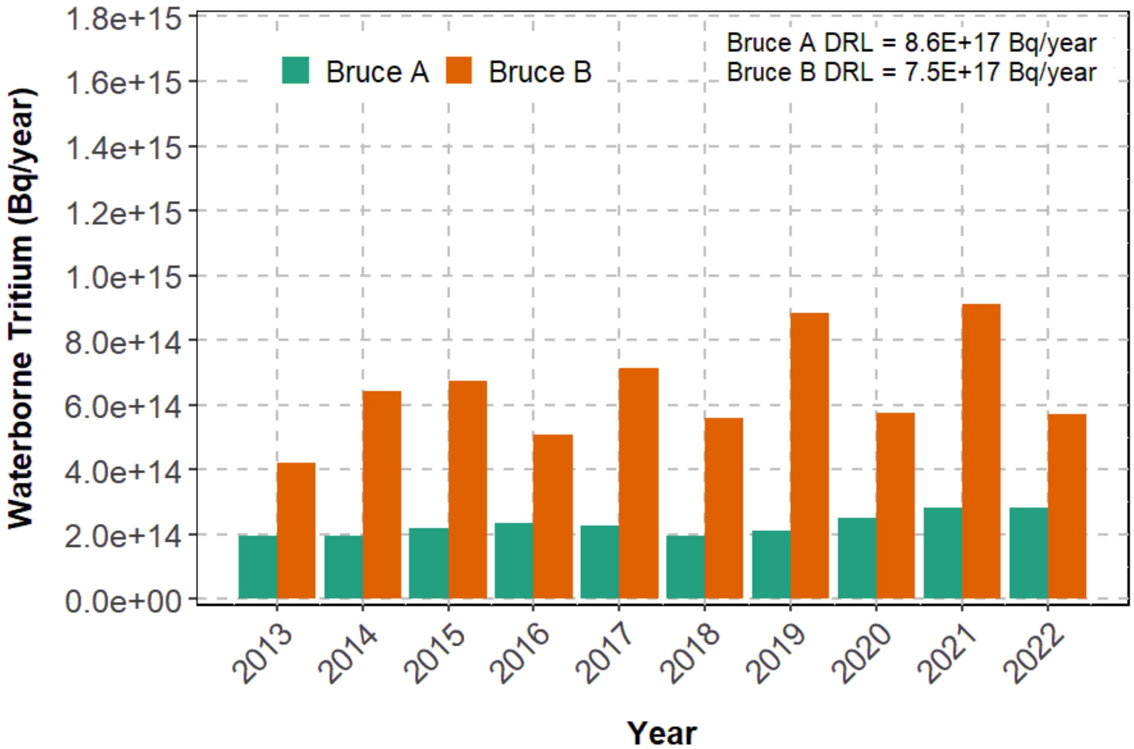


Figure 12 - Historical Tritium Waterborne Effluent

Figure 13 details the historical trend of waterborne carbon-14 effluent. Carbon-14 in water is a radiological effluent associated with dose to public and control/oversight is provided through Bruce Power's resin management program. In 2022, Bruce A and Bruce B carbon-14 waterborne effluent remained low. In 2014 and 2015, increases in carbon-14 effluent at Bruce B were attributed to the drainage of the Emergency Water Storage Tank in preparation for a Vacuum Building Outage. These emissions remained well below the regulatory limit and dose to public remained *de minimus*. Since 2016, carbon-14 in waterborne effluent has fluctuated due to variations in the volume of Moderator ion exchange resins that were processed each year.

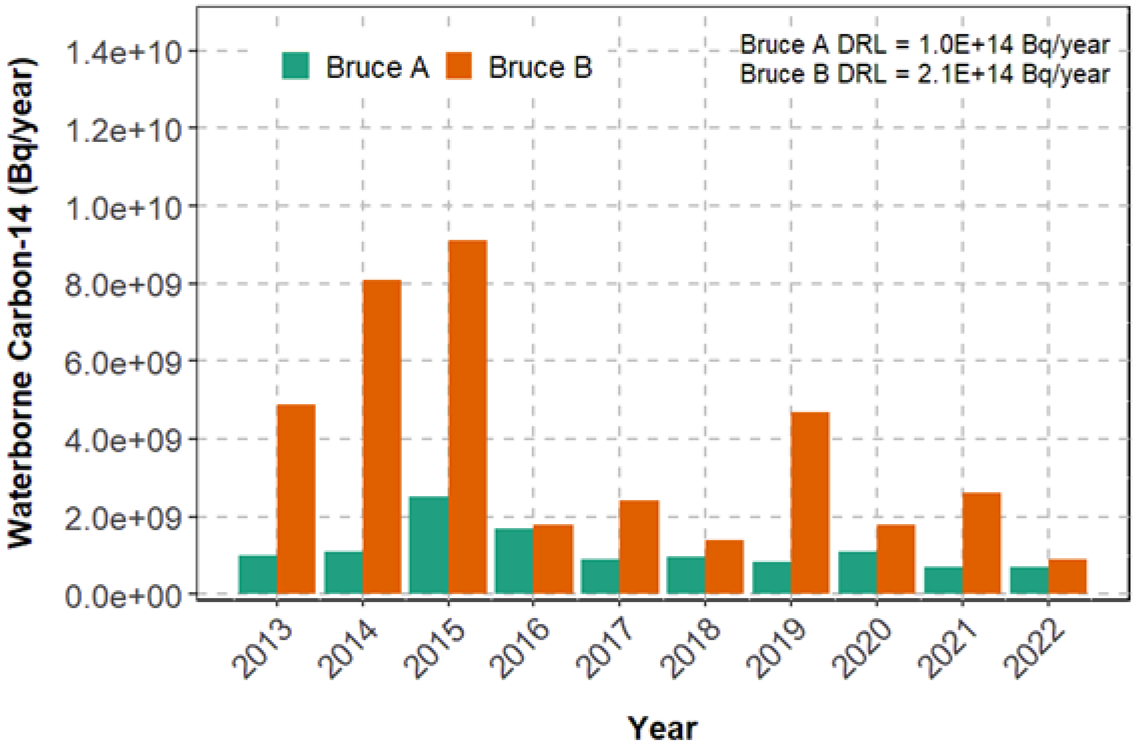


Figure 13 - Historical Carbon-14 Waterborne Effluent

Historical waterborne gamma effluent is shown in Figure 14. Bruce A and Bruce B waterborne gamma effluent in 2022 remained low and well within regulatory limits. Since 2017, Unit 5 at Bruce B experienced a minor boiler tube leak that contributed to gamma effluent. Repairs were completed during an outage that ended in April 2022. Releases from this leak were closely monitored, remained well within the regulatory limits, and are included in the total annual waterborne effluents for Bruce B. Bruce A experienced slightly elevated levels of gamma in effluent in late 2021 due to water ingress into the Primary Irradiated Fuel Bay and the associated controlled discharges of this water to the Active Liquid Waste System to maintain bay levels.

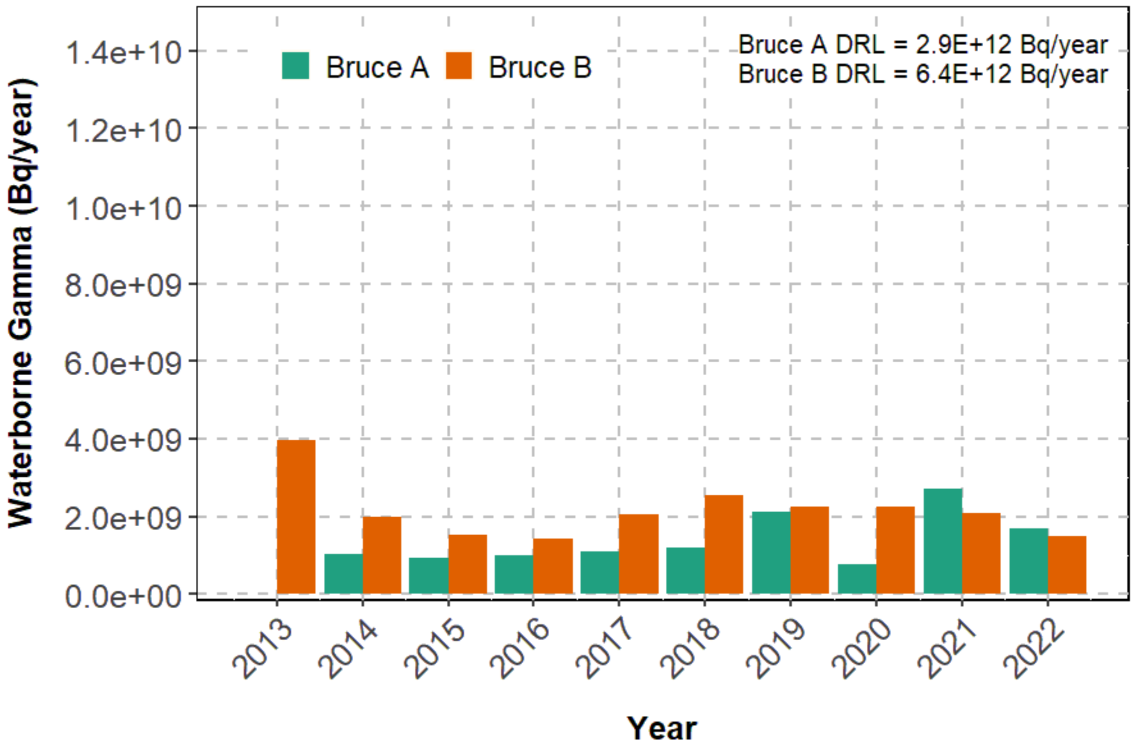


Figure 14 - Historical Waterborne Gamma Effluent

5.1.3.3 Sewage

Domestic wastewater (sanitary sewage) is collected from all facilities at the Bruce Power site including Bruce A and Bruce B, Central Maintenance Facility, Central Storage Facility, Canadian Nuclear Laboratories (Douglas Point), Ontario Power Generation (Western Waste Management Facility) and Centre of Site buildings. This wastewater is treated onsite at the Bruce Power Sewage Processing Plant. The sanitary sewage collection system is a 10 kilometres network of gravity sewers and force mains.

The sewage processing plant has an average design flow capacity of 1,590 cubic metres per day and a maximum design flow capacity of 4,700 cubic metres per day. The plant consists of an inlet chamber, aerated equalization tank, screening and grinding equipment, liquid chemical injection, and two parallel biological treatment trains consisting of aeration tanks, settling tanks, and aerobic sludge digesters, followed by ultraviolet disinfection, and two onsite lagoons for sludge storage. Final effluent from the plant is discharged to Lake Huron via a gravity pipe to the Lake Huron outfall located near Douglas Point.

Sewage processing plant effluent monitoring data was previously reported to the Canadian Nuclear Safety Commission via quarterly technical reports, which included radiological analytical results from the treated liquid effluent routed to the lake and the sludge digester tanks routed to onsite lagoons. In 2017, Bruce Power requested to have the Waste Nuclear Substance Licence for the Central Maintenance Facility revoked and consolidated into the Bruce A and Bruce B Power Reactor Operating Licence since the activities were already described in the Bruce Power Reactor Operating Licence. The consolidation occurred July 1, 2017, and requires the sewage effluent to be reported in this Environmental Protection Report.

As shown in Table 12 and Table 13, quarterly and annual averages for radiological parameters in sludge and sewage effluent in 2022 were low and remained well below Bruce Power's internal acceptance criteria of 5,956 becquerels per litre for tritium, 4.3 becquerels per litre for gross beta, and 9.0 becquerels per litre for gross gamma. Additionally, the annual averages are well below the Ontario Drinking Water Quality Objective for tritium (7,000 becquerels per litre) [R-65].

Table 12 - 2022 Sewage Processing Plant Monitoring - Sewage Digester Sludge

Sample Source	**Units**	**Tritium**	**Gamma**
Quarter 1	becquerels per litre	470	None detected
Quarter 2	becquerels per litre	530	None detected
Quarter 3	becquerels per litre	340	None detected
Quarter 4	becquerels per litre	370	None detected
Annual Average	becquerels per litre	**430**	**None detected**

Note: Beta analyses are not done on sludge samples due to sample beta self-absorption

Table 13 - 2022 Sewage Processing Plant Monitoring - Sewage Effluent

Sample Source	**Units**	**Tritium**	**Gross Beta**
Quarter 1	becquerels per litre	620	0.59
Quarter 2	becquerels per litre	650	0.61
Quarter 3	becquerels per litre	310	0.55
Quarter 4	becquerels per litre	380	0.52
Annual Average	becquerels per litre	**490**	**0.57**

Note: Gamma analyses are not done on effluent samples since beta analysis is the most sensitive analysis for liquids.

5.2 Conventional (Non-Radiological) Emission and Effluent Monitoring

Bruce Power performs extensive modelling and monitoring of its emissions and effluent for conventional contaminants to ensure that releases occur within acceptable limits and environmental impact is minimized.

The objectives of the conventional emission and effluent monitoring program are to:

- Demonstrate compliance with authorized release limits and any other regulatory requirements concerning the release of hazardous substances from the source;
- Demonstrate adherence to internal objectives and targets set on release amounts, for purposes of effluent control;
- Confirm the adequacy of control on releases from the source and ensure that appropriate measures are taken if new or existing activities will increase or change air or water emissions;
- Provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring;
- Provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the hazardous substances of concern released from the facility;
- Provide data which, when combined with the results of environmental monitoring, can be used to test, verify or refine models used in Environmental Risk Assessments, and incorporate recommendations into program design.

The results of monitoring events are submitted to the appropriate environmental agencies at various times throughout the year. Table 14 provides a summary of the monitoring reports that Bruce Power submits throughout the year as well as identifies the time of submission and the lead regulatory agency. The reports provide details and information necessary to meet regulatory reporting requirements. The following sections describe some of the regulatory context for each report.

5.2.1 Conventional (Non-Radiological) Emission and Effluent Monitoring Program Methodologies

Effluent sampling and monitoring is conducted in compliance with limits set forth in the following:

- *Ontario Regulation 215/95: Effluent Monitoring and Effluent Limits - Electrical Power Generation Sector* [R-66] – this was revoked on July 1st, 2021 and now is enforced via ECA notices (outlined below).

- *Ontario Regulation 419/05: Air Pollution - Local Air Quality)* [R-67], the *Environmental Protection Act* (R.S.O. 1990, c. E. 19) [R-14]

- *Ontario Water Resources Act* (R.S.O. 1990, c.O.40) [R-68]

- Environmental Compliance Approvals issued by the Ministry of the Environment Conservation and Parks (MECP) [R-69] [R-69] [R-70][R-71] including Notice 1 for each [R-72] [R-73] [R-74]

- Permits to Take Water (PTTW) [R-75]–[R-77] issued by MECP - New Permits were acquired in May 2021 [R-78] [R-79] [R-80].

- *Ontario Regulation 390/18: Greenhouse Gas Emissions: Quantification, Reporting and Verification* [R-81]

- *Federal Halocarbon Regulations, 2022, SOR/2022-210* [R-82]

- Notice to Report: Under the authority of Section 46 of the *Canadian Environmental Protection Act* (CEPA), operators of facilities that meet the criteria specified in the annual notice with respect to reporting of greenhouse gases (GHGs), published in the Canada Gazette, are required to report facility Greenhouse Gas emissions to Environment and Climate Change Canada by the annual June 1st reporting deadline [R-83].

- Notice to Report: Under the authority of the *Canadian Environmental Protection Act*, 1999 (CEPA 1999), owners or operators of facilities that meet published reporting requirements are required to report to the NPRI [R-84]

- *Ontario Regulation 463/10: Ozone Depleting Substances and other Halocarbons* [R-85]

- *Ozone-Depleting Substances and Halocarbon Alternatives Regulations (SOR/2016-137)* [R-86]

Table 14 – 2022 Bruce Power Regulator Reporting for Conventional Parameters

Regulatory Instrument	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
Air - ECA	Written Summary for Reporting Year 2022 Environmental Compliance Approval – Air 7747-8PGMTZ (BP-CORR-00541-00194)	Ministry of the Environment, Conservation and Parks	15JUN2023 (Annual)
Air - Halocarbon	Halocarbon Release Report Pursuant to the *Federal Halocarbon Regulations (SOR/2022-210)* Section 25 January to June 2022 (BP-CORR-00521-00038)	Environment and Climate Change Canada	31JUL2022 (Semi-annual)
Air - Halocarbon	Halocarbon Release Report Pursuant to the *Federal Halocarbon Regulations (SOR/2022-210)* Section 25 July to December 2022 (BP-CORR-00521-00039)	Environment and Climate Change Canada	31JAN2023 (Semi-annual)
Air – Greenhouse Gas	Not required to report 2022 Federal and Provincial Greenhouse gas Reporting	Internal Report	Quantify GHG emissions by 01JUN2023 (Annual) Not required to report
Air - NPRI	2022 national Pollutant Release Inventory for Bruce Power NPRI ID #7041 (BP-CORR-00521-00059	Environment and Climate Change Canada	01JUN2023 (Annual)
Water – Annual Effluent (formerly EMEL)	2022 Annual Effluent Discharge Report (BP-CORR-00541-00191)	Ministry of the Environment, Conservation and Parks	01JUN2023 (Annual)
Water – Quarterly Effluent and ECA Report (formerly EMEL/ECA)	Q1 2022 Effluent Discharge Report (BP-CORR-00541-00140)	Ministry of the Environment, Conservation and Parks	15MAY2022 (Quarterly)
Water – Quarterly Effluent and ECA Report (formerly EMEL/ECA)	Q2 2022 Effluent Discharge Report (BP-CORR-00541-00149)	Ministry of the Environment, Conservation and Parks	14AUG2022 (Quarterly)
Water – Quarterly Effluent and ECA Report (formerly EMEL/ECA)	Q3 2022 Effluent Discharge Report (BP-CORR-00541-00156)	Ministry of the Environment, Conservation and Parks	14NOV2022 (Quarterly)

Regulatory Instrument	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
Water – Quarterly Effluent and ECA Report (formerly EMEL/ECA)	Q4 2022 Effluent Discharge Report (BP-CORR-00541-00183)	Ministry of the Environment, Conservation and Parks	14FEB2023 (Quarterly)
Water - ECA	2022 Environmental Compliance Approval (Water) Annual Compliance Report for Bruce A (BP-CORR-00541-00188)	Ministry of the Environment, Conservation and Parks	01JUN2023 (Annual)
Water - ECA	2022 Environmental Compliance Approval (Water) Annual Compliance Report for Bruce B (BP-CORR-00541-00189)	Ministry of the Environment, Conservation and Parks	01JUN2023 (Annual)
Water - ECA	2022 Environmental Compliance Approval (Water) Annual Compliance Report for Centre of Site (BP-CORR-00541-00190)	Ministry of the Environment, Conservation and Parks	01MAR2023 (Annual)
Water - PTTW	2022 BA Water Taking Data – Permit To Take Water #P-300-2114648110 (BP-CORR-00541-00185)	Ministry of the Environment, Conservation and Parks	31MAR2023 (Annual)
Water - PTTW	2022 BB Water Taking Data – Permit To Take Water #P-300-4114675736 (BP-CORR-00541-00186)	Ministry of the Environment, Conservation and Parks	31MAR2023 (Annual)
Water - PTTW	2022 CS Water Taking Data – Permit To Take Water #P-300-7116089842 (BP-CORR-00541-00187)	Ministry of the Environment, Conservation and Parks	31MAR2023 (Annual)
Water - WSER	2022 Q1 Wastewater System Effluent Regulation (WSER) Report (BP-CORR-00521-00028)	Environment and Climate Change Canada	15MAY2022 (Quarterly)
Water - WSER	2022 Q2 Wastewater System Effluent Regulation (WSER) Report (BP-CORR-00521-00030)	Environment and Climate Change Canada	14AUG2022 (Quarterly)
Water - WSER	2022 Q3 Wastewater System Effluent Regulation (WSER) Report (BP-CORR-00521-00031)	Environment and Climate Change Canada	14NOV2022 (Quarterly)

Regulatory Instrument	Report Title (Document Control Number)	Regulatory Agency	Submission Date (Frequency)
Water - WSER	2022 Q4 Wastewater System Effluent Regulation (WSER) Report (BP-CORR-00521-00036)	Environment and Climate Change Canada	14FEB2023 (Quarterly)

5.2.2 Conventional Air Emissions

5.2.2.1 Environmental Compliance Approval

Conventional air emissions are held to performance standards stipulated in Environmental Compliance Approval for Air Number 7477-8PGMTZ [R-87] which incorporates all non-radiological air emission sources on site. The environmental compliance approval for air allows flexibility to release contaminants up to a maximum Point of Impingement concentration limit at its property boundary. These limits are typically Ministry of the Environment, Conservation and Parks limits (as per *Ontario Regulation 419/05*) [R-67], and for cases where there is no pre-defined Ministry of the Environment, Conservation and Parks Point of Impingement limit, Bruce Power is bound by a Maximum Ground Level Concentration accepted by the Ministry of the Environment, Conservation and Parks upon its environmental compliance approval for air application submission.

Bruce Power's environmental compliance approval for air limited operational flexibility expired December 31, 2021. An application to renew the limited operational flexibility was submitted to the Ministry of the Environment, Conservation and Parks on January 1, 2021. The application to review the limited operational flexibility is currently under review by the Ministry of the Environment, Conservation and Parks. The Ministry of the Environment, Conservation and Parks Director issued a letter indicating that Condition 2.1 of the environmental compliance approval for air allows the limited operational flexibility to remain in effect until the environmental compliance approval for air has been revoked with the issuance of the new limited operational flexibility. All other terms and conditions of the environmental compliance approval for air shall remain in effect [R-88].

Air contaminants of concern are modelled for all non-negligible sources in worst-case scenarios. Estimated emission rates are then analyzed to ensure regulatory limits at the point of impingement are met. While Bruce Power is bound by environmental compliance approval for air performance limits, the company has operational flexibility to do things like modify the location of emissions sources or add new buildings and exhaust stacks, once it can be demonstrated that it will remain within these limits.

Specific contaminants emitted from every air emission source on site are identified in the Emission Summary and Dispersion Modelling report that reflects the actual operation of the facility [R-67]:

- Bruce Power maintains an up-to-date Emission Summary and Dispersion Modelling report that reflects current operations. Upon making any modifications (within the bounds of the operational flexibility prescribed in the environmental compliance approval for air [R-87]), the modification log and Emission Summary and Dispersion Modelling report are updated to document that the facility is in compliance. The Emission Summary and Dispersion Modelling Report shows that:
    - The nature of the operations of the facility continues to be consistent with the description section of the environmental compliance approval for air;
    - The production at the facility continues to be below the facility production limit specified in the environmental compliance approval for air; and
    - The performance limits are met.

During 2022, one modification was made for the use of fifteen diesel compressors and three 60-kilowatt diesel generators for a vacuum building pressure test. In addition, a temporary elevator shaft was constructed that was powered by two 1000-kilowatt diesel generators. The modifications demonstrated compliance with the point of impingement limits (as per *Ontario Regulation 419/05*) and the conditions of Bruce Power's environmental compliance approval for air.

5.2.2.2 Noise

The environmental compliance approval for air [R-87] requires that Bruce Power is within the noise limits of Noise Pollution Clearinghouse-232 Sound Level Limits for Stationary Sources in Class 3 Areas (Rural).

No noise complaints were received in 2022.

5.2.2.3 Halocarbons

In Canada, the federal, provincial, and territorial governments have legislation to protect the ozone layer and manage ozone-depleting substances and their halocarbon alternatives. The use and handling of these substances are regulated by the provinces and territories in their respective jurisdictions, and through the *Federal Halocarbon Regulations, 2022* [R-89] for refrigeration, air-conditioning, fire extinguishing, and solvent systems under federal jurisdiction. Bruce Power is governed by both the provincial and federal regulations.

Figure 15 - 2022 Bruce Power Halocarbon Release Occurrences below provides the number of reportable halocarbon releases across site for the 2022 calendar year. These releases are broken down by magnitude. Halocarbon releases of 10 – 100 kilograms are reported to Environment and Climate Change Canada in semi-annual release reports. Halocarbon releases greater than 100 kilograms are immediately reportable to Environment and Climate Change Canada and Ministry of the Environment, Conservation and Parks. There were four

releases reported in the semi-annual release reports and two immediately reportable releases in 2022.

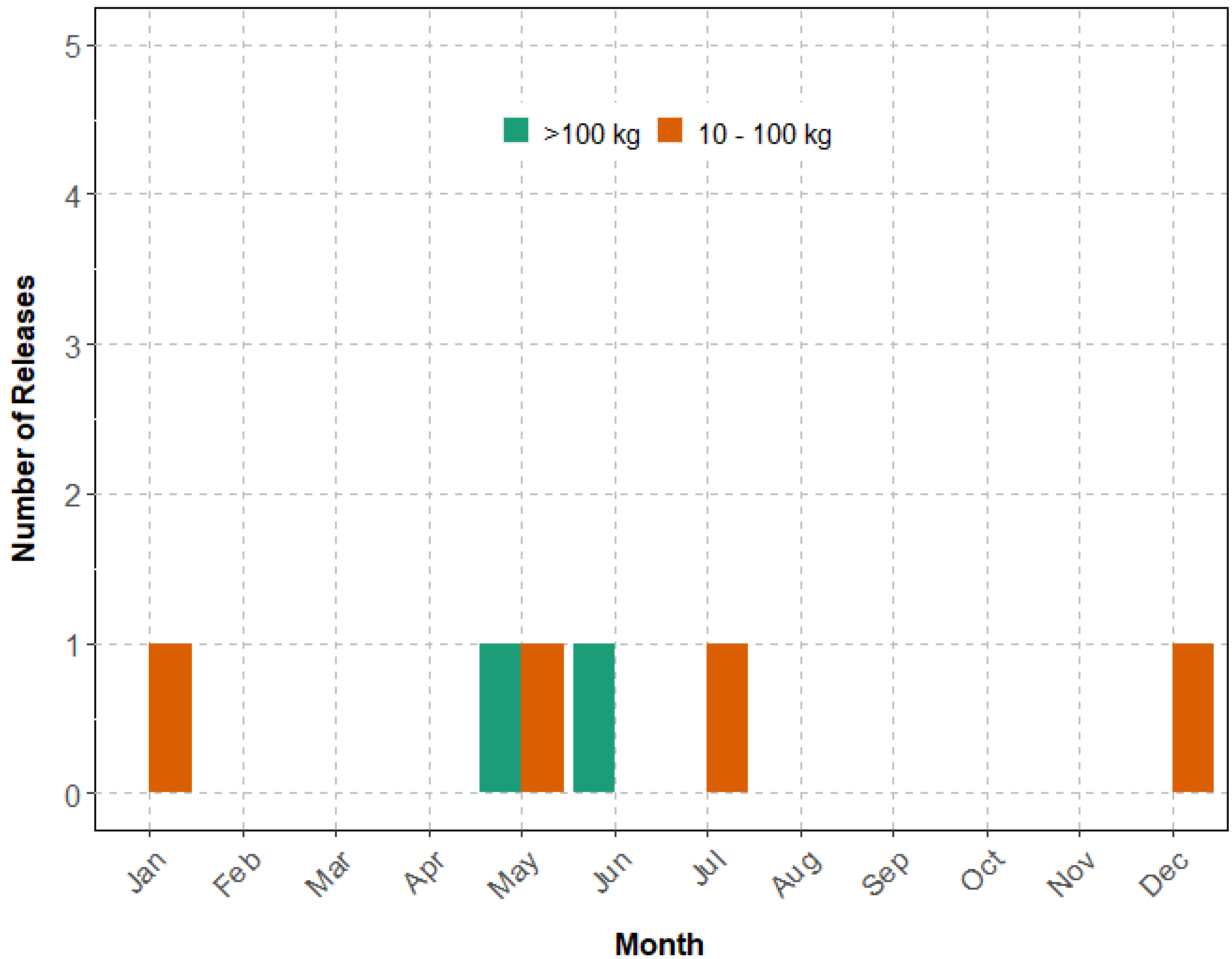


Figure 15 - 2022 Bruce Power Halocarbon Release Occurrences

Historical Halocarbon Releases

The environmental impact of these halocarbon discharges is reduced as a result of the older ozone depleting refrigerants (chlorofluorocarbon and hydrochlorofluorocarbons) being replaced by hydrofluorocarbons with negligible impact on the ozone layer (examples include R134a and R410). Hydrofluorocarbons however have high global warming potential and pose a threat as a greenhouse gas [R-89].

Figure 16 below provides the historical trend of the total number of halocarbon releases since 2014. Between 2017 and 2020, no halocarbon releases greater than 100 kilograms were reported to Environment and Climate Change Canada. However, three halocarbon releases greater than 100 kilograms were reported to Environment and Climate Change Canada in 2021 (Bruce B – 317 kilograms, Bruce B - 209 kilograms and Centre of Site – 99 kilograms), and two releases were reported in 2022 (Centre of Site – 215 kilograms and Bruce A – 274.4 kilograms). The 99 kilograms release at Centre of Site in 2021 was conservatively reported given that the exact volume of halocarbon release cannot be determined.

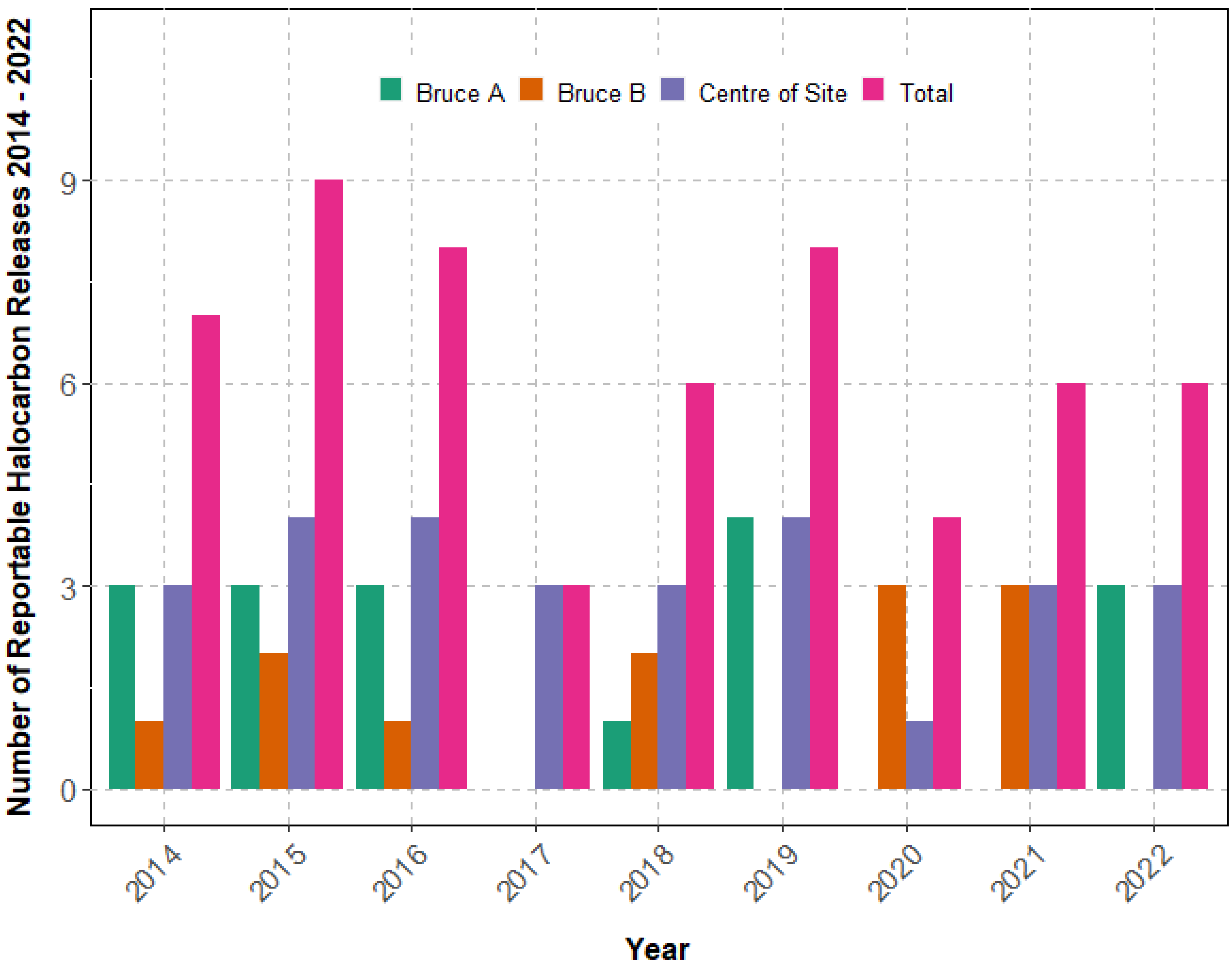


Figure 16 - Historical Bruce Power Halocarbon Releases

5.2.2.4 Greenhouse Gas Emissions

The provincial threshold for reporting greenhouse gas emissions dropped from 25,000 tonnes of carbon dioxide equivalent to 10,000 tonnes of carbon dioxide equivalent in 2015. Bruce Power was below the 25,000 tonnes of carbon dioxide equivalent threshold in 2013 and 2014 and below the 10,000 tonnes of carbon dioxide equivalent threshold from 2015 to 2021. In order to cease reporting, there must be three consecutive years reported under the threshold. Therefore, 2015 was the last year of reporting greenhouse gas emissions.

Greenhouse gas emissions will continue to be calculated for 2022 and onwards to confirm they remain below threshold values. The calculation of 2022 emissions will be completed by June 1, 2023.

Historical Greenhouse Gas Emissions

Figure 17 - Provincial Greenhouse Gas Reporting Tonnes Carbon Dioxide Equivalent Conventional Air shows greenhouse gas emissions from 2012 to 2021. Greenhouse gas emissions on site have been consistent since the Bruce Steam Plant shut down strategy. The Steam Plant last operated in 2015 to supplement the Vacuum Building Outage at Bruce B and was officially shut down in December of 2015 when the stack was removed. Since 2012, greenhouse gas emissions from Bruce Power included combustion of stove oil and diesel by boilers at the steam plant and combustion of stove oil and diesel from stationary equipment (examples include: standby generators, temporary generators, heaters).

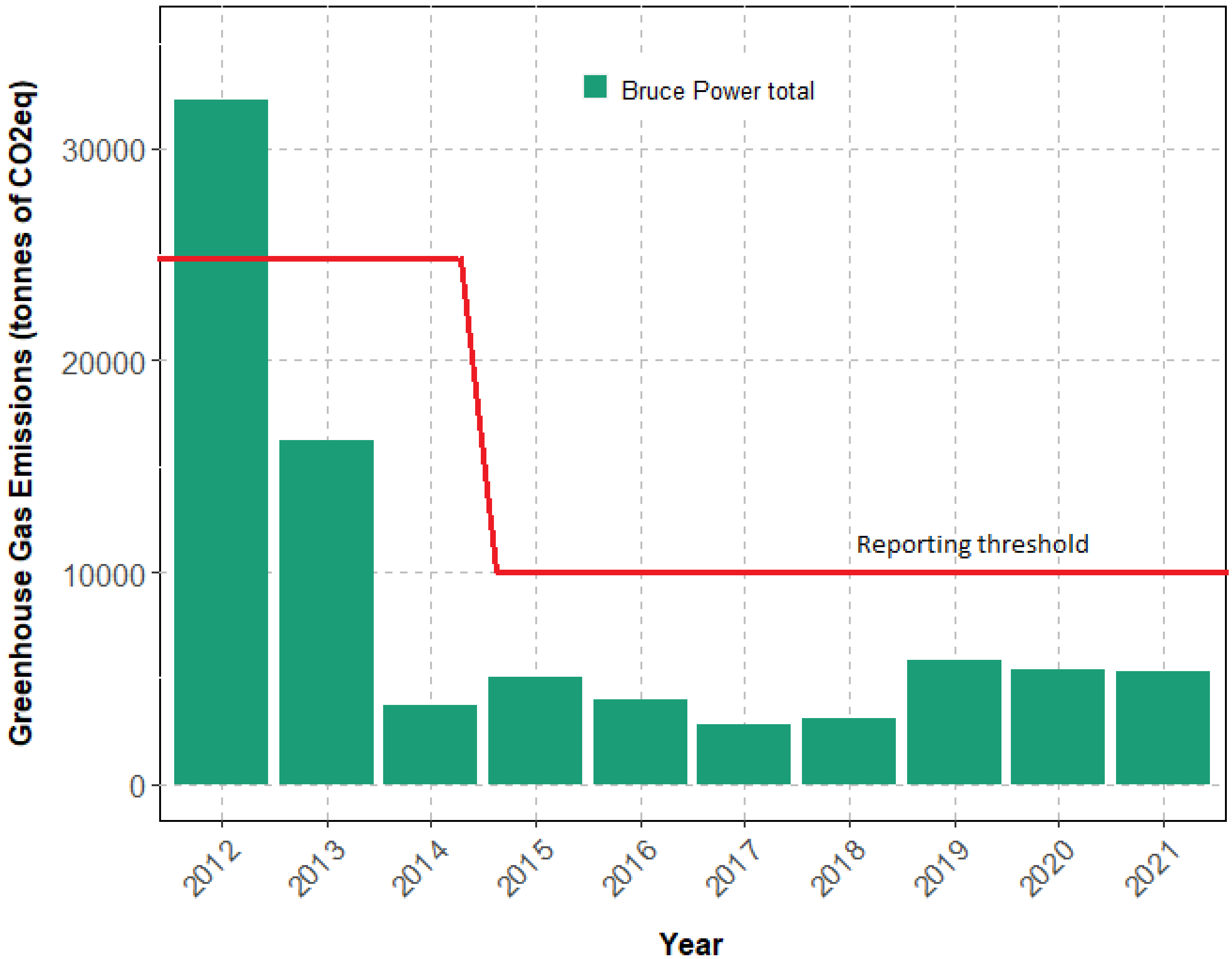


Figure 17 - Provincial Greenhouse Gas Reporting Tonnes Carbon Dioxide Equivalent Conventional Air

5.2.2.5 National Pollutant Release Inventory

The National Pollutant Release Inventory is Canada's legislated, publicly accessible inventory of pollutant releases, disposals and recycling. National Pollutant Release Inventory information is a major starting point for identifying and monitoring sources of pollution in Canada, and in developing indicators for the quality of air, land, and water. The National Pollutant Release Inventory provides Canadians with annual information on industrial, institutional, commercial, and other releases and transfers in Canadian communities [R-90]. Bruce Power complies with reporting requirements and regulatory limits, as shown in Sections 5.2.2 and 5.2.3. Bruce Power's National Pollutant Release Inventory contaminants reported for the 2021 calendar year are presented in Table 15. Calculations and reporting for the 2022 calendar year will be completed by June 1, 2023.

Table 15 - National Pollutant Release Inventory Contaminants Reported for 2021

Contaminant	Volume to Air (kg)	Volume to Water (kg)	Volume to Land (kg)
Ammonia (total)	9,000	3290	-
Hydrazine	24.2	1,464.6	737.2
Lead	9.1	-	150.8
Oxides of nitrogen	32,870	-	-
PM10	3,040	-	-
PM2.5	2,730	-	-

A graphical comparison of releases reported under National Pollutant Release Inventory to air, water and land is shown in Figure 18.

Changes to reporting requirements and refinements to calculations over the years has resulted in changes to ammonia, hydrazine and volatile organic compound releases to air. Refinements to construction dust calculations were made in 2020 resulting in changes to emissions of particulate matter and hence the step change in emissions. In addition, parking lot construction during 2020 resulted in an increase in particulate matter emissions. The volume of ammonia released to water has decreased since 2017 due to refinements in calculations for system drains during outages. The volume of hydrazine released to water has remained consistent.

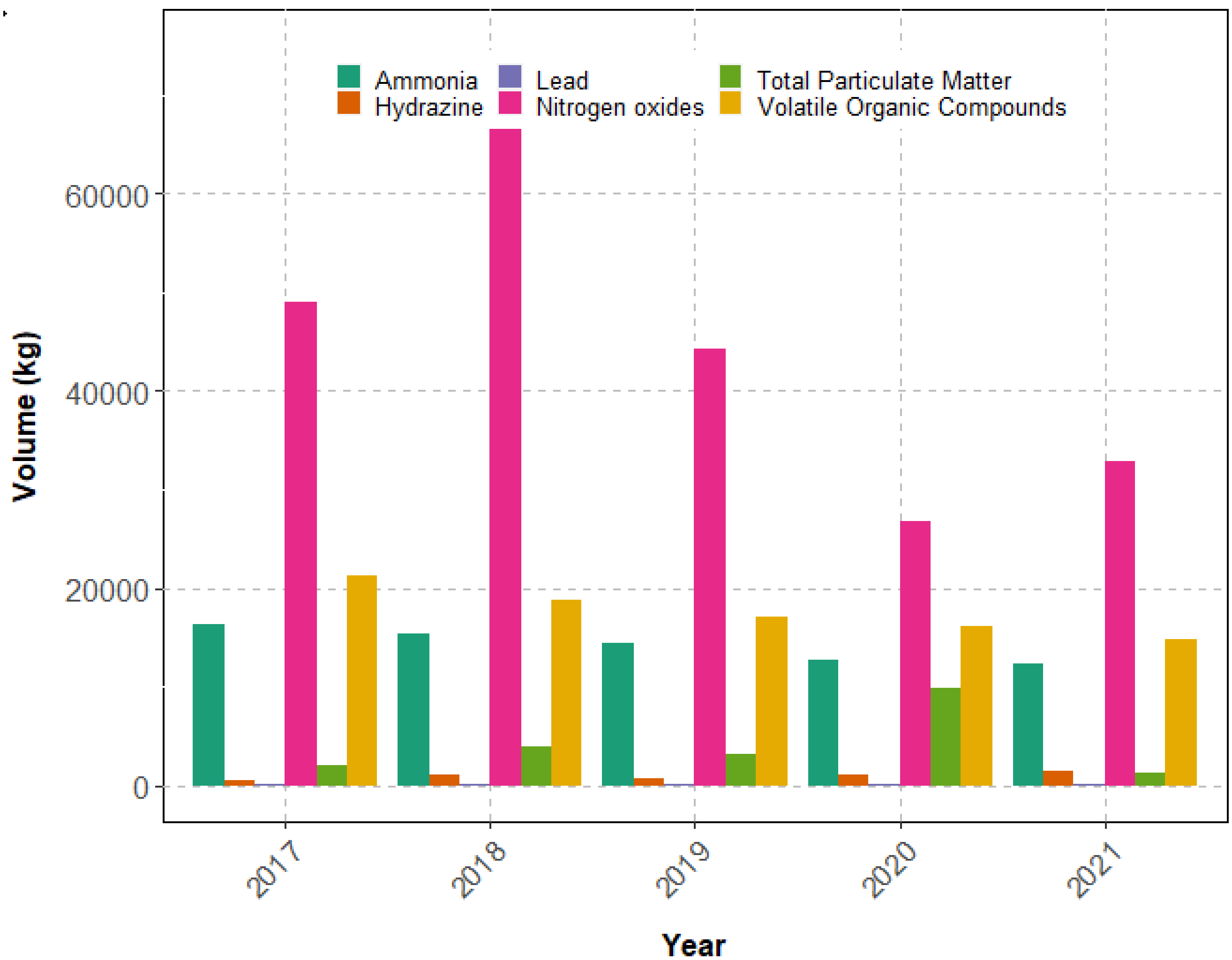


Figure 18 - 2017 to 2021 Releases to Air, Water and Land (kg)

Quality Assurance/Quality Control

Quality assurance activities for conventional air emissions are outlined in the Emission Summary and Dispersion Modelling report [R-91]. The Emission Summary and Dispersion Modelling report includes the operating conditions, emission estimating, data quality and sample calculations. Modelling is conducted in accordance with the Air Dispersion Modelling Guideline for Ontario, Version 3.0 [R-92].

Data included in the National Pollutant Release Inventory reporting follows the guideline released by Environment and Climate Change Canada [R-93]. Hydrazine, Ammonia and Morpholine Calculation Methodology for National Pollutant Release Inventory Reporting [R-

94], describes the process for obtaining continuous emissions monitoring data, plant information, drain data for the calculation of air and water emissions for hydrazine, morpholine and ammonia.

Data included in the greenhouse gas calculations follows Canada's Greenhouse Gas Quantification Requirements [R-95].

5.2.3 Conventional Water Effluent

Site conventional water effluents are controlled to meet regulatory requirements and to minimize environmental impacts to protect the environment. Conventional water effluents at Bruce Power are discharged according to specific licenses, permits, and regulations under (but not limited to) the *Environmental Protection Act* [R-96] and the Ontario Water Resources Act [R-68].

5.2.3.1 Environmental Compliance Approvals

The *Ontario Water Resources Act* states that no person shall use, operate, establish, alter, extend, or replace new or existing sewage works except under, and in accordance with, an environmental compliance approval. Bruce Power operates according to three environmental compliance approvals regulating conventional water effluents across site; Bruce A, Bruce B, and Centre of Site[R-97],[R-98],[R-99]. These environmental compliance approvals impose site-specific effluent limits, and monitoring and reporting requirements for the operation of the facility. Non-compliances of environmental compliance approval limits are reportable to the Ministry of Environment, Conservation and Parks and are subject to Environmental Penalties under *Ontario Regulation 223/07* [R-100]. Table 16 to Table 18show summaries of the measured effluent concentrations in the Bruce A and Bruce B cooling water discharge ducts, and the Centre of Site sewage processing plant between 2018 and 2022. The maximum measured values for all regulated parameters were all below the approved limits, demonstrating continuous compliance over the last 5 years.

Table 16 - Range of Monthly Effluent Concentrations Measured in the BA Cooling Water Discharge Duct (2018-2022)

Parameter	Units	Method Detection Limit	Environmental Compliance Approval Limit (or Objective)	Minimum	Maximum
Ammonia (unionized)	micrograms per litre	Varies based on pH and temperature, does not exceed 3.5 µg/L	<20	<Method Detection Limit	<MDL
Boron	micrograms per litre	4	5,000	<Method Detection Limit	21
Hydrazine	micrograms per litre	3	100	<Method Detection Limit	20
Morpholine	micrograms per litre	15	2,500	<Method Detection Limit	770
Total Residual Chlorine	micrograms per litre	1	<10	<Method Detection Limit	<Method Detection Limit
pH	Not Applicable	Not Applicable	6.0 – 9.5	7.0	8.5
Phosphorus	micrograms per litre	5	1,000 (objective)	<Method Detection Limit	62

Table 17 - Range of Monthly Effluent Concentrations Measured in the BB Cooling Water Discharge Duct (2018-2022)

Parameter	Units	Method Detection Limit	Environmental Compliance Approval Limit (or Objective)	Minimum	Maximum
Ammonia (unionized)	micrograms per litre	Varies based on pH and temperature, does not exceed 3.5 μg/L	<20	<Method Detection Limit	<Method Detection Limit
Hydrazine	micrograms per litre	3	100	<Method Detection Limit	73
Morpholine	micrograms per litre	15	2,500	<Method Detection Limit	15
Total Residual Chlorine	micrograms per litre	1	<10	<Method Detection Limit	<Method Detection Limit
pH	Not Applicable	Not Applicable	6.0 – 9.5	7.0	8.7
Phosphorus	micrograms per litre	5	1,000 (objective)	<Method Detection Limit	54

Table 18 - Maximum Daily and Monthly Average Environmental Compliance Approval Effluent Concentrations at the Centre of Site Sewage Processing Plant (2018 to 2022)

Parameter	Units	Method Detection Limit (2023)	Daily Limit	Minimum Daily (range)	Monthly Average Limit	Maximum Monthly Average
Biochemical Oxygen Demand (5 day)	milligrams per litre	Not Applicable	Not Applicable	Not Applicable	25.0	5.8
Nitrogen (Ammonia + Ammonium)	milligrams per litre	0.006	Not Applicable	Not Applicable	7.000	5.420
Total Phosphorus	milligrams per litre	0.014	Not Applicable	Not Applicable	1.000	0.361
Total Suspended Solids	milligrams per litre	0.4	44.0	22.0	18.0	15.1
Oil and Grease	milligrams per litre	1.0	38.0	6.6	12.0	2.1
pH	Not Applicable	Not Applicable	6.0 – 9.5	(6.1 – 8.9)	N/A	N/A
E. Coli	CFU/100 ml (rolling geometric mean)	Not Applicable	Not Applicable	Not Applicable	200	9

Table 19 - Range of Quarterly Wastewater Systems Effluent Regulation Concentrations at the Centre of Site Sewage Processing Plant (2018 to 2022)

Parameter	Units	Method Detection Limits	Quarterly Average Limit	Minimum Quarterly Average	Maximum Quarterly Average
Carbonaceous Biochemical Oxygen Demand	milligrams per litre	2.0	25.0	2.0	17.4
Total Suspended Solids	milligrams per litre	2.0	25.0	2.9	9.4

The10 year trend of the annual average effluent concentrations in the Bruce A and Bruce B cooling water discharge ducts is shown in Figure 19 for ammonia, hydrazine and morpholine. The annual average values for these parameters have been well below the limits over the last 10 years, demonstrating continued compliance and protection of the receiving environment.

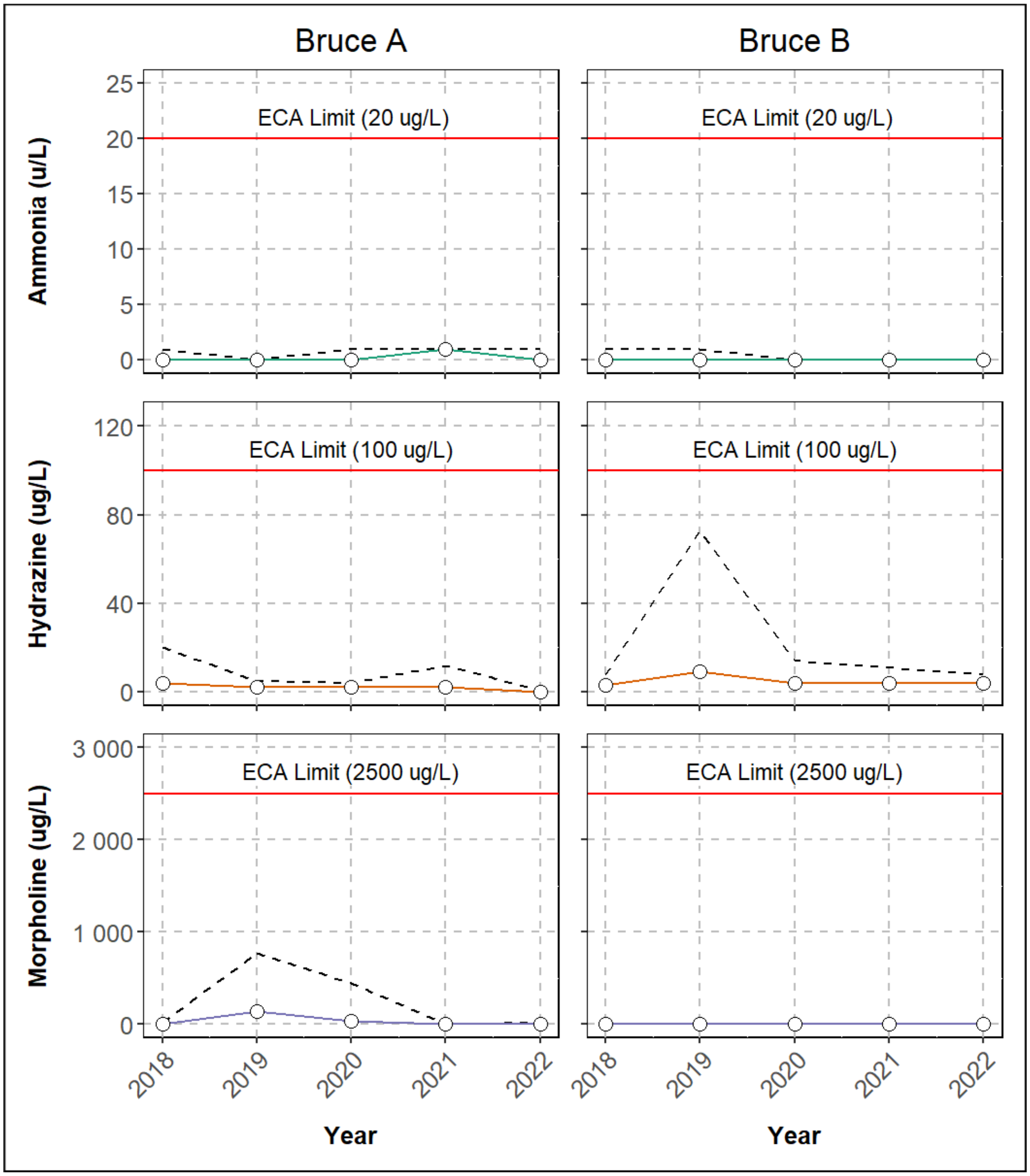


Figure 19 - Bruce A and Bruce B cooling water discharges of ammonia, hydrazine, morpholine from 2018 through 2022. The open symbols with the solid line represent the annual average concentrations at the Cooling Water Discharge Duct, and the dashed line represents the maximum monthly measurement in a given year. Where the dashed line is not visible, the maximum monthly measurement was smaller than the size of the open symbol.

In 2021, environmental compliance approval amendment applications were submitted to the Ministry of Environment, Conservation and Parks for all three environmental compliance approvals. In January 2023 the amended Centre of Site environmental compliance approval was issued as 4640-CEGKDU [R-101]. The Bruce A and Bruce B applications continue to be reviewed by the Ministry of the Environment, Conservation and Parks. The Bruce A and Bruce B amendment applications focus on the proposed use and discharge of Film Forming Amines used for protecting the feedwater system from corrosion, as well as other changes and updates to the environmental compliance approval language and the supporting documents. The Centre of Site environmental compliance approval amendment approved a third treatment train for the Sewage Processing Plant, removal of the Bruce Steam Plant, and incorporation of requirements of the former *Effluent Monitoring Effluent Limits Regulation*. Although the Sewage Processing Plant third train was approved, the expansion project is not currently active.

Environmental Compliance Approval Notice 1

Prior to July 2021, the electric power generating sector was regulated under *Ontario Regulation 215/95 Effluent Monitoring Effluent Limits* [R-102]. When this regulation was revoked in 2021 the requirements formerly captured in this legislation were incorporated into Notices which accompanied Bruce Power's three environmental compliance approvals [R-72],[R-73],[R-74].

The Notices prescribe daily limits on regulated effluents, and in some cases, they describe monthly average limits. The Notices also describe requirements that discharges must not be toxic to fish. Monitoring and reporting requirements to confirm compliance are also defined within the Notices. Non-compliance to environmental compliance approval notices are reportable to the Ministry of Environment, Conservation and Parks and are subject to Environmental Penalties under *Ontario Regulation 222/07* [R-103].

Notice 1 was associated with the Centre of Site environmental compliance approval, however this was revoked in January 2023 because the newly issued Centre of Site Environmental Compliance Approval 4640-CEGKDU [R-101] incorporated all the necessary requirements for effluent limits previously prescribed in Notice 1. In 2022, there were four reportable events related to environmental compliance approval Notice 1; each event is discussed in quarterly reports submitted to the Ministry of Environment, Conservation and Parks[R-104][R-105]. There were no reportable environmental compliance approval events at Bruce A, Bruce B or Centre of Site.

5.2.3.2 Wastewater Systems Effluent Regulations

The *Wastewater Systems Effluent Regulations*[R-106] is a federal wastewater regulation under the *Fisheries Act* that came into effect in 2012. The regulation applies to wastewater treatment systems like Bruce Power's Sewage Processing Plant because it discharges wastewater effluent at a flowrate that exceeds 100 cubic metres. Table 18 shows a summary of the measured Sewage Processing Plant effluent concentrations from 2018 to 2022. There were no exceedances reported in 2022.

5.2.3.3 Permit To Take Water

Most operations in Ontario that take more than 50,000 litres of water per day from a lake, river, stream, or groundwater source must obtain a Permit to Take Water from the Ministry of Environment, Conservation and Parks [R-68]. These permits help ensure Ontario's water is conserved, protected, managed, and used sustainably. Ontario's Water Taking Regulation (*Ontario Regulation 387/04*) [R-107] helps ensure fair sharing of water resources and it prevents interferences among water users. Permits are not issued to assign rights to water or to establish priorities on water use. *Ontario Regulation 387/04* [R-107] sets out criteria that the Ministry must consider when assessing an application for a Permit to Take Water. A permit will not be issued if the Ministry determines that the proposed water taking will adversely impact existing users or the environment [R-107].

Bruce Power has a separate permit for each station Bruce A P-300-2114648110 [R-78], Bruce B P-300-4114675736 [R-79] and Centre of Site P-300-7116089842 [R-80]. The Bruce A and Bruce B permits include flexibility throughout the year to allow for future planned increases in unit output as well as changes to CCW pumps. Bruce Power remained in compliance with all PTTW requirements in 2022.

Bruce Power recognizes the value and importance of its interactions with Lake Huron. Bruce Power uses the cold, deep Lake Huron water in a once-through cooling process to supply operational needs including consumption for boiler feedwater and domestic water. We greatly value this resource and return more than 99 per cent of the water used for once through cooling. This process is highly regulated, including provincial permits for water taking and imposing protective limits on water quality for waters returned to the lake. This ensures the conservation, protection, management, and sustainable use of Ontario's freshwater resources.

In our effort to uphold and support these goals, we monitor our usage, including the amounts returned directly to the lake with no chemical changes, and report on daily amounts drawn. Beyond considerations of water quantity management, we are committed to monitoring and ensuring the protection of the quality of water, and our fish habitats in and around our shores and the greater region.

5.2.3.4 Quality Assurance/Quality Control

Quality Assurance, quality control for the conventional water emissions program has been developed by applying the requirements of both the Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater [R-108] for environmental compliance approvals [R-97],[R-98],[R-99]and Notices to them [R-72] [R-73] [R-74] (formerly *Effluent Monitoring and Effluent Limits regulation*) which also meets the requirements of Canadian Standards Association N288.5-11 – Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills standard [R-109]. The Quality Assurance Quality Control program also includes requirements of the Environment and Climate Change Canada *Wastewater Systems Effluent Regulation* [R-106].

The Quality Assurance Quality Control requirements for conventional water include field quality control, lab quality control, tracking of quality control data. The Quality Assurance Quality Control program documentation further defines when lab accreditation is required for specific sampling parameters, and at times defines actions and how to report data depending on the Quality Assurance Quality Control results.

5.3 Chemical Management Plans

Environment and Climate Change Canada routinely collects information from industry to assist in managing toxic and priority substances identified under the *Canadian Environmental Protection Act*, 1999 Part 5 [R-110] in order to protect the environment and human health. Bruce Power participates in the information collection. Environment and Climate Change Canada did not request any mandatory surveys of the Chemical Management Plans in 2022.

5.4 Pollution Prevention

Under Part 4 of *Canadian Environmental Protection Act* [R-111], Environment and Climate Change Canada has the authority to require preparation and implementation of pollution prevention plans for toxic substances. Pollution prevention planning is a method of identifying and implementing pollution prevention options to minimize or avoid the creation of pollutants or waste. Environment and Climate Change Canada issued a pollution prevention planning notice for any person who operates a facility in the electricity sector that has a concentration of hydrazine that is higher than the specified target levels under normal operating conditions and at any final discharge point. Bruce Power reviewed the notice and determined that it does not apply and as such, submitted a Notification of Non-Engagement [R-112].

5.5 Environmental Emergency Regulations

The aim of the Federal *Environmental Emergencies Regulations, 2019* [R-113] (under *Canadian Environmental Protection Act*) is to help reduce the frequency and severity of accidental releases of hazardous substances into the environment. Two hundred and forty-nine hazardous substances are included in the regulations, identified for their emergency hazard characteristics (oxidizer that may explode, inhalation, aquatically toxic, explosion, combustible, pool fire). The *Environmental Emergencies Regulations* identify minimum threshold quantities for these substances, above which there are requirements for submitting notices, developing Environmental Emergency Plans, and completing drills. These are based on both the total volume on site and the size of the largest container system for the substance(s). There are additional reporting requirements for Environmental Emergencies. To date, Bruce Power has not had a reportable Environmental Emergency under this regulation. Bruce Power currently meets the reporting threshold for two substances on site: diesel (Chemical Abstract Service Number 68334-30-5) and propane (Chemical Abstract Service

Number 74-98-6). Diesel and propane volumes on site are above the total volume on site threshold; this requires submitting Schedule 2 notices to Environment and Climate Change Canada. Propane is also above the container system threshold, triggering the requirement to have an Environmental Emergency Plan and conduct drills. The temporary propane tanks at the Central Storage Facility were removed in July 2022 and no longer puts Bruce Power above the threshold for propane and the requirement for emergency plans and drills for propane will no longer be required after July 2023.

6.0 ENVIRONMENTAL MONITORING

Bruce Power's Environmental Protection Program is built upon an integrated monitoring approach that strives to understand environmental impact, verify environmental protection, and continuously improve by driving strategic research and innovation through collaborations with industry and community. Environmental safety and responsibility are woven into all aspects of the company's nuclear safety culture, and Bruce Power commits to meet or exceed all relevant legal and voluntary environmental requirements. The company holds itself accountable to prevent pollution through strong management of emissions, effluents, and waste, and it implements robust spill mitigation measures in order to provide effective containment and control of contaminants.

To demonstrate environmental protection Bruce Power performs extensive monitoring and modelling of radiological and conventional contaminants in the Earth's Critical Zone [R-114]. The Critical Zone is comprised of the permeable zones near the Earth's surface where living organisms, air, water, soil, sediment, and groundwater interact (Figure 20).

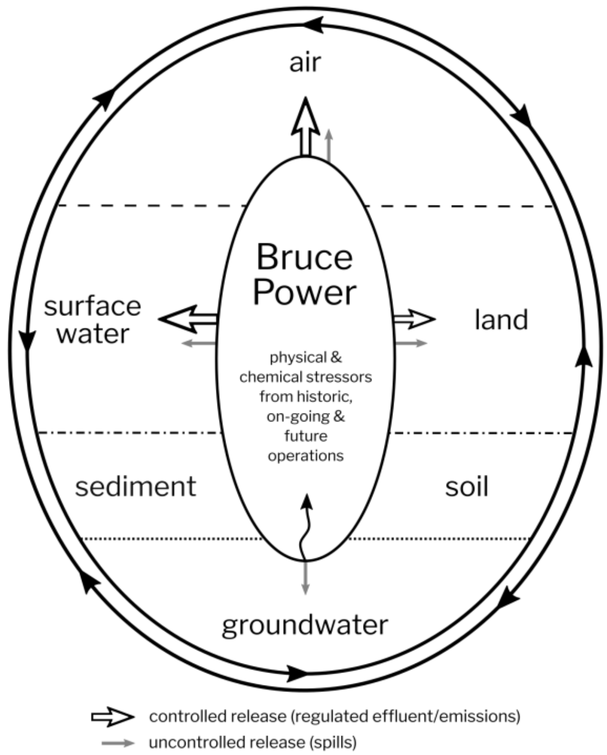


Figure 20 - Bruce Power has multiple layers of protection in place to minimize emissions and effluents released during facility operations. The Environmental Protection Program monitors and models physical and chemical stressors released to the environment and continuously assesses their risk and impact.

Air emissions and water/land effluents are controlled, and regulated releases occur in a manner that minimizes environmental impact. Bruce Power's radiological and conventional environmental monitoring programs are designed to continuously verify that environmental protection is being maintained and that these releases have a minimal impact on the surroundings. The programs are based on Canadian Standards Association N288.4-10 Environmental monitoring programs at nuclear facilities and uranium mines and mills [R-5], Canadian Nuclear Safety Commission REGDOC-2.9.1 Environmental Protection: Environmental Principals, Assessments and Protection Measures [R-14], and reporting requirements in Canadian Nuclear Safety Commission REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants [R-2].

The primary objectives of the Environmental Monitoring Program are to:

- Demonstrate compliance with all applicable environmental compliance obligations, Licence conditions and the Environmental Policy

- To have in place environmental monitoring to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to identify when and where.
- To protect human and ecological health that may be affected by the release of contaminants or physical stressors into the environment arising from the facility.
- Support business decisions to drive environmental protection, sustainability principles and Environment Social Governance (ESG) strategy.
- Maintain strong engagement and collaboration with stakeholders, community members and Indigenous communities.

Additionally, the Canadian Standards Association standard N288.4, Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills outlines the following objectives for Environmental Monitoring Programs [R-5]:

- Collect environmental monitoring data to assess the level of risk to human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility.
- Demonstrate compliance with limits on the concentration and/or intensity of contaminants and physical stressors in the environment and their effect on the environment; and
- Verify that the facility has effective containment and effluent control measures in place.

Bruce Power has well-established environmental monitoring programs that focus on the local area around the facility, including neighboring communities and Lake Huron. Together, the results build an overall understanding of the risk to human health and impact on the environment. The company's strong commitment to excellence has yielded excellent environmental performance, and Environmental Risk Assessments continually show the operation of the facility has little-to-no impact on human and ecological health. This conclusion is supported by evidence independently collected by the Federal and Provincial governments who monitor and measure concentrations of contaminants in the environment near Bruce Power.

Bruce Power continues to engage with Saugeen Ojibway Nation, Métis Nation of Ontario and Historic Saugeen Métis and make progress on all commitments made at the 2018 licence renewal. Regular meetings are held with the Saugeen Ojibway Nation, Métis Nation of Ontario, and Historic Saugeen Métis to discuss key concerns, regulatory items, and other items of interest. This continued dialogue results in improved understanding and opportunities for feedback and collaboration. Over the last 5 years, topics of focus have included thermal effluent, fish impingement and entrainment, environmental monitoring and assessment, and dietary surveys. In 2022 progress on commitments are as follows:

- Results of the community specific, Changing Climate, Changing Landscape story maps, were presented to each community through collaborative work between the Climate Risk Institute with support from the Council of the Great Lakes Region, input from each community and funded through Bruce Power.
- Sustained support for the joint environmental monitoring and stewardship program, between Bruce Power and the Saugeen Ojibway Nation, called the Coastal Waters Monitoring Program, currently in year 5. This project enhances the existing body of knowledge compiled through Bruce Power's environmental monitoring program and was integrated throughout the 2022 Environmental Risk Assessment.
- Discussions on the results of the 2022 Environmental Risk Assessment with each community to receive feedback prior to the report submission.
- Continued sharing of Impingement and Entrainment and thermal effluent information.
- Continued support for the fish offset project to remove phragmites from the Fishing Islands wetland complex, an area important to the Historic Saugeen Métis community. This project will help to restore fish habitat and encourage naturalization of the area.
- Ongoing monitoring and mitigation of Fairy Lake to improve wetland quality as this location is of historic significance to the local métis community. This is a joint project between the Historic Saugeen Métis, Town of Saugeen Shores, University of Waterloo, the Nuclear Innovation Institute and Bruce Power.
- Development of a plan to address concerns of the Métis Nation of Ontario on the condition of Bothwell's Creek to improve fish habitat.

In 2023 Bruce Power will continue to engage with each community on thermal effluent monitoring, fish impingement and entrainment including the pilot scheduled for Q2 2023, as well as continue work on community specific offset plans as required by the Fisheries Act Authorization.

6.1 Radiological Environmental Monitoring

The Radiological Environmental Monitoring Program establishes a database of radiological activity measured in the environment near Bruce Power and determines the contribution of overall radiation dose to members of the public as a result of the radiological releases from normal operations on Site. The Radiological Environmental Monitoring Program is conducted in accordance with Canadian Standards Association N288.4-10 [R-5] and is integrated into the Environmental Management System framework which requires a regular review, assessment and refinement of the program to ensure the environment and the public are adequately protected.

The Radiological Environmental Monitoring data implicitly reflects the influence of releases from all licensed activities carried out at Bruce Power licensed facilities (i.e., Bruce A, Bruce B, Central Maintenance Facility and Central Storage Facility) as well as from facilities within or adjacent to the Bruce Power site boundary that are owned by other parties. This includes the Western Waste Management Facility (owned and operated by Ontario Power Generation), the Douglas Point Waste Facility (owned by Canadian Nuclear Laboratories), and Ontario Nuclear Services Facility (previously KI North, owned by Kinectrics).

The Radiological Environmental Monitoring Program involves the annual collection and analysis of environmental media for radionuclides specific to nuclear power generation. Background levels due to naturally occurring sources are subtracted from the totals in order to elucidate the impact specific to Bruce Power operations. The data gathered each year is used in the annual dose to public calculation, which is described in Section 3.0.

The design of the Radiological Environmental Monitoring Program is based on risk and is informed by a radionuclide and exposure pathways analysis. This analysis outlines which radionuclides and environmental media should be monitored due to their contribution to human or non-human radiological dose. For radionuclide-media pairs contributing >10% to the total dose of any human receptor, Bruce Power attempts to obtain samples at a minimum of one location per 22.5° wind sector over land to provide spatial resolution at the cardinal points of the compass and align with standard partitioning of meteorological data. The media contributing greater than 10% to receptor dose are air, milk, meat, and terrestrial plants such as grains, fruit and vegetables. For radionuclide-media contributing <10% to the total dose, a total of three locations over land within the Radiological Environmental Monitoring boundary are required.

The following environmental media are collected and analyzed by the Bruce Power Health Physics Laboratory as part of the annual Radiological Environmental Monitoring Program:

- Air
- Precipitation
- Water
    - Drinking water (e.g. water supply plants, residential wells)
    - Lake and stream water
- Terrestrial Samples

    - Animal products (e.g. milk, eggs, honey, animal meat)
    - Agricultural products (e.g. fruits, vegetables, farm crops, animal feed)
    - Soil
- Aquatic Samples
    - Fish
    - Sediment and beach sand

The radionuclides that are measured in the environmental media collected include tritiated water (tritium oxide), carbon-14 (C-14), iodine-131 (I-131), beta and gamma emitting radionuclides.

Bruce Power relies on the Ontario Power Generation Health Physics Laboratory in Whitby, Ontario for provincial background radiation levels measured in a variety of environmental media collected at locations outside the influence of Bruce Power or other nuclear power plants. Background radiation comes from naturally occurring radioactive materials present in the environment (see Section 3.0), and these levels are subtracted from Bruce Power environmental monitoring results for dose calculations each year. The provincial background sampling locations are shown in Figure 21.

For the Bruce Power Radiological Environmental Monitoring Program, monitoring locations for aquatic media such as lake water, fish and sediment are downstream of the site, at locations where radionuclides are expected to accumulate. For air sampling, monitors are situated at varying distances from Bruce Power, at locations covering all landward wind directions. For terrestrial foodstuffs (e.g., milk, meat, fruit, vegetables, grains, eggs, honey), sampling is performed at nearby areas or at local farms and residences, as applicable. Monitoring locations are based on practical considerations, including the availability of samples and participation of local residents and farmers. Wild animals are sampled only when available (e.g., subject to on-site vehicle collisions or samples provided by local hunters). Milk is monitored from several local dairy farms through an agreement with the Dairy Farmers of Ontario.

Bruce Power groups the sampling locations by proximity to site and these groups include indicator, area near and area far locations. **Indicator** locations are used to assess the potential dose to the public. These locations are on or outside the facility perimeter and represent the highest risk of public exposure as they are closest to the source. Indicator locations are within 20 kilometres of the facility and take into consideration the locations of representative persons and where they get their food/water for consumption, as well as prevailing wind directions. **Area Near** locations are used in conjunction with indicator locations to provide confirmation of the validity of the computing models used to assign dose to the public. Area Near location data is used to estimate atmospheric dispersion and doses to people in local population centres located further away from the site than the indicator locations, but less than 20 kilometres from the facility. Data from the Area Near location may be used to calculate the average dilution available as a function of distance for a given monitoring period. **Area Far** locations are located further away but potentially still under the possible influence of Bruce Power. Area Far locations include the towns of Port Elgin, Paisley and Kincardine. Control locations are used specifically for fish samples and are collected in Lake Huron at locations not expected to be impacted by Bruce Power.

Bruce Power area near and area far sampling locations are provided in Figure 22 and Figure 23, Residential sampling locations (labelled Other) where fruit, vegetable and milk samples are collected are included on Figure 24, alongside the locations of representative persons/groups.

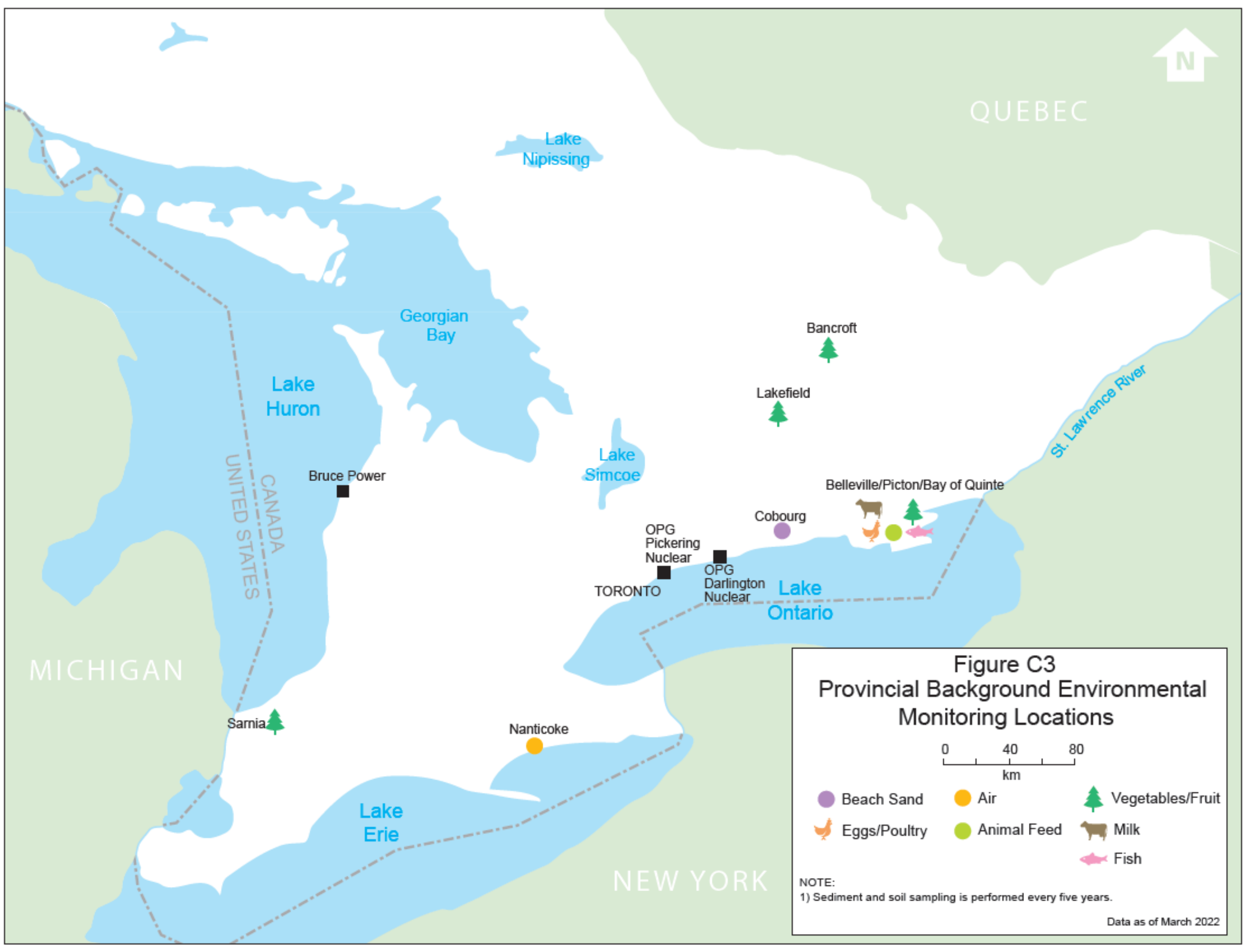


Figure 21 - Provincial Background Radiological Environmental Monitoring Locations

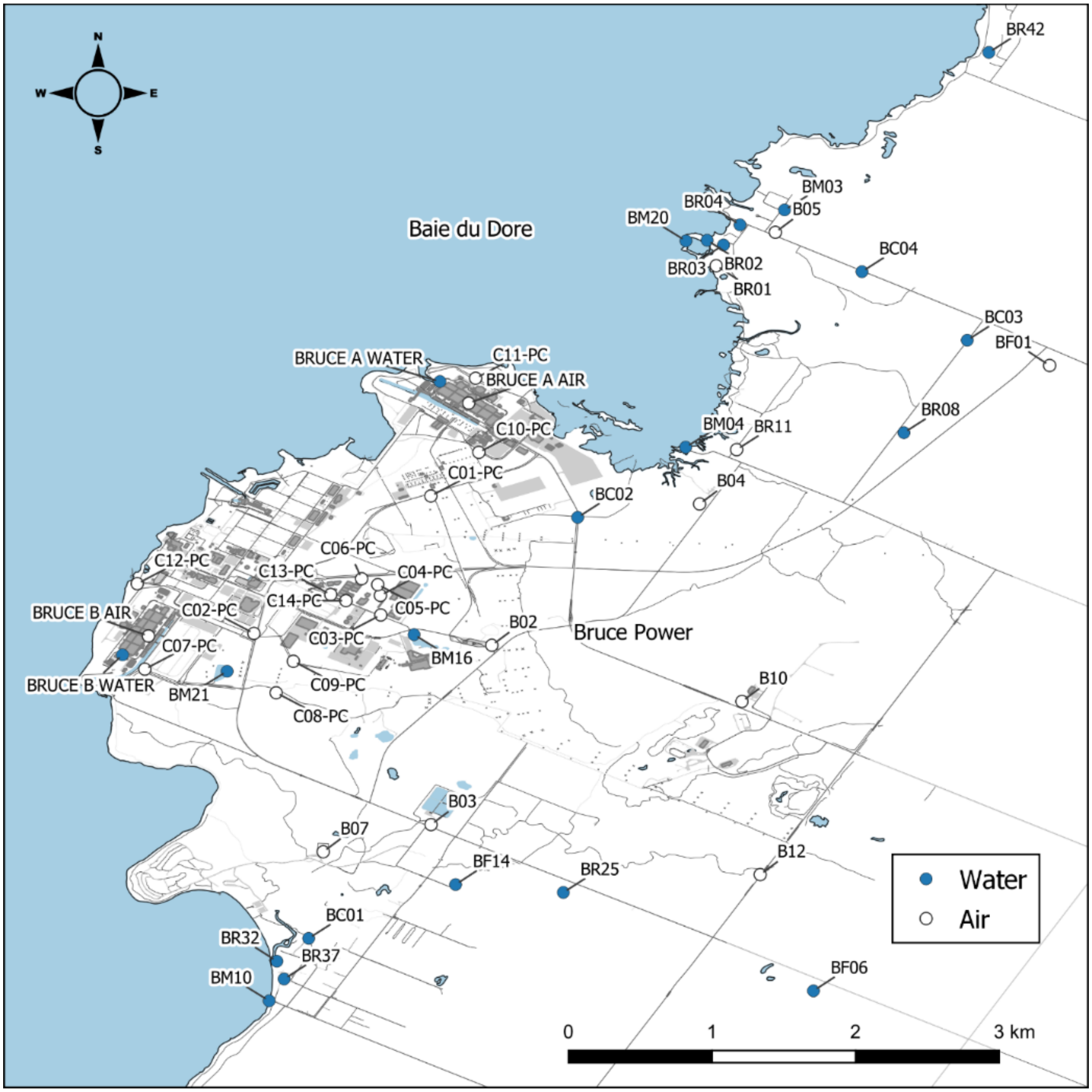


Figure 22 - Bruce Power On-Site and Area Near Radiological Environmental Monitoring Locations

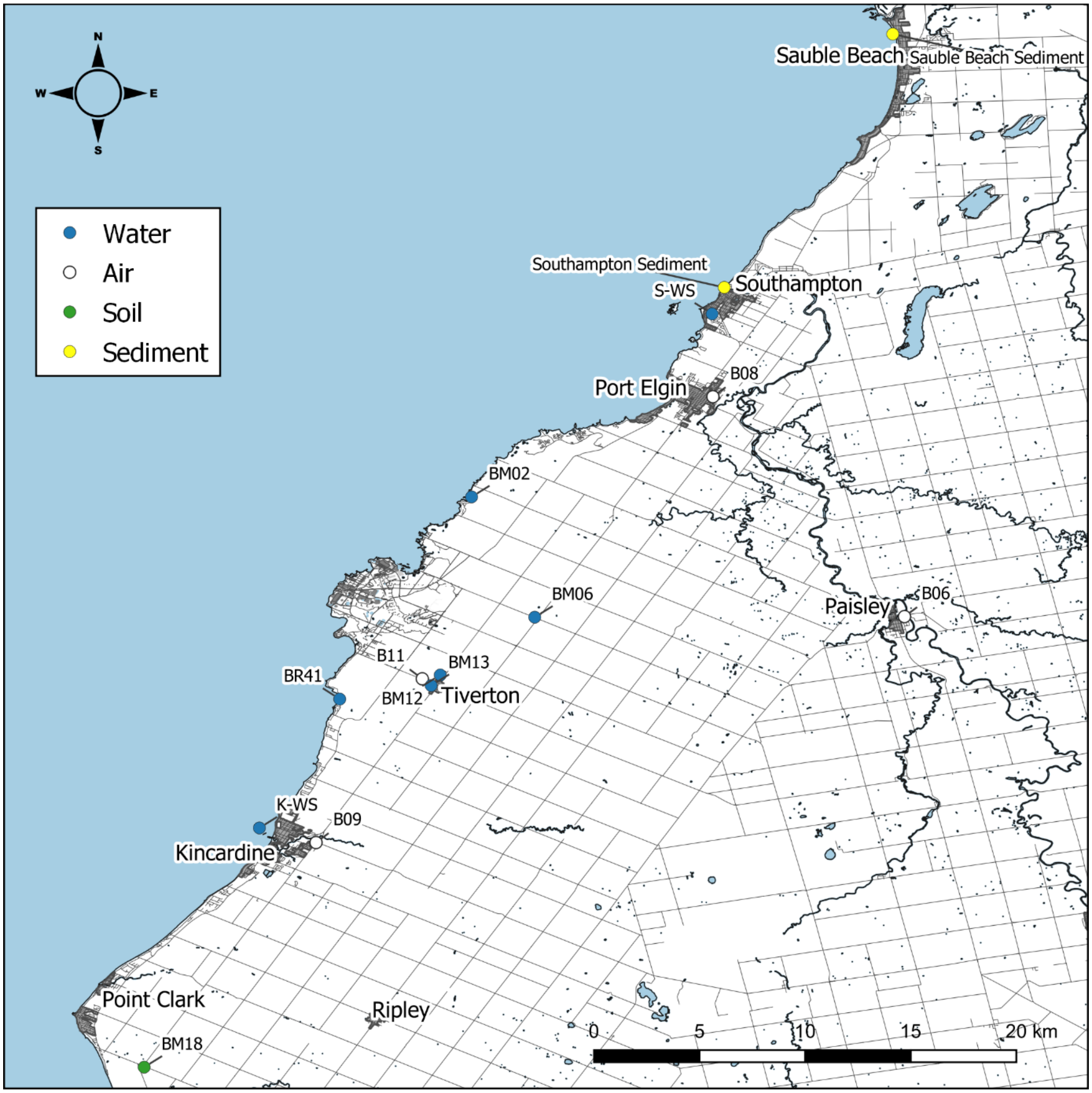


Figure 23 – Bruce Power Area Near and Far Radiological Environmental Monitoring Locations

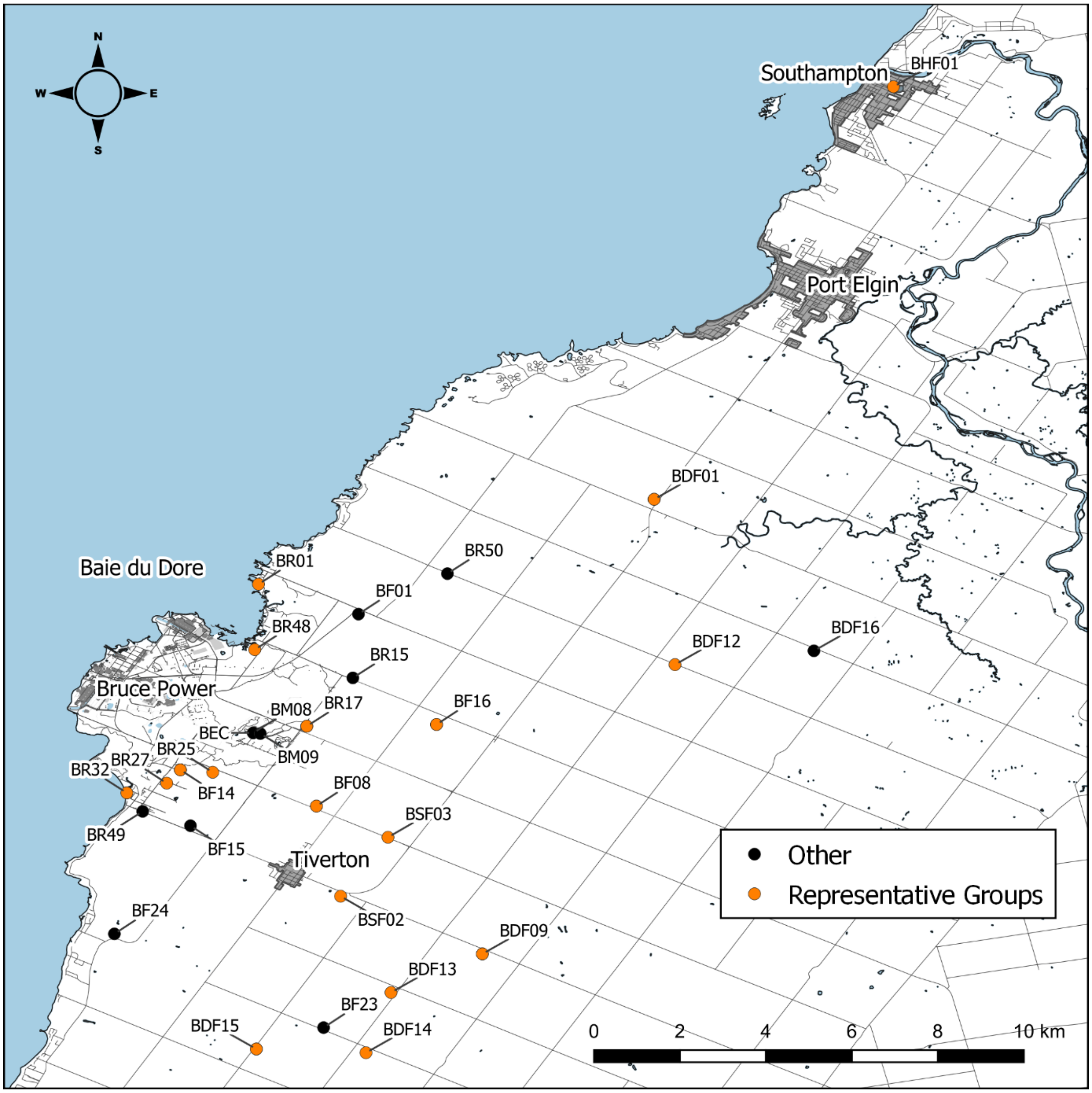


Figure 24 - Bruce Power Radiological Environmental Monitoring Residential Locations (Other) and Representative Groups

For Radiological Environmental Monitoring data analysis, the actual measured value, uncertainty, critical level and detection limit are recorded in a data management system. 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. The detection limit (Ld) is the calculated value based on the decision threshold and the measurement system parameters (e.g., count time) above which the net counts measured from the sample are expected to exceed the decision threshold at the 95% confidence level. These definitions of critical level and detection limit are consistent with Canadian Standards Association N288.4-10 Annex D [R-5].

For Bruce Power Radiological Environmental Monitoring data, when the actual measured value is less than the associated critical level (<Lc), those values were taken as reported (i.e., not censored). In the calculation of averages where some measured values were reported as less than the critical level, the uncensored analytical results were used in the calculation. For instances where the annual *average* value is negative or where all individual analytical results were less than the critical level, the result is stated as “<Lc” for simplification. For provincial background data where the result was less than the detection limit (<Ld), the detection limit value was used in the annual average. When all of the results for a particular radionuclide-media pair were less than the detection limit, or where the annual average was negative, then “<Ld” was stated for the annual average.

The following sections provide the results of Radiological Environmental Monitoring carried out by Bruce Power in 2022 and previous years. The provincial background results are also provided where appropriate. The Canadian Nuclear Safety Commission completed the Independent Environmental Monitoring Program in the Bruce County area most recently in 2022 but the results were not yet available for comparison. Instead, the 2019 results are presented, as applicable, for additional demonstration that there is low radiological risk to the environment from Bruce Power operations.

6.1.1 Air Monitoring

Bruce Power monitors for external gamma radiation, tritium oxide and carbon-14 concentrations in air at a variety of locations near and far from site. The results are used in the annual dose to public calculation for each of the representative persons that live near Bruce Power. In addition, the results inform the environmental monitoring and Environmental Risk Assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

6.1.1.1 External Gamma in Air

Ambient external gamma radiation in air was measured using Harshaw Environmental Thermoluminescent Dosimeters (TLDs) at 10 air monitoring stations near and far from Bruce Power (Figure 22 and Figure 23). The dosimeters are exposed for three-month periods, collected quarterly and measured by the Ontario Power Generation’s Whitby Health Physics Laboratory. The annual dose rates are calculated as the sum of the quarterly results.

Provincial background dosimeters are located at various locations around Ontario (Figure 21) and are also collected quarterly and measured by the Whitby Health Physics Laboratory. The dosimeter locations throughout the province show the range of background radiation levels experienced during the year. Bruce Power and provincial background results are detailed in Table 20.

The Bruce Power indicator sites B02, B03, and B04 are located closest to the Bruce Power site and the average external gamma dose in air was 50 nanogray per hour for 2022. For comparison, the average of the 8 provincial background sites was slightly higher at 58 nanogray per hour.

Thermoluminescent dosimeter measurements alone cannot resolve the very low gamma doses in air associated with radiological emissions from the Bruce Power site or those observed provincially. As a result, a conservative modelling method of estimating noble gas activity in the environment using emissions data and atmospheric dilution factors is used in the dose estimates. This demonstrates that the impact of Bruce Power on the surrounding environment, with regards to gamma radiation in air, is *de minimus* or negligible.

Table 20 - 2022 Annual External Gamma Dose Rate Measurements

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**

The annual average external gamma dose rates for Bruce Power indicator, area near and area far sites over time are shown in Figure 25, along with the annual average provincial background. External gamma values have remained relatively constant over the past ten years. Both Bruce Power and provincial measurements show similar trends, although Bruce Power is consistently below the provincial background. A general linear model (α=0.05) was performed by site over the last 10 years and identified that there is no statistically significant change over time ($p>0.05$) and no significant difference by site over time. An analysis of variance ($\alpha=0.05$) shows a statistically significant difference in the means by site ($p<0.001$). The results showed that the provincial site had the highest mean gamma in air, that the indicator and area near sites had no significant difference from each other and that the area far site had the lowest mean gamma in air.

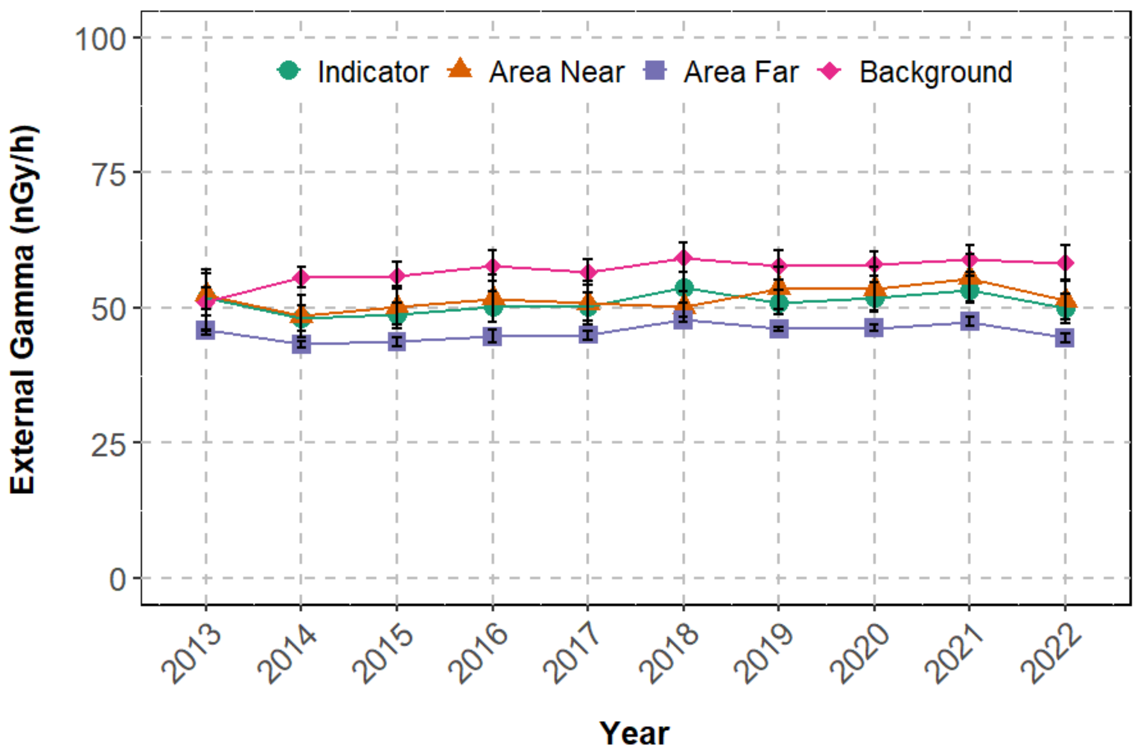


Figure 25 – 2022 Annual Average External Gamma Dose Rates (nGy/h) at Bruce Power Indicator, Near, Far and Provincial Background Locations Over Time (± Standard Error)

Health Canada also monitors total external gamma dose in the local area [R-115]. The Fixed Point Surveillance network monitors radiation dose to the public in real-time due to radioactive materials (natural and manmade) in the terrestrial environment, whether they are airborne or on the ground. The radiation dose from all external gamma sources, which includes natural background from mineral deposits in the ground or radon gas in the air is provided as Total Air Kinectic Energy Released in Matter. The contributions to external dose from 3 radioactive noble gases argon-41, xenon-133 and xenon-135 are reported in nanogray per month (1 nanogray = $1\text{x}10^{-6}$ millisieverts). There are 8 Fixed Point Surveillance network monitors in the area near Bruce Power, including at the site boundary, the Visitor's Centre (Infocentre), Scott Point, Kincardine, Inverhuron, Port Elgin, Tiverton, and Shore Road. In 2022, the results for xenon-133 and xenon-135 were less than the limit of detection for all months at all 8 locations.

At most locations and months the results for argon-41 were less than the limit of detection, although there were 1-3 months at the Site Boundary, Scott Point, Inverhuron, Infocentre, Tiverton and Shore Rd that detected argon-41 at or above the limit of detection of 6 nanogray per month, but were very low (less than 32 nanogray per month) [R-116]. These levels are considered negligible.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program does not monitor for external gamma using the same approach used by Bruce Power, the Province or Health Canada, but instead measures individual gamma emitting radionuclides in air. Therefore, the results are not comparable; however, they are presented to show all of the monitoring results in the Bruce area. The 2019 Canadian Nuclear Safety Commission Independent Environmental Monitoring Program monitored for cesium-137 in air at Baie du Doré, Inverhuron and Tiverton locations. All results were <0.000068 becquerels per cubic metre, which are well below the Guidance/Reference Level of 2.56 becquerels per cubic metre. The Canadian Nuclear Safety Commission also measured iodine-131 at these locations in 2019, in addition to Neyaashiinigmiing and Southampton locations. The results at these five locations were <0.00082 becquerels per cubic metre, much lower than the Guidance/Reference Level of 0.228 becquerels per cubic metre [R-28].

6.1.1.2 Tritium Oxide in Air

Tritium oxide in air is measured at 10 locations near Bruce Power (Figure 22 and Figure 23) using active air samplers that pass air at a continuous rate through molecular sieves, where water vapour from the atmosphere is absorbed. The molecular sieves are changed out on a monthly basis and the water is extracted and analyzed for tritium by liquid scintillation counting. The results are obtained by multiplying the specific activity of tritium in the extracted water by the average absolute humidity measured for the sampling period. The average absolute humidity is determined by dividing the mass of water collected on the molecular sieve by the volume of air sampled as measured by an integrated flow metre.

Monthly samples are averaged by location for the year and are shown in Table 21, along with the provincial background value measured in Nanticoke (Figure 21). The results for 2022 are shown on a monthly basis in Figure 26.

Table 21 – 2022 Annual Average Tritium Oxide in Air

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

Note:

1. E+00 represents scientific notation, E+03 = $X10^3$
2. Sample count = 12 in all cases, except B02-ST sample count = 11
3. For calculation of averages the uncensored analytical result was used

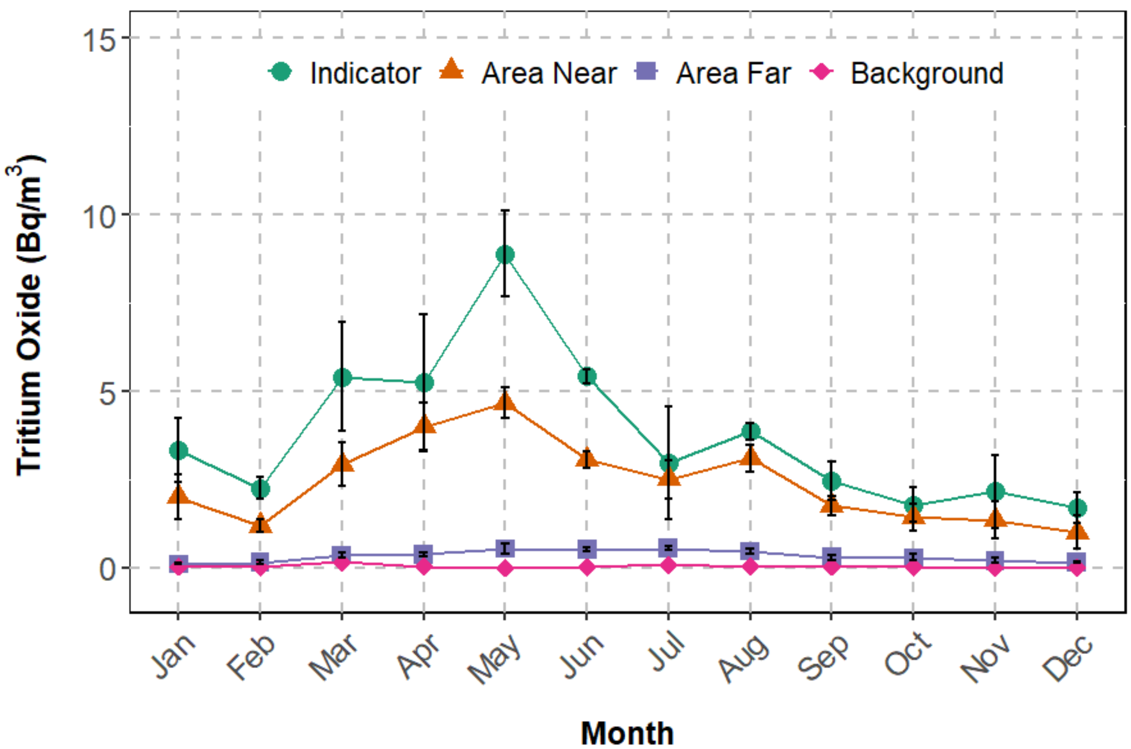


Figure 26 – 2022 Monthly Tritium Oxide in Air Concentrations (Bq/m^3) at Bruce Power Indicator, Near, Far and Provincial Background Locations (± Standard Error); Reference Level = 340 Bq/m^3

As illustrated in Figure 26, the annual average tritium oxide levels in air for 2022 were higher at indicator sites closest to Bruce Power (B02, B03, B04), with sites further away (area near and area far) being progressively lower. The annual average for the area far location was close to the provincial background value each month, which was consistently lower than all Bruce Power results. In 2022 tritium oxide levels at indicator and area near locations were higher in March through June compared to other months, with the peak in May. These results may be attributed to elevated tritium releases at Bruce A due to equipment deficiencies within vapour recovery systems and work performed as part of the vacuum building outage, as described in Section 5.1.2.1. The tritium oxide concentrations measured in air near Bruce Power were well below the Canadian Nuclear Safety Commission Reference Level of 340 becquerels per cubic metre.

The historical trend of the annual average tritium oxide in air is shown in Figure 27 for indicator, area near, area far and provincial background locations. From year to year, concentrations of tritium oxide in air are higher closer to site and decrease with distance. The annual averages fluctuate with changes to airborne tritium emissions from the site each year. In 2014 airborne tritium emissions were impacted by outage work at Bruce A that involved moderator heat exchanger and end fitting work. In 2017, similar maintenance on reactor systems occurred at both Bruce A and Bruce B that included heat transport and moderator systems that resulted in higher annual tritium emissions in air. In 2021, there was a moderator pump seal leak at Bruce A, and as mentioned previously, the average tritium in air results for 2022 were impacted by elevated emissions at Bruce A due to equipment deficiencies in the vapour recovery systems and work completed as part of the vacuum building outage. Provincial background tritium in air is typically lower than near Bruce Power. It is not known why the 2018 provincial value is higher than other years.

A general linear model (α=0.05) was performed by site over the last 10 years and identified that there is a statistically significant increase over time ($p<0.05$) and a significant difference by site. An analysis of variance (α=0.05) shows that there is a significant difference in the means by site between the indicator, area near and area far sites, and the mean for area far site is not significantly different to provincial background ($p<0.001$).

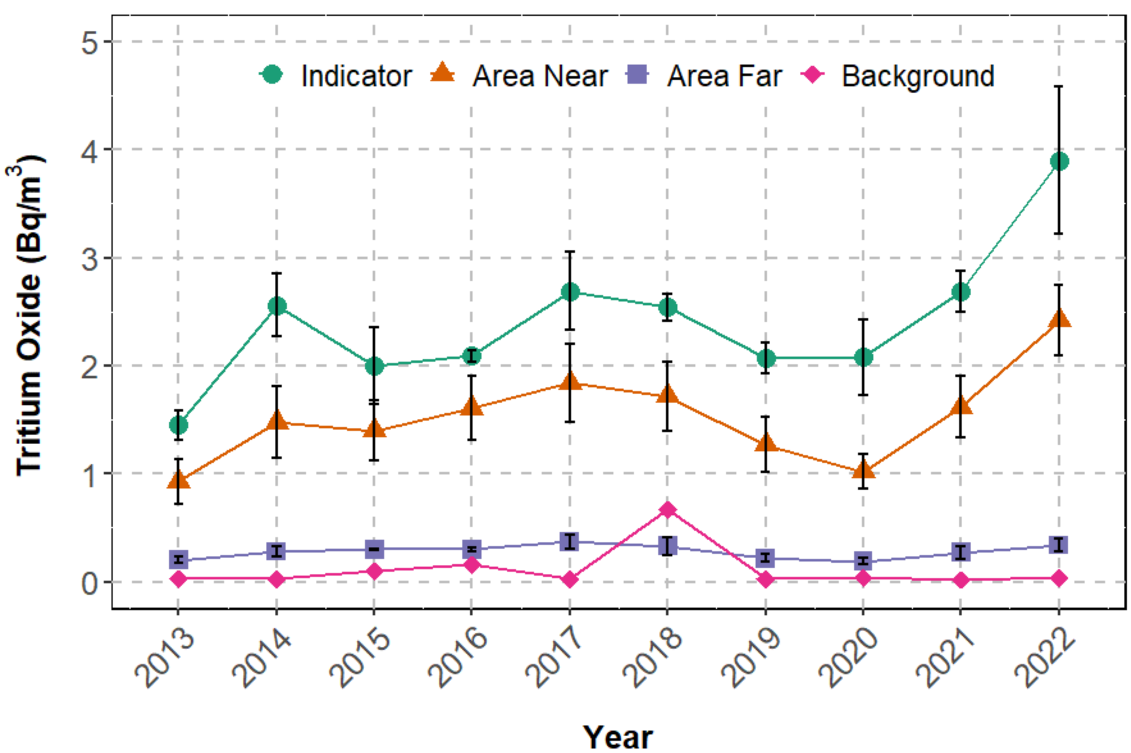


Figure 27 - 2022 Annual Average Tritium Oxide in Air Concentrations (Bq/m^3) at Bruce Power Indicator, Near, Far and Provincial Background Locations Over Time (± Standard Error); Reference Level = 340 Bq/m^3

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program measured air samples for tritiated water and elemental tritium at five locations near Bruce

Power in 2019 including Inverhuron, Baie du Doré, Tiverton, Southampton and Neyaashiinigmiing [R-28]. All results were less than the limit of detection, with the exception of one which was obtained at the Inverhuron location with 4.8 becquerel per cubic metre tritiated water. During the 2016 Independent Environmental Monitoring Program, the result for this location was less than the detection limit (less than 2.5 becquerel per cubic metre). All results were well below the guideline/reference level of 340 becquerel per cubic metre for tritiated water and 5,100,000 becquerel per cubic metre for elemental tritium and were not expected to cause a human health impact.

6.1.1.3 Carbon-14 in Air

Carbon-14 (C-14) in air is monitored using passive air samplers that contain mixed soda lime pellets that absorb carbon dioxide (CO_2) from the atmosphere at a controlled rate. The absorbent material is collected on a quarterly basis for analysis in the laboratory. The carbon dioxide is released from the pellets by titration with acid and then analyzed by liquid scintillation counting for carbon-14 content. There are eight sampling locations near Bruce Power (Figure 22), with a duplicate sampler at B05 at Scott Point. There are 14 passive samplers on-site situated around Bruce A, Bruce B and Ontario Power Generation Western Waste Management Facility. The Provincial Environmental Monitoring Program has five carbon-14 samplers, shown in Figure 21, to measure background levels.

The 2022 quarterly carbon-14 in air results are shown in Figure 28, and the annual average concentrations are provided in Table 22 for the off-site locations and in 5.1.2.1 for the on-site locations.

In 2022, the average carbon-14 concentrations measured at indicator and area near locations were slightly higher in the second and third quarter compared to the other periods in the year and were also above the provincial background. These results are attributed to elevated carbon-14 emissions at Bruce A during the Vacuum Building Outage and preparations for the Major Component Replacement at Unit 3, as described in Section 5.1.2.1.

As seen in other years, the indicator annual average was similar to the area near average, and both were slightly higher than the annual average background concentration (Table 22). The locations north (i.e. BR01, BR05) of Bruce A had marginally higher results than other locations, as these are located closest to the Site boundary and in the predominant wind direction for 2022 (blowing from SSW) [R-46].

The 2022 carbon-14 results from the on-site passive samplers circling the Ontario Power Generation Western Waste Management Facility (5.1.2.1) are typically higher than other areas on-site, including monitors near the Bruce A and Bruce B stations. In late summer 2022, Ontario Power Generation installed carbon dioxide scrubbers in select spent resin storage containers to reduce carbon-14 emissions released from this area.

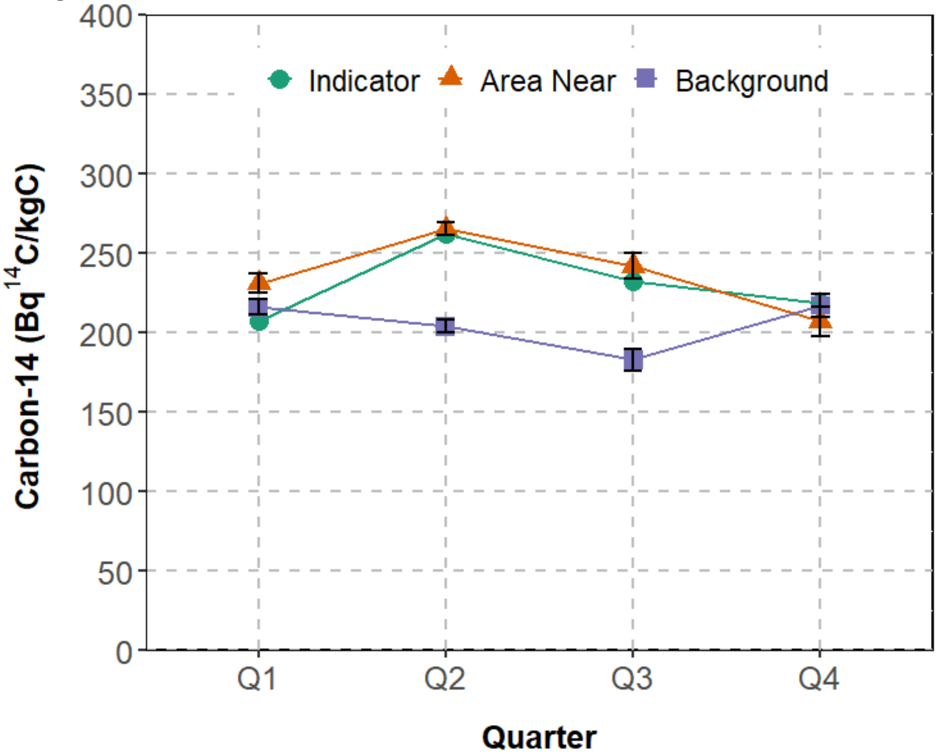


Figure 28 - 2022 Quarterly Average Carbon-14 in Air Concentrations at Bruce Power Indicator, Area Near and Provincial Background Locations (± Standard Error)

Table 22 - 2022 Annual Average Carbon-14 in Air from Passive Samplers Off-Site

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**

Note:

1. E+00 represents scientific notation, E+03 = x10^3
2. Sample count = 4
3. For calculation of averages the uncensored analytical result was used

Table 23 - 2022 Annual Average Carbon-14 in Air from Passive Samplers On-Site

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

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$
2. Sample count = 4
3. For calculation of averages the uncensored analytical result was used

The annual average carbon-14 in air concentrations for the last ten years is shown in Figure 29. The Bruce Power annual average is consistently just above the provincial annual average, with trends in both being relatively stable. There is little change between the 2022 averages from the previous year. A general linear model (α=0.05) was performed by site over the last 10 years and identified a statistically significant decrease ($p<0.001$), with no significant difference by site. An analysis of variance (α=0.05) by site shows that the means for indicator and area near sites are not significantly different from one another, with both means being significantly higher than provincial background ($p<0.001$).

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program carried out near Bruce Power in 2019 did not monitor for carbon-14 in air.

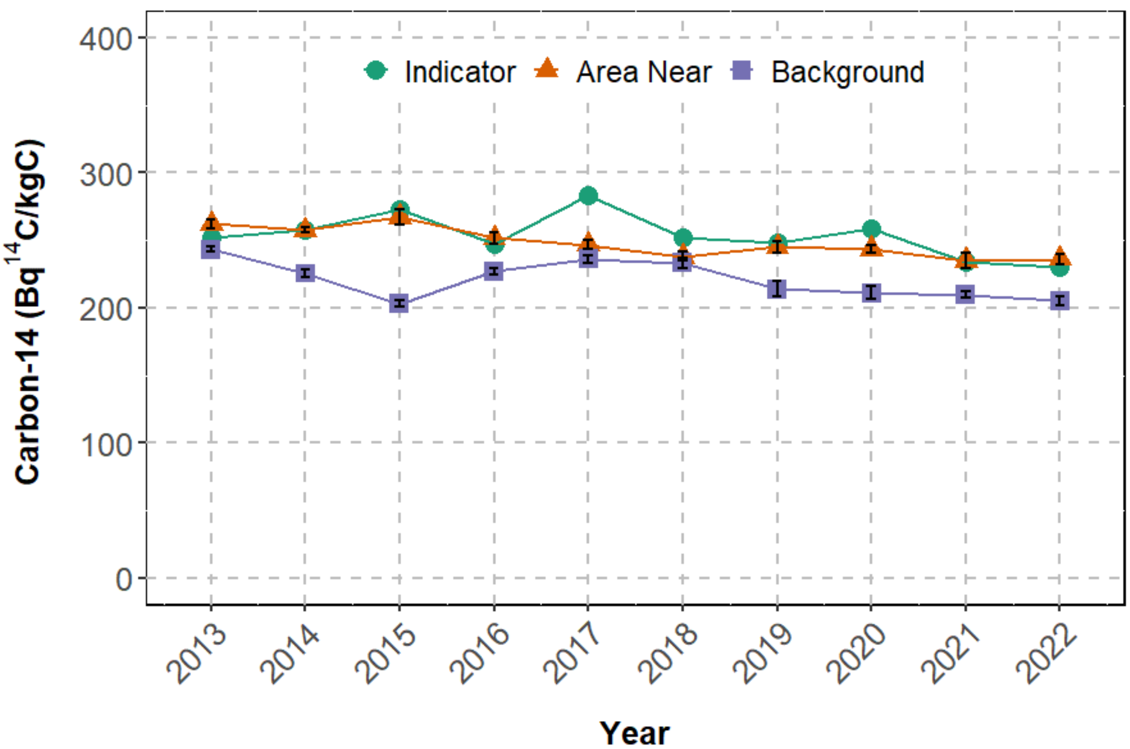


Figure 29 - Annual Average Carbon-14 in Air Concentrations at Bruce Power Indicator, Area Near and Provincial Background Locations Over Time (± Standard Error)

6.1.1.4 Air Monitoring Summary

Bruce Power monitors external gamma radiation and tritium oxide and carbon-14 concentrations in air on a continuous basis at locations near Site. External gamma and carbon-14 results for 2022 were within normal ranges and similar to historical levels, although tritium oxide results were elevated compared to previous years. None the less, no human health impacts are expected from these releases to the environment.

A summary of each radionuclide group is provided here:

- External gamma results for 2022 were less than provincial background and have remained relatively constant over the last decade.

- Tritium levels in air for 2022 increased compared to previous years, however the annual averages were well below the Canadian Nuclear Safety Commission Reference Level.

- For 2022, carbon-14 levels in air were similar to previous years and slightly higher than background levels.

6.1.2 Precipitation

Precipitation is collected in a bucket at 10 locations near and far from Bruce Power (Figure 22 and Figure 23). The province does not collect precipitation as part of their Environmental Monitoring Program; however, the Bruce Power area far locations in Kincardine (B09), Port Elgin (B08) and Paisley (B06) may be used for reference. The water that has accumulated in the buckets is collected each month and analyzed for tritium oxide by liquid scintillation counting and gross beta radiation by proportional counting.

The volume of water collected is highly variable and depending on the year and season the pail may be empty or filled with snow or ice. The concentration of radioactivity in a sample is dependent on the time and amount of rainfall in relation to the collection date, due to dilution and/or evaporation. The results are not representative and are therefore not used in the dose calculations for members of the public. However, radioactivity measured in precipitation may give a rough estimate of airborne emissions, and precipitation will invariably become surface water and ground water, and potentially a source of drinking water via shallow wells or surface water.

In 2022 the months of May through August were drier than other months and several (3 - 5) collection buckets were found to be nearly empty (< 0.5 L). This affected the analysis as there was not enough volume to perform one or both of the measurements (e.g., tritium or gross beta). In June there were 3 locations (30%), in July there was 1 location (10%), and in August, there were 4 locations (40%) that did not have enough volume for the tritium analysis, while one location did not have a beta analysis completed in August. In February the pail at B04 was cracked and some sample was lost (estimated 10-20%), however this is expected to have a minimal impact on the results.

The annual average results for tritium oxide and gross beta in precipitation are presented in Table 24. As seen in previous years, the average tritium oxide results decrease with distance from Bruce Power (indicator > area near > area far locations), while gross beta remains consistent regardless of proximity to site. The annual average for tritium in precipitation at indicator locations was 320 becquerels per litre, while the annual average for area near locations was 197 becquerels per litre and area far locations was 25.3 becquerels per litre. By contrast the annual average gross beta deposition rate at indicator locations was 21.1 becquerels per metre squared per month, while area near and far locations had an annual average of 22.1 becquerels per metre squared per month and 20.6 becquerels per metre squared per month, respectively. This suggests that Bruce Power operations are not a significant contributor to beta radiation measured in precipitation.

Table 24 - 2022 Annual Average Precipitation Data

Location Type	Sample Location	Tritium Oxide (Bq/L)	Gross Beta (Bq/m^2/ month
Indicator	B02-WP	2.75E+02	2.03E+01
Indicator	B03-WP	2.70E+02	2.15E+01
Indicator	B04-WP	4.04E+02	2.15E+01
Indicator	**Average**	**3.20E+02**	**2.11E+01**
Area Near	B05-WP	2.86E+02	2.22E+01
Area Near	B07-WP	1.79E+02	2.51E+01
Area Near	B10-WP	1.83E+02	2.41E+01
Area Near	B11-WP	9.83E+01	1.76E+01
Area Near	**Average**	**1.97E+02**	**2.21E+01**
Area Far	B06-WP	2.17E+01	2.12E+01
Area Far	B08-WP	3.47E+01	2.01E+01
Area Far	B09-WP	2.39E+01	2.05E+01
Area Far	**Average**	**2.53E+01**	**2.06E+01**

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$

2. For tritium analysis, sample count = 12 in all cases, except at B02-WP, B03-WP, B09-WP, B10-WP with sample count = 11, and B08-WP, B11-WP with sample count = 10. For beta analysis, sample count =12 in all cases, except B10-WP with sample count = 11

3. For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used

Tritium oxide in precipitation measured at Bruce Power monitoring locations are shown for the last ten years in Figure 30. Consistently the tritium concentration decreases with distance from Bruce Power. Averages vary from year to year mirroring the airborne tritium emissions from Site. The annual averages at the indicator and area near locations for 2022 were higher than in previous years, similar to the trends observed for tritium oxide in air (Section 6.1.1.2).

A general linear model ($\alpha=0.05$) was performed by site over the last 10 years and identified that there is a statistically significant increase over time ($p<0.05$), with no significant difference by site ($p>0.05$). An analysis of variance ($\alpha=0.05$) shows that there is a significant difference in the means between the indicator, area near and area far sites ($p<0.001$).

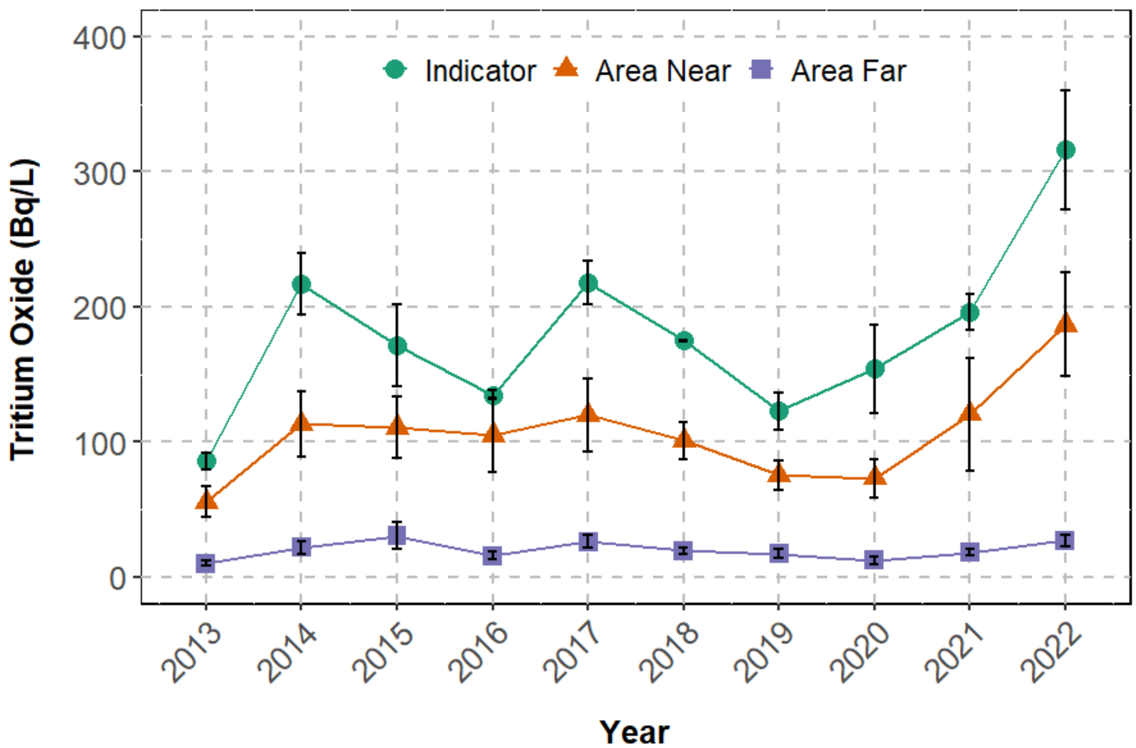


Figure 30 - Annual Average Tritium Concentrations in Precipitation at Bruce Power Indicator, Area Near, Area Far Locations over Time (± Standard Error)

6.1.3 Water Monitoring

Bruce Power regularly collects drinking water samples from the local municipal water supply plants and municipal and residential wells near Site for use in calculating dose to members of the public each year. Surface water samples are also collected from Lake Huron and local streams off site, as well as at locations within the Bruce Power Site boundary. Both drinking water and surface water are monitored for tritium oxide, gross beta and gross gamma radiation. Bruce Power water sampling locations are shown in Figure 22 and Figure 23.

Background levels of tritium in lake water are a combination of natural cosmogenic sources (produced by the action of cosmic rays) and residual fallout from historical nuclear weapons testing. The Atomic Energy Canada Limited developed a mathematical model for estimating background tritium activity in Lake Huron from cosmogenic sources and fallout from nuclear weapons testing [R-117]. Natural Lake Huron tritium levels in the absence of CANDU tritium releases are estimated to be 1.5 becquerels per litre.

Ontario Power Generation monitors for tritium oxide and gross beta in samples collected at water supply plants, municipal drinking water locations and lakes within Ontario that are outside the influence of nuclear power plants. Provincial background sampling locations are shown in Figure 21. Background values are subtracted from the local results in the annual dose calculation of members of the public.

The routine monitoring of the on and off-site waterbodies informs the environmental monitoring and Environmental Risk Assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

6.1.3.1 Municipal Water Supply Plants

Municipal drinking water is sampled at two municipal water supply plants on Lake Huron – one in Southampton (22 kilometres northeast of Bruce A) and one in Kincardine (15 kilometres south-southwest of Bruce B). Water samples are collected twice per day during regular business hours and weekly composite samples are analyzed for tritium oxide by liquid scintillation counting. Monthly composite samples are analyzed for gross beta radiation by proportional counting. The Ontario Drinking Water Standard for tritium is 7,000 becquerels per litre (annual average), however Bruce Power has a long standing commitment with the municipalities to maintain an annual and monthly average tritium concentration at the water supply plants below 100 becquerels per litre [R-118].

The 2022 annual average tritium and gross beta results for drinking water samples collected by Bruce Power and the Province are listed in Table 25. The 2022 annual average for tritium at the Kincardine water supply plant was 4.0 becquerels per litre and at the Southampton water supply plant was 10.4 becquerels per litre. These values are well below the Ontario Drinking Water Standard and Canadian Nuclear Safety Commission Reference level (7,000 becquerels per litre), as well as the committed administrative level of 100 becquerels per litre. The average annual tritium concentration at the provincial water supply locations ranged between less than the detection limit and 4.2 becquerels per litre.

The gross beta results at the local water supply plants for 2022 (0.06 - 0.07 becquerels per litre) were similar to historical and provincial background results (0.04 - 0.11 becquerels per litre) and were well below the Canadian Nuclear Safety Commission Reference Level of 1 becquerels per litre.

Table 25 - 2022 Annual Average Tritium and Gross Beta Concentrations in Drinking Water at Municipal Water Supply Locations

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

Note:

1. E+00 represents scientific notation, E+03 = x10^3. WSP is water supply plant
2. 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.
3. 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

The impact of Bruce Power discharges to Lake Huron on the local water supply plants varies from year to year and is dependent on the distance from the stations, lake current direction and general dispersion conditions in the lake. The tritium concentrations at the water supply plants over the last ten years are shown in Figure 31. The Southampton water supply plant has marginally higher annual average tritium concentrations each year compared to Kincardine due to the predominant lake currents outside Bruce Power travelling northward. These values are very low (a small fraction of the administrative level) and no impacts to human health are expected from these levels.

Tritium oxide concentrations are consistently low and stable from 2013 through 2022, with Southampton being slightly higher than Kincardine and provincial averages. All results are below 15% of the administrative level value of 100 becquerels per liter.

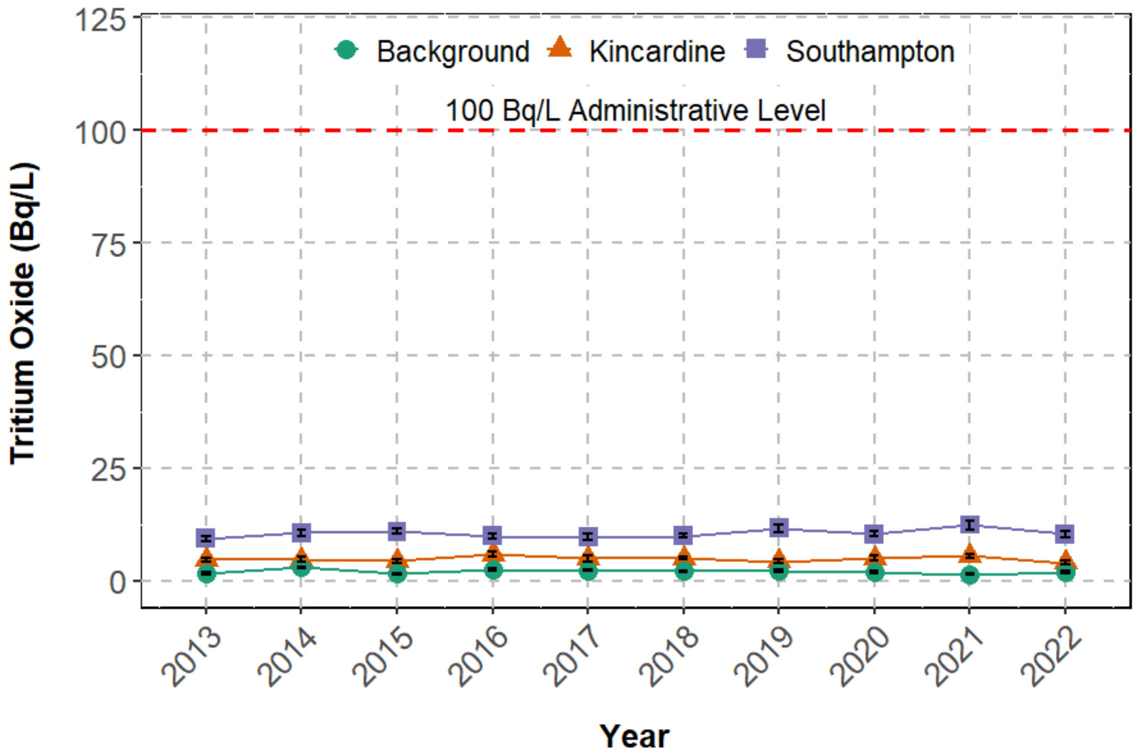


Figure 31 - Annual Average Tritium Concentrations (Bq/L) at the Municipal Water Supply Plants near Bruce Power and Provincial Background Locations Over Time. Reference Level = 7000 Bq/L; Administrative Level = 100 Bq/L.

6.1.3.2 Municipal and Residential Wells

In addition to the water supply plants in Southampton and Kincardine, drinking water is also collected at a number of municipal and local residential wells. Four municipal wells, located at Scott Point (BM03-WW), Underwood (BM06-WW) and Tiverton (BM12-WW, BM13-WW), are sampled semiannually. Seven deep residential wells are also sampled semiannually, while six shallow residential wells are sampled bimonthly, based on occupant availability. Water samples are analyzed for tritium oxide by liquid scintillation counting. Two representative locations, one to the north of Bruce Power at Scott Point (BR02-WW) and one to the south at Inverhuron (BR32-WW), are also analyzed semiannually for gross beta and gross gamma radiation. Annual average tritium oxide and gross beta results are shown in Table 26.

Table 26 - 2022 Annual Average Tritium and Gross Beta Concentrations in Drinking Water at Bruce Power Well Locations

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

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$

2. 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

Annual results for CANDU related radionuclides cobalt-60, cesium-134 and cesium-137 from the gamma scan are not provided as the results were less than or very close to the critical level and indistinguishable from background. No semi-annual samples were obtained for deep wells BR01 (Scott Point) and BM02 (Brucedale Conservation Area) in 2022 due to resident unavailability during the collection period.

For shallow wells, the source of tritium may be attributed to deposition of airborne tritium emissions from Bruce Power or precipitation washout migrating into the shallow wells. The deep wells are less likely to be affected by airborne deposition. Tritium oxide concentrations for all municipal wells were less than the critical level for detection (Lc) and indistinguishable from background. Of the five available deep residential wells, three had values less than the critical level, and the other two had annual averages less than 0.4 becquerels per litre. For the shallow wells the tritium oxide results were slightly higher, although 3 out of 7 available wells had results less than the critical level. The other four wells had annual averages ranging between 14.4 and 137 becquerels per litre and well below the Ontario Drinking Water Standard of 7000 becquerels per litre. The average gross beta result for BR02 and BR32 were slightly higher than the background locations but were only a fraction of the Canadian Nuclear Safety Commission Reference Level of 1 becquerels per litre.

Canadian Nuclear Safety Commission Independent Environmental Monitoring Program samples collected near Bruce Power in 2019 did not include drinking water from the municipal water supply plants or residential wells. However, samples of lake water, streams and ponds were collected, and these results are discussed in the appropriate sections below.

6.1.3.3 Lakes and Streams

Water samples are collected bimonthly from Lake Huron and ponds and streams in the vicinity of Bruce Power. Bruce Power sampling locations are shown on Figure 22. On-site sample locations within the Bruce Power perimeter fence include two ponds and one stream (B31 Pond - BM16, Former Sewage Lagoon - BM21 and Stream C - BC02). Off-site samples are collected from three stream locations near Bruce Power, which include Little Sauble (BC01) to the south and two locations on Underwood Creek (BC03 and BC04) to the north. Streams may be impacted by deposition of airborne radiological emissions from the Site or by precipitation washout migrating into waterways. Lake water is sampled at Baie du Doré (BM04), Inverhuron (BM10) to the south and Scott Point (BM20) to the north. Lake water may be impacted from waterborne effluent from discharge points on site, where as Baie du Doré may also be influenced by Stream C and atmospheric downwash. The stream indicator location is Stream C (BC-02) located on the north side of the Bruce Power boundary and feeds into Baie du Doré. The lake indicator location (BM04) is sampled from the eastern shore of Baie du Doré at the end of Concession Road 6.

Lake and stream water are sampled bimonthly when free of ice and analyzed for tritium oxide by liquid scintillation counting. Gross beta is measured by proportional counting on lake water samples bi-monthly and stream samples semiannually. Lake water samples are also analyzed for gross gamma twice per year using gamma spectroscopy. The 2022 annual average tritium oxide and gross beta results are shown in Table 27. Gamma results for 2022 are not shown as all results for CANDU related radionuclides cobalt-60, cesium-134 and cesium-137 were less than or very close to the critical level (Lc) and indistinguishable from background.

Lake water is collected by Ontario Power Generation on a quarterly basis at three locations (Bancroft, Belleville and Cobourg) as shown in Figure 21 and analyzed for tritium oxide and gross beta radiation. Samples are not collected when the lake is frozen (typically the first and fourth quarters). The 2022 annual average results are presented in Table 27.

Table 27 - 2022 Annual Average Tritium and Gross Beta Concentrations in Ponds, Lakes and Streams

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

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$
2. Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used
3. Provincial background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used

4. Bancroft, Belleville, and Cobourg are not sampled during winter months (Quarter 1 and 4)

The 2022 Bruce Power results for lake and stream water show similar trends as those observed for shallow wells and air monitoring; tritium values decrease with increasing distance from Bruce Power. All values are well below the Ontario Drinking Water Standard and Canadian Nuclear Safety Commission Reference Level for tritium in drinking water (7000 becquerels per litre). The gross beta results show little variation with proximity to Bruce Power and are similar to what is measured at Cobourg (Lake Ontario). The gross beta concentrations in surface water are well below the Canadian Nuclear Safety Commission Reference Level of 1 becquerel per litre.

Average annual tritium concentrations in lake and stream water samples measured at Bruce Power indicator and area near locations over time are shown in Figure 32. In 2022, both the indicator stream and indicator lake annual averages were higher than in previous years. Elevated levels of tritium in the environment may be attributed to the higher tritium releases to air from Site (see Section 5.1.2.1). This is consistent with the higher area near stream average, which may be impacted by atmospheric deposition.

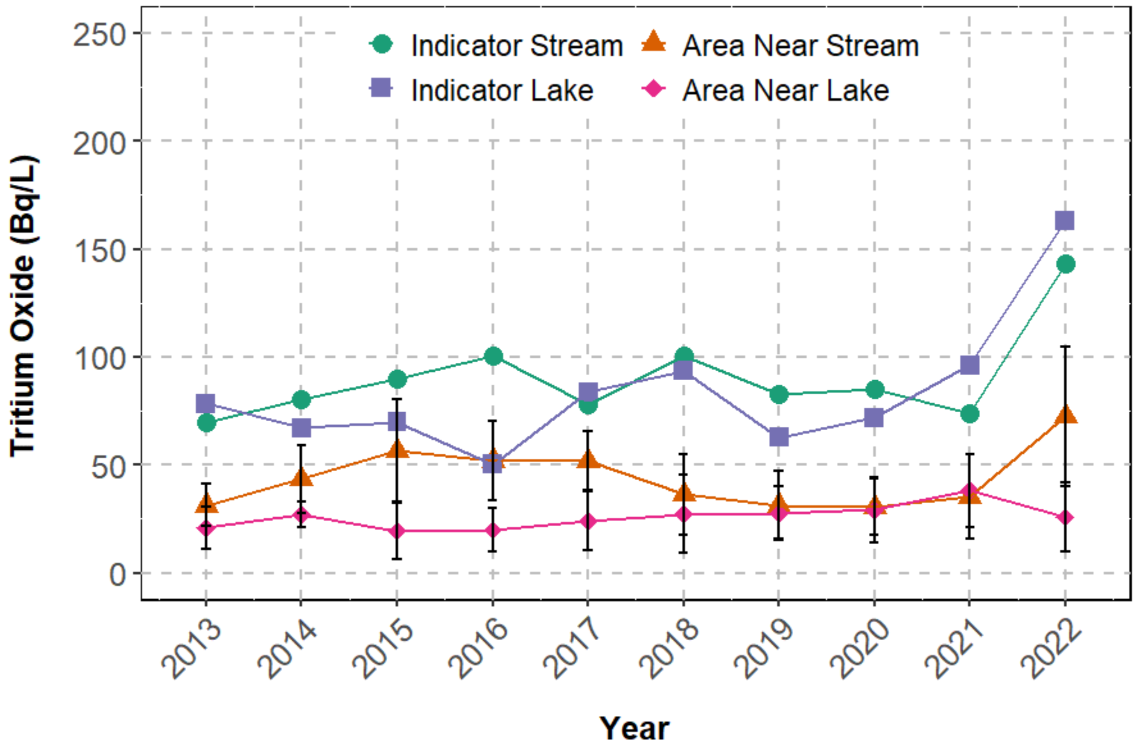


Figure 32 – 2022 Annual Average Tritium Concentrations (Bq/L) in Lake Huron and Streams Near Bruce Power Over Time (± Standard Error). CNSC reference level = 7000 Bq/L

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program for 2019 included surface water sampling at ten locations near Bruce Power including two locations in the Saugeen River in Southampton, on the shores of Southampton, Port Elgin, Baie du Doré and Kincardine, offshore Lake Huron near Loscombe Bank and Baie du Doré, offshore Georgian Bay near Owen Sound, and at an inland location near Concession Road 2 close to the Bruce Power site. The following radionuclides or radionuclide groups were measured in the surface water samples: tritiated water, gross alpha, gross beta, cobalt-60 and cesium-137. The Canadian Nuclear Safety Commission found that tritiated water concentrations were in the range of 2.0 becquerel per litre to 53.6 becquerel per litre and below the Guideline/Reference Level of 7000 becquerel per litre. All gross alpha, cobalt-60 and cesium-137 results were less than the limit of detection. Gross beta results at most locations were less than the detection limit (<0.15 becquerel per litre) except at the Concession Road 2 inland location with a value of 0.19 becquerel per litre. This value is much lower than the Guideline/Reference Level of 1 becquerel per litre. These results are consistent with what Bruce Power reports and indicate that no human health impacts are expected from surface water in the local area [R-28].

6.1.3.4 Water Monitoring Summary

Bruce Power regularly monitors tritium oxide, beta and/or gamma emitters in drinking water and surface water at a variety of locations on and off Site, including municipal water supply plants and residential wells, in lakes, streams and ponds. All results were well below the Canadian Nuclear Safety Commission Reference Levels, indicating that there is no risk to members of the public or the environment.

A summary is provided here:

- Concentrations of tritium oxide in drinking water at the municipal water supply plants in Kincardine and Southampton are similar to previous years and well below the Ontario Drinking Water Standard and the commitment with the municipalities.

- Radionuclide concentrations in drinking water from local municipal residential wells are well below the Canadian Nuclear Safety Commission Reference Levels for tritium oxide and gross beta radiation.

- Annual average tritium concentrations in lake and streams collected closest to Site are higher in 2022 than in the past, but quickly decrease with distance from Bruce Power.

6.1.4 Agricultural and Animal Products Monitoring

Bruce Power collects a variety of foodstuffs each year, including milk, fish, animal products and agricultural products and measures for radioactivity. The results are used in the annual dose to public calculation for each of the representative persons that live near Bruce Power. Additionally, the results inform the environmental monitoring and Environmental Risk Assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

6.1.4.1 Fish

Bruce Power monitors fish in Lake Huron for radionuclide concentrations as part of the Radiological Environmental Monitoring Program. Samples of benthic forager (bottom feeders) and pelagic forager (open water) fish species are collected near Bruce Power and further afield at locations along the western shore of Lake Huron well away from Bruce Power for use as a control. The control sampling locations were updated in 2017 due to importation policies that came into effect that year. Starting in 2017, control fish are collected on the Canadian side of Lake Huron north of Tobermory, by a contractor assisted by local Indigenous members.

The analysis of two types of fish species provides some insight into potential impacts from Bruce Power operations on the lakebed where benthic species inhabit, and through open water ecosystems where pelagic fish inhabit. The target fish species representing benthic and pelagic foragers are as follows:

- White Sucker (*Catostomus commersoni*) represents a benthic forager species. Brown Bullhead (*Ictalurus nebulosus*) is the alternate benthic species. Sample collection is conducted in the spring when adults are near shore to spawn.

- Lake Whitefish (*Coregonus clupeaformis*) represents a predominantly pelagic forager that feeds on a wide variety of organisms from invertebrates to small fish, to plankton. Round Whitefish (*Prosopium cylindraceum*) is the alternate pelagic species. Collection is conducted in the fall when adults are near shore to spawn. The secondary alternative is Lake Trout (*Salvelinus namaycush*).

Eight fish samples for each species and location are analyzed for tritiated water, carbon-14 and organically bound tritium (OBT) by liquid scintillation counting and for cobalt-60, cesium-134, cesium-137 by gamma spectrometry. The fish flesh ventral to the lateral line is included in the samples prepared for analysis. The sample preparation and analysis method for each radionuclide group is outlined in Table 28. No samples of near field or control pelagic fish were obtained in 2022 as the contractor was unable to provide samples due to boat issues and difficulty finding the desired species.

Table 28 - Fish Preparation and Methods

Analyte	Sample	Preparation	Method
Cobalt-60, Cesium-134, Cesium-137	Individual fish	Skinned, filleted, and flesh sliced	Gamma spectrometry
Carbon-14	Two counts of a single sample per individual fish	Freeze-dried flesh combusted	Liquid scintillation counting
Tritium oxide	Average of two samples per individual fish	Water from freeze dried flesh	Liquid scintillation counting
Organically Bound Tritium	Single composite by fish type	Solid residue (washed to remove free tritium oxide) combusted	Liquid scintillation counting

The 2022 annual average results for benthic fish are provided in Table 29 and Table 30 for Bruce Power area near and control fish. Also shown are the provincial background annual average results for benthic and pelagic fish from Lake Huron and benthic fish from Lake Ontario for comparison.

Table 29 - 2022 Annual Average Radionuclide Concentrations for Fish

Location Type	**Sample Type, Location**	**Tritium Oxide (Bq/L)**	**Carbon-14 (BqC^{14}/kg-C)**	**Organically Bound Tritium (Bq/L)**	**Organically Bound Tritium (±2σ)**
Area Near	Benthic, Lake Huron	1.88E+01	2.07E+02	1.03E+01	3.9E+00
Area Near	Pelagic, Lake Huron	No sample	No sample	No sample	No sample
Bruce Power Control	Benthic, Lake Huron	1.86E+01	2.17E+02	1.16E+01	3.9E+00
Bruce Power Control	Pelagic, Lake Huron	No sample	No sample	No sample	No sample
Background	Benthic, Lake Ontario	3.6E+00	2.1E+02	1.0E+02	3.9E+00
Background	Benthic, Lake Huron	5.2E+00	2.3E+02	3.9E+01	2.6E+00
Background	Pelagic, Lake Huron	6.2E+00	2.3E+02	3.0E+01	2.4E+00

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$
2. Sample count = 8 in all cases, except for organically bound tritium, which includes one composite and raw data is provided
3. For organically bound tritium results: ±2σ is the uncertainty associated with the analytical measurement, the detection limit is 8.6 Bq/L (Bruce Power) and 2.3 Bq/L (provincial)
4. Bruce Power: For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used
5. Provincial background: For calculation of averages where the result was less than the minimum detection level (Ld), the minimum detection level was used

Table 30 - 2022 Annual Average Gamma Spectroscopy Results for Fish

Location Type	Sample Type, Location	Cobalt-60 (Bq/kg)	Cesium-134 (Bq/kg)	Cesium-137 (Bq/kg)
Area Near	Benthic, Lake Huron	4.49E-02	<Lc	1.46E-01
Area Near	Pelagic, Lake Huron	No sample	No sample	No sample
Bruce Power Control	Benthic, Lake Huron	<Lc	<Lc	1.41E-01
Bruce Power Control	Pelagic, Lake Huron	No sample	No sample	No sample
Background	Benthic, Lake Ontario	<Ld	<Ld	2.62E-01
Background	Benthic, Lake Huron	<Ld	<Ld	1.91E-01
Background	Pelagic, Lake Huron	<Ld	<Ld	4.00E-01

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$
2. Sample count = 8 in all cases
3. 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 over 50% of the results were <Lc
4. 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 results were <Ld

Tritium Oxide in Fish

The 2022 annual average concentration of tritium oxide in benthic fish was 18.8 becquerel per litre for area near, 18.6 becquerel per litre for the control group and 5.2 becquerel per litre for the Lake Huron provincial background group. No pelagic fish were available for the 2022 year.

The annual average tritium oxide concentrations in fish for the past 10 years are shown in Figure 33 for pelagic fish and Figure 34 for benthic fish. There has been little variation in tritium oxide levels in pelagic fish over the years, except for the higher result for the control group in 2018 for reasons unknown. The annual average tritium oxide concentration for benthic fish collected near Bruce Power returned to typical levels in 2022, after a higher average in 2021 due to elevated waterborne releases from Bruce B during the sample collection period of May/June.

A general linear model could not be used as the variance was not homogenous. A Kruskal Wallis analysis of variance ($\alpha=0.05$) showed a statistically significant difference in the medians for benthic fish by site ($p<0.001$). The benthic area near fish had a higher median than the control and provincial fish; these latter two were not significantly different from each other.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program collected fish at 3 locations in Lake Huron in 2019 that included Loscombe Bank, Baie du Doré and Georgian Bay near Owen Sound. Four fish species types were sampled, including Lake Trout, Bass, Suckers and Whitefish, for a total of 22 samples. The tritiated water results for all Lake Trout, Suckers and Whitefish ranged from 3.1 becquerel per kilogram to less than detection, with 7 out of 20 results being less than the minimum detectable limit. The results for the two Bass retrieved from Baie du Doré were higher at 26.0 becquerel per kilogram and 17.0 becquerel per kilogram. All sample results reported by the Canadian Nuclear Safety Commission for tritiated water in fish tissue for all species and locations were well below the Guideline/ Reference level of 488,000 becquerel per kilogram. No human health impacts are expected from the measured values.

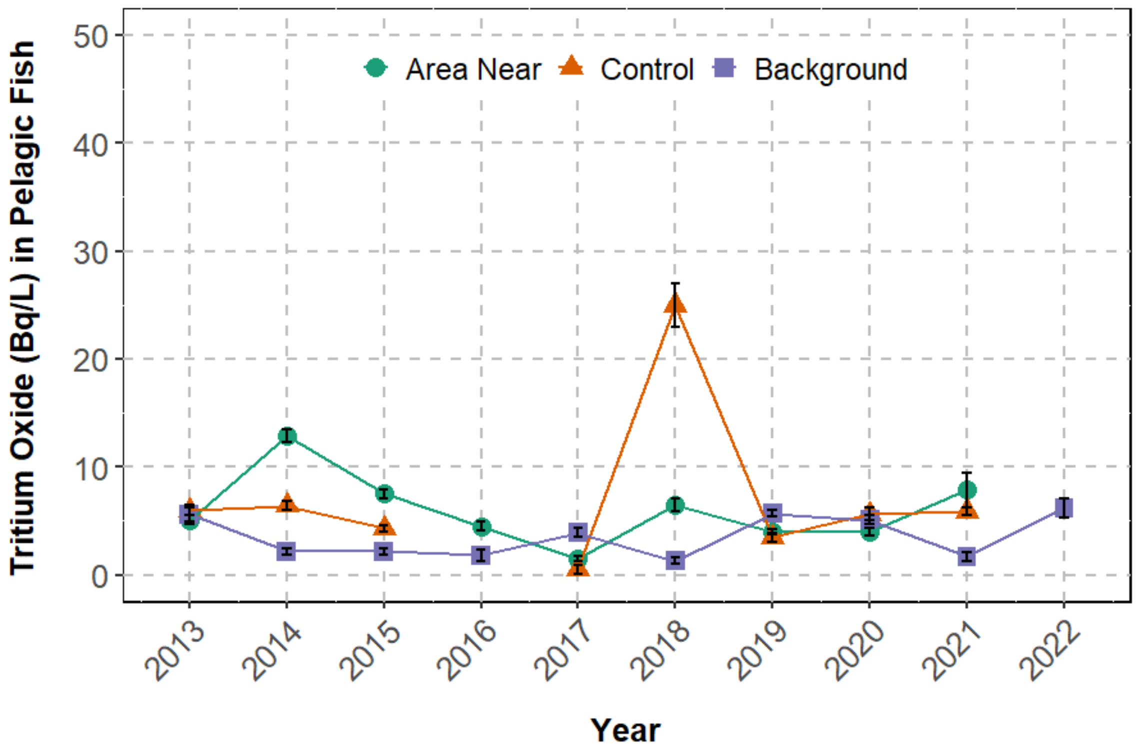


Figure 33 - Annual Average Tritium Oxide (Bq/L) in Pelagic Fish Tissue by Year Over Time (± Standard Error). No Bruce Power samples available in 2022.

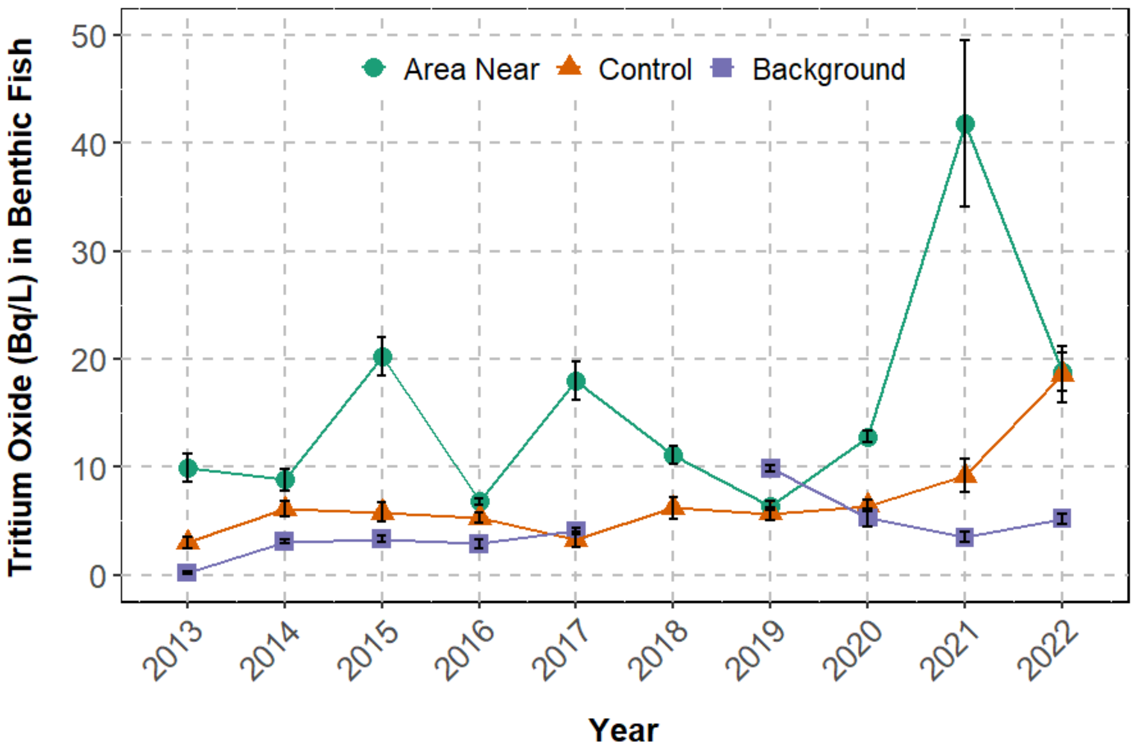


Figure 34 - Annual Average Tritium Oxide (Bq/L) in Benthic Fish Tissue by Year Over Time (± Standard Error).

Carbon-14 in Fish

The 2022 annual average concentration of carbon-14 in benthic fish collected near Bruce Power was 207 becquerel per kilogram and for control fish was 217 becquerel per kilogram. No pelagic fish were available for the 2022 year. The average provincial results for Lake Huron benthic fish collected in 2022 was slightly higher, at 225 becquerel per kilogram. The annual average carbon-14 concentrations over time are shown in Figure 35 for pelagic fish and Figure 36 for benthic fish. The carbon-14 levels measured in fish tissue of both species' types collected from Lake Huron have remained steady over time.

A general linear model (α=0.05) was performed by site over the last 10 years and identified that there is a statistically significant change over time ($p<0.001$) and no significant difference by site ($p<0.05$). An analysis of variance (α=0.05) shows that there is a significant difference in the means between the area near and control sites, and that the provincial mean is not significantly different from either.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program near Bruce Power did not analyze for carbon-14 in fish.

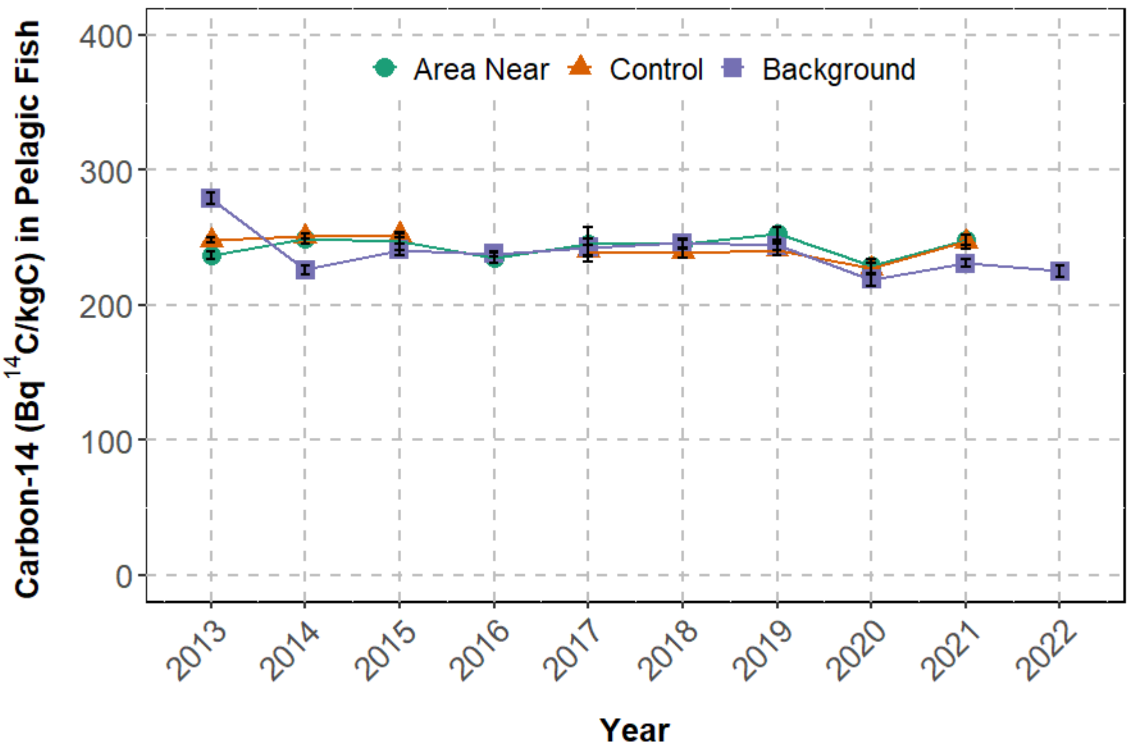


Figure 35 - Annual Average Carbon-14 (Bq/Kg) in Pelagic Fish Tissue by Year Over Time (± Standard Error). No Bruce Power samples available in 2022.

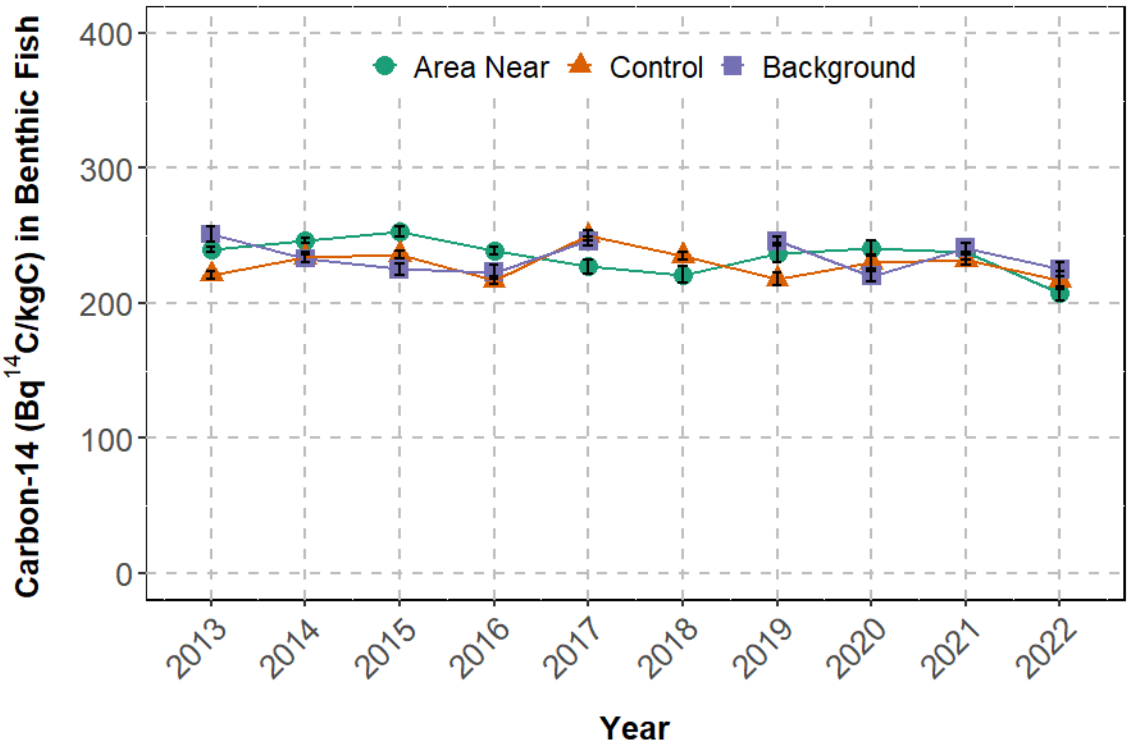


Figure 36 - Annual Average Carbon-14 (Bq/Kg) in Benthic Fish Tissue by Year Over Time (± Standard Error).

Cobalt-60 and Cesium-134 in Fish

The cobalt-60 and cesium-134 concentrations in fish samples measured by Bruce Power in 2022 were all less than the critical level (<Lc) or slightly above, indicating that these concentrations are indistinguishable from background and considered negligible. Where at least one fish result was >Lc the annual average, which includes uncensored data, was provided in Table 30. For groupings where all results were less than the critical level, the annual average was stated as <Lc. All fish measured by the province had cobalt-60 and cesium-134 concentrations less than the detection limit (<Ld) and annual averages were stated as <Ld.

Cesium-137 in Fish

The 2022 annual average concentration of cesium-137 in benthic fish collected near Bruce Power was 0.2 becquerel per kilogram and the control was 0.1 becquerel per kilogram. No samples of pelagic fish were available for the 2022 year. The provincial average cesium-137 results for Lake Huron benthic fish were similar to Bruce Power at 0.2 becquerel per kilogram.

These values are well below the Canadian Nuclear Safety Commission Reference Level of 1040 becquerel per kilogram.

The annual average cesium-137 results for the last ten years for Bruce Power area near, control and provincial background pelagic and benthic fish are shown in Figure 37 and Figure 38, respectively. For benthic fish the cesium-137 levels measured in 2022 are similar to historical values and near zero. Generally, the cesium-137 concentrations in fish tissue of pelagic and benthic fish collected in Lake Huron are low and have remained steady over time. A general linear model could not be used as the variance was not homogenous. A Kruskal Wallis analysis of variance (α= 0.05) showed no significant difference in the medians for benthic fish by site.

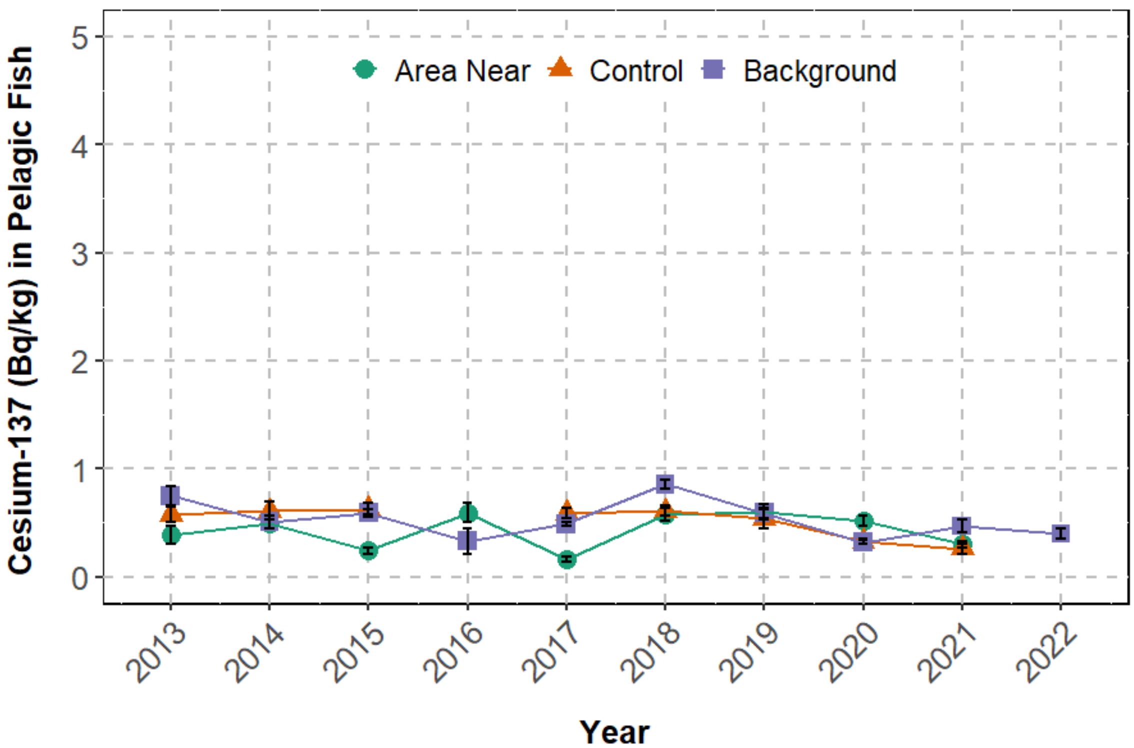


Figure 37 - Annual Average Cesium-137 (Bq/Kg) in Pelagic Fish Tissue by Year Over Time (± Standard Error). Reference Level = 1040 Bq/kg. No Bruce Power samples available for 2022.

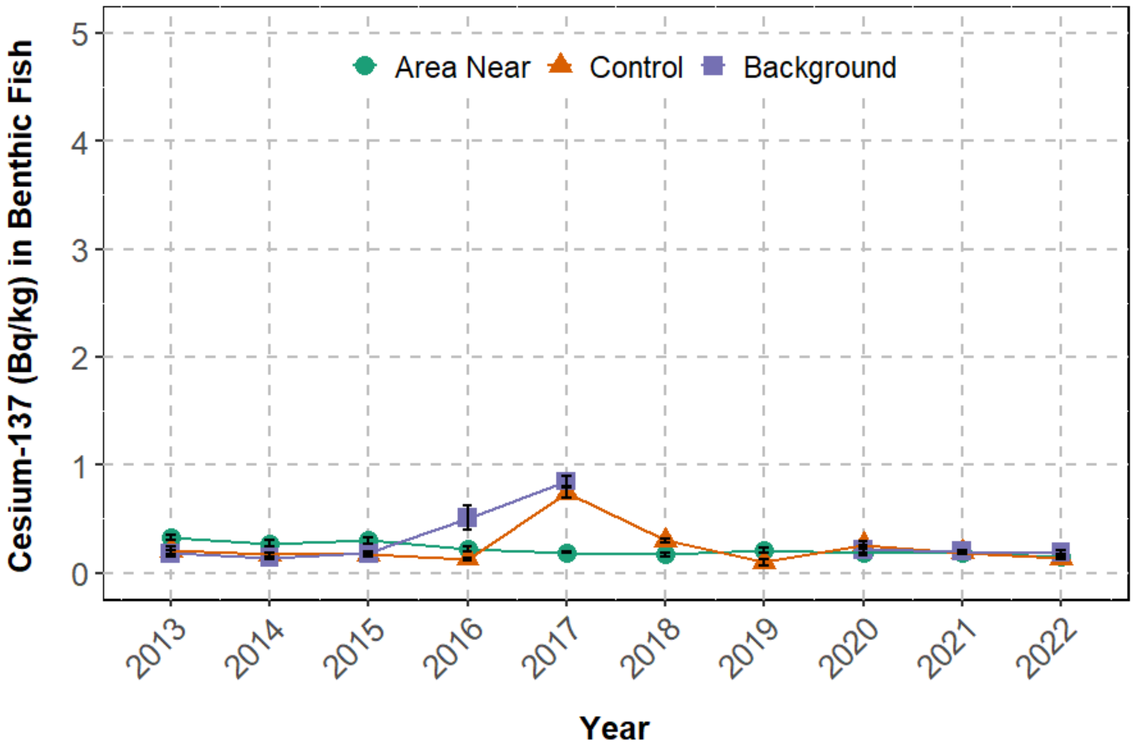


Figure 38 - Annual Average Cesium-137 (Bq/Kg) in Benthic Fish Tissue by Year Over Time (± Standard Error). Reference Level = 1040 Bq/kg.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program measured cesium-137 concentrations in fish collected at 3 locations in Lake Huron, including near Loscombe Bank, Baie du Doré and in Georgian Bay near Owen Sound. Fish species included Lake Trout, Bass, Suckers and Whitefish. Out of the 22 fish samples taken, only 10 had results that were greater than the limit of detection. The maximum cesium-137 value was for a Lake Trout (pelagic species) sample at 1.2 becquerel per kilogram, which is much lower than the Guideline/Reference Level of 1040 becquerel per kilogram. The Independent Environmental Monitoring Program results for the same species as used for the Bruce Power and provincial Monitoring Programs (Suckers and Whitefish) had cesium-137 values less than the detection limit.

Organically Bound Tritium in Fish

Organically bound tritium is measured on a composite sample of the eight fish samples collected for each type (pelagic and benthic) and location (area near and control) by Bruce Power. The result is based on the arithmetic mean of the activity of the single composite sample counted twice. In 2022, no samples of pelagic fish were available for analysis. For benthic fish, the area near and control organically bound tritium results were similar, at 10.3 becquerel per litre and 11.6 becquerel per litre, respectively.

The provincial background organically bound tritium results for fish are typically higher than the Bruce Power results. In 2022, the average organically bound tritium in Lake Huron pelagic and benthic fish were 29.9 becquerel per litre and 39.2 becquerel per litre, respectively. The methodology used to prepare fish samples for measurement of organically bound tritium in fish is not standardized, and Bruce Power uses a different methodology than the province. It was established in 2022 that the provincial results include both exchangeable and non-exchangeable tritium, whereas Bruce Power results include only the non-exchangeable organically bound tritium. Therefore, the annual results cannot be directly compared, and are not included on graphs showing long term trends.

The organically bound tritium results for the past 10 years are presented in Figure 39 for pelagic fish and Figure 40 for benthic fish. The 2017 results for Bruce Power (area near and control) pelagic and benthic fish were not available due to several factors including sample delivery, equipment reliability and QC failure. The ten-year trends show that, in general, the Bruce Power results for near and control fish for both types (pelagic and benthic) are similar to one another each year and are consistently less than or equal to 10 becquerel per litre. This demonstrates that fish residing closer to Bruce Power are not impacted by organically bound tritium more than fish collected further away.

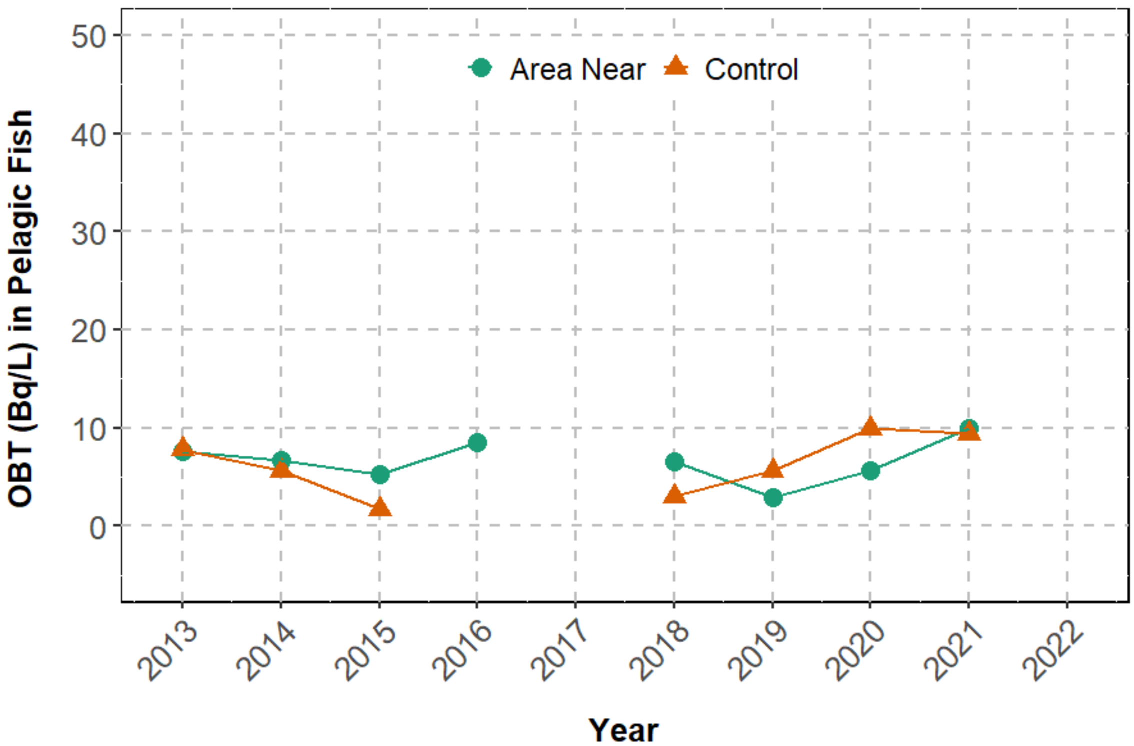


Figure 39 - Organically Bound Tritium (OBT) in Pelagic Fish Tissue. No Bruce Power samples available in 2022.

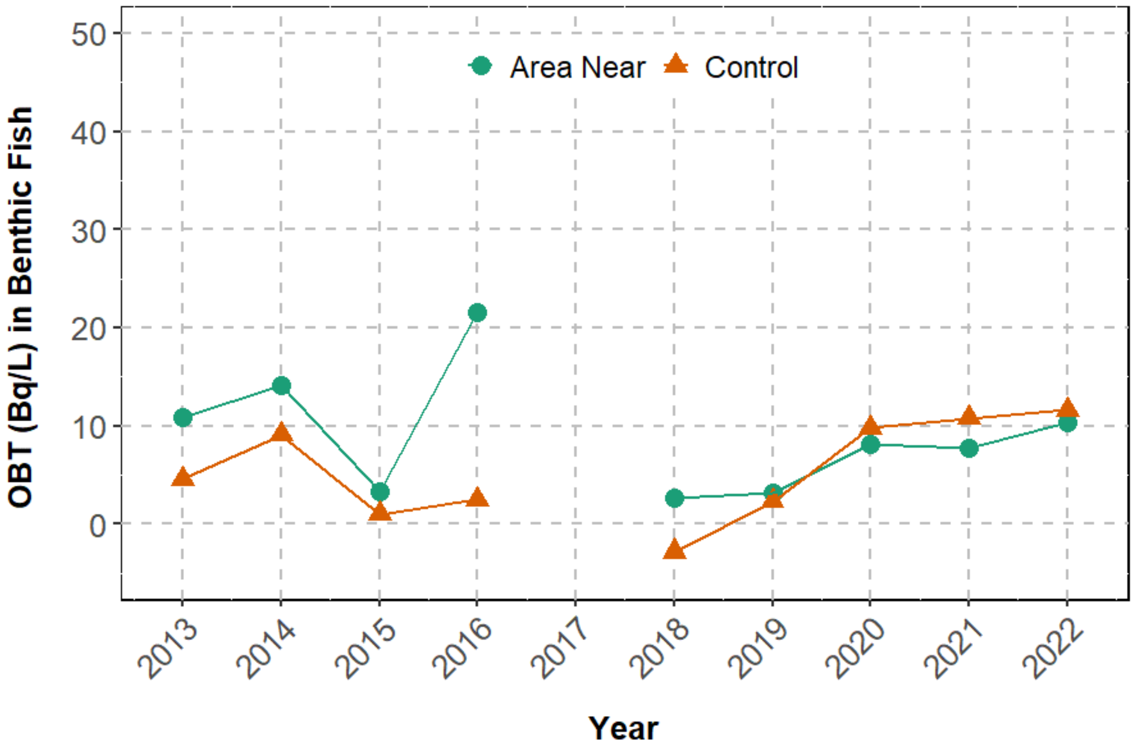


Figure 40 - Organically Bound Tritium (OBT) in Benthic Fish Tissue.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program collected 22 fish samples from 3 locations in Lake Huron, including Loscombe Bank, Baie due Doré and Georgian Bay near Owen Sound [R-28]. The fish types included Lake Trout, Bass, Suckers and Whitefish. Out of the 22 organically bound tritium results only 7 were greater than the limit of detection, with the maximum value of 4.1 becquerel per kilogram fresh weight, which is well below the Guideline/Reference Level of 212,000 becquerel per kilogram fresh weight.

6.1.4.2 Animal Products

Bruce Power samples animal products including honey, eggs, beef and poultry. Sampling locations are shown in Figure 24. Honey (harvested in area near and area far locations) is collected on an annual basis, while eggs are collected twice each year (spring and fall). There was a change to the ownership of the beef location in 2022 and no samples were obtained for this year. Chicken from a local farm was collected, however only enough sample was provided for tritium oxide and carbon-14 analysis this year.

On occasion, Bruce Power collects samples from wild animal fatalities that occur onsite (i.e., vehicular collisions) or from donations made by local hunters. In 2022, deer meat was provided by a local hunter, taken near MacGregor Park.

Animal products are analyzed for tritium oxide and carbon-14 by liquid scintillation counting, and the 2022 results are listed in Table 31. Some samples are also analyzed by gamma spectroscopy and the 2022 results for cobalt-60, cesium-134 and cesium-137 are shown in Table 32. The tritium oxide results are an average of two subsamples, the carbon-14 results are an average of two counts of a single sample, and the gamma results represent a single count of a single sample. As there is only one sample of each type, the analytical (uncensored) result is provided.

The province measures for background tritium oxide and carbon-14 in eggs (3 locations sampled quarterly) and poultry (8 samples) obtained from Picton, Ontario. The sampling location is shown in Figure 21, and the annual average values for 2022 are provided in Table 31.

Honey collected from a hive located near Bruce Power had a lower concentration of tritiated water compared to the honey sample collected farther afield (50.0 becquerel per litre vs 57.3 becquerel per litre, respectively). The area near sample is lower in 2022 compared to the previous year (101 becquerel per litre for 2021) but is similar to historical levels. The 2022 carbon-14 concentrations were similar to one another, at 210 becquerel per kilogram for area near and 201 becquerel per kilogram for area far, and slightly lower than in recent years. Like other years, the CANDU radionuclides cobalt-60, cesium-134 and cesium-137 were less than or similar to the critical level (Lc) and indistinguishable from background. Low levels of cesium-137 occur in the environment due to historical weapon's testing and other anthropogenic sources separate from Bruce Power.

The 2022 tritium oxide result measured in eggs obtained from a farm located near Bruce Power is slightly higher than the provincial background average (11.5 becquerel per litre vs 3.5 becquerel per litre), although the carbon-14 result is similar (225 becquerel per kilogram vs 226 becquerel per kilogram). The farm where eggs are collected changed in 2021 and there was a minor step change in the results for this year. In comparison to the 2021, tritium oxide increased in 2022 (3.0 becquerel per litre in 2021), but carbon-14 decreased (252 becquerel per kilogram in 2021). The new farm added in 2021 for eggs also now supplies poultry for the program. For 2022, the area near chicken sample had higher tritium oxide compared to both the provincial background average (20.7 becquerel per litre vs 1.1 becquerel per litre) and the previous year (0.7 becquerel per litre in 2021). By contrast, the carbon-14 concentration for 2022 was lower than the provincial background average (184 becquerel per kilogram vs 226 becquerel per kilogram), as well as the previous year (225 becquerel per kilogram in 2021). For 2022, not enough sample was available for a gamma analysis.

In 2022 a local hunter provided deer meat from a deer caught near MacGregor Park to be analyzed for radioactivity. The tritiated water (53.2 becquerel per litre) and carbon-14 (248 becquerel per kilogram) concentrations are similar to what has been measured in previous years (e.g., in 2021, tritium oxide 21.6 becquerel per litre; carbon-14 246 becquerel per kilogram). As observed in previous years, the gamma scan results for cobalt-60, cesium-134 and cesium-137 are very close to or are below the critical level and considered negligible.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program included locally sourced beef and pork samples in 2019 that were analyzed for tritiated water and organically bound tritium [R-28]. For the beef samples (stewing and ground) the tritiated water results were 3.9 becquerel per kilogram fresh weight and 11.1 becquerel per kilogram fresh weight, respectively, which are below the Guideline/Reference Level of 159,000 becquerel per kilogram fresh weight. The maximum organically bound tritium result was 2.1 becquerel per kilogram fresh weight with the other sample being less than the limit of detection (<1.5 becquerel per kilogram fresh weight). These are much lower than the Guideline/Reference Level of 69,300 becquerel per kilogram fresh weight. The results for the local pork sample were also below the Guideline/Reference Levels, with tritiated water measured at 3.7 becquerel per kilogram fresh weight (Reference Level of 392,000 becquerel per kilogram fresh weight) and organically bound tritium at 1.9 becquerel per kilogram fresh weight (Reference Level of 171,000 becquerel per kilogram fresh weight).

Table 31 - 2022 Annual Tritium Oxide and Carbon-14 Concentrations in Animal Products

Location Type	Sample Label	Sample Type	Tritium Oxide (Bq/L)	Tritium Oxide (± 2σ)	Tritium Oxide (Lc)	Carbon-14 (BqC^{14}/kg-C)	Carbon-14 (± 2σ)	Carbon-14 (Lc)
Bruce Power	Near-Deer-AM	Deer	5.32E+01	4.38E+00	2.65E+00	2.48E+02	2.80E+01	1.50E+01
Bruce Power	Near-Beef-AM	Beef	No sample	No sample	No sample	No sample	No sample	No sample
Bruce Power	BF25-AM	Chicken	2.07E+01	3.48E+00	3.04E+00	1.84E+02	2.43E+01	1.43E+01
Bruce Power	BF25-EG (spring)	Eggs	1.71E+01	3.30E+00	2.94E+00	2.21E+02	2.76E+01	1.57E+01
Bruce Power	BF25-EG (fall)	Eggs	5.97E+00	2.75E+00	2.89E+00	2.28E+02	2.78E+01	1.60E+01
Bruce Power	Near-BR22-HO	Honey	5.00E+01	4.46E+00	2.89E+00	2.10E+02	2.64E+01	1.53E+01
Bruce Power	Far-BR22-HO	Honey	5.73E+01	4.68E+00	2.89E+00	2.01E+02	2.57E+01	1.50E+01
Background	Picton - Average	Eggs	3.5E+00	-	-	2.3E+02	-	-
Background	Picton - Average	Poultry	1.1E+00	-	-	2.2E+02	-	-

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$. Lc is critical level. 2σ is uncertainty in the analytical result
2. Provincial background: Sample count = 12 for eggs and 8 for poultry (turkey).
3. Provincial background: For calculation of averages where result was less than detection limit (<Ld), the uncensored analytical result was used

Table 32 - 2022 Annual Gamma Radionuclide Concentrations in Animal Products Near Bruce Power

Location Type	Sample Label	Sample Type	Cobalt-60 (Bq/kg)	Cobalt -60 (± 2σ)	Cobalt - 60 (Lc)	Cesium-134 (Bq/kg)	Cesium - 134 (± 2σ)	Cesium - 134 (Lc)	Cesium - 137 (Bq/kg)	Cesium - 137 (± 2σ)	Cesium - 137 (Lc)
Bruce Power	Near-Deer-AM	Deer	<Lc	-	-	<Lc	-	-	1.91E-01	9.08E-02	6.97E-02
Bruce Power	Far-Beef-AM	Beef	No sample	No sample	No sample	No sample	No sample	No sample	No sample	No sample	No sample
Bruce Power	Near-Beef-AM	Beef	No sample	No sample	No sample	No sample	No sample	No sample	No sample	No sample	No sample
Bruce Power	BF25-AM	Chicken	No sample	No sample	No sample	No sample	No sample	No sample	No sample	No sample	No sample
Bruce Power	Far-BR22-HO	Honey	<Lc	-	-	<Lc	-	-	2.74E-01	2.79E-01	1.68E-01
Bruce Power	Near-BR22-HO	Honey	<Lc	-	-	<Lc	-	-	<Lc	-	-

Note:

1. E+00 represents scientific notation, E+03 = x10^3. Lc is critical level. 2σ is uncertainty in the analytical result
2. For honey, gamma results in Bq/L
3. When activity value was a negative number, ‘<Lc’ is stated in table

6.1.4.3 Milk

Since 2016 Bruce Power has worked with the Dairy Farmers of Ontario to ensure that milk samples may be collected from local dairy farmers on a weekly basis. One weekly sample from all farm locations are composited together and analyzed for iodine-131 by gamma spectrometry. Samples are analyzed for iodine-131 more frequently than other radionuclides because of its shorter half-life. A second weekly sample is collected from each farm and a monthly composite is analyzed for each individual farm for tritium oxide and carbon-14 by liquid scintillation counting. These radionuclides may be present in milk from the ingestion of feed and water and the inhalation of air by dairy cattle. For 2022 there were four farms participating in the Radiological Environmental Monitoring Program.

The milk sampling locations for Bruce Power are shown in Figure 24 and the provincial background locations (Belleville and London) are shown in Figure 21. The 2022 results for tritium oxide, iodine-131 and carbon-14 are shown in Table 33. Gamma emitting radionuclides other than iodine-131 were also measured, but results for CANDU related radionuclides cobalt-60, cesium-134 and cesium-137 were less than the limit of detection and not shown.

Table 33 - 2022 Annual Average Concentration Tritium Oxide, Iodine-131, Carbon-14 in Milk Samples

Location Type	Sample Location	Tritium Oxide (Bq/L)	Iodine-131 (Bq/L)	Carbon-14 (Bq/L)
Area Near	BDF01-MK	1.27E+01	Not applicable	2.23E+02
Area Near	BDF09-MK	9.08E+00	Not applicable	2.16E+02
Area Near	BDF15-MK	8.88E+00	Not applicable	2.19E+02
Area Near	BDF16-MK	7.60E+00	Not applicable	2.18E+02
Area Near	BDF-MK Composite	Not applicable	<Lc	Not applicable
Area Near	Average	9.67E+00	<Lc	2.19E+02
Background	DF1 Belleville D	1.4E+00	<Ld	2.1E+02
Background	DF1 Belleville E	1.9E+00	<Ld	2.2E+02
Background	DF1 Belleville F	2.2E+00	<Ld	2.3E+02
Background	DF2 London	<Ld	<Ld	2.3E+02

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$

2. 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 average was a negative number

3. Provincial background: For calculation of averages where result was less than detection limit (<Ld), the uncensored analytical result was used. '<Ld' stated in table when all values were <Ld

4. Sample count for Bruce Power is 12, except for I-131 which is 52. For provincial background sample count is 4 for Belleville and 3 for London

For 2022, the average annual tritium oxide concentration in milk at local dairy farms was 9.7 becquerel per litre. Although this value is higher than the provincial background values (Belleville average 1.8 becquerel per litre), this is well below the Ontario Drinking Water Standard for tritium (7000 becquerel per litre) [R-119]. Bruce Power and provincial annual average tritium concentrations in milk for the last seven years are shown in Figure 41. For 2022 there was a slight increase from the previous year, but the average is similar to historical values. The 2022 results may have been impacted by the higher tritium emissions released from Site, as described in Section 5.1.2.1. A general linear model (α=0.05) was performed by site over the last 10 years and identified that there is no statistically significant change over time ($p>0.05$) and that there is a significant difference by site. An analysis of variance (α=0.05) shows that there is a significant difference in the means between the area near and provincial background sites ($p<0.001$), with area near having the higher mean.

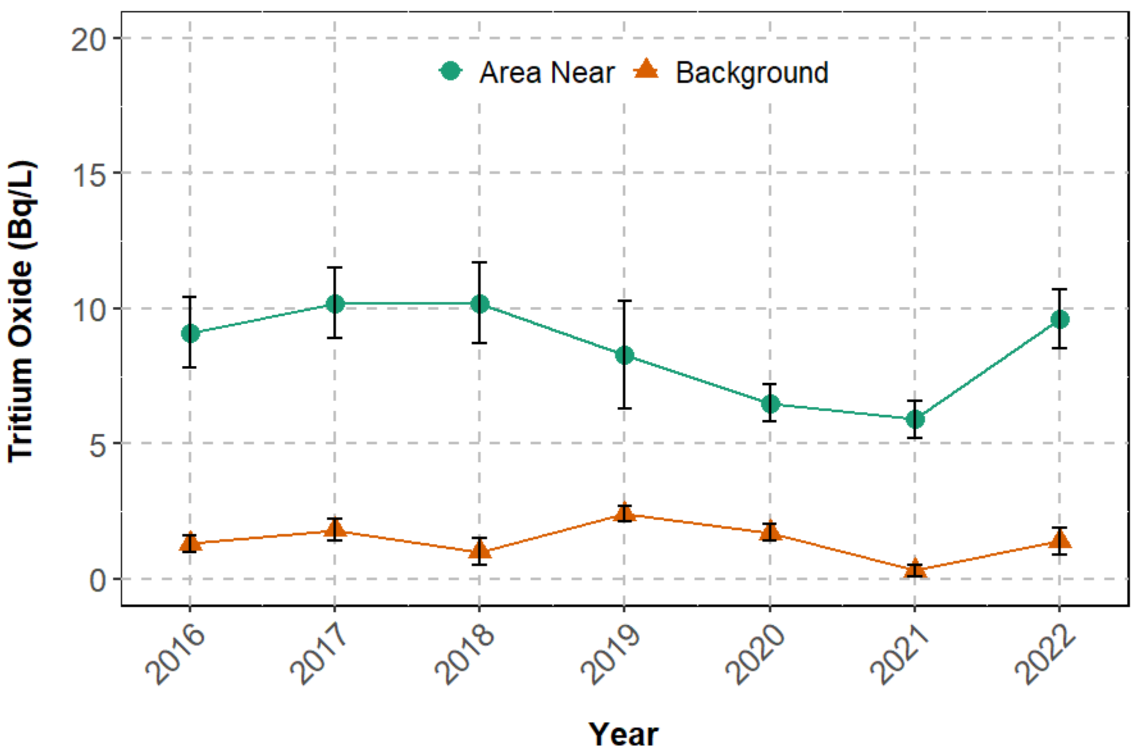


Figure 41 - Annual Average Tritium Oxide Concentration (Bq/L) in Milk Samples Collected Near the Bruce Power Site and Provincial Background Locations Over Time (± Standard Error)

The annual average carbon-14 result for area near milk samples was 219 becquerel per kilogram, which is similar to the provincial background average of 221 becquerel per kilogram. Both the area near and background averages for 2022 were slightly lower than in previous years (e.g., for 2021, 229 becquerel per kilogram for area near and 228 becquerel per kilogram for background). Annual iodine-131 concentrations in milk for both Bruce Power and provincial samples were negligible.

For the 2019 Canadian Nuclear Safety Commission Independent Environmental Monitoring Program milk was collected at a location near Tiverton and analyzed for tritiated water, iodine-131, cesium-137 and organically bound tritium [R-28]. The result for tritiated water was 19.6 becquerel per kilogram fresh weight, which is well below the Guideline/Reference Level of 5,560 becquerel per kilogram fresh weight. The results for iodine-131, cesium-137 and organically bound tritium were less than the limit of detection. These results are consistent with what Bruce Power reports and are not expected to have an impact on human health.

6.1.4.4 Agricultural Products

Local farms and residents supply Bruce Power with samples of various grains, fruits and vegetables grown on lands in the vicinity of Bruce Power. Sample locations are shown on Figure 24. These agricultural products are collected annually in specific wind sectors around the Bruce Power site and are analyzed for tritium oxide and carbon-14 by liquid scintillation counting. The commercial alcohol plant at the Bruce Eco-Industrial Park, formerly the Bruce Energy Centre (BEC), also provides Bruce Power with samples of corn mash (used for animal feed) for tritium oxide analysis on a quarterly basis.

The annual average tritium oxide and carbon-14 results for agricultural products measured by Bruce Power are provided in Table 34. For 2022, the types of grains collected were corn and soybeans and fruit samples consisted of apples. Bruce Power collects a variety of vegetable types to include above ground, leafy and below ground vegetables. In 2022 the above ground variety included tomatoes, the leafy group included samples of rhubarb, lettuce and sorrel, and the below ground vegetables were horseradish, potato, and carrot. Where multiple samples within a group (i.e., above ground) were found at the same location, the samples were combined into a composite sample for analysis.

Provincial background samples for fruits and vegetables typically include two sets of composite samples at four locations. For animal feed, sampling consists of semiannual collection at four locations. Sampling locations are provided in Figure 21 and the annual averages are provided in Table 34. The provincial results for animal feed, fruit and vegetables are not equivalent to Bruce Power as the items are different and analysis is done on composites. However, the results may be broadly compared.

Table 34 - 2022 Annual Average Data for Agricultural Products

Location Type	Sample Type	Tritium Oxide (Bq/L)	Carbon-14 ($Bq^{14}C/kg$-C)
Area Near	Grains	8.80E+01	2.08E+02
Area Near	Corn Mash	1.88E+01	Not applicable
Area Near	Fruit	1.08E+02	2.26E+02
Area Near	Vegetables - Above Ground	9.26E+01	2.19E+02
Area Near	Vegetables – Leafy	6.09E+01	2.15E+02
Area Near	Vegetables - Below Ground	7.49E+01	2.18E+02
Background	Animal Feed	2.0E+00	2.2E+02
Background	Fruit Composite	1.7E+00	2.1E+02
Background	Vegetable Composite	<Ld	2.2E+02

Note:

1. E+00 represents scientific notation, E+03 = $x10^3$
2. Bruce Power - For calculation of averages where result was less than critical level (Lc) the uncensored analytical result was used
3. Provincial background – For calculation of averages where the result was less than the minimum detection level (Ld), uncensored analytical result was used. If the average was a negative number, '<Ld' was used

Tritium oxide and carbon-14 content in agricultural products may vary each year based on the operational activities (i.e., radiological airborne emissions) that occur during the growing season. The annual average trend of tritiated water in fruits and vegetables over time are shown in Figure 42 and Figure 43, respectively. Consistently fruit and vegetables near Bruce Power have higher tritium oxide concentrations than that at provincial locations. The 2022 annual average for fruit harvested near Bruce Power increased in comparison to the previous year (108 becquerel per litre vs 47.4 becquerel per litre in 2021) but was similar to what has been observed in previous years (e.g., 105 becquerel per litre in 2015). There was a slight decrease in the annual average tritium oxide concentration for vegetables in 2022 compared to the previous year (76.1 becquerel per litre vs 80.4 becquerel per litre for 2021). Average tritium oxide concentrations in grains follow similar trends to those observed in vegetables. Tritium oxide results in 2022 for fruit, vegetables and grains were impacted by elevated airborne tritium releases at Bruce A (See Section 5.1.2.1). The annual average trend of carbon-14 in fruit and vegetables over time is shown in Figure 44 and Figure 45. Carbon-14 average values in fruit and vegetables remain consistent with historic trends and were very similar to the provincial values in 2022.

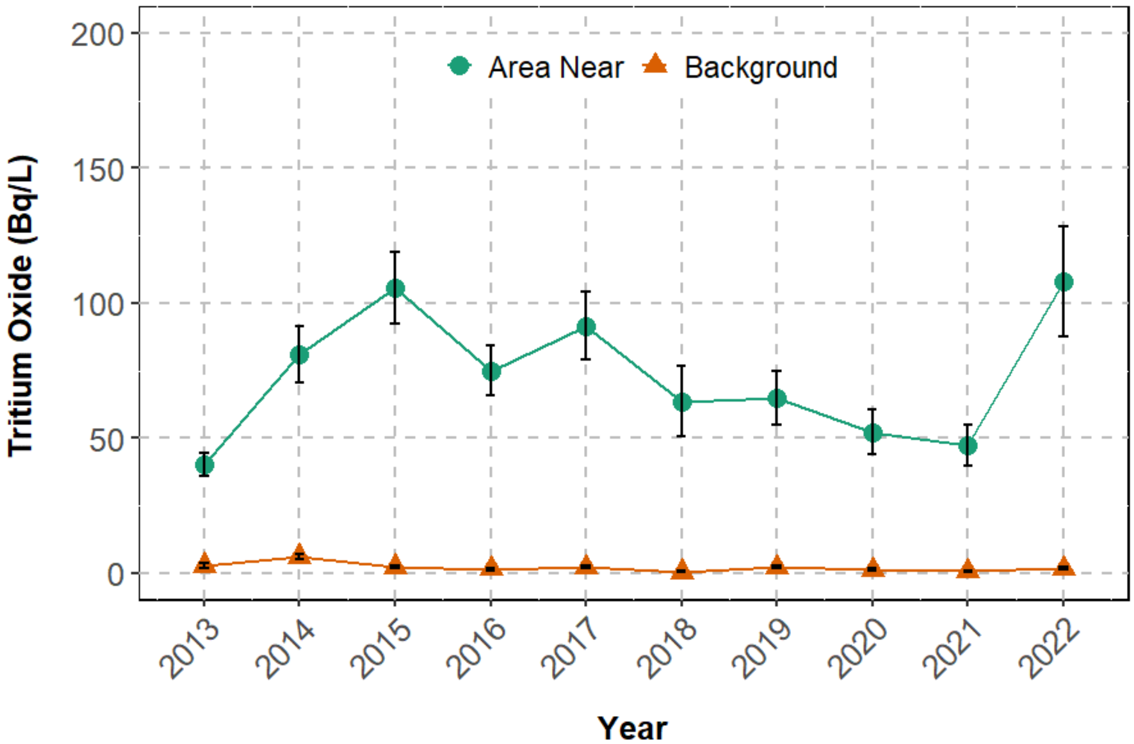


Figure 42 - Annual Average Tritium Oxide in Fruit at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

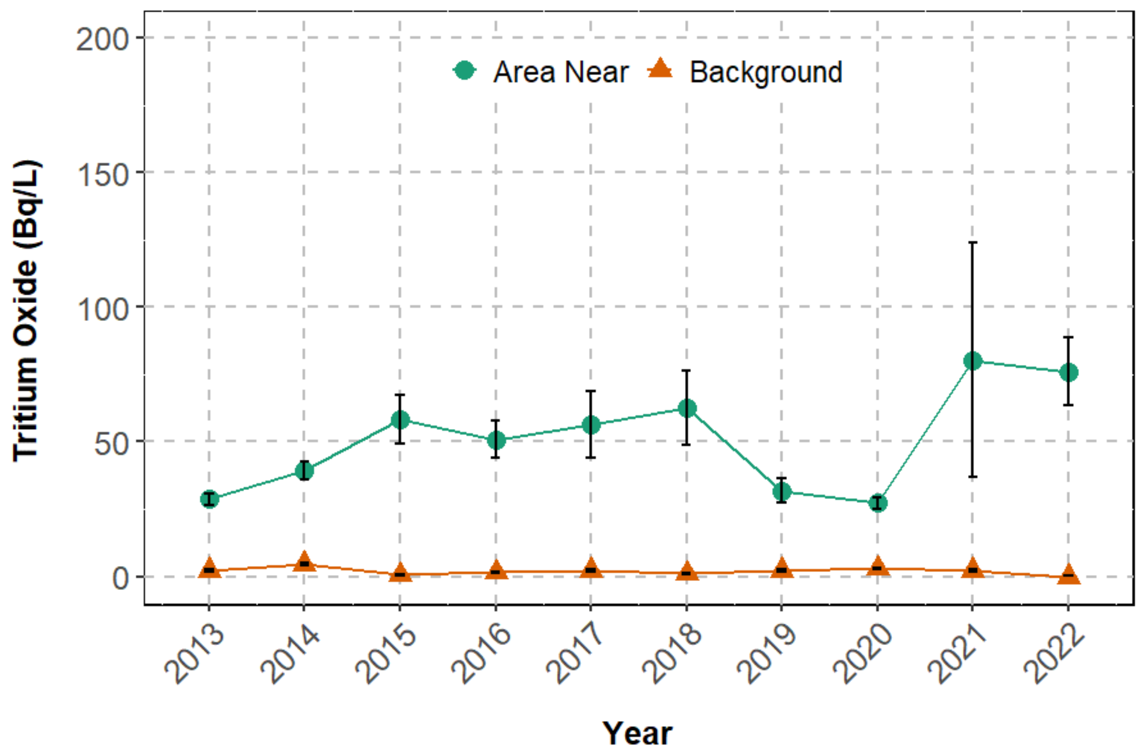


Figure 43 - Annual Average Tritium Oxide in Vegetables at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

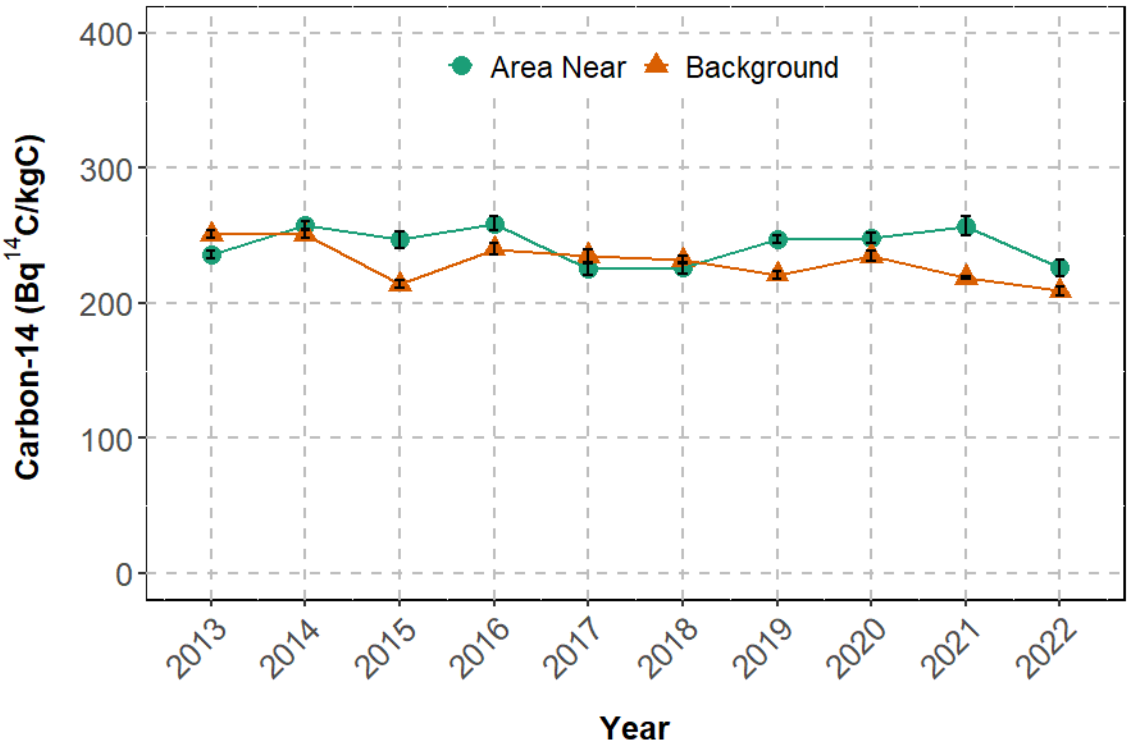


Figure 44 - Annual Average Carbon-14 in Fruit at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

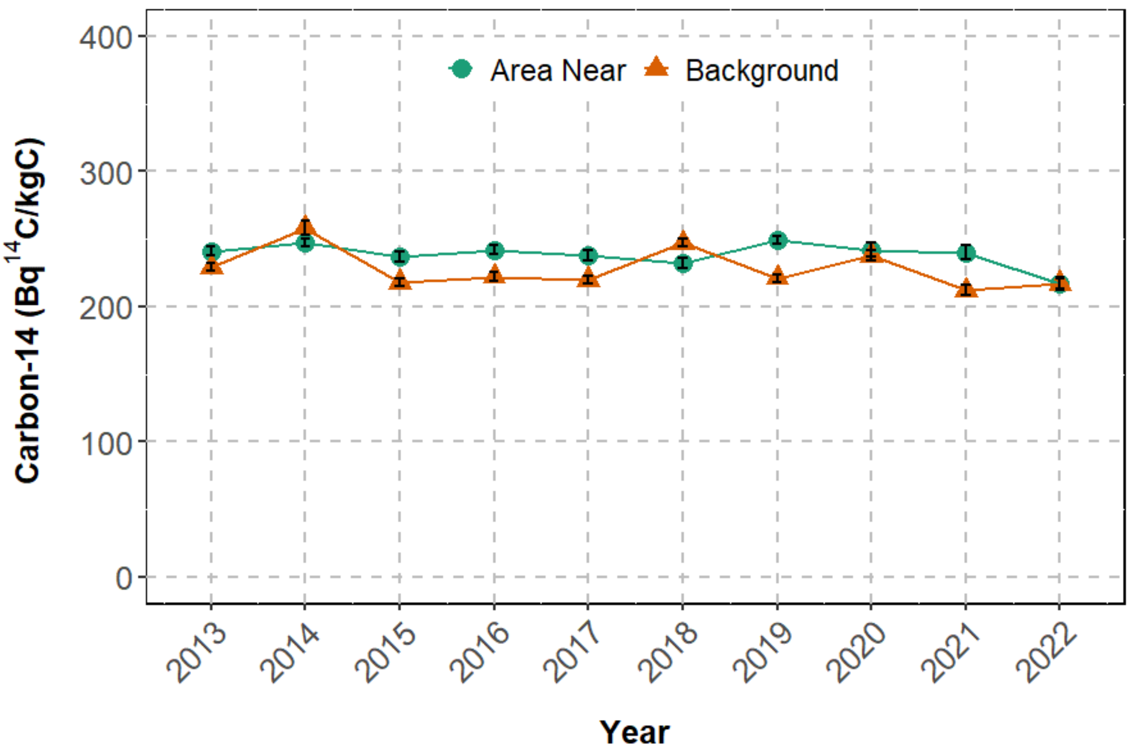


Figure 45 - Annual Average Carbon-14 in Vegetables at Bruce Power and Provincial Background Locations Over Time (± Standard Error).

As part of the 2019 Canadian Nuclear Safety Commission Independent Environmental Monitoring Program a variety of agricultural products were sampled including fruits, vegetables and vegetation [R-28]. Fruit samples were collected at Inverhuron (apples), Saugeen Shores (strawberries) and Concession Road 2 near Bruce Power (pears) and were analyzed for tritiated water and organically bound tritium. The results for tritiated water ranged from 4.2 becquerel per kilogram to 57.4 becquerel per kilogram fresh weight and were well below the Guideline/Reference Level of 123,000 becquerel per kilogram fresh weight. The organically bound tritium results ranged from 4.7 becquerel per kilogram to less than detection and were also below the Guideline/Reference Level (50,300 becquerel per kilogram).

Vegetables were sampled from Saugeen Shores (tomato, carrot, kale) and Concession 2 near Bruce Power (asparagus, rhubarb root) and analyzed for tritiated water and organically bound tritium. The results for tritiated water ranged from 8.6 becquerel per kilogram to 13.3 becquerel per kilogram fresh weight and were well below the Guideline/Reference Level of 104,000 becquerel per kilogram fresh weight. The organically bound tritium results ranged from 9.4 becquerel per kilogram to less than detection and were also below the Guideline/Reference Level (45,200 becquerel per kilogram). These results indicate that the tritium levels in fruits and vegetables sampled near Bruce Power are very low.

Locations where vegetation was collected included Baie du Doré, Inverhuron, Kincardine, Southampton and Neyaashiinigmiing (also known as Cape Croker). Samples included plantain, Eastern white cedar, cat tails (roots and leaves) and Balsam fir and were analyzed for cesium-137. All results, for all sample types and locations, had cesium-137 values that were less than the limit of detection (<3.2 becquerel per kilogram).

6.1.4.5 Agricultural and Animal Products Summary

Bruce Power regularly monitors tritium oxide, carbon-14 and gamma emitters in fish, animal meat, honey, eggs, milk, fruit and vegetables, grains, and animal feed at a variety of locations near Bruce Power. All results in 2022 were within historical levels and where applicable were well below the Canadian Nuclear Safety Commission Reference Levels, indicating that there is no impact to members of the public from ingesting foods grown locally to Bruce Power.

A summary is provided here:

- No pelagic fish were sampled in 2022 due to vendor issues. Tritium oxide levels in benthic fish decreased to typical levels in 2022. Other radionuclide concentrations, including carbon-14, cesium-137 and organically bound tritium, were very similar to background levels. No human health impacts are expected from these low levels.

- Levels of tritiated water in milk increased in 2022 compared to the previous year but were within historical values. Consistently, all other radionuclides measured in milk (i.e., carbon-14, iodine-131) were indistinguishable from background.

- As in other years, concentrations of tritiated water are higher in fruits and vegetables grown near Bruce Power, varying with operational activities that occur during harvest time. Regardless of the small fluctuations from year to year, the values are small and the dose to public remains negligible.

6.1.5 Beach Sand, Soil and Sediment Monitoring

Samples of garden soil and sediment are collected once every five years, while beach sand is collected annually. This is aligned with the sampling frequency carried out by the province. Samples are dried, sieved and analyzed for gamma-emitting radionuclides using gamma spectroscopy. The results are used in the annual dose to public calculation and inform the Environmental Monitoring and Environmental Risk Assessment programs to ensure that Bruce Power is appropriately monitoring and understanding its impact on the environment.

Sampling locations in the vicinity of Bruce Power and further afield along the shore of Lake Huron are shown in Figure 22, Figure 23 and Figure 24. Off-site samples of sediment and garden soil were last collected in 2019, as were the on-site soil samples for the Environmental Risk Assessment [R-120]. In 2022, samples of Lake Huron beach sand were collected and used in the dose calculation.

6.1.5.1 Offsite Beach Sand Monitoring

Beach sand was collected in 2022 at Baie du Doré, Inverhuron (duplicate samples) and Scott Point. The annual average results for CANDU related radionuclides cobalt-60, cesium-134 and cesium-137 are shown in Table 35, along with the provincial background results. The provincial radiological environmental monitoring program collects 8 beach sand samples from Cobourg and 2 samples from Goderich.

Table 35 - 2022 Annual Average Beach Sand Data

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

Note:

1. E+00 represents scientific notation, E+03 = x10^3

2. 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

3. 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

As in other years, the annual average cobalt-60 and cesium-134 values in beach sand at the area near location was less than the critical level, or indistinguishable from background. The area near average for cesium-137 is consistently very low. Although it was marginally higher than the provincial background averages for Cobourg and Goderich, it was well below the Canadian Nuclear Safety Commission Reference Level for soil (58.6 becquerel per kilogram dry weight) or sediment (37,300 becquerel per kilogram dry weight). As observed in previous years, cesium-137 levels are marginally higher to the north at Scott Point and Baie du Doré, which is consistent with the predominant lake current direction moving in the northerly direction and the position of the point in relation to the sill at the mouth of Baie du Doré.

The Canadian Nuclear Safety Commission Independent Environmental Monitoring Program included both soil and sediment samples in 2019. Soil was sampled at 4 locations, including Neyaashiinigmiing, Southampton, Tiverton, and a Concession Rd. 2 location near Bruce Power, and analyzed for cesium-137. The results were in the range of 3.0 becquerel per kilogram to 13.0 becquerel per kilogram and were well below the Guideline/Reference Level of 58.6 becquerel per kilogram dry weight. One sediment sample was included in the 2019 Independent Environmental Monitoring Program and was collected in Baie du Doré. The result for cesium-137 was 1.6 becquerel per kilogram, a value much lower than the

Guideline/Reference Level of 37,300 becquerel per kilogram dry weight sited by the Canadian Nuclear Safety Commission, and consistent with what is reported by Bruce Power.

6.1.5.2 Sediment Sampling

Samples of sediment are typically collected on a five-year frequency. The off-site monitoring locations were last sampled in 2019 and the on-site waterbodies were last sampled in 2021. No sediment samples were collected in 2022.

6.1.6 Radiological Environmental Monitoring Program Summary

The main objectives of the Radiological Environmental Monitoring Program, which are listed in Section 6.0, are to (i) obtain concentrations of radioactivity in environmental media each year, (ii) calculate radiation exposure doses to representative persons and demonstrate they are below the legal limit, and (iii) check the effectiveness of emission and effluent controls in place and provide public assurance of the efficacy of these measures. The Radiological Environmental Monitoring data collected in 2022 is provided in section 6.1 and the dose calculated from this information is described and compared to the legal dose limit in Section 3.0. The results demonstrate that radionuclide concentrations in the environment remain very low and that the emissions and effluent controls in place are effective and adequate. For 2022, the environmental monitoring results obtained were effective in meeting the Radiological Environmental Monitoring Program objectives.

6.1.7 Quality Assurance/Quality Control

6.1.7.1 Meteorological Data Analysis

The meteorological data analysis documented in this report was conducted in accordance with the Kinectrics Quality Assurance program [R-121]. The Kinectrics Quality Assurance program is registered to the 2015 International Organization for Standardization 9001 standard and the scope of the registration covers "consulting, scientific and engineering services to nuclear and other industries to support siting, safety, licensing, design and operations by providing specialized: asset management, project management, procurement, software, environmental, integrated analytical and engineering solutions and services". The Kinectrics Quality Assurance program is regularly audited by organizations such as CANDU Procurement Audit Committee (CANPAC) and has consistently been assessed as compliant with requirements of Canadian Standards Association Z299.1-85 [R-122] and Canadian Standards Association N286-12 [R-123].

6.1.7.2 Public Dose Calculations

The Public Dose calculations for 2022 were conducted in accordance with the Calian Engineering and Technical Services Quality Assurance Program. Calian has implemented and maintains a Quality Management System that is certified to the International Organization for Standardization 9001:2015 Standard [R-124].

The 2022 public dose calculations were conducted using the IMPACT 5.5.2 software. All inputs to the IMPACT model were verified based on Bruce Power environmental and emissions and effluents data. A verification tool was utilized to ensure that all numerical entries to the IMPACT model were inputted correctly, and the results of this IMPACT model verification were recorded. The results of the IMPACT calculation were independently verified.

The development of IMPACT 5.5.2 has been guided by, and subject to, an overall Tool Qualification Program, which follows the Canadian Standards Association N286.7-99 guidelines for quality assurance in software development for nuclear power plants [R-125].

6.1.7.3 Provincial Background – Ontario Power Generation Whitby Laboratory

The Ontario Power Generation Whitby Laboratory performed the thermoluminescent dosimeter gamma analyses and the provincial sample analyses. Details regarding the Ontario Power Generation Quality Assurance and Quality Control program are described in the Ontario Power Generation report *2022 Results of Environmental Monitoring Programs* [R-126].

6.1.7.4 Bruce Power Health Physics Lab

The Bruce Power Health Physics Lab operates a comprehensive Quality Assurance program, which includes quality control samples, blank/background samples, process control samples, and externally generated proficiency testing samples.

Sample Availability

The Bruce Power Health Physics Lab collected and analyzed 926 analyte samples against a target of 984 for an overall sample availability of 94%. This meets the sampling criteria of greater than 90% for the Radiological Environmental Monitoring Program. Typically, sample unavailability is due to seasonal conditions (such as variations in agricultural yields or frozen streams/ponds) or due to the nature of seasonal residences closed for certain months of the year, making wells unavailable for sampling. In addition, for 2022 maintenance activities at the Kincardine Water Supply Plant in May and October prevented sample collection for a total of 5 weeks, and the external vendor that supplies fish samples was not able to provide Lake Whitefish samples in the fall due to equipment deficiencies and issues finding fish. Details of the sample availability for 2022 are presented in Table 36 below.

Table 36 - 2022 Sample Availability Data

Sample Types	Collection Frequency	Planned	Actual	% Complete
Air Emissions	Monthly (tritium)	120	118	98%
Air Emissions	Quarterly (tritium, carbon-14)	172	172	100%
Environmental Gamma	Quarterly (gamma)	44	44	100%

Sample Types	Collection Frequency	Planned	Actual	% Complete
Precipitation	Monthly (tritium, GB)	120	120	100%
Water Supply Plants	Weekly Composite (tritium)	96	91	95%
Water Supply Plants	Monthly Composite (beta)	24	24	100%
Resident Well & Lake Water	Bi-Monthly (tritium, beta)	66	59	89%
Resident Well & Lake Water	Semi-Annually (tritium, beta, gamma)	32	31	97%
Local Streams	Bi-Monthly (tritium)	36	31	86%
Local Streams	Semi-Annually (beta)	8	8	100%
Site Ground Water	Semi-Annually (tritium)	80	73	91%
Fish	Annually (tritium, carbon-14, gamma, organically bound tritium)	32	16	50%
Milk	Weekly Composite (gamma)	52	52	100%
Milk	Monthly Composite (tritium, carbon-14)	48	48	100%
Fruits & Vegetables	Annually (tritium, carbon-14)	32	19	59%
Honey	Annually (tritium, carbon-14, gamma)	2	2	100%
Eggs	Annually (tritium, carbon-14)	2	2	100%
Grains	Annually (tritium, carbon-14)	6	6	100%
Grains	Quarterly (tritium)	4	4	100%
Animal Meat & Feed	Annually (tritium, carbon-14, gamma)	4	2	50%
Soil & Sand	Annually (gamma)	4	4	100%
Overall Site Sample Availability		984	926	94%

Note: Samples may have been unavailable because of seasonal conditions (e.g., freezing of water samples and seasonal residences that are closed for certain months of the year).

Laboratory Analysis Summary

A total of 1,174 laboratory analyses were conducted in support of the Bruce Power Radiological Environmental Monitoring Program in 2022. The analyses included tritium, gross beta, carbon-14, iodine-131, thermoluminescent dosimeter gamma (under contract to Ontario Power Generation), gamma spectrometry and organically bound tritium. Table 37 provides a summary of the number of samples analyzed for each analysis method.

Table 37 - 2022 Laboratory Analysis Summary

Laboratory Analysis	Number of Analyses
Tritium oxide	605
Gross Beta	174
Carbon-14	267
Iodine-131	52
Thermoluminescent Dosimetre Gamma	44
Gamma Spectrometry	32
Organically Bound Tritium	2
Total	1176

Note: Thermoluminescent dosimetre gamma analysis was completed by Ontario Power Generation, Whitby.

Laboratory Quality Assurance and Quality Control

The purpose of inter-laboratory proficiency testing is to provide independent assurance to Bruce Power, the Canadian Nuclear Safety Commission, and external stakeholders that the laboratory's analytical performance is adequate, and the accuracy of the measurements meets required standards. Table 38 presents a summary of the Bruce Power Radiological Environmental Monitoring Quality Assurance and Quality Control Program.

Table 38 - Summary of the Quality Assurance and Quality Control Program

Analyses	**Tritium**	**Tritium**	**Tritium**	**Gross Beta**	**Carbon-14**	**Gamma Spec**	**Gamma Spec**	**Gamma Spec**
Medium	**Organically bound**	**Water**	**Air**	**Water**	**Produce**	**Water**	**Sediment**	**Soil**
Historical	X	X	X	X	X		X	X
Relative	X	X	X		X		X	X
Inter lab Comparison	-	Eckert & Ziegler Analytics	-	Eckert & Ziegler Analytics	-	Eckert & Ziegler Analytics	Eckert & Ziegler Analytics	Eckert & Ziegler Analytics
Bias	QC Sample	QC Sample	QC Sample	QC Sample (^{137}Cs)	QC Sample (Sawdust)	Mixed Gamma QC Sample	Mixed Gamma QC Sample	Mixed Gamma QC Sample
Precision	QC Sample	QC Sample	QC Sample	QC Sample (^{137}Cs)	QC Sample (Sawdust)	Mixed Gamma QC Sample	Mixed Gamma QC Sample	Mixed Gamma QC Sample
Background	Low Tritium Water	Low Tritium Water	Low Tritium Water	Blank	Blank	Blank	Blank	Blank
Process Controls	Contamination	Contamination	Contamination	Contamination (de-min water)	Contamination (Coal)	-	-	-

Laboratory Quality Control

Various quality control samples are utilized to estimate the precision and accuracy of analytical results and to indicate errors introduced by laboratory practices. There are two types of quality control samples used to accompany the analyses of the environmental samples collected for the Radiological Environmental Monitoring Program: process control samples and quality control samples.

1. Process Control Samples

Process Control samples are low analyte samples that are treated as actual samples and go through the same handling process. These are intended to detect contamination and specific sources of error. The following main process control samples are used for Radiological Environmental Monitoring samples:

- Low tritium reference water samples kept open to the air during sample handling to detect if tritium contamination is picked up

- Coal (low carbon-14) samples to detect anomalies with carbon-14 analyses

- Demineralized water samples run as low gross beta samples to detect contamination
- Blank thermoluminescent dosimeters to detect radiation exposure during shipping to and from the Ontario Power Generation Whitby laboratory

2. Quality Control Samples

Quality control samples are samples which contain known values of the analyte (usually derived from traceable standards), which are included for analysis. Statistically based quality control charts are used to evaluate validity of environmental sample results; results are considered valid when the values for the accompanying quality control samples are within ± 3 standard deviations of the known or expected value for the respective control chart.

Proficiency Testing and Inter-laboratory Comparisons

The main purpose of inter-laboratory comparison programs is to provide independent assurance to Bruce Power, the Canadian Nuclear Safety Commission, and external stakeholders that the laboratory's analytical proficiency is adequate, and the accuracy of the measurements meets required standards. The comparison program forms a crucial part of the overall laboratory Quality Assurance program and demonstrates that the laboratory is performing within acceptable limits as measured against external unbiased standards.

Proficiency testing service is operated by Eckert & Ziegler Analytics Inc. of Atlanta, Georgia. On a quarterly basis Eckert & Ziegler Analytics provides samples containing known quantities of radionuclides to the Bruce Power Health Physics Laboratory. The samples are environmental matrices which are analogous to the samples collected for the Radiological Environmental Monitoring Program.

These samples include:

- Tritium in water
- Beta emitters in water
- Iodine in milk
- Gamma emitters in water
- Gamma emitters in soil
- Iodine-131 in iodine cartridge (annually)
- Gamma emitters on particulate filter (annually)

Upon completion of analysis, the Bruce Power analytical values are submitted to Eckert & Ziegler Analytics, which subsequently provides a final report for Bruce Power, detailing the expected values and the ratio of the laboratory value to the expected value.

All results obtained from Eckert & Ziegler Analytics shall meet the following self-imposed pass/fail investigation criteria:

$$\frac{(V_L + 1\sigma_L)}{V_A} \geq 0.75 \text{ AND } \frac{(V_L - 1\sigma_L)}{V_A} \leq 1.2$$

Where:

V_L = Bruce Power HPL value
σ_L = Bruce Power HPL one sigma uncertainty value
V_A = Analytics Supplier value

The results for the proficiency testing are presented in APPENDIX D:. All results for 2022 met the acceptance criteria and were acceptable.

6.1.8 Updates to Radiological Environmental Monitoring

The following changes were made to Radiological Environmental Monitoring in 2022:

- Loss of Dairy Farm BDF12 in January 2022 with no replacement available. As of 2022, the Radiological Environmental Monitoring Program has 4 dairy farm participants providing weekly samples of milk.

- Ownership of Beefway near Kincardine changed in 2022 and participation in the Radiological Environmental Monitoring Program was not reestablished in time to obtain near and far field samples of beef for 2022.

- A new vegetable sample location was added for the east-southeast wind sector.

6.2 Conventional Environmental Monitoring

The Canadian Standards Association standard N288.4, Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills outlines the following objectives for Environmental Monitoring Programs [R-127]:

- measure the concentration of hazardous substances and physical stressors in the environment to allow for the assessment of potential biological effects from stressors arising from the facility;

- demonstrate compliance with limits on hazardous substances and physical stressors in the environment; and

- verify that the facility has effective containment and effluent control measures in place.

The Bruce Power Conventional Environmental Monitoring Program monitors for conventional contaminants, physical stressors, potential biological effects, and pathways for both human and non-human biota. Non-radiological chemical stressors from historic and current operations are monitored (with future effects predicted using models as needed) in local surface waters, sediments, soil, and/or air using an activity-centered, risk-based approach. Effects on wildlife from physical stressors are documented using numerous Biological Effects Monitoring approaches.

Chemical stressors that have the *potential* for environmental impact are referred as Chemicals of Potential Concern. Chemicals of Potential Concern are routinely monitored at Bruce Power, and they are chosen based on known controlled releases from the facility. Controlled effluents and emissions are regulated and are described in Bruce Power's Conventional Effluents and Emissions Monitoring Program (see section 5.2). A second pathway to the environment is through an uncontrolled release (i.e., spill). If a spill was to occur and a contaminant reached the environment, the location and frequency of Chemicals of Potential Concern monitoring may change on a case-by-case basis, as dictated by remediation activities and/or follow-up monitoring.

Routine monitoring for conventional Chemicals of Potential Concern occurs in surface waters (annually) and sediments (every 5 years) because they have the highest probability of impact from facility operations such as station effluents, storm water discharges, and Centre of Site operations (e.g., sewage treatment and discharges). Soil has a low probability of being impacted by chemical stressors at Bruce Power, primarily because Chemicals of Potential Concern are not discharged directly to soil under normal operations. This has been repeatedly demonstrated in past Environmental Risk Assessments [R-43]. Sediments and soils were sampled in 2021 to inform an updated Environmental Risk Assessment. For a detailed assessment of risk to potential receptors please refer to the 2022 Environmental Risk Assessment [R-43].

The impact of air emissions on the surrounding environment is assessed annually in the Conventional Environmental Monitoring Program and in recurring Environmental Risk Assessments which have demonstrated that these impacts are very low [R-43]. The transport of Chemicals of Potential Concern through the air to surface water (and potentially sediment, soil or groundwater) occurs via deposition, runoff and percolation processes. Transport through air is short-lived and thus there is minimal interaction between Chemicals of Potential Concern and potential receptors.

6.2.1 Routine Lake Water Quality and Stream Water Quality Assessment – 2022

6.2.1.1 Lake Water Quality

Lake Huron surface water quality samples were taken from 1 metre below the lake surface at five long-term monitoring locations near Bruce Power on July 6, 2022, and October 4, 2022 (Figure 46). These locations are representative of near field, wildlife habitat and reference areas. Bruce A and Bruce B discharges (LWQ1 and LWQ2, respectively) were sampled to sufficiently characterize the effluent from facility operations. Baie du Doré (LWQ5) was sampled as it is a wildlife habitat area. Sampling locations at the southern (LWQ8) and northern (LWQ7) limits are reference locations. The results of these water quality analyses are presented in APPENDIX E:, Table 100 and Table 101, alongside the historical trend observed between 2017 and 2022. These data continue to show that Bruce Power has effective containment and effluent control measures in place, and that facility operations have little-to-no effect on the water quality in Lake Huron [R-43] .

Sample results are compared to several criteria including:

- Provincial Water Quality Objectives as established by the Ontario Ministry of Environment, Conservation and Parks [R-128];
- The Canadian Council of Ministers of the Environment freshwater, long-term water quality guidelines for the protection of aquatic life [R-129];
- Ontario Drinking Water Standards as listed in *Ontario Regulation 169/03* [R-65];
- Health Canada Guidelines for Canadian Drinking Water Quality [R-130]; and
- Site-specific target levels, as developed in the 2022 Environmental Risk Assessment (Table 38) [R-43].

All lake water quality parameters in 2022 were below the screening criteria, with the exception of pH, unionized ammonia, phosphorous, phenolics, copper, lead and zinc in some locations.

Two out of the 11 samples were greater than the screening criteria set by the Ministry of the Environment, Conservation and Parks (6.5 to 8.5), but they both fell within the Canadian Council of Ministers of the Environment acceptable pH range for freshwater, which is between 6.5 and 9.0 [R-131]. This range is considered to be protective of fish and benthic invertebrate toxicity [R-132].

For unionized ammonia and phosphorous, it is not unusual to see elevated levels. Ammonia inputs into Lake Huron from sewage, agriculture and/or nearby industry have been shown to impact water quality, as documented in nearby Provincial Water Quality Monitoring Network monitoring sites and off-site samples collected from within Stream C (upstream) [R-43]. Studies along the Lake Huron shoreline have identified that agricultural land uses are a significant source of phosphorous to Lake Huron [R-133]. The Ontario Provincial Water Quality Monitoring Network (https://data.ontario.ca/dataset/provincial-stream-water-quality-monitoring-network) has active monitoring stations near Bruce Power to the north (Mill Creek) and south (Pine River). Data from these Ontario Provincial Water Quality Monitoring Network stations demonstrates that these local rivers are impacted by agriculture as phosphorus concentrations are almost always above the preliminary benchmark concentration of 20 micrograms/litre. Phosphorus inputs to Lake Huron from across the lake fringe watersheds can reasonably account for the elevated phosphorus concentrations observed in surface water samples collected within Lake Huron in 2022. Although Bruce Power contributes to these Chemicals of Potential Concern, all releases in 2022 were within environmental compliance approval limits.

Prior to 2022, phenolics were not routinely analyzed in Lake Huron water quality samples because they were not part of the analysis package offered by the external laboratory. In 2022 this parameter was added to the analysis package and seven out of 11 samples collected showed elevated levels of phenolics. This Chemical of Potential Concern occurs naturally in aquatic environments due to the decomposition of aquatic vegetation or can originate from industrial effluent, domestic sewage or pesticides [R-131]. Given the prevalence of phosphorous in Lake Huron from agricultural sources, it is possible that a similar situation may exist for phenolics.

For the first time, two occurrences of lead above the screening criteria (at the Bruce A outfall LWQ1 and Bruce B outfall LWQ2) and one occurrence of copper above the screening criteria (at MacGregor Point LWQ7) in Lake Huron were identified in October 2022. Sampling in 2023 will continue to monitor for these Chemicals of Potential Concern to determine their prevalence. The same three locations had zinc concentrations above the screening criteria in October as well. Elevated zinc concentrations were found in these two locations near Bruce Power in June 2021 and MacGregor Point in December 2018. The reason for the anomalies is unknown, but it is noted that pH was elevated during these periods of time.

Historical lake water quality data collected between 2017and 2021 are presented in the 2022 Environmental Risk Assessment [R-43]. These data were collected from the locations shown in Figure 46, retired monitoring locations, and from the Coastal Waters Monitoring Program stations in Baie du Dore and Inverhuron Bay. The 2017-2021 data are comprehensively assessed in the 2022 Environmental Risk Assessment [R-43], including a discussion of any exceedances of the screening criteria and characterization of the risk to potential receptors.

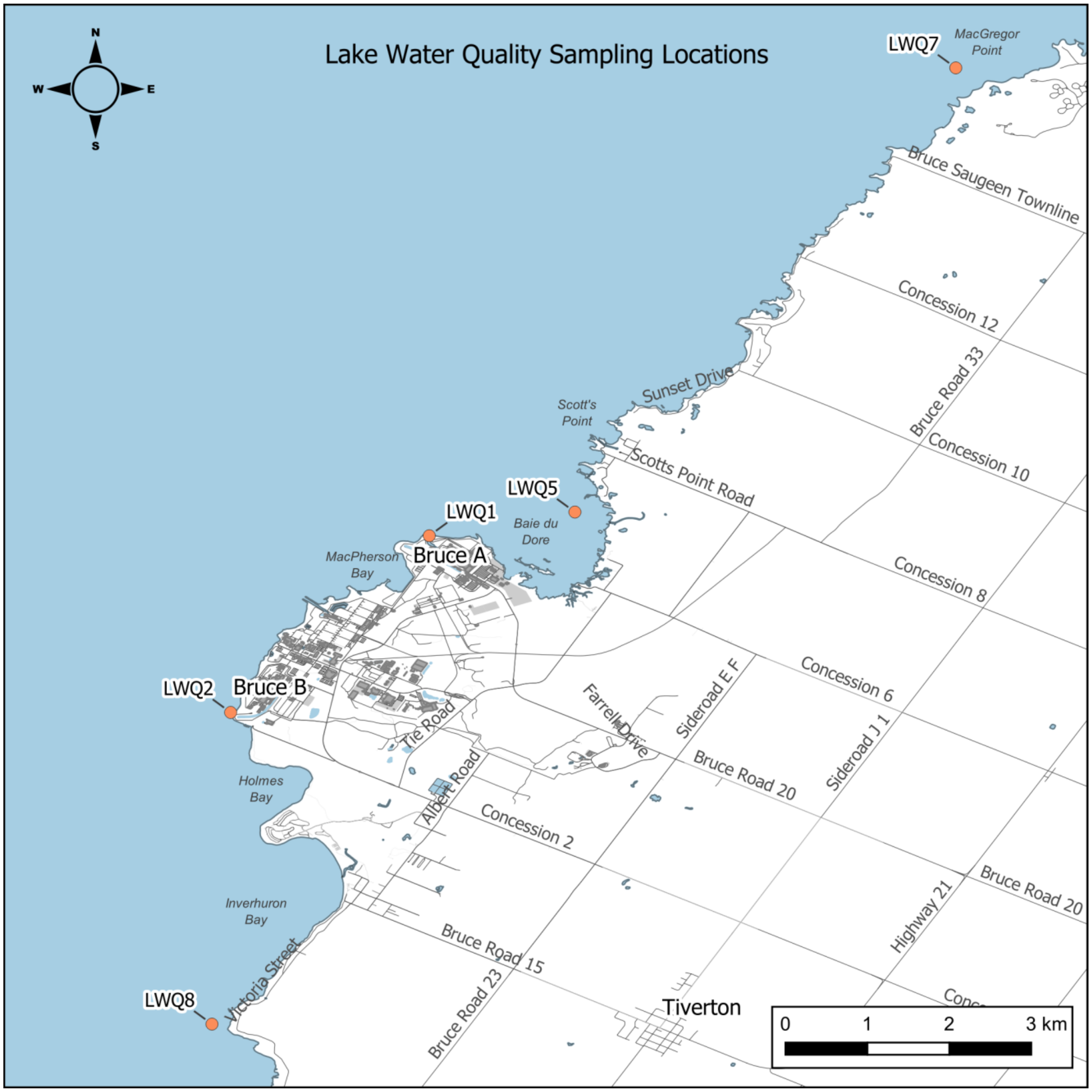


Figure 46 - Long-term Water Quality Monitoring Locations Sampled in Lake Huron in 2022

6.2.1.2 Water Quality in Stream C and On-site Drainage Features

Surface water quality samples were taken at several locations across the Bruce Power site in 2022, including the long-term monitoring locations in 'Stream C' (Figure 47). Stream C is a small stream that originates off-site (headwaters on the Nipissing Bluff just east of site), flows through site including Hydro One and Ontario Power Generation lands, and discharges to Baie du Doré. Two long-term monitoring locations exist in Stream C; one at the upstream boundary of the facility (SW1), and one at a downstream location near the discharge to Lake

Huron (SW2). Additional on-site surface water monitoring locations (SW3-SW6) were sampled throughout the year in the spring, summer, and fall of 2022. Sampling at SW4-SW6 was contingent upon sufficient flow, which is restrictive during summer months when base-flow conditions are low. Additional samples were taken from the pond adjacent building B31 and the former Ontario Power Generation Construction Landfill #4 (historically referred to as 'Ornamental Pond'). Samples were also taken from the pond beside B16 and from the pond at the 'Former Sewage Lagoon'. One sample taken by Ontario Power Generation in 2020 for their Western Waste Management Facility Environmental Risk Assessment ('Stream C Confluence') is shown for reference only and was not sampled by Bruce Power in 2022 (Figure 47).

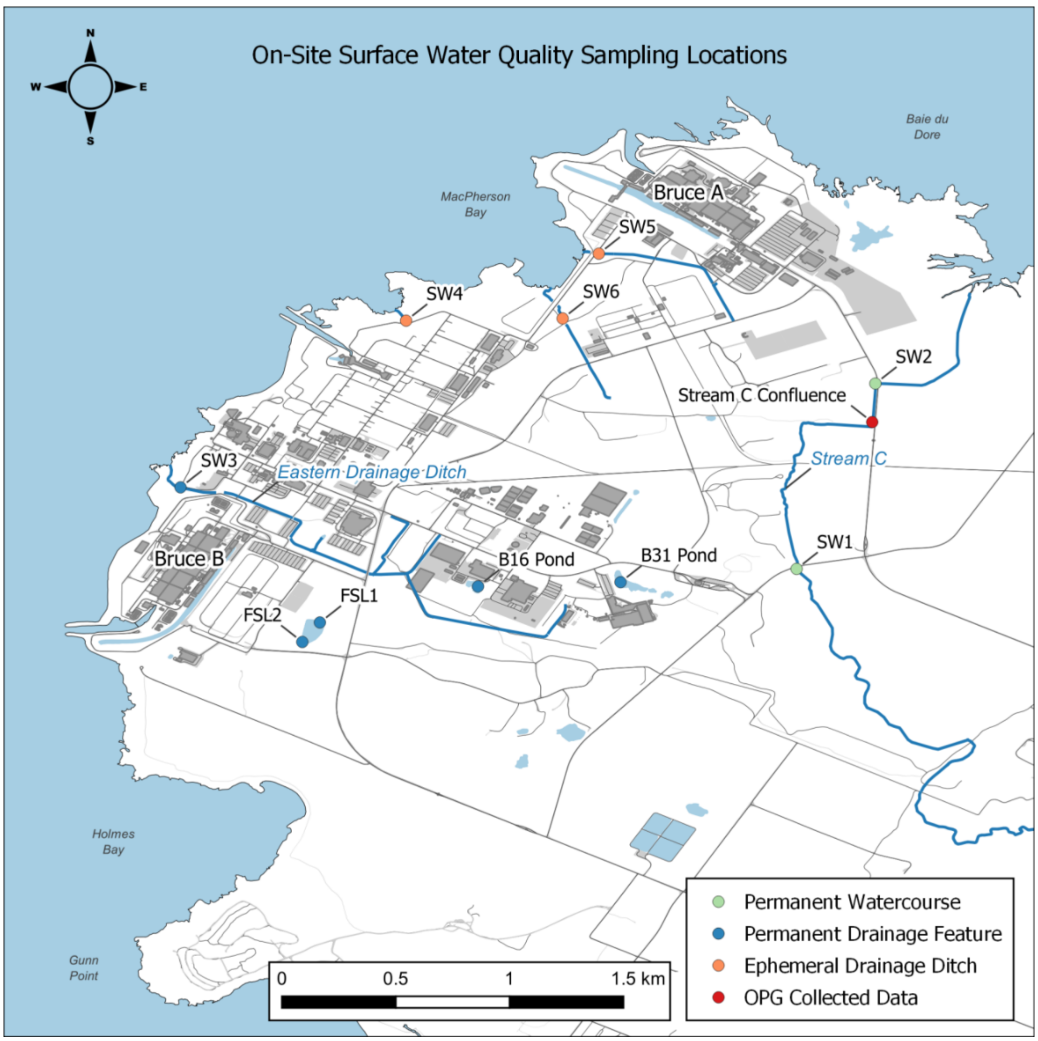


Figure 47 - Water quality monitoring locations sampled in 2022 from Stream C and on-site drainage features. The Ontario Power Generation sampling station 'Stream C Confluence' is shown here for reference only and was not sampled in 2022 by Bruce Power

Sample results are compared to several criteria including:

- Provincial Water Quality Objectives as established by the Ontario Ministry of Environment, Conservation and Parks [R-128];
- The Canadian Council of Ministers of the Environment freshwater, long-term water quality guidelines for the protection of aquatic life [R-129];
- Ontario Drinking Water Standards as listed in *Ontario Regulation 169/03* [R-65];
- Health Canada Guidelines for Canadian Drinking Water Quality [R-130]; and
- Site-specific target levels, as developed in the 2022 Environmental Risk Assessment (Table 38) [R-43].

A comprehensive assessment of data from 2017 to 2021 is outlined in the 2022 Environmental Risk Assessment [R-1], including a discussion of any exceedances of the screening criteria and characterization of the risk to potential receptors.

In 2022, results above the screening criteria continued to be recorded in some on-site surface water samples for the following Chemicals of Potential Concern: unionized ammonia, phosphorous, chloride, fluoride, aluminum, copper, iron, uranium, vanadium, and zinc.

The concentration of unionized ammonia in surface waters is dependent on the concentration of total ammonia, and the temperature and pH of the lake water. As temperature and pH rise, the fraction of unionized ammonia increases.

As mentioned in Section 6.2.1.1, phosphorous has been shown to be elevated in Lake Huron and other local surface water bodies due to run-off from agricultural activities. This is supported by the observation that phosphorous is elevated in the upstream portion of Stream C (SW1), prior to any influence from the Bruce Power site.

According to the 2022 Environmental Risk Assessment, elevated chloride levels are expected due to road salting practices as part of the facility’s general maintenance programs and fluoride is naturally elevated in regional groundwaters and surface waters due to the geology of the region [R-134].

Aluminum concentrations were generally higher in the upstream portion of Stream C (SW1) when compared to the downstream portion (SW2), indicating that loading is occurring somewhere before the permanent drainage system enters the site.

Copper concentrations in a sample from Stream C (upstream of the site at SW1) in March 2022 were above the preliminary screening criteria. However, levels returned below the screening criteria in May, July, August, and November 2022 sampling events. Copper concentrations at SW8 in November 2022 were above the preliminary screening criteria as well. Monitoring will continue in 2023 to determine if this is an ongoing issue.

In March 2022, iron was elevated above the screening criteria in Stream C (SW1 and SW2) and the Heavy Water Lands discharge (SW4). The March concentration at SW1 was approximately two times that at SW2 and therefore, suggests an impact from off-site activities farther upstream. Iron continued to be elevated in Stream C (upstream) through May, July, August, and November 2022. Stream C (downstream) saw elevated iron in July, but then remained below the screening criteria for August and November. In August 2022, SW7, SW8 and the B16 Pond saw iron above the screening criteria. By November, only SW8 Iron had persisted above the screening criteria. These results are in alignment with the trend of Iron levels in previous years. Monitoring will continue in 2023 to look for any changes.

For the first time since on-site surface water quality sampling began, uranium concentrations above the screening criteria were seen in Heavy Water Lands drainage (SW4) in November 2022. The source of uranium is unknown at this time, but monitoring will continue in 2023 to assess the impact.

Vanadium concentrations in the Eastern Drainage Ditch (SW3) were above the screening criteria in July and November 2021, as well as March 2022. However, concentrations returned to below the screening level in August and November 2022, leading to the assumption that the source has been eliminated or that fluctuations are cyclical. Routine on-site surface water quality monitoring of this location will continue in 2023 and sampling of benthic invertebrates will be carried out to determine the transfer factor from water and sediment to insectivorous aquatic organisms.

The Eastern Drainage Ditch (SW3) and SW8 saw increased levels of zinc in March and August 2022, respectively but returned to concentrations below the screening criteria by the November 2022 monitoring event.

The full results of the 2022 water quality analyses are presented in APPENDIX E:, Table 100 and Table 101, alongside the historical trend observed between 2017 and 2022.

6.2.1.3 Sediment Sampling in Lake Huron, Stream C and On-site Drainage Features

No sediment sampling was performed by Bruce Power in 2022. Sediment sampling is performed once every five years and was last completed in 2021. Results of these samples are documented in the 2021 Environmental Protection Report [R-135] and the 2022 Environmental Risk Assessment [R-43].

Alternatively, historical sediment data can be viewed using a new interactive tool that has been developed for this purpose. The tool can be accessed through the following link:

https://wsp-shinyapps.shinyapps.io/ERA_screening_tables/

6.2.1.4 On-site Soil Sampling

No on-site soil sampling was performed by Bruce Power in 2022. Soil sampling is performed once every five years and was last completed in 2021. Results of these samples are documented in the 2021 Environmental Protection Report [R-135] and the 2022 Environmental Risk Assessment [R-43].

Alternatively, historical soil data can be viewed using a new interactive tool that has been developed for this purpose. The tool can be accessed through the following link:

https://wsp-shinyapps.shinyapps.io/ERA_screening_tables/

6.2.1.5 Quality Assurance and Quality Control

The external laboratory that analyzes samples from the Conventional Environmental Monitoring Program is certified under The Canadian Association for Laboratory Accreditation and operates a Quality Assurance and Quality Control program in accordance with International Organization for Standardization 17025 for competence of testing and calibration laboratories.

The internal Bruce Power laboratory also operates a documented, comprehensive Quality Assurance and Quality Control Program, which includes the use of blank samples, blind duplicate samples and spike samples.

Performance criteria are specific to each monitoring effort and are outlined in the annual Conventional Environmental Monitoring Program plan. Data acceptance criteria are defined for chemical analyses and are analyte-group specific. These criteria are defined in terms of specific data quality metrics such as analyte detection limits, matrix spike recovery, precision and blank results. The detection limit of the method used to measure the concentration, intensity should be less than the benchmark value identified for that contaminant, physical stressor, or effect [R-127].

6.2.1.6 Achievement of Program Objectives – 2022

As demonstrated in this report, the 2022 Conventional Environmental Monitoring Program is effective as the program continued to meet the objectives defined in the Canadian Standards Association standard N288.4, Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills, by:

- measuring the concentration of hazardous substances and physical stressors in the environment to allow for the assessment of potential biological effects from stressors arising from the facility;
- demonstrating compliance with limits on hazardous substances and physical stressors in the environment; and
- verifying that Bruce Power has effective containment and effluent control measures in place [R-127].

6.2.1.7 Future Environmental Monitoring Activities

Water quality monitoring of Lake Huron, Stream C and on-site drainage features will continue in 2023 and the monitoring effort will be equal to, or greater than, the effort expended in 2022. Sediment and soil sampling at areas of interest will occur according to the five-year cycle for these media.

The Conventional Environmental Monitoring Program has a focus on locations with historical activity in order to monitor for impacts and ensure risk to receptors is sufficiently characterized. Additions or changes to the Environmental Monitoring program in 2023 and subsequent years will be guided by the conclusions and recommendations outlined in the 2022 Environmental Risk Assessment [R-43].

Potential risks identified by the conventional Ecological Risk Assessment are listed in Table 6. The conservative nature of the methodology used to assess risks due to conventional contaminants in the Ecological Risk Assessment results in the identification of areas of potential risk but does not necessarily indicate a current risk to receptors.

6.2.2 Fish Impingement, Entrainment and Offsetting Activities

Bruce Power uses cold, deep Lake Huron water in a once-through-cooling system to condense steam and supply operational needs. This cooling requirement can cause adult fish and larger juveniles to become trapped against water intake screens (impingement). Smaller aquatic organisms, like fish eggs and larvae, can fit through the intake screens and then be carried through the cooling water system before returning to the lake (entrainment).

Bruce Power received a *Fisheries Act* Authorization from Fisheries and Oceans Canada in December 2019 [R-136]. The Authorization requires Bruce Power to quantify fish losses through continued monitoring of fish impingement and entrainment and to measure fish gains obtained from approved offsetting measures. These monitoring results are reported annually to Fisheries and Oceans Canada. Bruce Power works closely with the Canadian Nuclear Safety Commission, Fisheries and Oceans Canada and local Indigenous communities to ensure the requirements of the Authorization are met and that all are well-informed of relevant fish impingement, entrainment, and fish offsetting activities.

6.2.2.1 Impingement and Entrainment – 2022

The total loss of fish due to impingement and entrainment at Bruce A and Bruce B Generating Stations in 2022 was 2,620 kilograms (Table 39) expressed as a Habitat Productivity Index metric [R-137] [R-138]). This was consistent with losses in prior years (Figure 48), below the administrative threshold of 4,500 kilograms per year, and well below the maximum loss permitted in Bruce Power's *Fisheries Act* Authorization (6,600 kilograms per year). None of the fish impinged in 2022 were listed as Threatened or Endangered on Schedule 1 of the *Species At Risk Act.*

Impingement losses were measured consistently throughout 2022 by Bruce Power Operations who identified and quantified fish impinged in all unit pump houses each day. The impingement monitoring program has several levels of Quality Assurance and Quality Control checks to ensure data integrity. Operators undergo training in fish identification and quantification prior to performing these tasks. The Quality Assurance and Quality Control program for fish impingement requires Operators to freeze Lake Whitefish and Round Whitefish so that identification can be confirmed by field biologists who oversee the program. Frozen fish are bagged, labelled, and placed in freezers stored in each pump house until they are inspected by Bruce Power's field biologists. Pump house Operations staff will also freeze specimens that they would like the field biologists to perform a confirmatory identification.

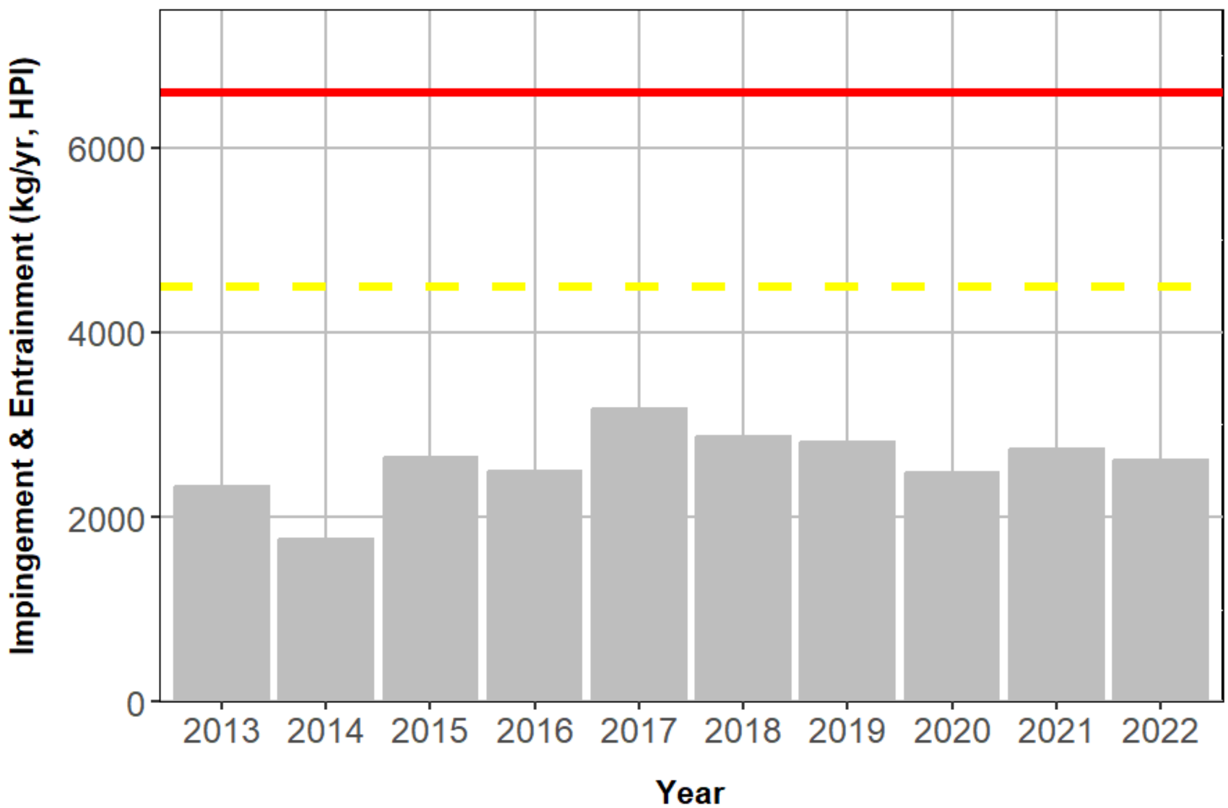


Figure 48 - Total impingement and entrainment losses at Bruce Power (2013-2022), calculated using the Habitat Productivity Index metric [R-13] [R-14]. Impingement was measured in all years. Entrainment was measured in 2013 and 2014 and estimated in 2015 through 2022 using a conservative approach.

Table 39 - Impingement and Entrainment Fish Losses at Bruce A and Bruce B in 2022

Species	2022 Impingement Count (#)	2022 Impingement Nominal Weight (g)	2013/2014 Entrainment[1] Count (# age-1 equivalents)	2013/2014 Entrainment[1] Age-1 Weight (g)	2022 Productivity Loss (HPI, kg yr^{-1})
Alewife	260	2,097	6	24	2,707
Bloater	-	-	14,124	790,944	510,368
Brown Trout	15	4,543	-	-	1,624
Bullhead	2	526	-	-	197
Burbot	204	121,123	9,089	78,165	179,938
Carp	26	31,678	-	-	6,956
Channel Catfish	53	27,215	-	-	8,086
Chinook Salmon	34	25,348	2,208	266,285	140,110
Cisco	-	-	17,545	538,632	428,941
Coho Salmon	30	59,440	-	-	11,009
Cyprinid	-	-	431	259	816
Deepwater Sculpin	-	-	2,610	3,654	8,575
Emerald Shiner	84	5,347			3,299
Freshwater Drum	13	14,948	-	-	3,349
Gizzard Shad	6,503	844,410	-	-	405,932
Lake Trout	81	98,993	-	-	21,713
Lake Whitefish	15	25,615	8,547	639,316	382,657
Rainbow Smelt	77	936	16,898	152,082	187,120
Rainbow Trout	26	15,240	-	-	4,323
Rock Bass	228	38,755	-	-	16,955
Round Goby	1,217	8,460	2,529	2,529	19,906
Round Whitefish	24	23,540	-	-	5,576
Salmonid	-	-	427	8,028	7,590
Smallmouth Bass	21	5,688	-	-	2,114
Spottail Shiner	355	31,772	-	-	17,398
Suckers	339	137,105	5,089	26,972	131,374
Walleye	21	11,424	75	8,730	8,189
White Bass	44	1,027			900

Species	2022 Impingement Count (#)	2022 Impingement Nominal Weight (g)	2013/2014 Entrainment[1] Count (# age-1 equivalents)	2013/2014 Entrainment[1] Age-1 Weight (g)	2022 Productivity Loss (HPI, kg yr^{-1})
White Perch	16	404	-	-	345
Yellow Perch	659	17,193	10,512	81,994	121,935
Total (kg/year)					2,640
Total (less Round Goby) (kg/year)					2,620

Entrainment losses were not measured in 2022; power generation facilities do not routinely measure entrainment because it is an intensive effort. Instead, entrainment was conservatively estimated in 2022 based on the highest value observed (by species) in either the 2013 or 2014 entrainment monitoring programs that were completed in preparation of the Authorization application. The 2,620 kg total loss value for 2022 includes this estimate of entrainment losses.

6.2.2.2 Truax Dam Removal Project Offsetting Activities – 2022

In August 2019, the Truax Dam (Saugeen River, Walkerton, Ontario) was successfully removed as part of Bruce Power's Fisheries Act Authorization Offsetting Plan. This project was completed in partnership between Bruce Power, the Lake Huron Fishing Club and the Municipality of Brockton, and represents the largest known dam removal to occur in the Province of Ontario in recent times (Figure 49). The successful dam removal in 2019 was a key step forward in Bruce Power's efforts to fully offset its fish losses from impingement and entrainment.

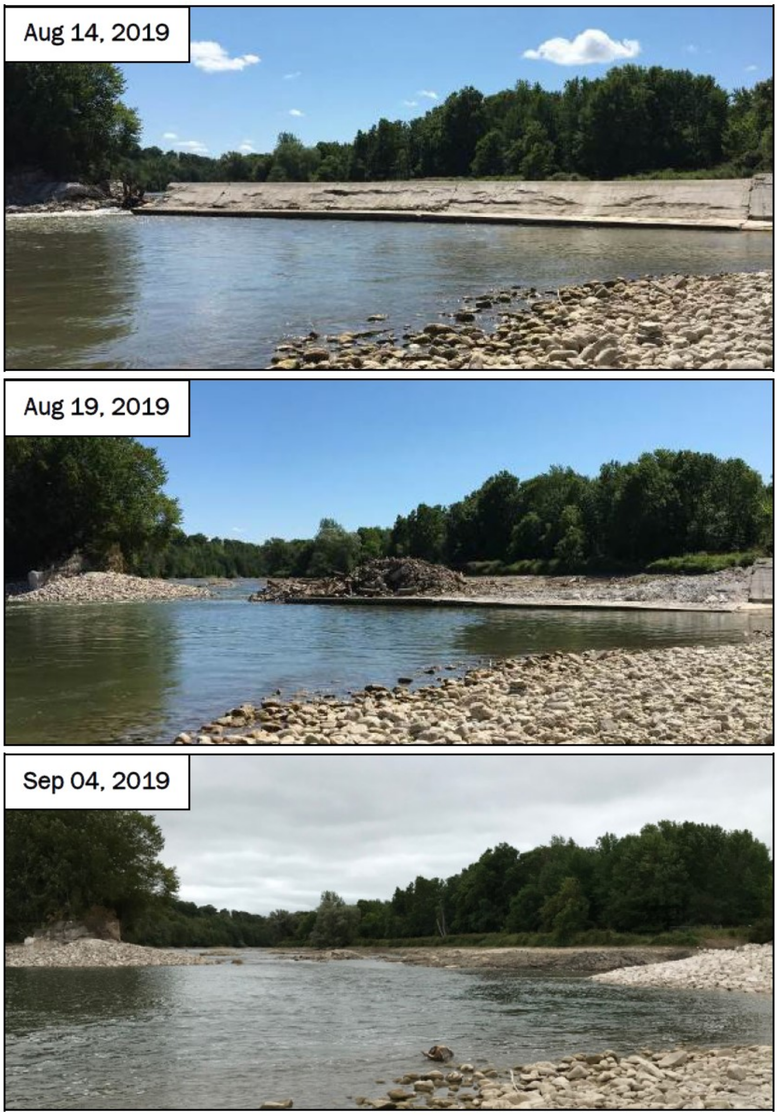


Figure 49 - Truax Dam, Walkerton, Ontario. The original wooden dam was built in 1852 and later replaced by the concrete structure shown above in 1919. The dam posed a significant barrier to fish passage for more than a century before it was removed in the summer of 2019 over the course of 3 weeks

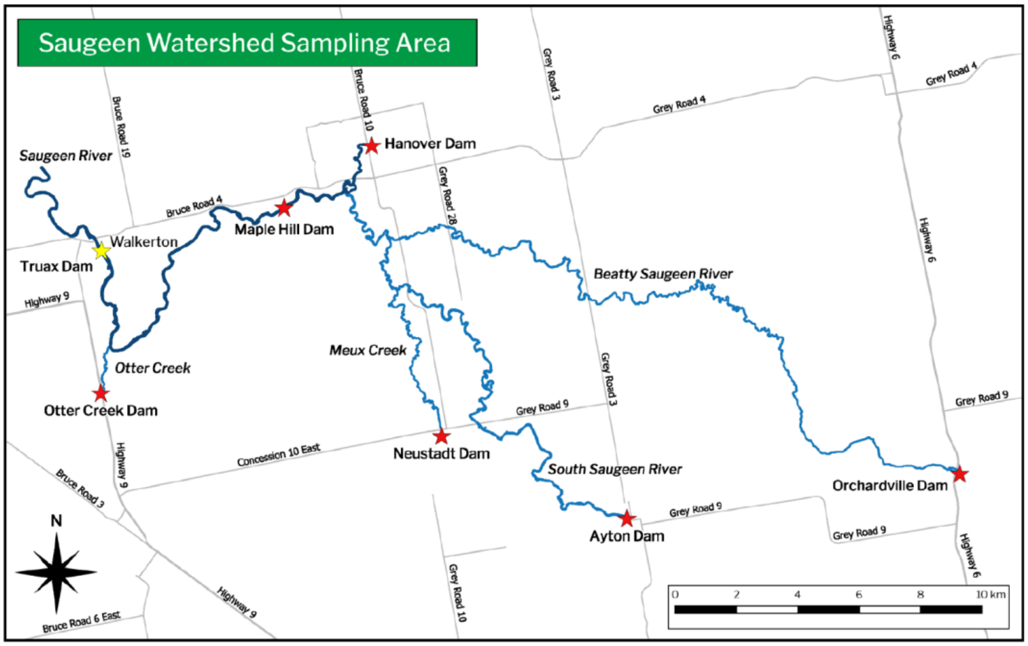


Figure 50 - Twenty-two long-term monitoring sites are located in the Saugeen (upstream & downstream of the former Truax Dam) and within the South Saugeen & Beatty Saugeen Rivers and Otter and Meux Creeks. Dams (red stars) are natural endpoints of the study area as fish cannot pass upstream of these structures. Control sites with independent fish communities are located outside of the study area, upstream of the Hanover and Otter Creek dams

Fish and fish habitat monitoring upstream and downstream of the former Truax Dam began in 2018 and continued in 2022 in order to quantify the change in fish biomass that has occurred as a result of the dam removal. Twenty-two long-term monitoring locations were established in the study area where biologists carry out electrofishing surveys to measure changes in fish biomass and production (Figure 50). Additionally, habitat assessments and redd surveys are used to monitor changes in fish spawning, and underwater video and radio-telemetry studies are being done to track fish passage throughout the watershed.

Fish biomass is expected to increase in the study area as a result of the dam removal, and the net increase in biomass is anticipated to fully offset fish impingement and entrainment losses that occur at Bruce Power. An in-term assessment of the Before-After-Control-Impact changes in fish production took place after the 2022 biomass monitoring was completed. This Before-After-Control-Impact analysis demonstrated that a statistically significant increase in fish biomass and production has occurred in the main stem of the Saugeen River upstream of the former Truax Dam in Walkerton, Ontario. This was firmly demonstrated in the data collected at the monitoring station located immediately upstream of the former Truax Dam. In 2020 and 2021, an estimated offset of 1,523 kilograms per year occurred. For 2022, the offset increased to 2,436 kilograms per year. This is a conservative estimate and will be refined as additional monitoring data is collected in future years.

For the first time since the dam removal, the Before-After-Control-Impact analysis in 2022 demonstrated a statistically significant increase in fish biomass and production occurred in one of the tributary locations (Otter Creek). This is evidence that changes in the upstream tributaries are starting to be realized.

Fish production within the Saugeen River main stem is expected to continue to increase in future years as the warm-water fish community re-distributes across the newly reconnected river system and as additional successful Salmonid spawning occurs within the newly formed habitat upstream of the dam footprint. Indeed, additional observations gathered through radiotelemetry studies of Rainbow Trout, Salmonid redd surveys and videography monitoring have demonstrated an almost instantaneous increase in Salmonid presence in the Saugeen River upstream of the Truax Dam to Carrick Dam and within Otter Creek. Increased fish production of Salmonids in the tributaries is also anticipated in future years.

A photographic collection of the Saugeen River watershed field work is found at [R-139]–[R-142]:

Radiotelemetry studies show Rainbow Trout migration past the Truax Dam has increased in the spring from an average of 65% pre-removal to 90% in 2022. Increases in migration were even higher in the fall, from a baseline of 17% in fall 2018 to 100% in fall 2021, post-removal (no fish were tagged fall 2022). In addition, the downstream delay of fish attempting to pass the Truax Dam has decreased, from an average of 27 hours baseline to only 5 hours in spring 2022 and an initial 193 hour baseline (2018) to only 11 minutes in fall 2021. Likely due to increased energy availability, this decreased delay has translated into decreased travel time and the increased ability of fish to pass Carrick and Maple Hill Dams further upstream. Videographic surveys have confirmed significant increases in Rainbow Trout passage at Maple Hill Dam. Additional information is available at Biotactic's website (www.biotactic.com, [R-143]) or by following these links:

2022 Summary - Saugeen River Telemetry [R-144]

Migratory Patterns of Rainbow Trout [R-145]

Rainbow Trout and Chinook Salmon redd counts have also increased post-removal, especially in Otter Creek where redd counts have almost tripled. An average of 33 Rainbow Trout redds were observed in Otter Creek pre-removal, increasing to 92 redds in 2022. Correspondingly the number of juvenile Rainbow Trout captured increased from an average of 559 individuals' pre-removal to 1128 individuals in 2022. Similarly, Chinook Salmon redds in Otter Creek increased from a count of eight in fall 2018 to 73 counted in fall 2021. The increase in redds counted in 2021 corresponded to an increase in captured juvenile salmon in 2022; from zero to 42, respectively. While fewer redds were observed in fall 2022 compared to fall 2021, this was due to significantly decreased water levels at the mouth and throughout Otter Creek which precluded the ability of fish to enter the tributary. Importantly no redds or juvenile Salmonids were found pre-removal in the dam headpond, however post-removal as many as 31 Rainbow Trout redds and 109 individuals have been observed or captured in the newly restored natural river habitat. While an increase in redd counts cannot directly be correlated to increases in biomass, this provides additional evidence of the benefit of the removal of Truax Dam to fish communities and will likely lead to further increases in fish biomass and fish biomass production throughout the watershed.

Redd Count Surveys [R-146]

6.2.2.3 Indigenous Nation and Community Offsetting Projects – 2022

In addition to the Truax Dam Removal Project, Bruce Power continues to collaborate with local Indigenous Nations and Communities to develop additional offsetting projects. These projects provide an opportunity to work together in meaningful ways to improve fish and fish habitat in areas of the Lake Huron watershed that are of special importance to local Indigenous Nations and Communities. These projects are in addition to Bruce Power's support of the Saugeen Ojibway Nation Coastal Waters Monitoring Program, which is a nearshore/coastal monitoring program with the goal of building a comprehensive baseline inventory of aquatic habitat and wildlife in the Saugeen Ojibway Nation Territory [R-147].

Bruce Power and the Historic Saugeen Métis have completed year two of the offsetting project known as "Fisheries Habitat Restoration and Enhancement: Removal of *Phragmites australis* from the Fishing Islands". The combination of western science and Indigenous knowledge is producing an all-encompassing improved formula for dealing with compensating offsets. The Fishing Islands are an important traditional harvest area for the Historic Saugeen Métis Community. Fish, aquatic plants and bird eggs are all part of the traditional harvest and ways of life. Maintaining ecological integrity in this area is therefore of high importance to the Historic Saugeen Métis Community. The proposed project plan was approved in 2021 and an amended Fisheries Act Authorization was issued to Bruce Power. As per the Authorization, annual reports documenting the work completed in 2021 and 2022 were submitted to Fisheries and Oceans Canada in March of 2022 and 2023. The goals of this project are: to strengthen the role of the Historic Saugeen Métis community in fisheries related projects; incorporate Historic Saugeen Métis community knowledge of coastal habitats and fish interactions; restore near shore coastal habitats that are important to the Historic Saugeen Métis community; increase shoreline complexity and restore native plant diversity; improve near shore fish habitat; enhance local hydraulic conditions to favour certain functions of fish habitat; and promote restoration of degraded habitats.

This program is also being undertaken by a number of partners including the Oliphant and Fishing Islands Phragmites Community Group, Bruce Power, Grey Sauble Conservation Authority, Township of South Bruce, Oliphant Campers Association, Bruce Peninsula Biosphere Association, Nature Conservancy of Canada and the Invasive Phragmites Control Centre as well many seasonal and fulltime residents. In 2022, the Invasive Phragmites Control Centre undertook Phragmites control efforts over a total of 26 days targeting 44.3 ha of phragmites. All high density stands remaining in the Fishing Islands were targeted in 2022. Bruce Power, Historic Saugeen Métis and Invasive Phragmites Control Centre will inspect the site in various stages in 2023 and it is anticipated that greater than 90% mortality of high density *Phragmites australis* will be achieved. Changes to native plant diversity and fish habitat will also be observed and documented as the project site evolves with the absence of *Phragmites australis.*

Bruce Power and the Saugeen Ojibway Nation have met on several occasions over the last two years and a list of potential project ideas has been developed. A field walk-down of Sucker Creek, on the Bruce Peninsula near Howdenvale, ON has been scheduled for April 2023 with the Saugeen Ojibway Nation, Bruce Power, and other community partners. Sucker Creek has been highlighted by the Saugeen Ojibway Nation community as a watercourse that has been degraded and would benefit from a restoration plan, particularly near the outlet to Lake Huron. Provided that the Saugeen Ojibway Nation community feels that restoration of Sucker Creek is a valuable project after visiting the site, a project plan will be developed by December 2023.

Finally, in consultation with the Métis Nation of Ontario, a project plan is being drafted around improving fish habitat and restoring connectivity in Bothwell's Creek. Near Leith, ON, Bothwell's Creek has traditionally been used by the Métis Nation of Ontario community for fishing and recreation but a decline in fish spawning has been noticed over the past decade. A decrease in ideal habitat due to erosion leading to high sedimentation, and large debris posing a barrier to fish migration is thought to be the leading causes of the observed decline in fish in the creek. Together with Bruce Power, the Métis Nation of Ontario propose to remove large debris from the stream to increase stream connectivity and flow and organize community events to plant riparian vegetation along more vulnerable stretches of the stream bank. A field walk-down of the creek will be performed in early spring 2023 and a formal project proposal is on track to be complete by June 2023.

6.2.3 Thermal Monitoring of Lake Temperatures

High-pressure steam is produced at Bruce A and Bruce B by heating demineralized light water in a closed-loop system. This steam is used to produce the electricity in the turbine-generator systems and is then condensed to liquid water in the Condenser Cooling Water system before travelling back to boilers to be reheated to high-pressure steam again. Steam condensation occurs in the Condenser Cooling Water system using a separate open loop of cool lake water that is drawn from offshore deep-water intakes, and warmer water is discharged back to the lake.

The temperature of water leaving the Bruce A and Bruce B discharge channels is monitored continuously to ensure it meets the specifications outlined in Ministry of Environment, Conservation and Parks environmental compliance approvals, which are established to be protective of the environment and minimize impacts to aquatic organisms and their habitat. Because this warmer discharge water has the potential to be a physical stressor to aquatic organisms, Bruce Power has carried out extensive thermal and current monitoring over several years in order to characterize any potential risk from thermal effluent [R-43]. Temperature and current monitoring in Lake Huron continued in 2022 in order to collect ongoing verification data for its thermal risk assessment, These data will be presented in the 2027 Environmental Risk Assessment. A comprehensive thermal risk assessment was completed in the 2022 Environmental Risk Assessment, using data from the period between April 2016 and March 2021. A low risk to some cold and cool water fish species and life stages was identified, based on modelled thermal benchmarks [R-43]. Given the similar habitat available along the length of the Lake Huron coast and the mobility of older life stages, no population level effects are expected.

As climate change gradually affects lake-wide temperature, a temporary amendment of the Bruce A environmental compliance approval is in place to allow a maximum effluent temperature of 34.5°C (an increase of 2.3°C) between June 15th and September 30th each year. This provides operational flexibility for a maximum of 30 aggregate days within this period, and for no more than a maximum of 15 consecutive days at a time. This operational flexibility was invoked once in 2022 on August 8th and 9th, due to elevated lake water intake temperatures. Indigenous communities were notified of the start and end of the operational flexibility period and Bruce Power continues to provide monthly (July to September) updates on its thermal effluent to local Indigenous communities as part of its ongoing commitment to Indigenous engagement and information sharing. Routine quarterly meetings include a discussion on thermal effluent and targeted technical meetings were held to review the thermal effects assessment.

Further details on thermal monitoring results can be found in the 2022 Environmental Qualitative Risk Assessment [R-43]. In addition, an interactive tool has been developed to present these data and can be accessed through the following link:

https://wsp-shinyapps.shinyapps.io/ERA_temperature/

6.2.4 Biological Effects Monitoring

Bruce Power has conducted long-term monitoring of local wildlife populations for many years to trend baseline wildlife populations on our site. By doing so, we can understand local population dynamics, detect changes if they occur, and ensure that facility operations have minimal impact on the environment. Each of the following biological effects monitoring programs provides an additional layer of assurance that Bruce Power continues to operate its facility safely and in a manner that is protective of the environment.

Many of the monitoring programs (including snake board studies, turtle nesting, breeding birds and amphibians) are completed in collaboration with Ontario Power Generation – Western Waste Management Facility. Additional details on findings can be viewed in the Ontario Power Generation Biological Survey 2022 Summary Report [R-148].

6.2.4.1 Amphibians

Amphibians are monitored as an indicator for ecosystem health as they have a dual life cycle (water and land) and are sensitive to pollutants during all life stages [R-149]. Incidental amphibian observations are recorded year-round during vehicle-wildlife interaction surveys, pedestrian surveys and with employee sightings. There were several incidental observations of frogs across the site in 2022.

Targeted nocturnal amphibian vocalization surveys were conducted in the spring and summer of 2022, following the methodology described by Bird Studies Canada/ Environment Canada Marsh Monitoring Protocol [R-149]. The protocol requires sampling on three separate calm, mild evenings at least 15 days apart to determine species presence and relative abundance. In addition to the targeted vocalization surveys, incidental observations were made throughout the year during other field studies (pedestrian surveys, vehicle/wildlife interaction surveys) in order to document evidence of amphibian breeding activity (e.g., egg masses, larvae, spermatophores, daytime calling).

Table 40 - Amphibian Call Level Codes used in Survey Protocol [R-25]

Level 1	Calls did not overlap and calling individuals could be discretely counted
Level 2	Calls of individuals occasionally overlap, but numbers of individuals could still reasonably be estimated
Level 3	Numerous individuals were calling, and an overlap of calls seemed continuous, making an estimate of individuals impossible

In 2022, 13 survey locations continued to be monitored, which were established in 2020 based on previous monitoring locations and proximity to wetlands, ponds, and ephemeral pools (Figure 51. Five different frog species were identified in 2022 over the three survey dates in April, May, and July.

The most common and abundant species continues to be the Spring Peeper (*Pseudacris crucifer*). This early breeding frog species was heard calling at every monitoring station in 2022. The call levels for Spring Peeper were relatively high with the majority of recorded levels at Level 2.

The second most recorded frog species was the Green Frog (*Rana clamitans*). This species was documented at 10 of the monitoring stations in comparison to the Wood Frog (*Lithobates sylvaticus*) which was found at five survey locations. This is the highest number of locations for Wood frogs since monitoring began, with observations at two locations in 2021 and one location in 2020. Northern Leopard Frog (*Lithobates pipiens*) was found at four locations in 2022; this is down from 2021 when this species of frog was detected at seven locations.

The Grey Treefrog (*Hyla versicolor*), was documented at 11 of the stations in 2021 but was only found in two locations in 2022, with a Call Level of 1.

The American Bullfrog (*Lithobates catesbeianus*) and American Toad (*Anaxyrus americanus*) have not been documented during any of the surveys from 2017 to 2022.

Overall, the station at Baie du Doré revealed the greatest diversity and abundance of breeding anuran species with all six expected frog species being documented during the 2022 surveys.

On April 11, 2022, visual surveys were completed on site for salamander and newt. Surveys involved walking wet areas, turning over rocks, logs etc. to search for the hiding spots of these amphibians. The surveys on this day revealed a total of 5 Yellow-Spotted salamanders (*Ambystoma maculatum*) and 4 Red-Spotted newts (*Notophthalmus viridescens*) along with two large Yellow-Spotted salamander egg masses.

Amphibian surveys will continue in 2023 using the same protocol.

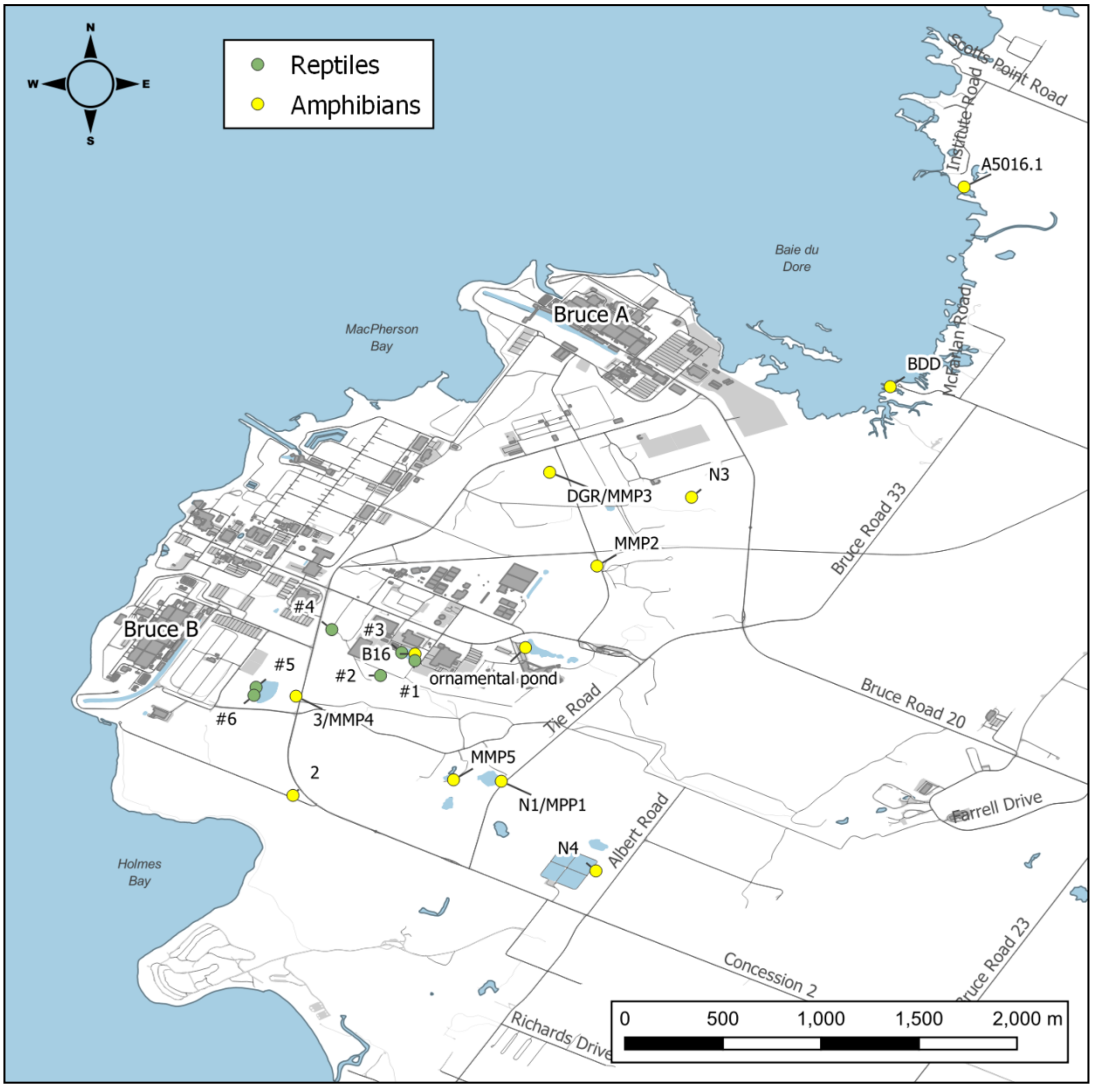


Figure 51 - Amphibian and Reptile Survey Monitoring Locations at Bruce Power

6.2.4.2 Reptiles

Several snake species inhabit the Bruce Power site. They are an important component in natural ecosystems for many reasons, one of which is their need for diverse habitats to complete their lifecycles. Habitats include hibernacula areas, grasslands, wetlands, and other surface water features. Due to the decline and sensitivity of certain populations in Ontario, data collected on snake species presence and abundance provides information to make planning decisions and manage property holdings from an ecological perspective. Due to the increasing number of snake Species at Risk in Ontario, it is vital to monitor vulnerable snake populations in our local area. Investigations specific to snakes have been conducted in the form of pedestrian surveys from 2017 to present. These surveys locate and characterize the species assemblage and identify potential critical habitat within the Bruce Power leased lands. Along with pedestrian surveys, bioinventories of the 2016-2017 seasons focused on identifying and recording snake species classified as Species at Risk. Data is also collected during Vehicle-Wildlife Collision Surveys and incidental observations by Bruce Power employees. Vehicle wildlife surveys began in June 2017 and are completed on a weekly basis to the extent possible.

Snake monitoring followed the guidelines outlined in the Ontario Ministry of Natural Resources and Forestry survey protocol [R-150]. Ontario Power Generation placed 33 snake monitoring boards at various locations throughout the site and Bruce Power added snake boards to 11 additional locations.

Five different snake species were recorded in 2022 by Bruce Power in the thirteen monitoring events. Eastern Garter snake (*Thamnophis sirtalis sirtalis*) was the most common snake observed, followed by Dekay's Brown snake (*Storeria dekayi*) and then Smooth Green snake (*Opheodrys vernalis*). A total of 19 individuals were found during the snake board monitoring with the most observations made during the May 17th monitoring event. A total of 31 individuals have been recorded since surveys began in 2022 with a total of 5 different species represented.

Ontario Power Generation staff performed observations at the snake hibernaculum just north of the East Pond on April 11, May 6, May 17, June 9, June 29 and September 30, 2022. The hibernaculum was constructed at this location in 2016. As has been the case in previous years, no snakes were noted, nor was snake activity evident on the 2022 trail camera images.

Deployment of the 33 snake coverboards at the Ontario Power Generation Western Waste Facility site has proven to be quite successful since snake monitoring began in 2020. A total of 73 individuals of eight different species have been recorded over the three field seasons. All snake species expected to occur in southern Bruce County have thus been found during coverboard monitoring on site.

Highlights of the 2022 coverboard surveys included an Eastern Milksnake (*Lampropeltis Triangulum*) (Special Concern, federally), two Smooth Green snakes and three Northern Ring-Necked snakes (*Diadophis punctatus edwardsii*). The most commonly found snake under coverboards in 2022 was Dekay's Brown snake, with six observations (compared to three in 2020 and only one in 2021).

As in 2021, an interesting non-snake species found under coverboards in 2022 was the "Red Eft" phase of the Eastern (Red-Spotted) Newt (*Notophthalmus viridescens*). Individuals of the terrestrial phase of this otherwise aquatic salamander were found on two occasions, May 6 and September 30, under the same coverboard in the North Parcel. An adult Eastern Newt was photographed in a small, apparently spring-fed, pond near a coverboard on May 17, 2022.

No targeted surveys for turtles were performed in 2022. However, incidental sightings of Midland Painted Turtles and Snapping Turtles were recorded during other routine monitoring events. No active turtle nests or eggs were found but a recently emerged juvenile Midland Painted Turtle was observed by Ontario Power Generation staff near a turtle nest cage.

Table 41 - Reptile Species Presence Recorded in the Local Area 2017-2022

Species	2017	2018	2019	2020	2021	2022
Dekay's Brown snake	Yes	Yes	Yes	Yes	Yes	Yes
Eastern Garter snake	Yes	Yes	Yes	Yes	Yes	Yes
Eastern Milk snake	No	No	No	No	Yes	Yes
Eastern Ribbon snake	Yes	No	Yes	Yes	Yes	Yes
Red-bellied snake	Yes	Yes	No	Yes	Yes	Yes
Northern Ring-necked snake	No	No	No	No	Yes	Yes
Smooth Green snake	No	No	No	Yes	Yes	Yes
Northern Water snake	Yes	No	No	No	No	Yes
Midland Painted Turtle	Yes	Yes	Yes	Yes	Yes	Yes
Snapping Turtle	Yes	Yes	Yes	Yes	Yes	Yes

Reptile surveys will continue in 2023, with the addition of turtle nesting and basking surveys.

6.2.4.3 Waterfowl and Shorebird Surveys

The purpose of waterfowl and shorebird surveys is to monitor overwintering and stopover migration areas to trend species abundance and distribution over time. The shoreline of Bruce Power is surveyed for waterfowl and shorebirds with both binoculars and a spotting scope from a set of nine viewpoints which were selected to cover most of the shoreline from Gunn Point to Scott Point with very little overlap (Figure 52).

In total, there were three spring and three fall survey days in 2022 completed between March and May and November to December. The total number of birds observed during the 2022 monitoring season was 3,584. A total of 32 waterfowl/shorebird and gull species were identified during the waterfowl/shorebird monitoring.

In comparison, a total of 3,138 birds across 35 species of waterfowl and shorebirds were observed in 2021. Surveys in the last several years have demonstrated that there are diverse populations of local and migrant waterfowl and shorebirds inhabiting the lands nearby Bruce Power, with the highest density in Baie du Doré (Figure 53).

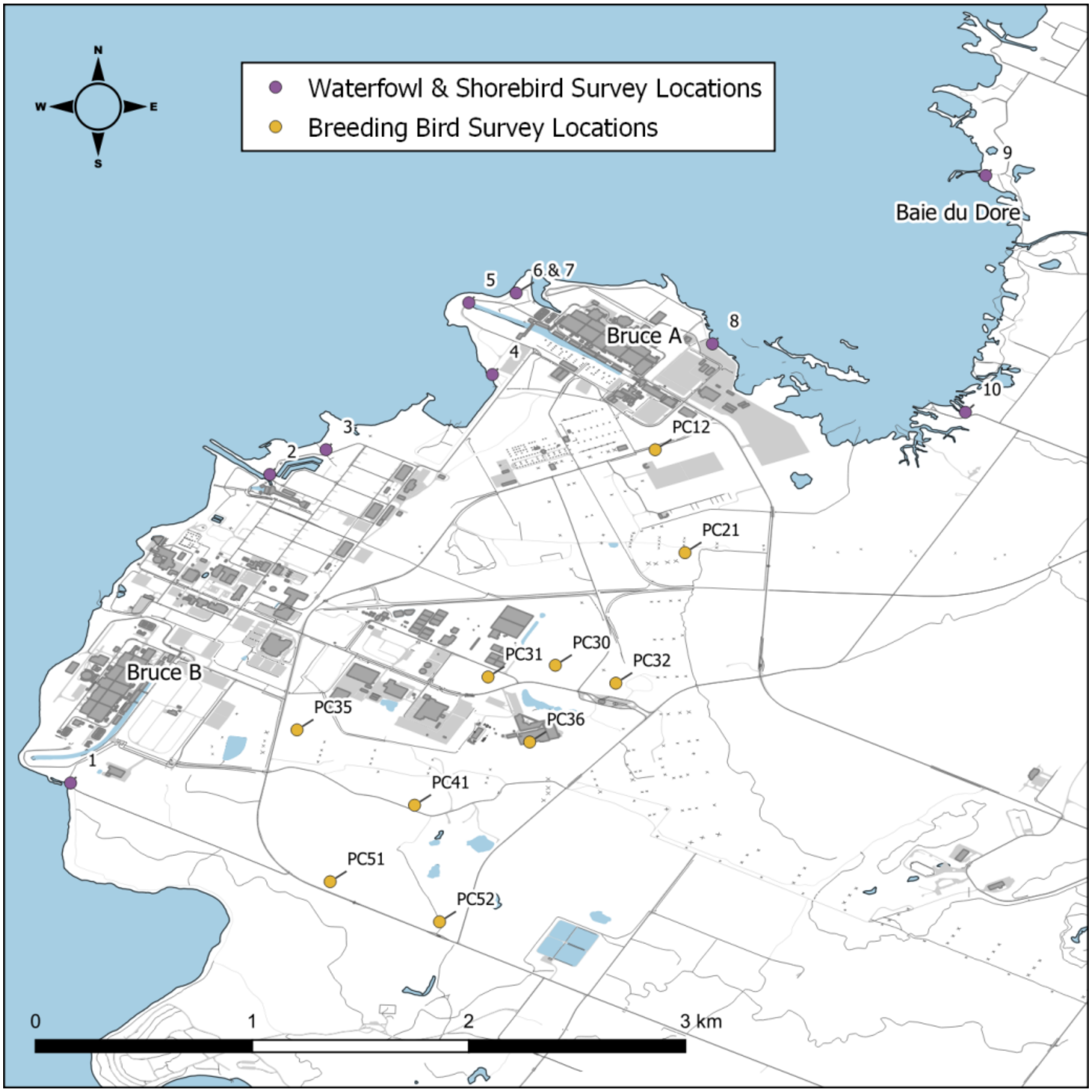


Figure 52 - Waterfowl & Shorebird and Breeding Bird Monitoring Locations at Bruce Power

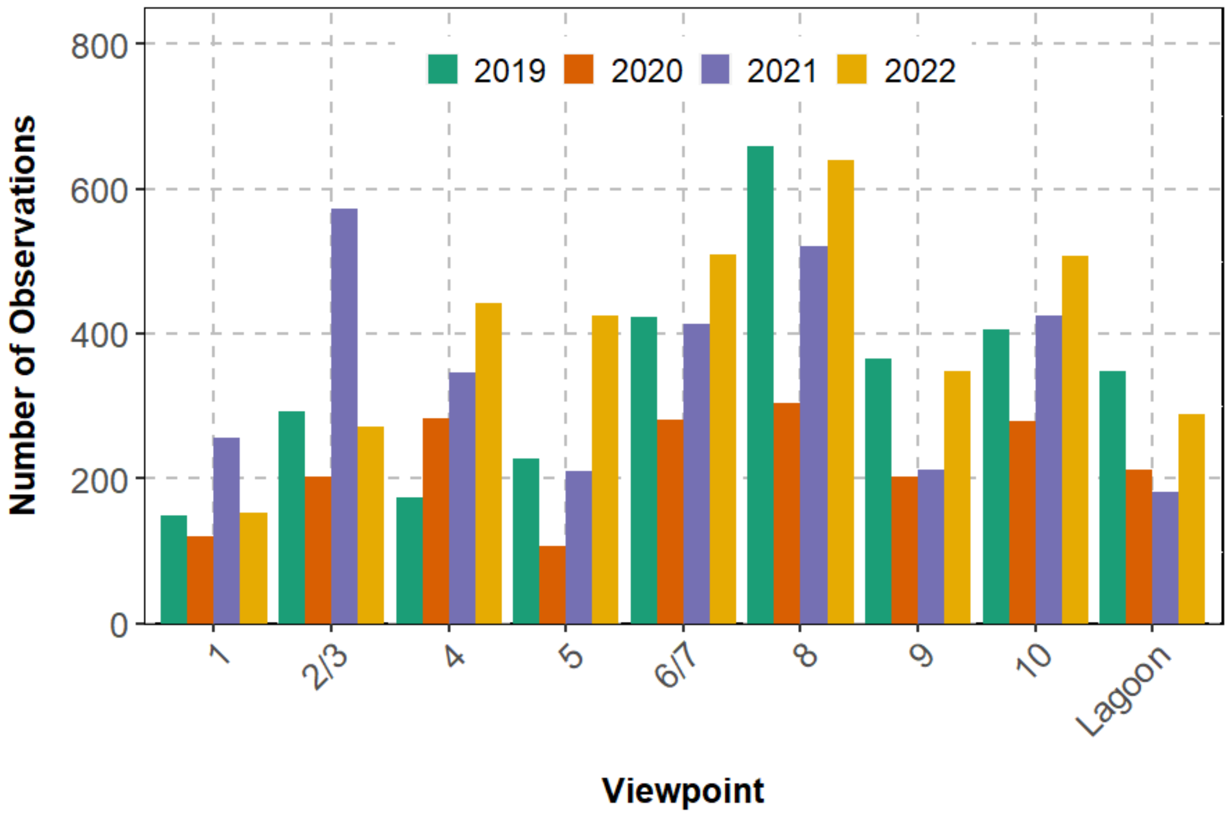


Figure 53 - Counts of Local Waterfowl and Shorebirds Observed 2019 to 2022

Canada Geese (*Branta Canadensis*) were the most abundant bird species recorded during the 2022 surveys; this is reflective of the large local population. The second most abundant was Herring Gull (*Larus argentatus*), this is normally a spot reserved for the Double-crested Cormorant (*Phalacrocorax auritus*), which was the fourth highest in total observations. The decrease in abundance of the Double-crested Cormorant may be a result of the Ontario-wide hunting season initiated in 2020.

Ducks were relatively abundant with a total of 15 different species recorded. Mallard (*Anas platyhynchos*) was the most abundant waterfowl species with 200 observations. Common merganser (*Mergus merganser*) had 112 observations and the third most commonly observed duck species during the 2022 surveys were Lesser Scaup (*Aythya affinis)*.

On February 1, 2022, during Bald Eagle monitoring, approximately 50 to 60 Redhead ducks (*Aythya Americana*) were observed in the Bruce A discharge channel; it is likely they were taking advantage of the ice-free and warm waters of the discharge channel.

Monitoring in 2022 resulting in the highest numbers of observations of Horned Grebes (*Podiceps auritus*) and Pied-billed grebes (*Podilymbus podiceps*) since monitoring began in 2019.

Two Scoter species, the White-winged scoter *(Melanitta deglandi*) and the Surf scoter (*Melanitta perspicillata*), were observed. Although these species are considered relatively uncommon, they have been recorded in very low numbers consistently during the fall migration since the waterfowl surveys were initiated.

Mute swans (*Cygnus olor*) are fairly regular inhabitants of Baie du Doré and are found all year round until freeze up. These natives of Eurasia have adapted very well to conditions in Canada and are common in city parks and sheltered bays. The Trumpeter swan (*Cygnu buccinator*) and Tundra swan *(Cygnus columbianus)* were observed for a second year in a row in Baie du Doré. The native Trumpeter swan is making a comeback in Ontario due to several restoration efforts.

Overall, the surveys in 2022 have shown an abundance and diversity of birds in the surrounding area of Bruce Power. The habitat diversity and area of available open lake environment is conducive to healthy local and migrant populations.

Waterfowl and shorebird surveys will continue in 2023 at the same locations.

6.2.4.4 Breeding Bird Monitoring Surveys

Nineteen 5-minute breeding bird surveys occurred across the site (Figure 52) on June 3 and 9, 2022. Monitoring protocols followed the standards prescribed by Birds Canada (formerly Bird Studies Canada) for the Ontario Breeding Bird Atlas [R-151]. A total of 60 breeding bird species were documented. Of these, 17 species were detected on June 3, 2022, and 41 species were observed on June 9, 2022. The most commonly observed species in 2022 was the Red-Eyed Vireo (*Sciurus vulgaris*), detected at all 19 stations, while American Crow (*Corvus brachyrhynchos*), Blue Jay (*Cyanocitta cristata*), Red-winged Blackbird (*Agelaius phoeniceus*), American Goldfinch (*Spinus tristis*), Common Yellowthroat (*Geothlypis trichas*), American Robin (*Turdus migratorius*) and Song Sparrow (*Melospiza melodia*) were also very common and widespread. Interesting observations included four Species at Risk (Eastern Wood-Pewee (*Contopus virens*), Wood Thrush (*Hylocichla mustelina*), Eastern Meadowlark (*Sturnella magna*), and Canada Warbler (*Cardellina canadensis*); all of them showing evidence of breeding at the site. The threatened Bobolink (*Dolichonyx oryzivorus*) was observed in 2021 but not in 2022.

Table 42 - Breeding Bird Species Detected at Bruce Power during Formal Surveys Conducted June 3 and 9, 2022

Canada Goose	American Crow	Eastern Towhee
Wild Turkey	Common Raven	Eastern Meadowlark
Ruffed Grouse	Black-capped Chickadee	Red-winged Blackbird
Mourning Dove	Tree Swallow	Brown-headed Cowbird
Yellow-billed Cuckoo	Barn Swallow	Ovenbird
Black-billed Cuckoo	Red-breasted Nuthatch	Black-and-white Warbler
Wilson’s Snipe	House Wren	Nashville Warbler
Ring-billed Gull	Winter Wren	Common Yellowthroat
Herring Gull	Gray Catbird	American Redstart
Turkey Vulture	Brown Thrasher	Magnolia Warbler
Belted Kingfisher	Veery	Blackburnian Warbler
Hairy Woodpecker	Wood Thrush	Yellow Warbler
Northern Flicker	American Robin	Chestnut-sided Warbler
Merlin	Cedar Waxwing	Yellow-rumped Warbler
Eastern Wood-Pewee	American Goldfinch	Black-throated Green Warbler
Alder Flycatcher	Chipping Sparrow	Canada Warbler
Great Crested Flycatcher	Field Sparrow	Scarlet Tanager
Eastern Kingbird	White-throated Sparrow	Northern Cardinal
Red-eyed Vireo	Song Sparrow	Rose-breasted Grosbeak
Blue Jay	Swamp Sparrow	Indigo Bunting

Breeding bird monitoring surveys will continue in 2023, using the same protocol and viewing stations.

6.2.4.5 Bald Eagle Surveys

Bald Eagles (*Haliaeetus leucocephalus*) are currently listed as a species of *Special Concern* in Ontario. Since 2016, Bruce Power has monitored habitat use by Bald Eagles and other raptors in the vicinity of the Bruce Power Site during the overwintering period (Nov-Mar). Four Bald Eagle monitoring surveys were completed in each of the last five winter monitoring periods. Observations of Bald Eagles continued in 2022-2023 at six monitoring stations, labelled Stn. 1, and Stn. 3-7 on Figure 54. Stn. 2 (not labelled on Figure 54) was abandoned in 2019 due to lack of visibility because of woody shoreline vegetation.

Bald Eagles are frequently observed at Stations 4, 5, 6 and 7 around Baie du Doré and lower numbers are recorded at Stations 1 and 3, where there are less foraging and perching opportunities. Overall, counts have increased across the whole site in the last five years indicating an increase in the abundance of the local overwintering Bald Eagle population (Figure 55).

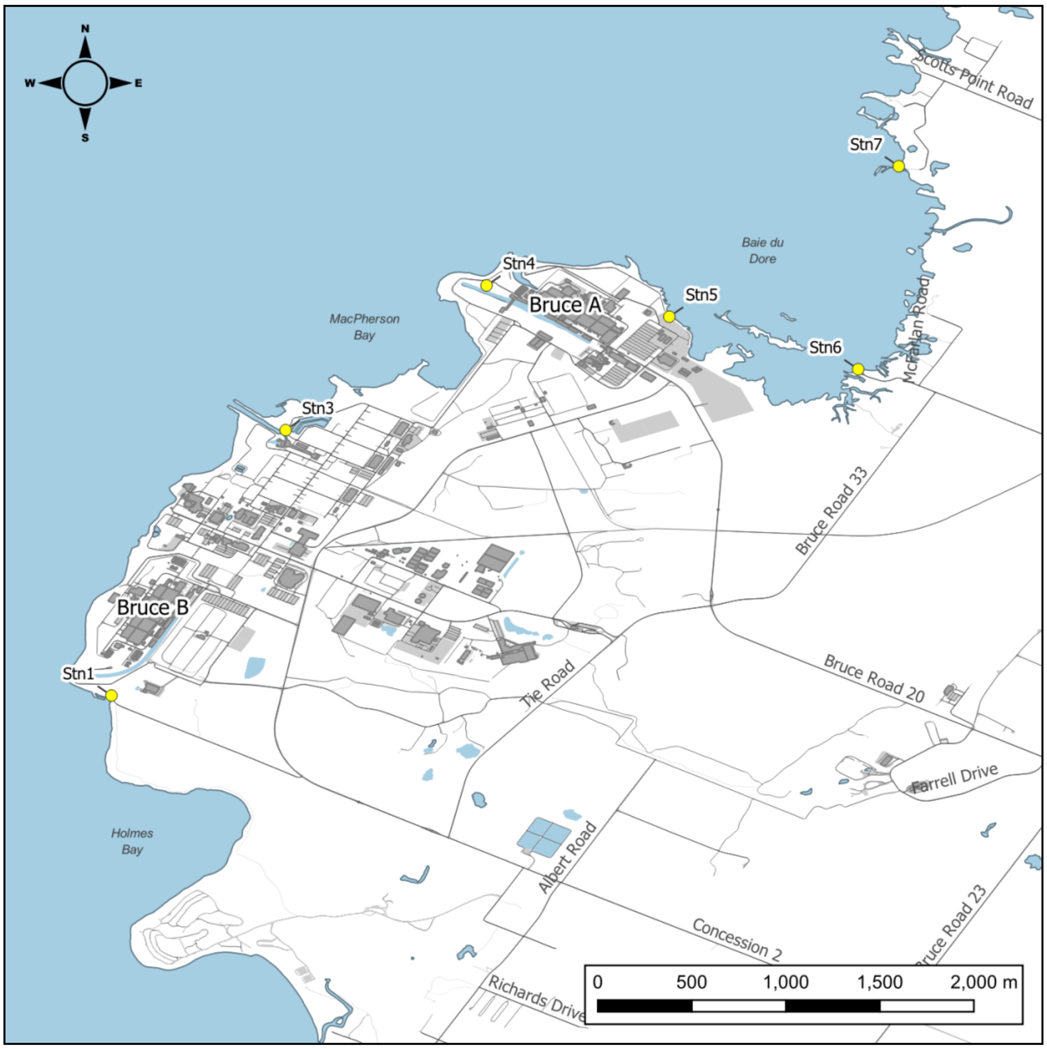


Figure 54 - Bald Eagle Monitoring Locations at Bruce Power

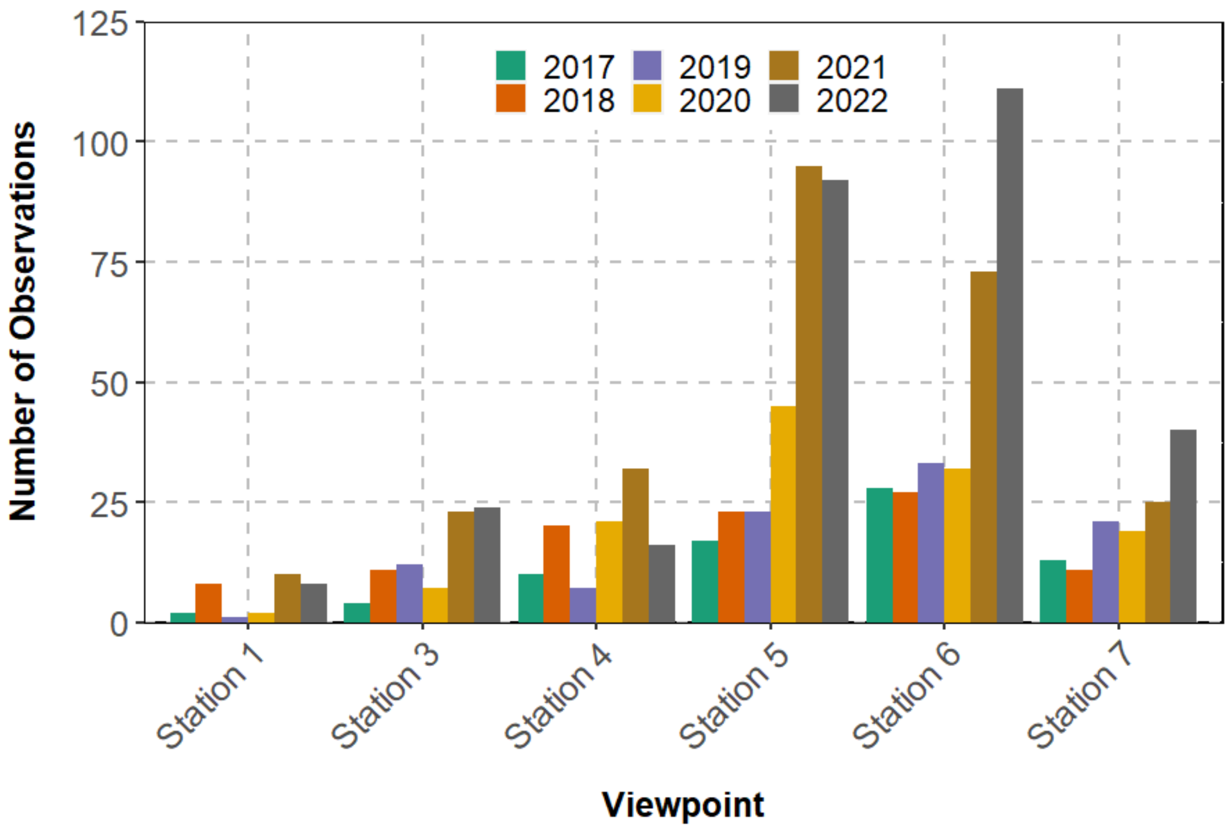


Figure 55 - Counts of Bald Eagles Observed near Bruce Power Between 2017 and 2022

Formal surveys for winter raptor species did not occur in 2021 or 2022 as none were observed during winter raptor surveys conducted in 2017-2018 and 2019-2020.; however incidental observations made by employees and Bruce Power field biologists are recorded. One Red-tailed Hawk (*Buteo jamaicensis*) was observed in 2018-2019, and one Snowy Owl (*Bubo scandiacus*) and one Northern Harrier (*Circus hudsonius*) were recorded in 2019-2020. In 2021 a Coopers Hawk (*Accipiter cooperii*), Northern Harrier and a Snowy Owl were observed on site. No additional winter raptors were observed in 2022.

Bald Eagle surveys will continue in 2023 at the same six monitoring stations.

6.2.4.6 Redd Surveys on Stream C

In the early spring and late fall, salmonids migrate upstream to reach suitable cool-cold water spawning grounds. The female selects a nest site and begins excavating a pit, referred to as a redd. This redd is where eggs will be deposited for fertilization by one or more males. Redd surveys are a tool for assessing the productivity and health of a watercourse, as presence and success of spawning salmonids indicates the watercourse has the necessary environmental conditions to promote healthy spawning, hatching, and rearing (i.e., substrate, temperature, and flow regimes). Timing of the start for the survey varies depending on conditions like water temperature, rainfall, and stream water levels. Stream C surveys are conducted in the spring to capture the migration of Rainbow Trout (*Onchorynkus mykiss*) and in the fall to observe various salmon species, which include both Chinook (*Oncorhynchus tshawytscha*) and Coho (*Oncorhynchus kisutch)* salmon.

Ten surveys were completed in 2022 (three in the spring, seven in the fall). Twenty-three Rainbow Trout redds were observed in 2022, which was four less than the number recorded in 2021 (Figure 56). Of these, 12 had a Rainbow Trout on or near the nest. Twenty-five Chinook Salmon redds were observed in Stream C in 2022 and a total of 18 Coho Salmon redds were recorded in the 2022 season. Of these fall redds, 15 of them had fish on or near the redd. Increased beaver activity in Stream C over the last few years has caused lower stream flow downstream of the dam structures. Several informal observations of Stream C occurred throughout the fall of 2022 to assess activity. The consistently high number of redds observed in Stream C since 2017 demonstrates there is high water quality that supports fish habitat in this stream.

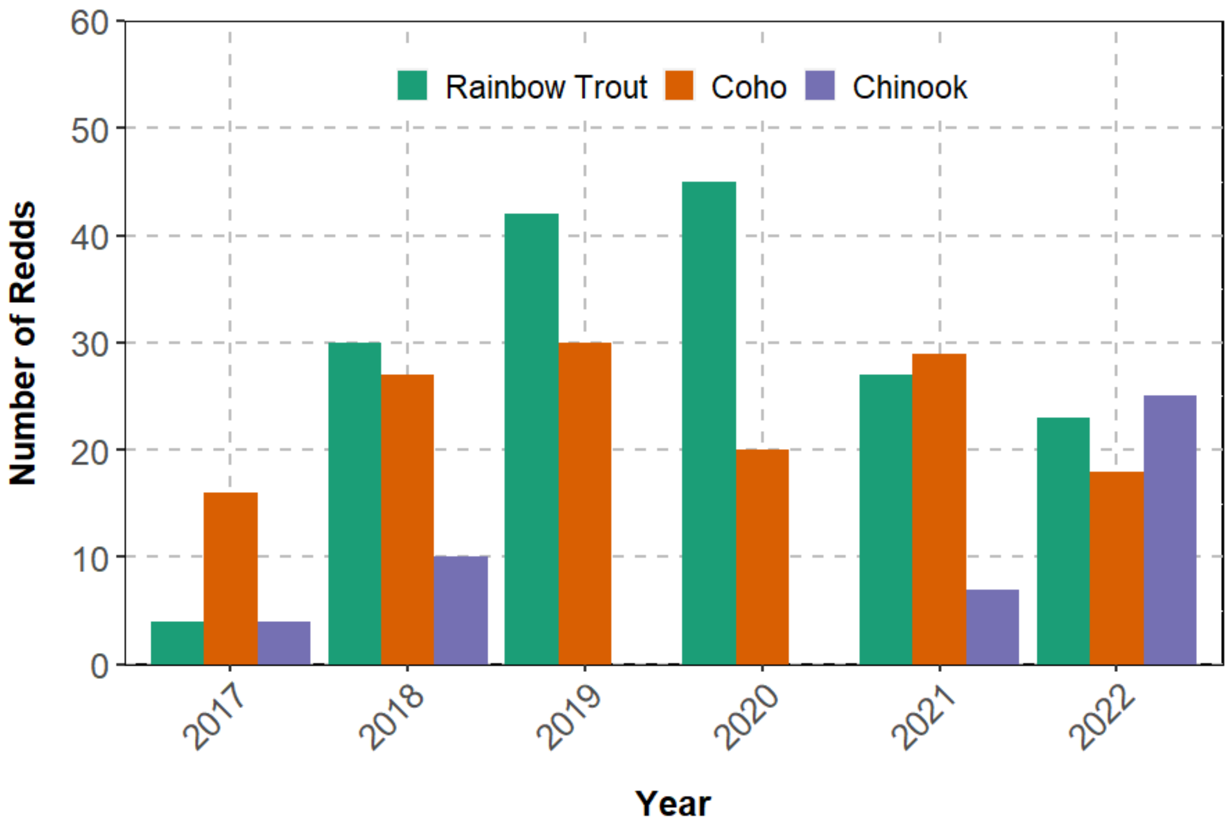


Figure 56 - Counts of Redds Observed in Stream C between 2017 and 2022

Redd surveys of Stream C will continue in the spring and fall of 2023 to confirm the suitability of this waterway for spawning, hatching, and rearing of fish.

6.2.4.7 Vehicle-Wildlife Collisions

Monitoring of vehicle-wildlife collisions on local roadways began in July 2017 to improve our understanding of wildlife mortality caused by vehicle collisions. This monitoring continued in 2022 with 48 formal surveys completed, targeting weekly sampling in the spring and fall.

Standardized two pass surveys occurred on the main access roads that run between Highway 21 and Bruce Power (Bruce Road 20 – Segment 5; Concession 2 – Segment 4) and on the major on-site roadways that have the most traffic (Segments 1-3, 6). Concession 6 (Segment 7) was added in 2019 because of increased traffic around the Farrell Drive industrial complex (Figure 57). Surveys were completed after 9:00 a.m. on weekdays after the peak morning traffic had subsided. All animals were identified to the species-level (wherever possible), photographed and georeferenced. Incidental observations of wildlife carcasses (outside of the formal surveys) were also recorded throughout the year.

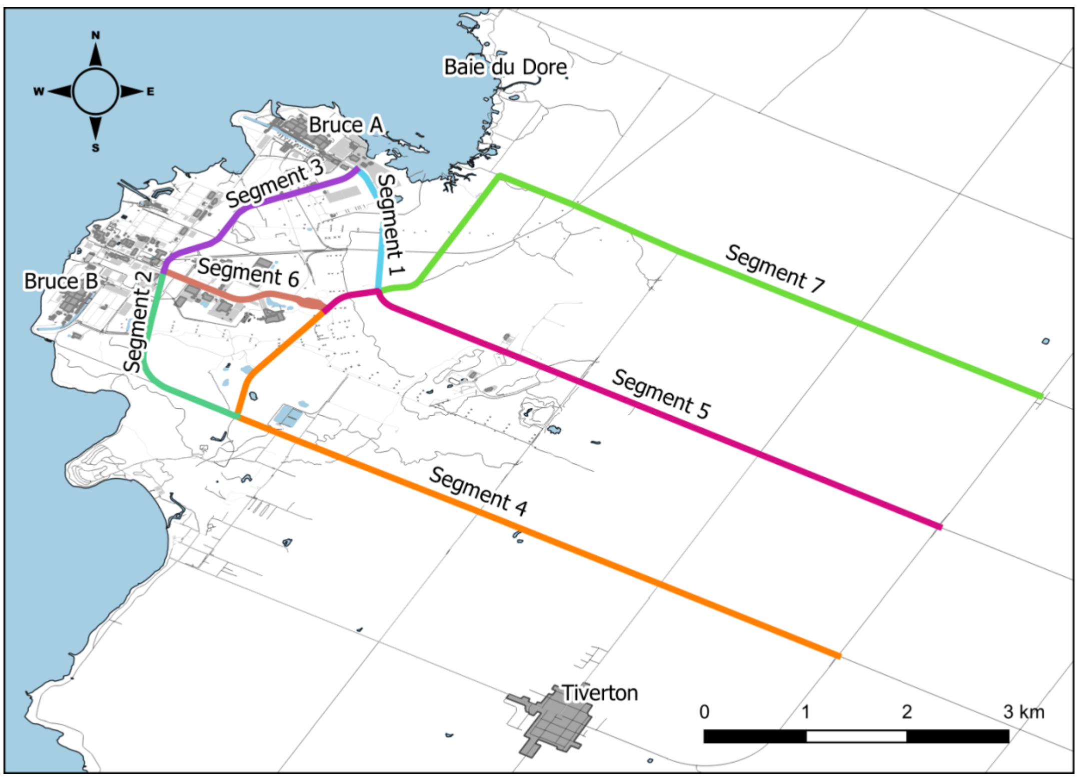


Figure 57 - Vehicle-Wildlife Collision Survey Areas

One hundred and nineteen deceased animals were recorded over the 48 formal surveys conducted in 2022 (2.5 animals per survey day in 2022). This represents an increase in mortality from that observed in recent years, but similar to 2017 (Table 44).

Table 43 - Results of Vehicle-Wildlife Collision Surveys Conducted in the Local Area (2017-2022)

Year	Number of Surveys Completed	Number of Deceased Animals Observed During Formal Surveys	Mortality Rate (Number of Animals Divided by Number of Surveys)	Number of Incidental Observations of Animal Mortality
2017	19	43	2.3	9
2018	46	60	1.3	31
2019	46	78	1.7	15
2020	37	50	1.3	10
2021	48	83	1.7	13
2022	48	119	2.5	10

The majority (62%) of the animals involved in collisions in 2022 were mammals (34%) or amphibians (28%) and included: North American Porcupine (*Erethizon dorsatum*), Raccoon (*Procyon lotor*), Red Squirrel (*Sciurus vulgaris*), Northern Leopard Frog and Green Frog. Two collisions between vehicles and White-tailed Deer (*Odocoileus virginianus*) were documented on the Bruce Power site in 2022. Both deer ran away from the collision, and it is uncertain whether they later succumbed to their injuries. Reptiles represented 16% of the collisions and included Eastern Gartersnake, Midland Painted Turtle, Snapping Turtle, and Eastern Ribbon Snake. The remaining animal mortalities (22%) were made up of birds and insects and most commonly included American Crow and Monarch butterfly (*Danaus plexippus*). The Monarch butterfly is classified as a Species of Special Concern in Ontario and classified as Endangered by the Committee on the Status of Endangered Wildlife in Canada.

Table 44 - Mortality by Survey Segment as a Proportion (%) of the Annual Total (2017-2022)

Year	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
2017	7	14	5	42	33	0	Not surveyed
2018	13	12	8	37	28	2	Not surveyed
2019	10	19	18	29	13	10	Not surveyed
2020	18	8	8	34	16	0	16
2021	13	19	6	24	12	2	23
2022	20	24	2	18	16	4	17
Average Proportion (%)	*14*	*16*	*8*	*31*	*20*	*3*	*19*

The highest frequencies of collisions occur along Segment 4 (Concession 2) where 18 to 42% of the total mortality happens each year. The main entrance for Inverhuron Provincial Park is located on the west end of Concession 2, along segment 4 and this adds considerable traffic to the concession road between the months of June and September. The park sees approximately 120,000 visitors over the course of the season. Segment 5 (Bruce Road 20) and Segment 7 (Concession 6) also have a high proportion of collisions with 12 to 33% of the annual mortality. The remaining segments have fewer collisions, which may be in part due to lower speed limits in these on-site areas.

Bruce Power is committed to reducing its environmental footprint and this includes working with its employees to minimize vehicle-wildlife collisions to the greatest extent possible. Year-round focused communications are used to reinforce safety on and off-site. These communications include sharing vehicle-wildlife collision data with our employees, so they understand where (and when) there is the greatest risk of collision with wildlife. In addition, Bruce Power has installed road signs on Bruce Rd 20 (segment 5) and on Concession 2 (segment 4), warning drivers of turtle and snake crossings and is working in conjunction with Inverhuron Provincial Park, the Municipality of Kincardine and the County of Bruce on possible speed reductions on those impacted sections. Finally, Bruce Power is also exploring possible infrastructure changes to existing culverts in conjunction with the region and municipality, with the aim of increasing wildlife usage as an alternative to road crossing. Amphibians are particularly susceptible to road mortality given that many species show little to no avoidance of roads, some species are attracted to roads for thermoregulation and most species are slow moving and difficult to see.

Vehicle-wildlife collision surveys will continue in 2023 using the same, standardized two-pass approach and existing survey segments.

7.0 GROUNDWATER

7.1 Alignment with Canadian Standards Association N288.7-15

The Canadian Standards Association group's nuclear power-related standards provide operators of nuclear facilities an interlinked set of requirements and guidelines for the management of facilities and operational activities. The overall direction for implementation of sound management practices and controls is provided by the Canadian Standards Association N286-series standards, while other Canadian Standards Association nuclear standards provide specific technical requirements and guidance that support the management system. The Canadian Nuclear Safety Commission's REGDOC-2.9.1, Environmental Protection: Environmental Principles, Assessments and Protection Measures [R-152], sets out regulatory requirements and expectations for programs related to environmental protection. It states that nuclear licensees shall implement a groundwater protection program in a graded approach, appropriate to their circumstances, to:

- prevent or minimize releases of nuclear or hazardous substances to groundwater
- prevent or minimize the effects of physical stressors on groundwater end uses
- confirm that adequate measures are in place to stop, contain, control, and monitor any releases and physical stressors that can occur under normal operation

The Canadian Standards Association N288.7 entitled: Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills [R-64] was published in 2015 and reaffirmed in 2020. The purpose of this Standard is to provide requirements and guidance which facilitate groundwater protection. It has been developed to address the design, implementation, and management of a groundwater protection program that incorporates best practices in Canada and internationally. Compliance with the standard will allow facilities to demonstrate that they will not pose an unreasonable risk to the environment or the health and safety of humans and non-human biota from groundwater. The Canadian Standards Association N288.7 standard provides requirements and guidance on the elements of a Groundwater Protection Program and detailed guidance on developing Groundwater Monitoring Programs as components of a Groundwater Protection Program.

Bruce Power voluntarily committed to have its groundwater protection program implemented and in general alignment with the Canadian Standards Association N288.7 standard by the end of 2020 which was achieved. Bruce Power has considered groundwater protection program goals as defined within the Canadian Standards Association N288.7 standard. Using a systematic approach, each groundwater protection goal defined within the standard was reviewed, considered for applicability to the Bruce Power site and a decision on the applicability of the goal was documented in the overall groundwater protection program design report.

The overall groundwater protection goal applicable to Bruce Power is:

To protect the quality and quantity of groundwater by minimizing interactions with the environment from the activities associated with the site, allowing for effective management of the groundwater resource.

The general goals applicable to Bruce Power are:

- Compliance with the authority having jurisdiction;
- To ensure there are control measures to prevent or minimize the release of nuclear and/or hazardous substances directly or indirectly to groundwater by design and operation of structures, systems, and components;
- To have in place groundwater monitoring to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to identify when and where; and
- To protect the identified groundwater end-use that is potentially affected by releases to groundwater

In order to meet these goals and in consideration of the conceptual site model, Bruce Power was required to review and evaluate the groundwater monitoring program and establish groundwater monitoring objectives in support of achieving the overall and general groundwater protection goals as noted above. A systematic planning process was used in development of groundwater monitoring objectives and the objectives, as defined in the standard, were considered for applicability to the Bruce Power site. Based on this, the objectives are:

- Demonstrate compliance with requirements and conditions of the Authority Having Jurisdiction concerning the release of nuclear and hazardous substances from the source, section 7.5.1.
- Provide data to verify the predictions made and models used in the Environmental Assessment or Ecological Risk Assessment, or reduce the uncertainty in predictions, section 7.5.2.
- Characterize groundwater flow and baseline groundwater quality conditions at a site, section 7.5.3.
- Evaluate monitoring data against groundwater evaluation criteria related to nuclear and hazardous substances in groundwater, section 7.5.4.
- Provide information to assess risks from site affected groundwater to human health and the environment, section 7.5.5.

- Provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring, section 7.5.6.

- To the extent possible, monitor for releases from high-risk systems, structures and components associated with a given facility, section 7.5.7.

7.2 History

Bruce Power has had a groundwater monitoring program in place since the late 1990's. Several groundwater investigations at the Site have included installing shallow and deep monitoring wells that have been used in various capacities to better understand and characterize the Site's hydrogeological characteristics and in some instances to assess for presence and or absence of contaminants of concern associated with various sites. Wells have been installed on an as-required basis to respond to and investigate known subsurface issues and as part of the proactive groundwater monitoring program implemented by Bruce Power. There were 16 legacy areas within the Site that are being monitored as part of the annual monitoring program. The legacy monitored sites have boundaries that have been defined based on past investigations and were chosen based on potential risk to groundwater or due to previous events which have impacted groundwater, however this infrastructure may have been removed since. As such, Bruce Power has re-organized the legacy monitored sites into a smaller set of groundwater monitoring areas. These areas have been defined using information provided through the Bruce Power conceptual site model. The conceptual site model considers all contributing pathways and mechanisms whereby contaminants of concern may be released and the extent of possible impact to the groundwater regime. The conceptual site model was developed in consideration of:

- contaminant sources and potential releases by identifying potentially contaminating activities, areas of potential environmental concern and contaminants of concern associated with each of these activities and areas

- the groundwater flow system including flow direction and hydraulic gradients, hydrostratigraphic units and contaminant migration

- end-use receptors and potential pathways to these receptors including human receptors, ecological receptors, surface water and other potential receptors that may not be intended to receive groundwater

- groundwater vulnerability which considers the thickness of the overburden and the permeability of the material above the water table

- controls in place such as spill response, secondary containment and existing groundwater monitoring programs

The purpose of the re-organization of groundwater sites is to eliminate confusion over the naming of sites where the associated infrastructure has been removed and in order to gain synergies from sites which are in proximity to each other thereby allowing for a broader view of the site as a whole. Conventional groundwater monitoring areas are represented in Figure 58 below and the groundwater monitoring area and associated legacy monitored sites are listed in Table 45 along with the main contaminant of concern for the respective area.

In addition to the conventional groundwater monitoring program, Bruce Power also conducts radiological groundwater monitoring at a subset of wells located within the protected areas of Bruce A and Bruce B. Multi-level monitoring wells were installed in December 1997 and are sampled semi-annually for tritium. These wells are located between the reactor building and Lake Huron. Additional sampling was implemented from around 2014 at wells located on the opposite side of the powerhouse to provide more information to the radiological groundwater monitoring program. Typically, these wells were sampled annually in the fall but are now sampled semi-annually in alignment with the multi-level wells. The location of wells monitored as part of the radiological groundwater monitoring program are shown in Figure 59 and Figure 60 below for Bruce A and Bruce B respectively.

7.3 Quality Control

Data quality for the 2022 groundwater sampling campaign was evaluated using groundwater samples which were collected from May 25 to May 31, June 1 and from October 13 to October 19. The evaluation followed individual method requirements and guidelines from the U.S. Environmental Protection Agency National Functional Guidelines for Inorganic Superfunds Method Data Review (EPA 2020a) [R-153] and National Functional Guidelines for Organic Superfunds Method Data Review (EPA 2020b) [R-154]. The analytical results were evaluated using the criteria of precision, accuracy, representativeness, comparability and completeness. The data quality evaluation covered 108 normal groundwater samples, 13 groundwater field duplicate samples, 11 field blank samples, 13 trip blank samples and the associated laboratory quality control samples.

The data quality evaluation is an assessment of whether the data meet the data quality objectives. The goal of the assessment is to demonstrate that a sufficient number of representative samples have been collected and the resulting analytical data can be used to support project decision-making processes.

For 2022, the groundwater analytical data provided for evaluation was considered valid and can be used for decision making.

7.4 Sample Methodology

Conventional groundwater sample collection for the spring sampling event (and for previous years sampling events) involved the “well volume” method where monitoring wells are purged a minimum of three times of either each individual well’s volume, or until the groundwater well was purged empty of all reasonably obtainable water. Field chemistry parameters were monitored to evaluate and determine that the groundwater had reached stability and samples obtained would be representative. For the fall sampling event, monitoring wells were purged and sampled using the “low flow” technique, that is, purging the well at a slower flow rate and recording measurements of field chemistry parameters frequently – every 3 to 5 minutes. Field chemistry parameters including temperature, electrical conductance, pH, oxidation reduction potential and dissolved oxygen were recorded utilizing field meters throughout purging. Sampling occurs once field parameters have stabilized, which is indicative of stabilized groundwater conditions.

In fall 2022, following this sampling methodology change to low flow purging/sampling from well-volume method purging/sampling, three locations were selected to have method duplicates taken based on the historic detection of petroleum hydrocarbons at these groundwater monitoring areas. Despite differences in observed petroleum hydrocarbon concentrations the low flow method is established to better reflect the dissolved concentrations of petroleum hydrocarbons. It is thought that the observed higher concentrations within the well-volume method samples reflect interference from entrained sediments or immiscible product due to agitation of the water column and does not provide a representative observation of the dissolved groundwater concentration only. Moving forward, Bruce Power will continue to utilize the low flow sampling methodology as this also produces less purge water which would otherwise be required to be processed as waste.

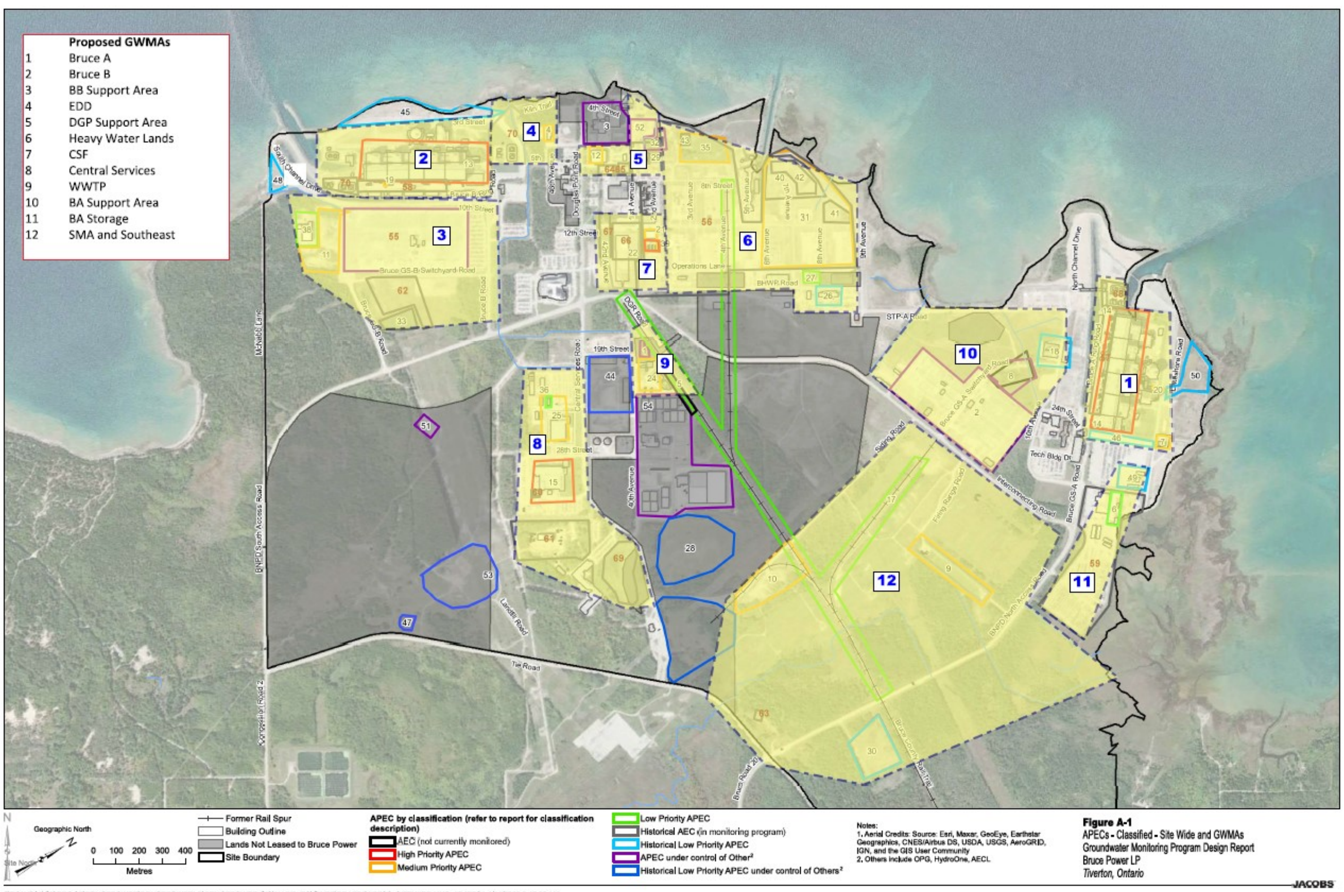


Figure 58 - Groundwater Monitoring Areas

Table 45 - Groundwater Monitoring Areas

Groundwater Monitoring Area	Legacy Monitored Site	Contaminant of Potential Concern
Bruce A	Bruce A Transformers; Bruce A Standby Generators; Bruce A Powerhouse	Hydrocarbons; Tritium
Bruce B	Bruce B Transformers; Bruce B Standby Generators - South Bruce B Emergency Power Generators; Bruce B Powerhouse	Hydrocarbons; Tritium
Bruce B Support Area	Former Sewage Lagoon	Historical Area of Environmental Concern
Eastern Drainage Ditch	Bruce B Standby Generator – North	Hydrocarbons
Douglas Point Support Area	Bunker C Oil and Ignition Day Tank; Acid Wash Pond; Bruce Heavy Water Lands	Hydrocarbons and Metals
Heavy Water Lands	Bruce Heavy Water Lands	Metals
Central Storage Facility	Bunker C Oil Aboveground Storage Tanks	Tritium
Central Services Area	Central Maintenance Facility; Fire Training Facility; Construction Landfill 4	Hydrocarbons; Metals
Wastewater Treatment Plant	None	Solvents
Bruce A Support Area	None	Hydrocarbons
Bruce A Storage	Bruce A Storage Compound	Metals; Solvents
Soil Management Area and Southeast Site	Soil Management Area; Distribution Station 1	Hydrocarbons; Metals

Figure 59 - Groundwater Monitoring Well Locations Sampled for Tritium at Bruce A

Figure 60 - Groundwater Monitoring Well Locations Sampled for Tritium at Bruce B

7.5 Performance Against Groundwater Monitoring Program Objectives

The applicable general objectives for the 2022 groundwater monitoring program are listed below. Along with each general objective listed is the information required to meet the objective and the annual performance against the objective which satisfies the requirements of Canadian Standards Association N288.7-15 c.11.3 [R-64].

All Bruce Power groundwater monitoring objectives were achieved in 2022.

7.5.1 Demonstrate Compliance with Requirements and Conditions Objective

As per the Licence Condition Handbook, the Canadian Nuclear Safety Commission requires Bruce Power to be in alignment with Canadian Standards Association N288.7. A groundwater monitoring program is required at Bruce Power as per the standard therefore groundwater monitoring is performed to demonstrate compliance with the requirements and conditions of the Authority Having Jurisdiction.

Bruce Power committed to implementation of the Canadian Standards Association standard N288.7-15 as of Dec. 31, 2020, which became part of the Licence Condition Handbook, LCH-PR-18.02/2028-R003 [R-9]. In aligning with the standard, Bruce Power evaluated the criteria in the standard to determine if a groundwater protection program and a groundwater monitoring program are required at the facility. Both programs were determined to be required.

Groundwater monitoring and sampling for conventional parameters at Bruce Power was completed in the spring and the fall of 2022. Spring sampling was conducted between May 25 and June 1. Fall groundwater sampling program was conducted between October 13 and October 20. Sampling occurred at a refined set of groundwater monitoring areas based on the previous year’s results (evaluation criteria exceedance follow-up) or due to site operational activities and potential risks to groundwater (i.e., existence of systems, structures, and components containing contaminants of potential concern). The 2022 Bruce Power groundwater sampling campaign is shown in Table 46 and Table 47. Table 46 shows the conventional parameter groundwater sampling campaign, the number of wells sampled at each legacy monitored site and the groundwater monitoring area which it belongs to. The Bruce Power groundwater monitoring areas are shown in Figure 58.

Table 47 shows the radiological groundwater sampling campaign. The Bruce Power radiological groundwater monitoring areas are shown in Figure 59 and Figure 60 for Bruce A and Bruce B respectively. Spring sampling for tritium was conducted between June 6 and June 20 with fall/winter sampling taking place between October 31 and January 18, 2023. Three spring re-samples were collected at Bruce A on October 19 as a follow-up to the spring results.

Groundwater monitoring took place in 2022 which meets the requirements of the Canadian Nuclear Safety Commission licence conditions therefore this objective was satisfied in 2022.

Table 46 - Bruce Power 2022 Groundwater Sampling Campaign for Conventional Parameters

Monitoring Site	Groundwater Monitoring Area Number (as per Figure 1)	Spring 2022 (Number of wells sampled)	Fall 2022 (Number of Wells Sampled)
Bruce A Standby Generator	1	0	9
Fire Training Facility	8	12	12
Bruce A Transformer Area	1	0	8
Bruce B Transformer Area	2	0	9
Bruce B Standby Generator – South	2	0	9
Bruce Heavy Water Land	5	7	7
Central Maintenance Facility	8	0	6
Bunker C Oil and Ignition Day Tank Area	5	0	12
Soil Management Area	12	7	7

Table 47 - Bruce Power 2022 Groundwater Sampling Campaign for Tritium

Facility	Spring 2022 (Number of wells sampled)	Spring re-sampled wells (Number of wells sampled)	Fall 2022 (Number of wells sampled)
Bruce A	20	3	20
Bruce B	17	0	16

7.5.2 Verify Predictions and Models used to Reduce Uncertainty Objective

The groundwater monitoring program results must be available for use in on-going revisions of the Ecological Risk Assessment. Use of this data provides information where there may be uncertainty in the Ecological Risk Assessment. Groundwater sub-sites which have been screened out of the risk assessment may be included in future assessments if groundwater monitoring program data shows an increased potential for adverse impact.

The main objective of the Bruce Power groundwater monitoring program is to evaluate the groundwater quality and conditions at established subject sites based on monitoring and sampling of the existing monitoring wells. These existing monitoring wells were installed during previous environmental site assessments and investigations at the sites. Additional wells were installed in 2012 to help further evaluate the groundwater quality at specific subject sites. Based on year-to-year evaluation, wells that are ineffective or are no longer representative of groundwater quality are decommissioned as per regulations under the *Ontario Water Resources Act*.

Groundwater was only retained in the 2022 Ecological Risk Assessment for potential root uptake by terrestrial plants. As a result, only data from groundwater monitoring wells with groundwater levels less than 1.5 metres below ground surface were considered given that plant roots generally do not extend beyond that depth. Additionally, areas that are actively used as part of the ongoing operations were not considered suitable habitat for ecological receptors as many of these areas are paved and do not contain the shelter and food sources that can support ecological life. Groundwater data from active industrial locations lacking ecological habitat were not applicable for the most recent Ecological Risk Assessment revision. Given these considerations, the Bruce A Storage Compound (Bruce A Storage Area or Area 11 of Figure 58) and the Former Sewage Lagoon (Bruce B Support Area or Area 3 of Figure 58) were the only locations at which shallow groundwater was present in an area that may also serve as ecological habitat. Water levels were taken at these locations in 2022.

Monitoring of groundwater occurs in areas which would be considered industrial barren or where the groundwater level is below that which would impact root systems, however migration of groundwater may occur to areas where it may discharge to surface water. Where impacts to groundwater are observed and there is an increased potential for these impacts to migrate to areas where discharge to surface water occurs, they may subsequently be included in the Ecological Risk Assessment for further assessment. This occurred at two monitoring sites in the most recent version of the Ecological Risk Assessment. Bruce B Standby Generator north site (Eastern Drainage Ditch Area or Area 4 of Figure 58) and the Bruce B Emergency Power Generator site (Bruce B Area or Area 2 of Figure 58) have both been included for further assessment in the Ecological Risk Assessment. Since the groundwater levels at these sites are below the level which would impact potential receptors, surface water was assessed at nearby discharge locations. Groundwater monitoring will continue at both of these locations to verify that the contaminant plume is not migrating, and the contaminant mass continues to decrease.

Bruce Power aligned with Canadian Standards Association N288.7 [R-64] at the end of 2020 and continues to improve groundwater protection at the Bruce Power site in accordance with principles from the standard. Further development of the conceptual site model continues to inform the Ecological Risk Assessment as does annual groundwater monitoring. Monitoring serves to inform the Ecological Risk Assessment by providing data confirming increased potential for impact and supports increased risk assessment and also provides data to confirm that groundwater does not represent increased risk to the environment.

Groundwater data for the Bruce A Storage Compound (Bruce A Storage Area or Area 11 of Figure 58) was last obtained in 2017. Lack of operational activity and absence of exceedances of evaluation criteria has led to decreased sampling activity. The 2022 groundwater monitoring program noted no obvious signs of contamination or impact at this site. The 2017 data was included/used for assessment in the 2022 Ecological Risk Assessment.

Groundwater data for the Former Sewage Lagoon (Bruce B Support Area or Area 3 of Figure 58) was last obtained in 2019. Lack of operational activity and absence of exceedances of evaluation criteria has led to decreased sampling activity. The 2022 groundwater monitoring program noted no obvious signs of contamination or impact at this site. The 2017, 2018 and 2019 data were included/used for assessment in the 2022 Ecological Risk Assessment.

The groundwater monitoring program has provided data to verify predictions made and models used in the Ecological Risk Assessment as well as reduce uncertainty in these predictions therefore this objective has been satisfied in 2022.

7.5.3 Characterize Groundwater Flow and baseline Quality Objective

On-going monitoring of water levels provides information needed to infer groundwater flow direction. Groundwater monitoring program data allows for assessment of groundwater conditions.

Groundwater level measurements relating to the 2022 groundwater protection program were conducted over the entire site between October 11th and October 12th, 2022. A total of 154 locations were observed, inspected and monitored in 2022. General site groundwater flow direction is shown in Figure 61. Groundwater flow across the site remains unchanged from previous years as confirmed by monitoring activities performed in 2022. Groundwater data obtained in 2022 allows for the evaluation of groundwater quality. Performance against evaluation criteria is performed in order to determine if corrective actions are required.

The inferred groundwater flow directions are shown in the Figure 62, Figure 63 and Figure 64 depicting Bruce A, Bruce B and Centre of Site respectively. This objective has been satisfied in 2022.

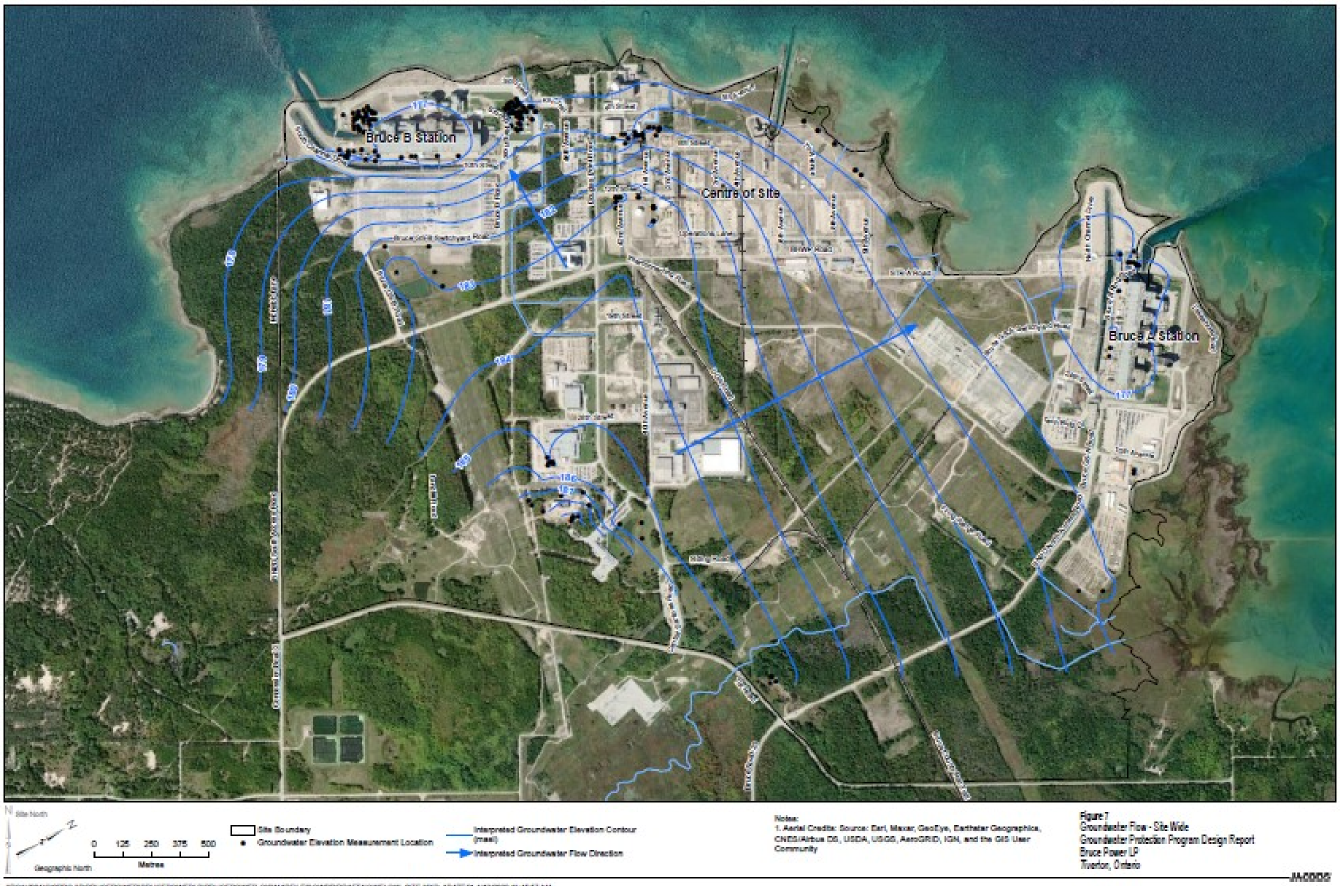


Figure 61 - Bruce Power Site Inferred Groundwater Flow Direction

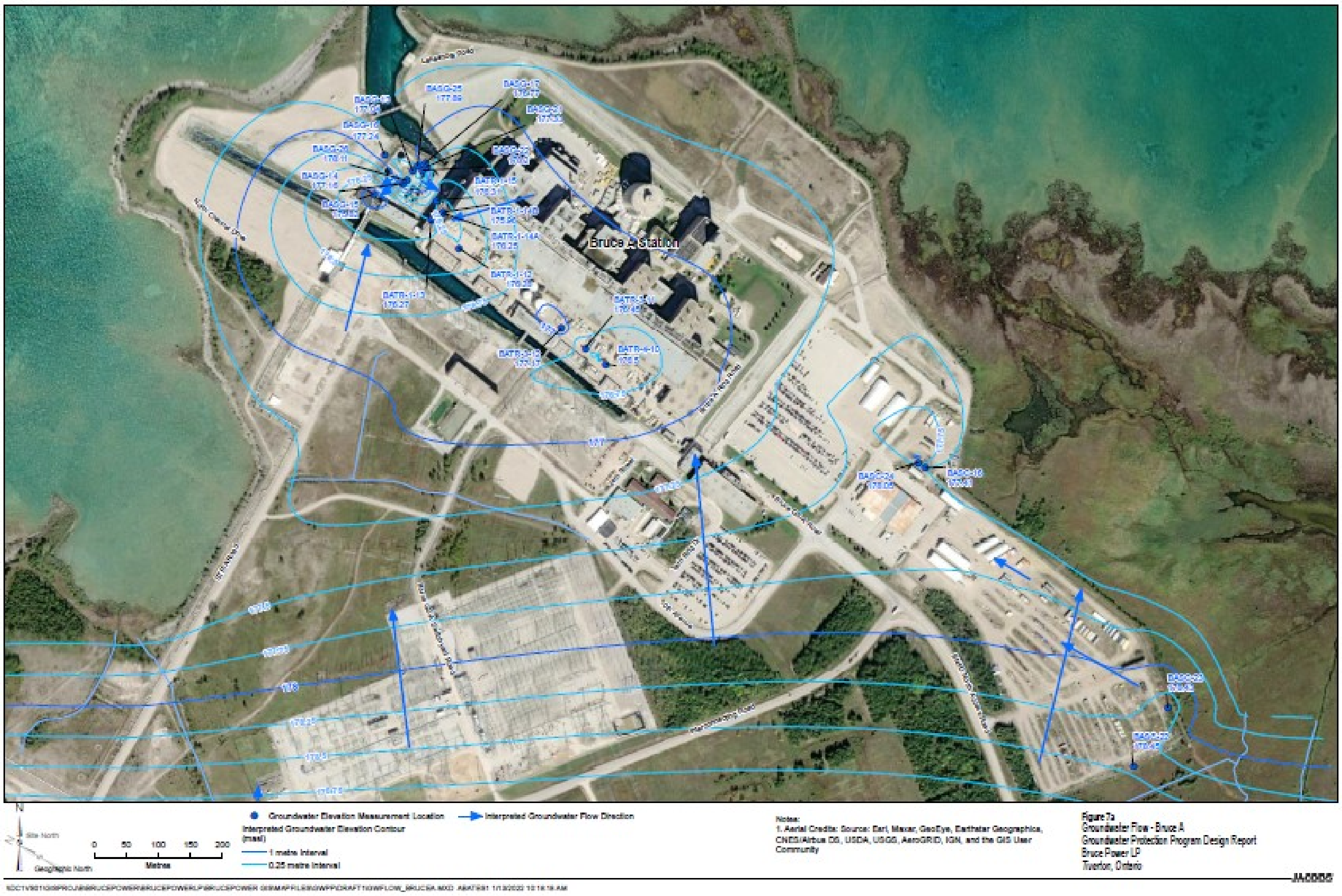


Figure 62 - Bruce A Inferred Groundwater Flow Direction

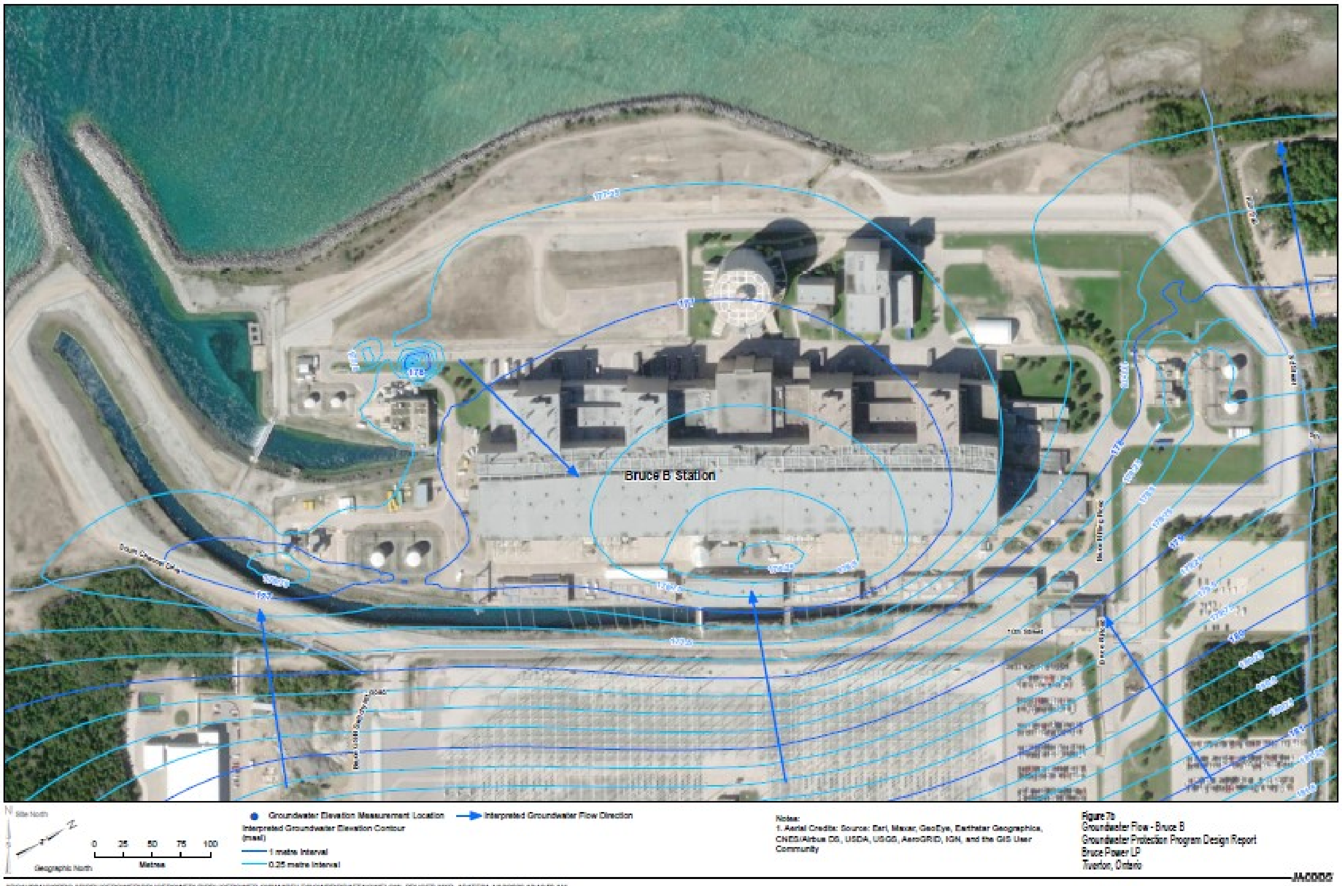


Figure 63 - Bruce B Inferred Groundwater Flow Direction

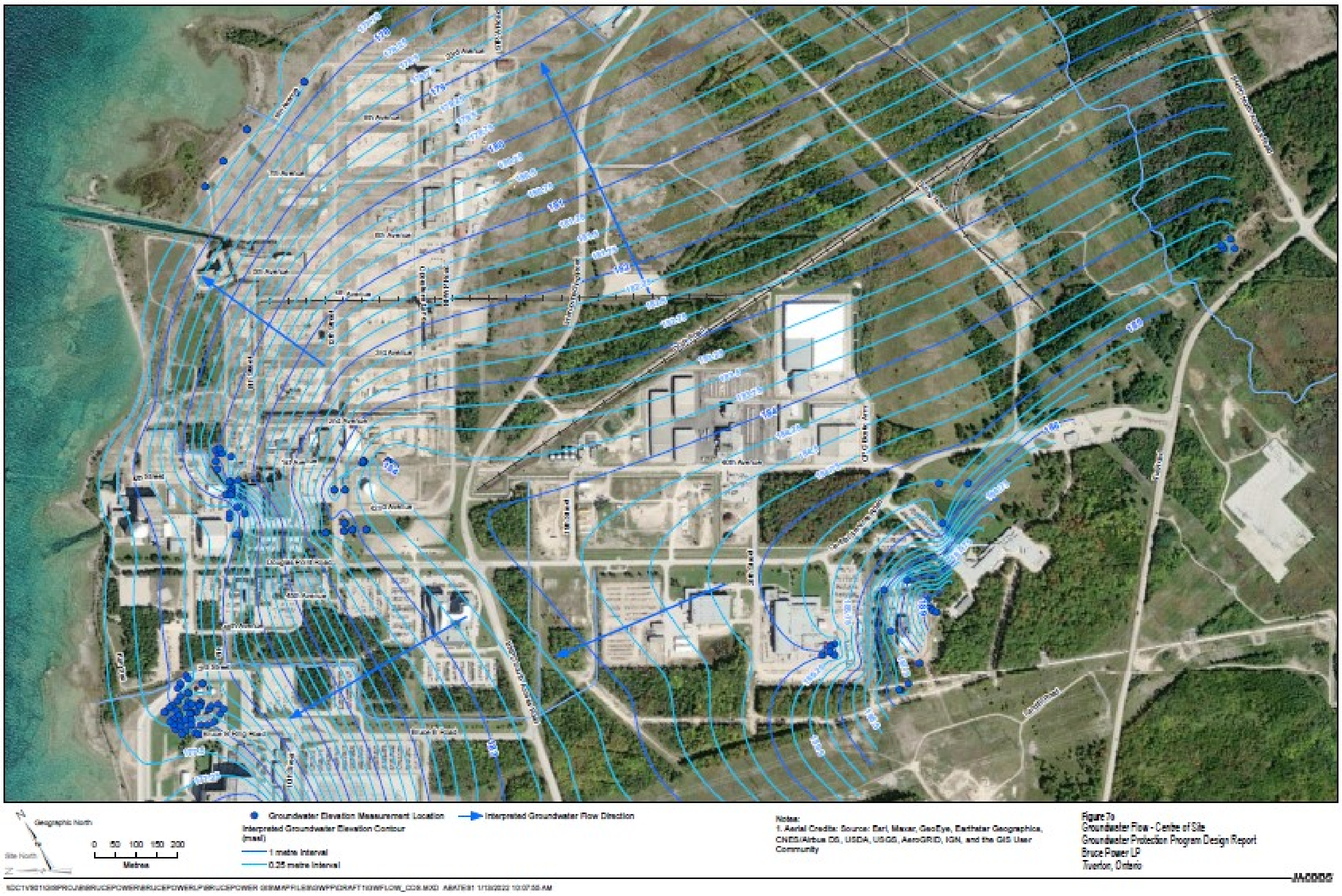


Figure 64 - Centre of Site Inferred Groundwater Flow Direction

7.5.4 Evaluate Monitoring Data against Groundwater Evaluation Criteria Objective

Evaluation criteria are established to allow for the assessment of risk from site affected groundwater to human health and the environment. Results from groundwater monitoring and sampling are used to compare against these evaluation criteria.

Groundwater monitoring and sampling was performed in the spring and fall of 2022. Results of conventional groundwater sampling are compared against the Ministry of Environment, Conservation and Parks Site Condition Standards [R-155] (either Table 2 –Full Depth Generic Site Condition Standards in a Potable Groundwater Condition or Table 8 –Generic Site Condition Standards for Use Within 30 metres of a Water Body in a Potable Groundwater Condition based on groundwater monitoring site location). These criteria are considered protective of the environment and human health but do not represent reportable limits. Exceedances of these criteria are summarized by locations. Reference to the groundwater monitoring area site map is provided (Figure 58). Table 48 through to Table 57 references the monitoring location from which the sample was taken, the parameter, which was exceeded, the criteria which the result was compared against, the result for 2022, and the range with respect to the parameter over the previous five years. The final column in the table shows the number of observations over the trend period denoting the number of those observations which were exceedances in parentheses.

The results above the evaluation criteria observed in 2022 can be attributed to known historical events or activities and do not represent a risk to human health or the environment based on the groundwater depth and distance to receptors. These areas will continue to be monitored in 2023.

Some of the tables shown below contain duplicate results (with one result contained in parentheses). In all instances, this represents a field duplicate result as part of the quality control program with the exception of Well I.D. FTF-48 in Table 56. In this case, the duplicate result is a method duplicate taken in support of the alternate sampling methodology used between the spring and the fall sampling events and as described in Section 7.4.

Table 57 provides the results for the perfluoroalkylated and polyfluoroalkylated sampling event which took place in the fall of 2022. Bruce Power performs firefighting exercises at its Fire Training Facility (Central Services Area or Area 8 of Figure 58). As a result of these activities, there may be residual groundwater contamination related to firefighting foams from these substances. There are currently no groundwater limits with respect to these chemicals, therefore the Health Canada drinking water guidelines [R-130] were used as a screening criteria for the sample results since groundwater is not used as drinking water on the Bruce Power site.

Semi-annual groundwater sampling for tritium was performed on a number of wells within the protected areas of Bruce A and Bruce B. For the purpose of identification of changes in conditions, statistically based evaluation criteria are derived using the mean plus three standard deviations approach. This value is established as the upper level of background and provides a reasonable benchmark for the identification of anomalous results which may potentially require further investigation. This value is calculated using results from all wells which would be considered “similar” in terms of atmospheric tritium exposure. Seasonality is not differentiated in the derivation of the value. Bruce A and Bruce B well locations are shown in Figure 59 and Figure 60 respectively and observations where tritium values were above the evaluation criteria are shown in Table 58. Follow-up samples were taken on the Bruce A spring samples which exceeded the criteria. These samples were taken in October to determine if levels were continuing to increase. The results of the follow-up samples showed that levels had decreased back to within normal trends. Winter sampling resulted in similar observations as the spring. It is likely that these tritium levels in groundwater are a result of localized atmospheric deposition. Semi-annual sampling will continue in 2023.

Table 48 - Bruce Heavy Water Lands (Douglas Point Support Area or Area 5 of Figure 58) Conventional Parameter Results, Spring Sampling

Well I.D	Parameter	Criteria (ug/L)	2022 Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
1-07	Petroleum hydrocarbons F2 (C10-C16)	150	370 (550)	550	1(1)
1-07	Petroleum hydrocarbons F3 (C16-C34)	500	63,800 (61,000)	63,800	1(1)
1-07	Petroleum hydrocarbons F4 (C34-C50)	500	4,440 (3,560)	4,440	1(1)
2-07	Petroleum hydrocarbons F2 (C10-C16)	150	320	320	1(1)
2-07	Petroleum hydrocarbons F3 (C16-C34)	500	27,600	27,600	1(1)
2-07	Petroleum hydrocarbons F4 (C34-C50)	500	1,670	1,670	1(1)
3-07	Petroleum hydrocarbons F2 (C10-C16)	150	400	400	1(1)
3-07	Petroleum hydrocarbons F3 (C16-C34)	500	5,650	5,650	1(1)
3-07	Petroleum hydrocarbons F4 (C34-C50)	500	1,080	1,080	1(1)
4-07	Petroleum hydrocarbons F2 (C10-C16)	150	290	290	1(1)
4-07	Petroleum hydrocarbons F3 (C16-C34)	500	44,200	44,200	1(1)

Well I.D	Parameter	Criteria (ug/L)	2022 Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
1-07	Petroleum hydrocarbons F2 (C10-C16)	150	370 (550)	550	1(1)
1-07	Petroleum hydrocarbons F3 (C16-C34)	500	63,800 (61,000)	63,800	1(1)
1-07	Petroleum hydrocarbons F4 (C34-C50)	500	4,440 (3,560)	4,440	1(1)
2-07	Petroleum hydrocarbons F2 (C10-C16)	150	320	320	1(1)
2-07	Petroleum hydrocarbons F3 (C16-C34)	500	27,600	27,600	1(1)
2-07	Petroleum hydrocarbons F4 (C34-C50)	500	1,670	1,670	1(1)
4-07	Petroleum hydrocarbons F4 (C34-C50)	500	2,510	2,510	1(1)
4B	Petroleum hydrocarbons F2 (C10-C16)	150	1,850	1,850	1(1)
4B	Petroleum hydrocarbons F3 (C16-C34)	500	10,100	10,100	1(1)
5-07	Petroleum hydrocarbons F2 (C10-C16)	150	390	390	1(1)
5-07	Petroleum hydrocarbons F3 (C16-C34)	500	2,860	2,860	1(1)

Table 49 - Fire Training Facility (Central Services Area or Area 8 of Figure 58) Conventional Parameter Results, Spring Sampling

Well I.D	Parameter	Criteria (ug/L)	2022 Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
38	Ethylbenzene	2.4	2.7	2.7	1(1)
38	Petroleum hydrocarbons F1 (C6-C10) – BTEX	No value derived	684	684	1(1)
38	Petroleum hydrocarbons F1 (C6-C10)	420	696	696	1(1)
38	Petroleum hydrocarbons F2 (C10-C16)	150	80,800	80,800	1(1)
38	Petroleum hydrocarbons F3 (C16-C34)	500	79,800	79,800	1(1)
24	Petroleum hydrocarbons F2 (C10-C16)	150	410	410	1(1)
26	Petroleum hydrocarbons F2 (C10-C16)	150	300	300	1(1)
30	Petroleum hydrocarbons F2 (C10-C16)	150	2,130	2,130	1(1)
30	Petroleum hydrocarbons F3 (C16-C34)	500	1,810	1,810	1(1)
42	Petroleum hydrocarbons F2 (C10-C16)	150	1,960	1,960	1(1)
42	Petroleum hydrocarbons F3 (C16-C34)	500	2,270	2,270	1(1)

Well I.D	Parameter	Criteria (ug/L)	2022 Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
45	Petroleum hydrocarbons F2 (C10-C16)	150	240	240	1(1)
48	Petroleum hydrocarbons F2 (C10-C16)	150	1,280	1,280	1(1)
48	Petroleum hydrocarbons F3 (C16-C34)	500	1,380	1,380	1(1)
50	Petroleum hydrocarbons F2 (C10-C16)	150	820	820	1(1)
50	Petroleum hydrocarbons F3 (C16-C34)	500	1,580	1,580	1(1)
52	Petroleum hydrocarbons F2 (C10-C16)	150	72,300	72,300	1(1)
52	Petroleum hydrocarbons F3 (C16-C34)	500	57,500	57,500	1(1)

Table 50 - Bruce A Standby Generator Area (Bruce A Area or Area 1 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	2022 Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
22	Petroleum hydrocarbons F2 (C10-C16)	150	180	<100 – 600	5(3)

Table 51 - Bruce A Transformer Area (Bruce A Area or Area 1 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
3-11	Volatile Organic Compounds - Chloroform	2.4	24.5 (24.6)	7.8 – 30	4(4)

Table 52 - Bruce B Standby Generator South Area (Bruce B Area or Area 2 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
18	Petroleum hydrocarbons F2 (C10-C16)	150	220	150 – 220	5(5)

Table 53 - Bruce B Transformer Area (Bruce B Area or Area 2 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
5-13	Metals – Uranium	20	25.8	12.0 – 25.8	5(5)
5-13	Chloride	790,000	882,000	227 - 952	5(5)
5-13	Sodium	490,000	499,000	143,000 – 580,000	5(5)
5-14	Metals – Uranium	20	24.5	22.3 – 28.5	5(5)
5-14	Chloride	790,000	952,000	540 – 1,230	5(5)
5-14	Sodium	490,000	579,000	347,000 – 817,000	5(5)
6-40	Chloride	790,000	1,020,000	549 – 1,020	5(5)
6-40	Sodium	490,000	658,000	396,000 – 658,000	5(5)

Table 54 - Bunker C Oil and Ignition Day Tank (Douglas Point Support Area or Area 5 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
27	Petroleum hydrocarbons F3 (C16-C34)	500	580	<250 - 580	4(1)
31B	Petroleum hydrocarbons F3 (C16-C34)	500	3,280	3,280	1(1)

Table 55 - Bruce Heavy Water Lands (Douglas Point Support Area or Area 5 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
1-07 (iv)	Petroleum hydrocarbons F3 (C16-C34)	500	520	520 – 266,000	3(3)

Table 56 - Fire Training Facility (Central Services Area or Area 8 of Figure 58) Conventional Parameter Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
30	Petroleum hydrocarbons F2 (C10-C16)	150	900	900 - 4520	4(4)
38	Petroleum hydrocarbons F2 (C10-C16)	150	860	860 – 200,000	4(4)
42	Petroleum hydrocarbons F2 (C10-C16)	150	280	280 – 8,670	4(4)
48	Petroleum hydrocarbons F2 (C10-C16)	150	530 (7,490)	530 – 48,200	4(4)
48	Petroleum hydrocarbons F3 (C16-C34)	500	250 (6,300)	250 – 36,400	4(4)
52	Petroleum hydrocarbons F2 (C10-C16)	150	240	180 – 21,600	4(4)

Table 57 - Fire Training Facility (Central Services Area or Area 8 of Figure 58) Perfluoroalkyl and Polyfluoroalkyl Substances Results, Fall Sampling

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
24	Perfluorohexanoate	0.2	0.268	0.268	1(1)
24	Perfluoropentanoate	0.2	0.352	0.352	1(1)
26	Perfluoroheptanoate	0.2	3.42	3.42	1(1)
26	Perfluorohexanesulfonate	0.6	0.76	0.76	1(1)
26	Perfluorohexanoate	0.2	22.3	22.3	1(1)
26	Perfluorononanoate	0.02	0.28	0.28	1(1)
26	Perfluorooctanoic acid	0.2	1.05	1.05	1(1)
26	Perfluorooctane sulfonate	0.6	1.1	1.1	1(1)
26	Perfluoropentanoate	0.2	52.4	52.4	1(1)
30	Perfluorohexanoate	0.2	0.658	0.658	1(1)
30	Perfluorohexanoate	0.2	1.27	1.27	1(1)
38	Perfluoroheptanoate	0.2	0.68	0.68	1(1)
38	Perfluorohexanoate	0.2	2.79	2.79	1(1)
38	Perfluorononanoate	0.02	0.022	0.022	1(1)
38	Perfluoropentanoate	0.2	5.89	5.89	1(1)
41	Perfluoropentanoate	0.2	0.406	0.406	1(1)
42	Perfluoroheptanoate	0.2	1.4	1.4	1(1)
42	Perfluorohexanoate	0.2	9.92	9.92	1(1)
42	Perfluorononanoate	0.02	0.084	0.084	1(1)
42	Perfluorooctanoic acid	0.2	0.286	0.286	1(1)
42	Perfluoropentanoate	0.2	14.7	14.7	1(1)
45	Perfluoroheptanoate	0.2	0.248	0.248	1(1)
45	Perfluorohexanoate	0.2	1.61	1.61	1(1)
45	Perfluorononanoate	0.02	0.026	0.026	1(1)
45	Perfluoropentanoate	0.2	2.5	2.5	1(1)
46	Perfluoroheptanoate	0.2	3.74	3.74	1(1)
46	Perfluorohexanoate	0.2	12.3	12.3	1(1)

Well I.D	Parameter	Criteria (ug/L)	Result (ug/L)	Range: 2018-2022 (ug/L)	Number of observations (and exceedances if applicable
46	Perfluorononanoate	0.02	0.082	0.082	1(1)
46	Perfluorooctanoic acid	0.2	0.284	0.284	1(1)
46	Perfluoropentanoate	0.2	29.2	29.2	1(1)

Table 58 - Bruce Power Tritium in Groundwater Evaluation Criteria Exceedances (Well locations shown in Figure 59 and Figure 60)

Well I.D.	Criteria (Bq/L)	June 20, 2022 Result (Bq/L)	January 12, 2023 Result (Bq/L)
BATR 1-14B	5,654	8,570	14,000
BATR 3-12	5,654	9,550	5,980
BATR 4-10	5,654	12,100	Below criteria
BBTR 7-12	3,130	5,390	7,630

7.5.5 Provide Information to Assess Risks to Human Health and Environment Objective

Execution of groundwater monitoring and sampling allows for the provision of information which is adequate for use in determination of risk assessment from site affected groundwater.

The 2022 groundwater sampling results were compared against Ministry of Environment, Conservation and Parks Site Condition Standards [R-155]. As previously noted, exceedances of these criteria do not represent reportable events but are used as a best practice since they enable Bruce Power to assess risks from site affected groundwater to human health and the environment. The exceedances noted above can be attributed to known historical events or activities and are grouped into a small number of parameter groups. These parameter groups are discussed below.

Petroleum Hydrocarbons and Benzene, Toluene, Ethylbenzene and Xylene - Exceedances are observed at areas where there has historically been firefighting training, fueling activities, combustion operations and large inventories of fuel oils and mineral oils maintained. Events have occurred which have caused Petroleum Hydrocarbons and Benzene, Toluene, Ethylbenzene and Xylene contamination in these areas.

Historical activities at the former oil storage area within the Bruce Heavy Water Lands (Douglas Point Support Area or Area 5 of Figure 58) resulted in residual hydrocarbon contamination. In 2006, partial remediation took place via bioremediation, excavation and offsite removal. Contaminated soil and stained bedrock were removed. Free product was identified in two of the monitoring wells in 2022. Free product represents a source of contamination to groundwater. The free product was removed and disposed of as hazardous waste. Different sampling methodologies were used between the spring and the fall sampling event. It is likely that the change in sampling methodology significantly reduced the number of evaluation criteria exceedances. More information on the change in methodologies is provided in section 7.4. Results related to the Bruce Heavy Water Lands are provided in Table 48 and Table 55 for spring and fall sampling respectively.

The Bruce A Standby Generator area (Bruce A Area or Area 1 of Figure 58) experienced a cracked valve in the supply pipeline in 1996 leading to a 22,000 litre fuel oil spill. Minor residual contamination remains in this area as a result however the result in 2022 was only observed in one of the method duplicate samples taken at the location using the high flow sampling method (the low flow method duplicate did not have any exceedances). More information on the sampling methodologies is provided in section 7.4. Results related to this area are provided in Table 50.

A main output transformer explosion occurred in 2005 in front of Bruce B Unit 6 causing a large mineral oil release which migrated to the subsurface. Residual hydrocarbon contamination has been observed in previous years however there were no observations of this in 2022.

The Bunker C Oil and Ignition Day Tank area (Douglas Point Support Area or Area 5 of Figure 58) previously contained large above and below grade oil tanks which were suspected to have leaked causing the minor residual hydrocarbon groundwater contamination observed. As seen at the Bruce A Standby Generator area one of the two results in 2022 was only observed in one of the method duplicate samples taken at the location using the high flow sampling method (the low flow method duplicate did not have any exceedances). These tanks were removed in the early 2000's. Long term monitoring is conducted annually to ensure that this contamination is not migrating or causing an adverse impact. Results related to this area are provided in Table 53.

The Fire Training Facility (Central Services Area or Area 8 of Figure 58) previously had stored fuel used for fire training activities. This was a gas/diesel mix that was replaced with a volatile fuel (Tekflame) around 1997. This was stored in a 38,000-litre aboveground storage tank enclosed in a concrete vault for secondary containment. A potential leak from the underground fuel lines was identified in 2007 at which point the fire training field was declared out of service and a site characterization and remediation program was implemented. Long term monitoring has been in place at the facility to monitor the residual impacts of site activities. The entire facility was redeveloped, and firefighting training continuously occurs and operates under an approved Environmental Compliance Approval. Annual compliance reports are submitted to the Ministry of Environment, Conservation and Parks with no issues requiring further action in 2022. Results related to this area are provided in Table 49 and Table 56 for spring and fall sampling respectively.

Residual contamination from petroleum hydrocarbons exists at a number of areas across the Bruce Power site, typically related to historical events. The exceedances noted in 2022 are not a cause for concern considering receptor location and depth of water levels. Long-term monitoring is in place at these locations to verify that this contamination is not migrating and is either stable or degrading with time verifying this absence of risk.

Perfluoroalkyl and Polyfluoroalkyl Substances - Bruce Power is approved to perform firefighting exercises at its Fire Training Facility (Central Services Area or Area 8 of Figure 58) under an Environmental Compliance Approval [R-99]. As a result of these past activities, it was suspected that there may be residual groundwater contamination related to firefighting foams used, namely perfluoroalkylated and polyfluoroalkylated substances. There are currently no limits with respect to these chemicals, therefore the Health Canada drinking water guidelines were used as a screening criteria for the sample results. Detections were noted at all locations which were sampled with eight of nine locations exceeding the guideline. Additional sampling will be conducted in 2023 to further characterize groundwater contamination related to these compounds. Groundwater at the facility is not consumed and therefore these results are not a cause for concern. Firefighting foams containing these chemicals are not used, however they are stored on site. Results related to this area are provided in Table 57.

Metals - Metals exceedances may be due to operational activities causing groundwater contamination or be due to natural sources from metal/mineral deposits. Groundwater samples were analyzed for a suite of metals based on previous site activities and are not anticipated to show increasing levels. In some cases, previous detections were not detected in the current year. This is true for uranium and exceedances observed in 2020 which were not observed in 2021 and 2022 except for minor exceedances at the Bruce B Transformer area (Bruce B Area or Area 2 of Figure 58). Chromium that was observed in 2020 in one well in the Bruce A Transformer Area (Bruce A Area or Area 1 of Figure 58) slightly above the Table 8 Site Condition Standard was not observed in 2021 or 2022. Vanadium exceedances have been observed in multiple wells at the former Bunker C Oil Ignition and Day Tank area (Douglas Point Support Area or Area 5 of Figure 58) and former Acid Wash Pond area (Douglas Point Support Area or Area 5 of Figure 58). These exceedances are likely due to former boiler cleaning activities related to these sites. Metals exceedances noted in 2021 are minor in nature and are not widespread. Samples were not taken for metals in 2022 and are scheduled in 2023. Based on levels seen in 2022, these exceedances are not a cause for concern due to low levels detected, lack of impact to receptor and absence of operational activities at the site. Metals will continue to be monitored at certain sites across Bruce Power to verify that levels are decreasing and not migrating.

Volatile Organic Compounds - A chloroform exceedance was observed at the Bruce A Transformer Area (Bruce A Area) in a single well in the vicinity of Unit 3. Chloroform was not included in the sampling plan for 2020, however exceedances have been observed over the last number of years. It is likely that a slow leak from a domestic water line was the cause of increased chloroform in groundwater. The chloroform result in 2022 is in trend with past results and may be a result of residual contamination from historical issues (leaking line fixed in 2021). Based on levels seen in 2022, this location will continue to be monitored. Results related to this area are provided in Table 51.

Chloride/Sodium - Exceedances were noted within the Bruce B Transformer Area (Bruce B Area) for sodium and chloride when compared against the evaluation criteria. The sampling locations where these results were identified correlate to areas which would be impacted by road-salting and winter road maintenance and therefore these results do not represent a cause for concern. Results related to this are provided in Table 53.

Tritium – Tritium in groundwater results in 2022 were indicative of localized atmospheric deposition. Levels in multi-level wells (between the stations and Lake Huron) were increased in the shallower intervals. Similarly, increased tritium levels were observed in shallower single interval wells versus deeper interval wells at each respective station. Currently Bruce Power uses a statistically based criteria as previously mentioned. This is appropriate to determine changes in environmental conditions which may require further investigation or increased monitoring. Ecologically based groundwater criteria are in the process of being developed and typically would represent much larger values taking into consideration distance to receptor from the groundwater monitoring location and natural processes which occur with respect to contaminant migration such as dilution, dispersion, attenuation etc. Using statistically based criteria represents a conservative level and does not represent a level above which protection of human or ecological health are not being met. All information from groundwater monitoring is provided to stakeholders to allow for assessment of risk from site affected groundwater to human health and the environment in alignment with the program objective.

7.5.6 Unusual or Unforeseen Conditions which may Require Corrective Action Objective

Groundwater monitoring program data are used to provide an indication of trend results which may lead to identification of conditions which require further investigation and corrective actions. As previously noted, evaluation criteria are used to provide a threshold for assessment.

The aerial maps provided below show 2022 sampling results for total petroleum hydrocarbons which is the primary contaminant of concern at several monitoring areas across the Bruce Power site. Increasing total petroleum hydrocarbon levels are shown using increasingly darker shading. These graded intervals were selected for display purposes only and do not represent a reportable limit. Ranges of values are shown in Table 48 through Table 56 (with the exception of Table 51 and Table 53). Levels observed in 2022 are at the low end of the range and do not represent unusual or unforeseen conditions requiring corrective action. Exceedances of other parameters have been discussed above and do not represent a cause for concern based on the low levels observed and minimal potential to cause impact to a receptor.

Table 59 - Aerial Map Graded Concentrations of Total Petroleum Hydrocarbons

Graded Interval Shading	Concentration of Total Petroleum Hydrocarbon Range (parts per billion)
	>50,000
	20,001 – 50,000
	5,001 – 20,000
	2,501 – 5,000
	901 – 2,500

The former Bruce Heavy Water Lands Area (Douglas Point Support Area or Area 5 of Figure 58) shown in Figure 65 had total petroleum hydrocarbon levels which were greater than 900 parts per billion. These results were all observed in the spring sampling event with samples collected using the well volume method. Fall sampling results were all less than 900 parts per billion using the low flow method. Free product was observed at MW 1-07 and MW 2-07 (~ 1 centimetre thickness). This was subsequently removed and sampled. Sampling methodologies are discussed in section 7.4.

Total petroleum hydrocarbon levels at the Bunker C Oil and Ignition Day Tank Area (Douglas Point Support Area) are also shown in Figure 65. The increased level observed in BCO 27 was in the method duplicate sample (using well volume method). The low flow duplicate sample indicated non-detect. The level observed in BCO 31B does not represent a cause for concern due to the depth of the water level and the distance to any receptors. Monitoring will continue to ensure that levels are not increasing, and contaminants are not migrating.

Total petroleum hydrocarbon levels at the Fire Training Facility (Central Services Area) are shown in Figure 66. Levels which were greater than 900 parts per billion were all observed in the spring sampling event where samples were collected using the well volume method. The fall sampling event levels were all at the lower end of the range using the low flow method.

Figure 67 and Figure 68 show sampling results from Bruce A and Bruce B respectively. All results were less than 900 parts per billion in 2022.

Figure 65 - Aerial Map of the Bunker C Oil and Ignition Day Tank Areas (Douglas Point Support Area or Area 5 of Figure 1) with Monitoring Well Locations Shaded According to Concentration Range of Total Petroleum Hydrocarbons

Figure 66 - Aerial Map of the Fire Training Facility (Central Services Area or Area 8 of Figure 1) with Monitoring Well Locations Shaded According to Concentration Range of Total Petroleum Hydrocarbons

Figure 67 - Aerial Map of the Bruce A Transformer Area and the Bruce A Standby Generator Area (Bruce A Area or Area 1 of Figure 1) with Monitoring Well Locations Shaded According to Concentration Range of Total Petroleum Hydrocarbons

Figure 68 - Aerial Map of the Bruce B Transformer Area and the Bruce B Standby Generator Area (Bruce B Area) with Monitoring Well Locations Shaded According to Concentration Range of Total Petroleum Hydrocarbons

Figure 69 and Figure 70 below represent the Bruce A and Bruce B tritium levels in the multi-level wells over the last several years respectively. The figures are laid out such that “Depth 1” is the deepest interval of the monitoring well location and “Depth 3” is the shallowest interval. Levels would be expected to be slightly increased in the shallower intervals with atmospheric deposition as the main mechanism for tritium in groundwater. The figures are also divided to show seasonal variation between spring and fall with levels slightly increased in the spring as would be expected with increased precipitation and snow melt from atmospheric deposition occurring.

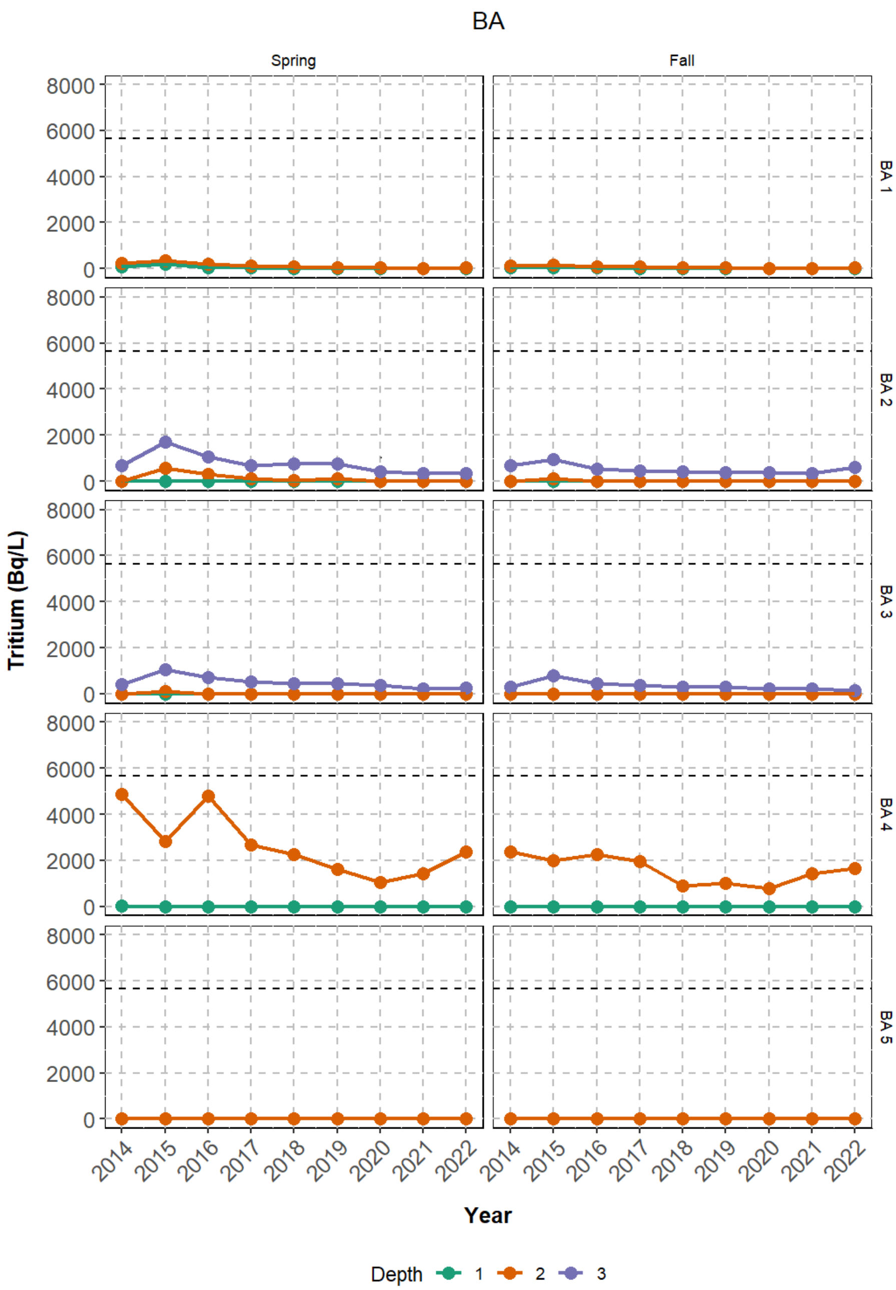


Figure 69 - Bruce A Multi-level Wells Arranged for Seasonal Variation and Depth of Interval

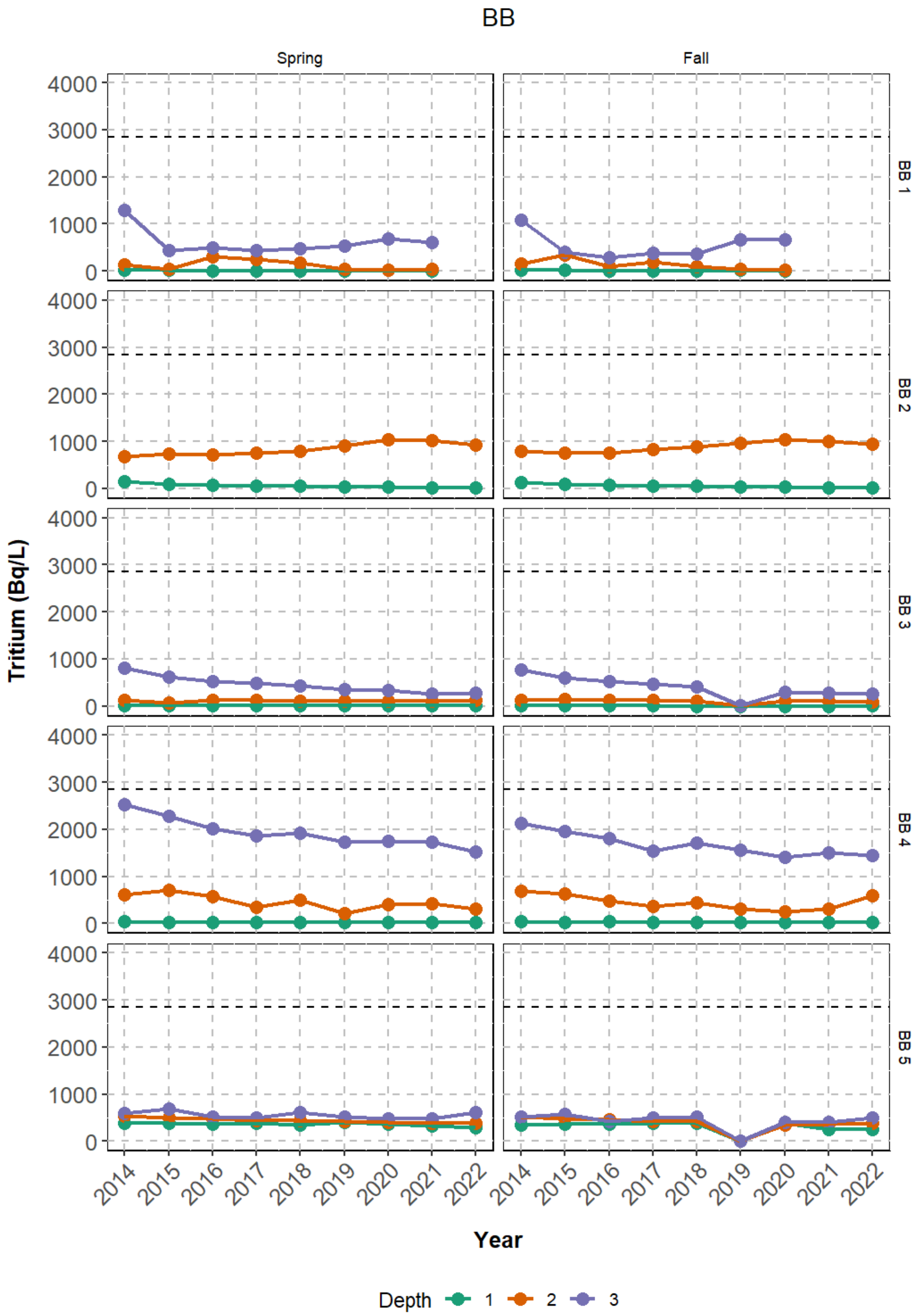


Figure 70 - Bruce B Multi-level Wells Arranged for Seasonal Variation and Depth of Interval

Similarly, increased tritium levels were observed in single interval wells which were shallower. Figure 71and Figure 72 below are laid out such that the monitoring well with the shallowest interval is first (at the top). As with the multi-level wells, the figures are divided to show differences in tritium levels between spring and fall/winter. Seasonal variation and increased levels due to interval depth appear to be more evident at Bruce A than at Bruce B. Also, spring sampling at the single interval wells has only been completed since 2021 and will continue, in order to provide further evidence of seasonal variation.

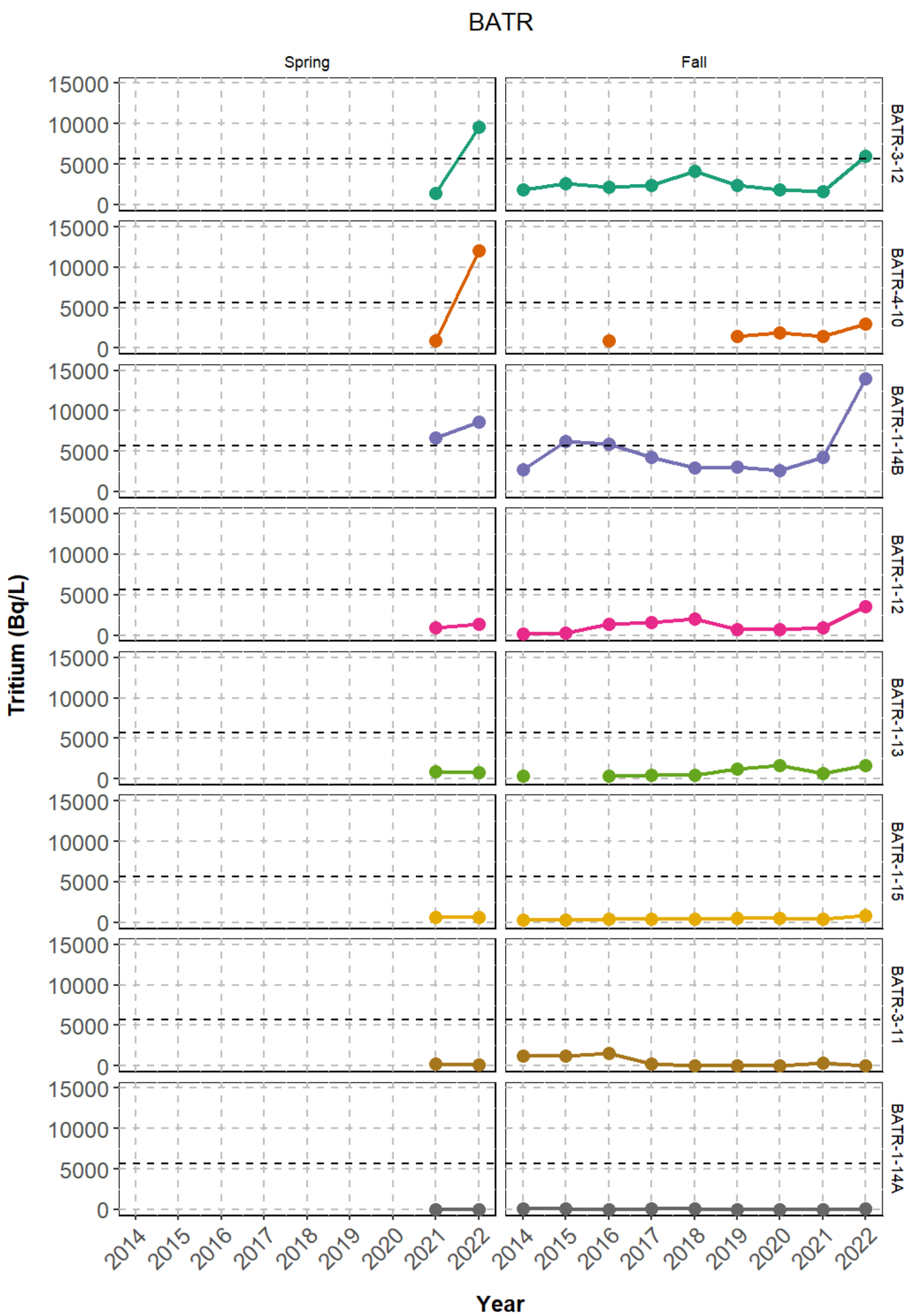


Figure 71 - Bruce A Single-level Wells Arranged for Seasonal Variation and Depth of Interval

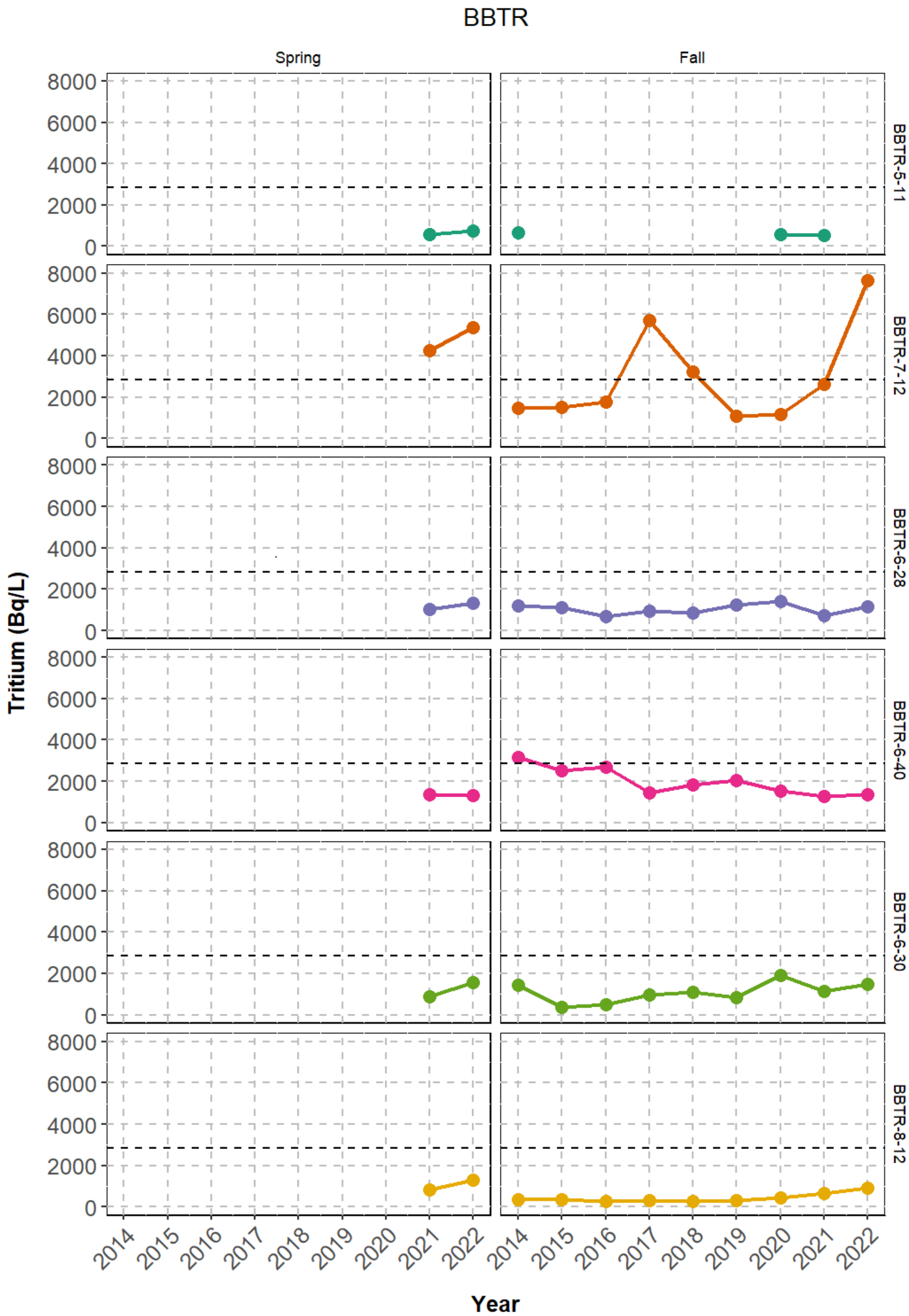


Figure 72 - Bruce B Single-level Wells Arranged for Seasonal Variation and Depth of Interval

While atmospheric deposition does appear to be the main mechanism for the observation of tritium in groundwater at both Bruce A and Bruce B, recent results at BATR 1-14B and BBTR 7-12 are at the highest levels since 2014. The result at BATR 1-14B is in alignment with increased tritium emissions from Bruce A and further supports atmospheric deposition. While the result at Bruce B monitoring well BBTR 7-12 appears to be significantly increased, the magnitude of this result is half of that seen at Bruce A. Continued monitoring in 2023 will provide more information. As per program objective, groundwater monitoring has provided an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring. These conditions will be addressed in 2023 with continued monitoring.

Overall, in 2022, spring and fall sampling for tritium in groundwater was conducted at historically sampled wells at locations behind each station as well as at additional monitoring well locations around Bruce A and Bruce B. The results from 2022 continue to verify that:

Tritium levels are typically within expected levels with minor deviations identified for follow-up action in 2023.

There were no adverse trends observed which required immediate follow-up action.

Seasonal variation is evident based on spring versus fall/winter sampling events. Tritium results in the spring are greater than the fall/winter which is in line with increased springtime precipitation and snow melt; and

Tritium in groundwater appears to be a result of atmospheric deposition based on the observation of increased tritium levels in the shallower intervals of the multi-level wells and the shallower single interval wells located on the “construction south” side of each powerhouse.

7.5.7 Monitoring of High-risk Systems, Structures and Components Objective

Groundwater wells were installed in the past as a result of a risk assessment to monitor historic releases and in proximity to systems, structures and components with the potential to have an adverse impact on groundwater. Groundwater wells near facilities containing contaminants of potential concern will be sampled to assist in monitoring for releases.

The groundwater monitoring program has evaluated areas of potential environmental concern and classifies them as high, medium, or low priority. Analytical results for areas considered as high priority areas are shown below. These areas are the Bruce A Powerhouse, the Bruce B Powerhouse, the Central Maintenance Facility – Former underground storage tanks/hoists and the Bruce Alternate Steam Supply Building (Standby Generators with three associated 15,000 litres fuel storage tanks). Results from 2022 indicate no unforeseen releases have occurred from the high-risk areas and that all exceedances of evaluation criteria are related to historical issues or events and are not a cause of concern. For the Central Maintenance Facility and the Bruce Alternate Steam Supply Building, although there is monitoring in the general area, an assessment will be required to verify that the existing monitoring well network is sufficient to allow for monitoring of releases. For these two areas, no analytical samples were submitted in 2022. Water level monitoring did take place and there were no obvious signs of contamination or impact. Areas of potential environmental concern are shown in Figure 73 below.

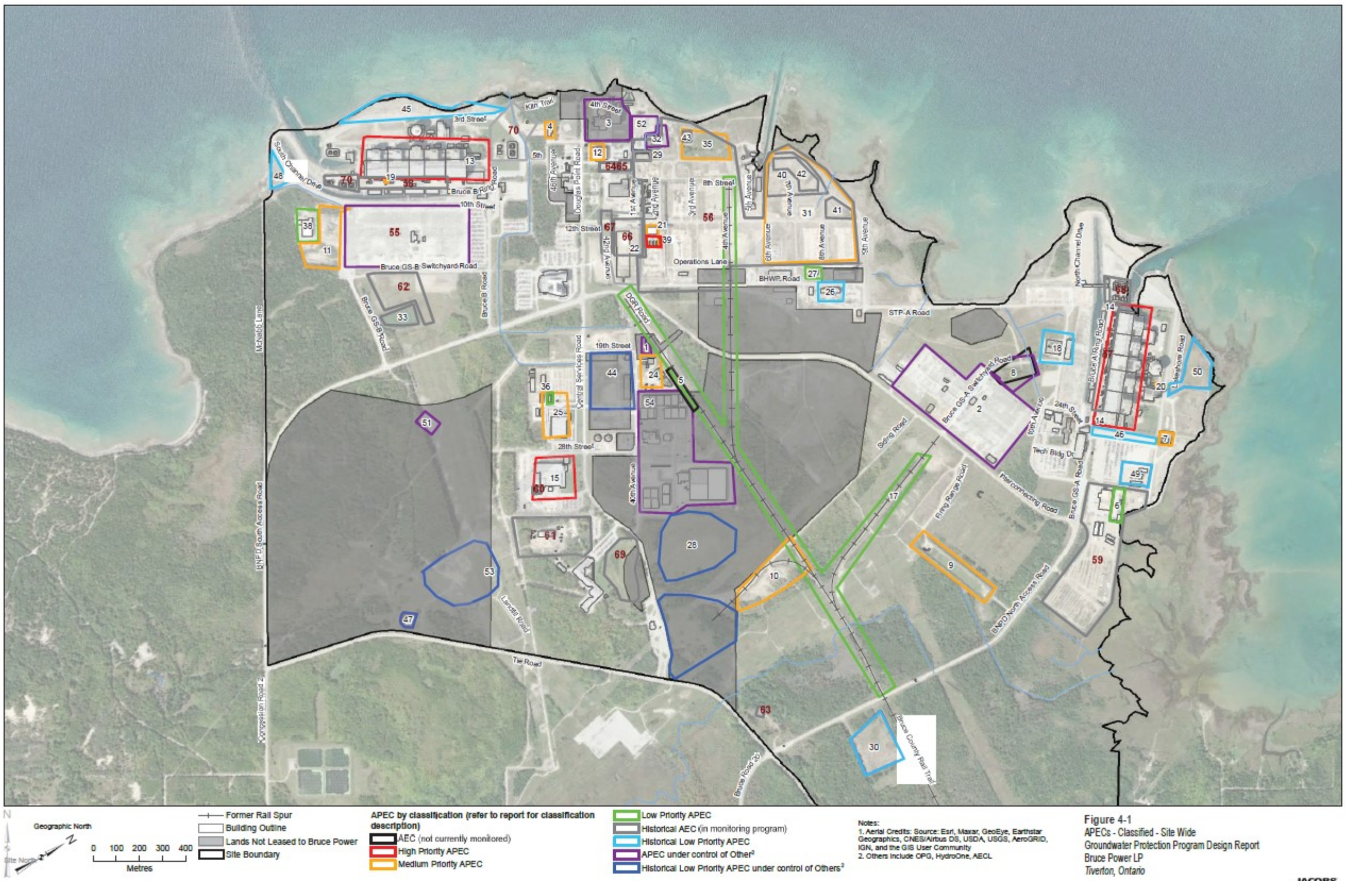


Figure 73 - Bruce Power Site Map with Ranking of Areas of Potential Environmental Concern Defined

7.6 Summary of Next Steps

In 2023, Bruce Power will continue to monitor groundwater at select locations based on ongoing site operations and related risk to groundwater (i.e., station tritium emissions, storage of fuel oil or transformer operation) to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring. Residual impacts from previous site activities and on-going station operations will continue to be monitored at an appropriate frequency to verify that levels are decreasing and confirm that subsurface contamination is not migrating. Water levels will be taken at all site monitoring locations to confirm the inferred groundwater flow direction. Groundwater results will be evaluated against appropriate criteria to assess risks from site-affected groundwater to human health and the environment.

8.0 WASTE MANAGEMENT

Bruce Power manages many different forms of waste to ensure they are disposed of safely without polluting the environment:

- Hazardous waste (oils, chemicals, lighting lamps and ballasts – some of these are recycled)
- Recyclable waste (glass, plastic, metal, cardboard, paper, wood, batteries, and electronics)
- Organics waste (food waste, compostable materials, paper towels)
- Radiological waste (low-, intermediate-, and high-level radiological waste is transferred to Ontario Power Generation for further processing and storage)
- Landfill waste (wastes that are neither hazardous, recyclable, compostable, nor radiological)

Bruce Power complies with all waste regulations and requirements of the relevant federal, provincial, and municipal authorities. Further, Bruce Power has taken an active role for many years to reduce all forms of waste: from an environmental and financial standpoint waste reduction is good for our company and the community in which we reside. Our philosophy employs a whole life-cycle approach in that we reduce waste at the consumer level, generate less waste at the company level, find opportunities to reuse products (on-site, off-site donations, or sell them at auction), and implement recycling programs that are available in the ever-changing recycling market. To minimize the amount of waste sent to landfill each day, Bruce Power has implemented several initiatives that apply the principles of reduce, reuse, recycle, and recover. Wherever its fate, each waste stream generated at Bruce Power is processed and disposed of in a safe and environmentally responsible manner.

Table 60 - Bruce Power Waste Regulatory Reporting summarizes the waste management and pollution prevention reports submitted to regulatory agencies.

Table 60 - Bruce Power Waste Regulatory Reporting

Waste	**Report Title**	**Regulatory Agency**	**Submission Date (Frequency)**
Conventional Waste	Report of a Waste Reduction Work Plan, O. Reg 102/94	Internal Report	Q1 2023 (Annual)
Conventional Waste	Report of a Waste Audit, O Reg 102/94	Internal Report	Q1 2023 (Annual)
Hazardous	Generator Registration Report, O. Reg 347	Ministry of Environment, Conservation and Parks	February 15, 2023 (Annual)
Waste & Pollution Prevention - Polychlorinated Biphenyl	Federal PCB Regulations Bruce Power 2022Annual Report Declaration	Environment and Climate Change Canada	March 31, 2023 (Annual)
Waste & Pollution Prevention - Polychlorinated Biphenyl	2022 Annual Polychlorinated Biphenyl Waste Storage Report for Bruce A Storage Facility #10400A003	Ministry of Environment, Conservation and Parks	January 31, 2023 (Annual)
Waste & Pollution Prevention - Polychlorinated Biphenyl	2022 Annual Polychlorinated Biphenyl (PCB) Waste Storage Report for the Waste Chemical Transfer Facility Storage Facility #10402A001	Ministry of Environment, Conservation and Parks	January 31, 2023 (Annual)

8.1 Conventional Waste

The primary objective of the Conventional Waste Program is to process wastes in a safe and environmentally responsible manner while diverting as much waste from landfill as possible. Bruce Power achieves waste minimization through the application of reduce, reuse, recover, and recycle principles.

Conventional waste at Bruce Power is managed and disposed of in accordance with regulatory requirements including:

- The *Ontario Environmental Protection Act* [R-156]

- *Ontario Regulation 347, General Waste Management* [R-157]
- *Ontario Regulation 103/94, Industrial, Commercial and Institutional Source Separation Programs* [R-158]
- *Ontario Regulation 102/94, Waste Audits and Waste Reduction Work Plans* [R-159]
- *Transport Canada's Transportation of Dangerous Goods Act* [R-160]

Management of conventional waste includes all non-hazardous and non-radiological items: recyclables, compost, and waste destined for landfill. As defined in Ontario Reg. 103/94 [R-158], Bruce Power is a large manufacturing establishment and is mandated to have recycling programs in place for the following materials:

- Aluminum
- Cardboard (corrugated)
- Fine paper
- Glass
- Newsprint
- High Density Polyethylene (jugs, pails, crates, totes, and drums
- Low Density Polyethylene (film*)
- Polystyrene expanded foam*
- Polystyrene trays, reels, and spools*
- Steel
- Wood (Excluding painted, treated, or laminated wood)

*Limitations apply depending on the availability of service providers able to recycle these materials.

In addition to these recycling programs, Bruce Power has an established composting program for organic waste including food waste, paper towels, and biodegradable coffee cups, lids, and food containers.

Bruce Power utilizes approved waste disposal vendors to collect conventional wastes on site. Waste disposal vendors are bound by environmental compliance approvals that stipulate approved wastes that can be accepted by the landfill or facility.

As shown in Table 61 - Conventional Waste Generated at Bruce Power from 2016 to 2021 [1 metric tonne = 1,000 kilograms], the total amount of conventional waste produced at Bruce Power in 2022 was 2,873 metric tonnes. While 929 metric tonnes of waste were sent to landfill, a total 1,944 metric tonnes were diverted to a recycling or compost program. More than two-thirds of all the conventional waste produced in 2022 was diverted from landfill.

Table 61 - Conventional Waste Generated at Bruce Power from 2016 to 2021 [1 metric tonne = 1,000 kilograms]

Year	Landfill in metric tonnes	Compost in metric tonnes	Recycling in metric tonnes	Total in metric tonnes	Diversion Rate
2016	555	103	1,145	1,965	64%
2017	462	97	1,042	1,795	63%
2018	572	111	1,226	1,967	68%
2019	609	61	1,287	2,016	67%
2020	524	62	1,219	1,805	71%
2021	597	98	1,457	2,152	72%
2022	929	93	1,851	2,873	68%

In 2022, 32% of Bruce Power's conventional waste was sent to landfill, 3% was composted, and the remainder was recycled via several different recycling streams (65%). The distribution among different waste streams has changed significantly over time, depending on the types of activities occurring at the company (commissioning/decommissioning) and the different recycling processes available in the global waste management market.

As per *Ontario Regulation 102/94* [R-159], Bruce Power must also perform an annual conventional waste audit. The waste audit must be completed by a third-party vendor, and a waste audit report that includes a waste reduction work plan must be prepared for Bruce Power. Independent assessments of Bruce Power's performance in conventional waste management have occurred annually for many years. The auditor's assessments consistently show that Bruce Power is performing well in comparison to other large industrial facilities.

8.1.1 Diversion Initiatives

Bruce Power makes every effort to increase diversion whenever possible. In 2022 three new significant diversion initiatives were introduced on site. Firstly, Bruce power established a contract with Habitat for Humanity to dispose of e-wastes such as computers, printers, and paper shredders. This new division stream saw 2,500 kilograms of e-waste recycled in addition to the e-waste volumes recycled by the Information Technology department (10,781 kilograms). The second initiative was establishing Styrofoam recycling on site. The new process saw 20 cubic metres of Styrofoam recycled in 2022. Finally, the third initiative introduced on site was a binder recycling and reuse program. This program saw 1,937 binders deconstructed for recycling and 514 binders donated to schools for reuse. For the deconstructed binders 45 cases of cardboard was donated for reuse and 500 pounds of scrap metal was recycled.

In addition, Bruce Power worked on increasing waste diversion by improving signage and messaging about waste streams across site in accordance with the site's Waste Reduction Work Plan prepared in compliance with *Ontario Regulation 102/94, Waste Audits and Waste Reduction Work Plans* [R-159]. New waste diversion bins were acquired and set up at several locations across Centre of Site and updated signage was installed. This new signage included pictures of common waste types sold or used on site to help employees determine which waste stream is appropriate to use. In addition, signage as well as articles in the company newsletter were installed and produced to communicate the need to reduce liquid contamination in the recycling stream. In 2021 liquid contamination in the mixed recycling stream (plastics, aluminum, steel, glass, cardboard, boxboard, and mixed paper) accounted for 86% of the contamination whereas in 2022 the liquid contamination in the mixed recycling stream was only 47% with an overall contamination rate down from 3% in 2021 to 1% in 2022.

8.2 Hazardous Waste

Bruce Power's Hazardous Waste Program ensures the safe handling, storage and disposal of hazardous wastes in accordance with regulatory requirements outlined in the *Environmental Protection Act*, *Ontario Regulation 347*, *General Waste Management* [R-161].

Hazardous wastes, such as chemicals, oils, batteries, and fluorescent tubes, are generated at numerous locations on-site. They are carefully tracked to ensure all hazardous waste is safely disposed of in accordance with all applicable regulatory requirements. Bruce Power has an excellent network of external waste vendors (certified to carry and/or receive hazardous wastes) who frequently work with us to dispose of all our hazardous waste streams in an industrially and environmentally safe manner. Hazardous wastes are routinely diverted from landfill by recycling batteries, lamps, oil, and electronic waste.

8.2.1 Oil Recycling

In 2021, a site wide oil recycling program was established with a hazardous waste vendor to recycle oils from turbine lubricating oil and electrical transformer systems. The used oil from these systems is often of high-quality with low levels of contaminants such as water, particulate or chemicals. As such, these used oils can be recycled and reused in other industrial applications.

In 2022, Bruce Power disposed of 706,831 litres of oil with 612,246 litres being recycled. This means 87% of Bruce Power's waste oil was able to be recycled and reused, reducing a significant quantity of oil that would otherwise go to a hazardous waste stream. It should be noted that in 2022, there was a significant amount of transformer replacement work which contributed to this high volume of oil. The volume of waste oil in 2021 was only 433,417 litres for comparison.

8.2.2 Hazardous Waste Inspections

In September 2022 Bruce Power's annual International Organization for Standardization 14001 Environmental Management System standard re-registration audit focused on Hazardous Waste significant environmental aspects. The external audit reported that all regulatory requirements are being met sufficiently and no findings were identified.

Monthly inspections of Bruce Power's two licensed Federal Polychlorinated Biphenyls Waste Storage Facilities continue to occur as required by the Federal *Polychlorinated Biphenyls Regulations Statutory Orders and Regulations/208-273 2008* [R-162]. No significant issues were identified in 2022.

8.2.3 Polychlorinated Biphenyls

According to the *Polychlorinated Biphenyls Regulation Statutory Orders and Regulations /208-273* [R-162], equipment containing Polychlorinated Biphenyls in a concentration of at least 50 parts per million but less than 500 parts per million, must have the equipment removed from site by December 31, 2025. This includes electrical transformers and their auxiliary electrical equipment, lighting ballasts, and capacitors. Electrical cables, not in use, in any concentration must also be removed so that they are not "abandoned in place" which is a violation of the *Environmental Protection Act* [R-110]. Currently, there is no regulatory removal date for Polychlorinated Biphenyls cables that are in use. In 2018, a plan was created for Polychlorinated Biphenyls removal, focusing on the above equipment, to meet the regulatory deadline of December 31, 2025. This plan is reviewed and updated on a regular basis to ensure that Bruce Power will complete the Polychlorinated Biphenyls removal work before the regulatory deadline. In 2022, 44 drums of Polychlorinated Biphenyls electrical equipment and lighting ballast waste was disposed of in support of this regulatory requirement.

9.0 AUDITS

Bruce Power has an internal audit program to meet the auditing requirements of both the N288 series of environmental standards for nuclear power plants and the Canadian Standards Association International Organization for Standardization 14001, Environmental Management System standard. This audit program identifies areas of non-conformance with the standards where corrective actions are taken as well as identifies opportunities for improvement for consideration.

Bruce Power also undergoes an audit of the environmental management system by an external, accredited third party auditor. This audit occurs annually with one in every three years being a re-certification audit which confirms adherence to the International Organization for Standardization 14001 standard.

9.1 N288 Series of Environmental Standards for Nuclear Power Plants

In 2022 there were no audits of the N288 Series of Environmental Standards. An audit scheduled in Quarter 1 2023 will assess conformance to N288.4, Environmental Monitoring

Programs at Nuclear Facilities and Uranium Mines and Mills [R-5] and N288.5, Effluent Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills [R-17]. In 2020 there was an audit of the Canadian Standards Association N288.7-15, Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills [R-19] to identify gaps to the standard in preparation for implementation of the standard. The next audit to the N288.7 standard will be in 2025.

9.2 Canadian Standards Association International Organization for Standardization 14001 Environmental Management System Standard

The 2022 external audit was a surveillance audit which confirmed Bruce Power's conformance to the International Organization for Standardization 14001, Environmental Management Systems standard. The results of the audit confirmed the following:

- Continues to effectively implement a management system that meets the International Organization for Standardization 14001:2015 standard for the scope of registration identified in the report.
- Ensures the management system remains effective considering internal and external changes.
- Demonstrates a commitment to maintain the effectiveness and improve the management system in order to enhance overall performance.
- Operates the management system to ensure the achievement of the slated policies and objectives.

There were no non-conformances and five opportunities for improvement with themes of; categorizing interested parties and provide opportunities for engagement amongst the different groups, utilize internal reports when developing contracts, perform a detailed assessment to further support waste reduction and minimization efforts, document climate change considerations when discussing environmental aspects and improvement of waste forms to include refined dates. Opportunities for improvement are for consideration to further enhance the environmental management system and environmental performance. In addition, there were many positive aspects identified by the auditor as well. General themes were; comprehensive review by senior leadership, environmental objectives are well defined and both qualitative and quantitative, Bruce Power strategically selects senior leadership to guide company through life extension projects, improvements have been made with environmental action levels and focus on the implementation of the new halocarbon regulations, positive community perspectives of Bruce Power, good level of environmental consideration when acquiring services and the on-going supplier performance throughout the life cycle, used oil recycling success, simplification of documentation and the culture and qualification levels of personnel working on site.

10.0 CONCLUSION

The purpose of this report is to fulfill regulatory requirements on environmental protection in accordance with Licence Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating Licence Bruce Nuclear Generating Stations A and B 18:02/2028 [R-1] and the Canadian Nuclear Safety Commission Regulatory Document REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants, Section 3.5 [R-2]. Within this report, Bruce Power has provided information on effluent and emission results, environmental monitoring findings and demonstrated our continued commitment to environmental protection and sustainability.

Bruce Power continued to have strong community relations and demonstrated commitment to continued engagement with the local Indigenous communities of the Saugeen Ojibway Nation, Métis Nation of Ontario, and Historic Saugeen Métis throughout 2022 and will continue to build on these strengths and commitments. In 2022, Bruce Power released its 2027 Net Zero Strategy, outlining the emissions reduction, substitution and offsetting actions that will be undertaken to achieve these targets. Bruce Power met its emission reduction targets in 2022 and continues to implement operational initiatives to support further reductions.

For the 31st consecutive year, Bruce Power's contribution to the annual dose of a member of the public is less than the lower threshold for significance (<10 microsieverts per year) and is considered *de minimus* [R-41]. The representative person's dose associated with Bruce Power operations in 2022, who is calculated to have the maximum, is the BSF2 Infant who received 2.4 microsieverts per year. All other representative persons have a lower dose. This maximum dose is a fraction of a percent of the legal dose limit of 1,000 microsieverts per year.

An updated retrospective and predictive Environmental Risk Assessment was prepared and submitted to regulators in June 2022. Review of the 2022 Environmental Risk Assessment by the Canadian Nuclear Safety Commission and Environment and Climate Change Canada concluded that the report is consistent with the overall methodology and complies with all the applicable requirements of Canadian Standards Association N288.6-12 [R-51]. The potential risk from physical stressors and from radiological and non-radiological releases to the environment were found to be generally low to negligible.

Through Bruce Power's normal operation and outage maintenance activities, airborne emissions and waterborne effluents are released to the environment and monitored following robust monitoring standards to confirm releases remain within compliance limits and ensure environmental protection. All radiological releases remained well below regulatory limits, and all conventional effluent parameter limits were met. Airborne tritium emissions saw an increase in 2022 as a result of both planned maintenance and outage activities as well as equipment challenges. This increase in airborne tritium emissions resulted in an impact to the inputs to the dose to public calculation which as a result, also saw an increase from 2021 to 2022. As stated above, the dose to public remained well below the lower threshold for significance at a fraction of a percent of the legal dose limit.

Bruce Power's radiological and conventional environmental monitoring programs are designed to continuously verify that environmental protection is being maintained and that any releases have a minimal impact on the surroundings. The radiological environmental monitoring program monitors radionuclides in the air, precipitation, water, agricultural and animal products, soil and sediment. The conventional environmental monitoring program monitors for conventional contaminants, physical stressors, and wildlife species presence. In 2022, conventional contaminant monitoring included water quality in the lake and on-site waterbodies. In addition, thermal monitoring, fish impingement monitoring and biological effects monitoring continued in 2022. Results of the radiological and conventional environmental monitoring programs in 2022 demonstrated that there were no significant or adverse changes to contaminant levels or wildlife species presence in the environment. This provides verification of the continued effectiveness of environmental protection policies and programs at Bruce Power.

Bruce Power's groundwater protection program is designed to achieve established groundwater protection goals in alignment with Canadian Standards Association N288.7-15, Groundwater Protection Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills. By establishing and monitoring performance against groundwater program objectives which include a robust groundwater monitoring program, Bruce Power continues to refine and improve the groundwater conceptual site model and inform key stakeholders with respect to groundwater quality.

Bruce Power continues to comply with all waste regulations and requirements of the relevant Federal, Provincial, and Municipal authorities. Further, Bruce Power plans to continue taking an active role to reduce all forms of waste: from an environmental and financial standpoint waste reduction is good for our company and the community in which we reside.

Finally, Bruce Power's compliance with the International Organization for Standardization 14001 standard and the Canadian Standards Association N288.4, N288.5 and N288.7 standards has been verified through internal independent oversight audits. Opportunities for improvement and any identified gaps are being addressed and do not impact overall conformance to the14001 or the N288 series standards.

The 2022 Environmental Protection Report provides evidence to support the conclusion that Bruce Power is complying with all relevant provincial, federal, and regulatory requirements and legislation. Beyond compliance, Bruce Power is striving to measure and minimize its impact on the environmental through excellence in effluent and emissions management, continuous environmental monitoring, spill prevention and waste management. Bruce Power plans to continue to strive for excellence in all aspects of environmental monitoring and protection throughout 2023.

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APPENDIX A: REPRESENTATIVE PERSON PARAMETERS FOR DOSE CALCULATION

Table 62 - Generic Rates of Intake of Air, Water and Various Foods

Parameter	Units	Infant (1 year old)	Child (10 year old)	Adult (male)
Inhalation Rate	Cubic metre per year	1830	5660	5950
Water Ingestion Rate	Litre per year	0	151.1	379.6
Grain Intake	Kilogram per year	55.2	140.7	163.5
Fruit & Berry Intake	Kilogram per year	54.6	88.8	99.4
Vegetable Intake	Kilogram per year	25.8	69.7	128.1
Mushrooms Intake	Kilogram per year	0.3	1.0	1.2
Potato Intake	Kilogram per year	8.7	30.9	47.9
Total Plant Product Ingestion Rate	**Kilogram per year**	**144.5**	**331.1**	**440.0**
Beef Intake	Kilogram per year	4.4	13.1	45.8
Pork Intake	Kilogram per year	3.5	10.4	19.8
Lamb Intake	Kilogram per year	0.0	1.0	0.6
Poultry Intake	Kilogram per year	8.2	21.9	38.9
Egg Intake	Kilogram per year	2.1	8.1	19.2
Game (Deer, Rabbit) Intake	Kilogram per year	0.5 or 0.7	1.6 or 2.2	5.8 or 7.8
Milk Intake	Kilogram per year	242.7	228.1	125.6
Total Animal Product Ingestion Rate	**Kilogram per year**	**262.8 or 263.0**	**286.8 or 287.4**	**260.4 or 262.4**
Total Fish Ingestion Rate	**Kilogram per year**	**1.8 or 2.5**	**5.4 or 7.2**	**8.2 or 11.1**

Note:

1. The 1-year old infant is assumed to ingest cow's milk, which accounts for all fluid needs. Water (or formula made from water) is not ingested, as per CSA N288.1 [R-21]

2. All values are mean or central values from CSA N288.1 [R-21], with the exception of the Hunter/Fisher fish intake and game (e.g. deer, rabbit) intake for all age classes, which is based on the Site Specific Survey [R-163]

Table 63 - Local Percentage of Food Intake Obtained by Local Sources for Non-Farm Resident

Food Type	Infant (1 year old)	Child (10 year old)	Adult
Milk and dairy	23.1%	19.9%	12.1%
Beef	0.72%	1.95%	6.95%
Pork	0.39%	1.07%	2.23%
Poultry	0.85%	2.07%	4.06%
Egg	0.29%	1.00%	2.62%
Deer	0.10%	0.29%	1.11%
Honey	0.08%	0.20%	0.27%
Total Animal Products	**25.5%**	**26.5%**	**29.3%**
Grain	3.44%	3.84%	3.35%
Fruit and Berries	10.4%	7.40%	6.23%
Vegetables (above-ground)	4.26%	5.02%	6.95%
Root Vegetables	1.57%	2.44%	2.85%
Total plant Products	**19.7%**	**18.7%**	**19.4%**
Fish	23.0%	23.0%	23.0%

Note: Values are percentage of total annual intake of combined food groups (e.g. fish, plants, animals)

Table 64 - Local Percentage of Food Intake Obtained by Local Sources for Non-Dairy Farm Resident

Food Type	Infant (1 year old)	Child (10 year old)	Adult
Milk and dairy	12.5%	10.7%	6.51%
Beef	1.04%	2.80%	9.97%
Pork	0.58%	1.59%	3.33%
Poultry	1.41%	3.42%	6.70%
Egg	0.56%	1.94%	5.10%
Deer	0.20%	0.57%	2.22%
Honey	0.10%	0.26%	0.34%
Total Animal Products	**16.4%**	**21.3%**	**34.2%**

Food Type	Infant (1 year old)	Child (10 year old)	Adult
Grain	4.25%	4.73%	4.13%
Fruit and Berries	21.1%	15.0%	12.6%
Vegetables (above-ground)	10.1%	12.0%	16.5%
Root Vegetables	3.60%	5.62%	6.56%
Total Plant Products	**39.1%**	**37.3%**	**39.8%**
Fish	22.3%	22.3%	22.3%

Note: Values are percentage of total annual intake of combined food groups (e.g. fish, plants, animals).

Table 65 - Local Percentage of Food Intake Obtained by Local Sources for Dairy Farm Resident

Food Type	Infant (1 year old)	Child (10 year old)	Adult
Milk and dairy	62.0%	53.4%	32.4%
Beef	1.04%	2.82%	10.1%
Pork	0.67%	1.82%	3.81%
Poultry	1.88%	4.57%	8.96%
Egg	0.66%	2.31%	6.07%
Deer	0.20%	0.57%	2.22%
Honey	0.12%	0.30%	0.40%
Total Animal Products	**66.6%**	**65.8%**	**63.9%**
Grain	7.92%	8.82%	7.71%
Fruit and Berries	13.8%	9.79%	8.25%
Vegetables (above-ground)	10.3%	12.1%	16.8%
Root Vegetables	3.51%	5.48%	6.39%
Total Plant Products	**35.5%**	**36.3%**	**39.1%**
Fish	25.0%	25.0%	25.0%

Note: Values are percentage of total annual intake of combined food groups (e.g. fish, plants, animals).

Table 66 - Local Percentage of Food Intake Obtained by Local Sources for Subsistence Farm Resident

Food Type	**Infant (1 year old)**	**Child (10 year old)**	**Adult**
Subsistence Farms			
Milk and dairy	73.9%	63.6%	38.6%
Beef	1.97%	5.33%	19.0%
Pork	1.33%	3.64%	7.61%
Poultry	3.14%	7.62%	14.9%
Egg	0.81%	2.81%	7.39%
Deer	0.20%	0.57%	2.22%
Honey	0.18%	0.47%	0.62%
Total Animal Products	**81.5%**	**84.1%**	**90.4%**
Grain	18.7%	20.8%	18.2%
Fruit and Berries	28.4%	20.2%	17.0%
Vegetables (above-ground)	17.1%	20.1%	27.9%
Root Vegetables	5.80%	9.04%	10.5%
Total Plant Products	**69.9%**	**70.2%**	**73.6%**
Fish	100%	100%	100%

Note: Values are percentage of total annual intake of combined food groups (e.g. fish, plants, animals)

Table 67 - Local Percentage of Food Intake Obtained by Local Sources for Hunter-Fisher Resident

Food Type	**Infant (1 year old)**	**Child (10 year old)**	**Adult**
Milk and dairy	23.1%	19.9%	12.0%
Beef	0.64%	1.72%	6.11%
Pork	0.39%	1.06%	2.21%
Poultry	0.86%	2.09%	4.07%
Egg	0.31%	1.08%	2.82%
Deer	0.27%	0.77%	2.97%
Honey	0.13%	0.33%	0.43%

Food Type	**Infant (1 year old)**	**Child (10 year old)**	**Adult**
Total Animal Products	**25.7%**	**26.9%**	**30.6%**
Grain	7.57%	8.44%	7.38%
Fruit and Berries	20.5%	14.5%	12.2%
Vegetables (above-ground)	8.60%	10.2%	14.0%
Root Vegetables	2.72%	4.24%	4.94%
Total Plant Products	**39.3%**	**37.4%**	**38.6%**
Fish	100%	100%	100%

Note: Values are percentage of total annual intake of combined food groups (e.g. fish, plants, animals)

APPENDIX B: 2022 METEOROLOGICAL DATA ANALYSIS

The 2022 meteorological data for the Bruce Power site were analyzed as outlined below [R-46]. The Triple Joint Frequency data at the 10 metre elevation of the on-site 50 metre tower that is used in the dose to public calculation.

The raw hourly data was screened, and in addition to the data gap at the 50 metre tower in September due to a lightning strike, there were also instances where the wind speed was 0 at both towers. These datasets cannot be used for air dispersion modelling and were considered missing data. For these cases, the data of the previous hour were used, provided that the data gap was less than four hours. For a data gap of four hours of more, the data from the on-site tower were used to fill out the gap identified for the off-site tower and vice versa. This is aligned with the requirements of Canadian Standards Association N288.1 [R-45].

Once the data gaps had been filled, the Double Joint Frequency was calculated for the 10 metre off-site tower and for the 10 metre and 50 metre elevations for the 50 metre on-site tower. The Triple Joint Frequency was then calculated for the 50 metre on-site tower at the 10 metre elevation only. The wind speed bins, wind direction sectors and stability class were determined as described below.

Wind speeds were grouped into bins defined in Canadian Standards Association N288.1 [R-21], where are reproduced in Table 68. The wind direction was then divided into 16 wind direction sectors with each sector being 22.5 degrees, as shown in Table 69.

Table 68 - Wind Speed Bins Used for the Generation of Double Joint Frequency and Triple Joint Frequency Tables

Wind Speed Class	Wind Speed, u (m/s)
1	$u \leq 2$
2	$2 < u \leq 3$
3	$3 < u \leq 4$
4	$4 < u \leq 5$
5	$5 < u \leq 6$
6	$u > 6$

Table 69 - Wind Direction Sectors

Wind Sector (direction from which wind is blowing)	Wind Direction (θ) in degrees
N	$\theta > 348.75$ or $\theta \leq 11.25$

NNE	11.25 < θ ≤ 33.75
NE	33.75 < θ ≤ 56.25
ENE	56.25 < θ ≤ 78.75
E	78.75 < θ ≤ 101.25
ESE	101.25 < θ ≤ 123.75
SE	123.75 < θ ≤ 146.25
SSE	146.25 < θ ≤ 168.75
S	168.75 25 < θ ≤ 191.25
SSW	191.25 < θ ≤ 213.75
SW	213.75 < θ ≤ 236.25
WSW	236.25 < θ ≤ 258.75
W	258.75 < θ ≤ 281.25
WNW	281.25 < θ ≤ 303.75
NW	303.75 < θ ≤ 326.25
NNW	326.25 < θ ≤ 348.75

The Pasquill-Gifford stability classes A to F were used. Stability class was estimated from the standard deviation of wind direction measured, taking into account night-time conditions and wind speeds [R-164]. A surface roughness of 0.4 m was assumed for all sectors. This value represents rural areas with mixed farming, tall bushes and small villages, consistent with CSA N288.2 [R-45]. Inclusion of surface roughness in the methodology for determining Pasquill-Gifford stability category is a refinement in the classification scheme, which results in shifting more cases towards the neutral D-stability class conditions with increased roughness [R-165].

The calculated Double Joint Frequency and Triple Joint Frequency data at the 50 metre on-site meteorological tower are presented in Table 70, Table 71 and Table 72.

Table 70 - Annual Average Double Joint Frequency for Bruce Power Site for Year 2022 – 50 metre Meteorological Tower at 10 metre Height

Wind Direction (wind blowing from)	**Wind Speed, u (m/s)**						
	u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
	Frequency (%) at 10 m Height						
N	1.80	1.44	1.19	0.98	0.37	0.08	5.86
NNE	1.48	0.68	0.47	0.31	0.03	0.00	2.98
NE	2.08	1.19	0.72	0.22	0.01	0.00	4.21
ENE	2.55	0.89	0.41	0.01	0.00	0.00	3.86

E	2.41	0.74	0.24	0.10	0.10	0.19	3.79
ESE	2.69	1.52	0.88	0.58	0.25	0.13	6.05
SE	4.69	2.17	1.44	0.66	0.21	0.21	9.37
SSE	2.60	1.59	1.79	1.85	0.55	0.34	8.72
S	2.03	1.69	1.78	1.89	1.54	1.07	10.01
SSW	1.24	1.48	2.21	2.13	0.89	0.74	8.71
SW	0.76	0.97	1.35	1.19	0.67	1.24	6.19
WSW	0.91	0.71	1.16	0.90	0.67	1.42	5.78
W	0.70	0.92	0.98	0.74	0.51	1.38	5.24
WNW	1.11	0.88	0.84	0.74	0.59	0.79	4.95
NW	1.71	1.23	0.87	1.14	0.99	1.42	7.36
NNW	1.82	1.43	1.40	1.22	0.71	0.34	6.92
Total	30.6	19.5	17.7	14.7	8.11	9.35	100

Table 71 - Annual Average Double Joint Frequency for Bruce Power Site for Year 2022 – 50 metre Metreological Tower at 50 metre Height

Wind Direction (wind blowing from)	**Wind Speed, u (m/s)**						
	u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
	Frequency (%) at 50 m Height						
N	0.43	0.53	0.65	0.72	0.69	1.99	5.02
NNE	0.44	0.53	0.75	0.64	0.52	1.47	4.36
NE	0.28	0.49	0.82	0.57	0.74	0.87	3.76
ENE	0.52	0.72	1.22	1.04	0.59	0.33	4.44
E	0.75	1.07	0.94	0.65	0.15	0.28	3.85
ESE	0.40	0.71	0.96	0.85	0.55	1.33	4.81
SE	0.39	0.65	0.88	0.99	1.09	2.47	6.47
SSE	0.28	0.43	0.75	1.33	1.42	3.05	7.26
S	0.26	0.45	0.85	1.22	1.70	5.03	9.52
SSW	0.28	0.40	0.95	1.65	1.89	6.37	11.55
SW	0.26	0.61	1.04	1.03	1.01	3.62	7.57
WSW	0.28	0.61	0.82	0.68	0.56	3.13	6.08
W	0.38	0.57	0.46	0.58	0.49	3.18	5.66
WNW	0.45	0.68	0.52	0.59	0.50	2.97	5.71
NW	0.65	0.74	0.53	0.37	0.43	3.96	6.68
NNW	0.61	0.95	1.07	0.74	0.91	2.98	7.25
Total	6.68	10.1	13.2	13.7	13.2	43.1	100

Table 72 - Annual Average Triple Joint Frequency for Bruce Power Site for Year 2022 – 50 metre Meteorological Tower at 10 metre Height

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
A	N	0.46	0.80	0.83	0.54	0.13	0.02	2.77
	NNE	0.19	0.22	0.18	0.08	0.01	0.00	0.68
	NE	0.15	0.19	0.07	0.03	0.00	0.00	0.45
	ENE	0.32	0.21	0.06	0.00	0.00	0.00	0.58
	E	0.30	0.19	0.08	0.01	0.00	0.00	0.58
	ESE	0.25	0.18	0.10	0.02	0.00	0.01	0.57
	SE	0.07	0.19	0.08	0.07	0.01	0.01	0.43
	SSE	0.17	0.16	0.24	0.16	0.05	0.06	0.83
	S	0.26	0.33	0.40	0.50	0.30	0.11	1.91
	SSW	0.23	0.59	1.11	1.03	0.19	0.11	3.26
	SW	0.16	0.39	0.46	0.18	0.05	0.01	1.24
	WSW	0.19	0.40	0.32	0.07	0.03	0.01	1.03
	W	0.16	0.31	0.16	0.08	0.01	0.01	0.73
	WNW	0.31	0.30	0.17	0.03	0.03	0.02	0.87
	NW	0.40	0.54	0.13	0.02	0.01	0.00	1.10
	NNW	0.41	0.40	0.26	0.27	0.19	0.06	1.60
	Total	**4.03**	**5.40**	**4.65**	**3.11**	**1.02**	**0.45**	**18.64**
B	N	0.27	0.07	0.02	0.00	0.00	0.00	0.37
	NNE	0.18	0.08	0.02	0.06	0.00	0.00	0.34
	NE	0.09	0.13	0.16	0.08	0.01	0.00	0.47
	ENE	0.13	0.08	0.06	0.00	0.00	0.00	0.26
	E	0.14	0.11	0.03	0.01	0.05	0.09	0.43
	ESE	0.11	0.18	0.23	0.22	0.13	0.09	0.96
	SE	0.16	0.19	0.23	0.16	0.06	0.05	0.84
	SSE	0.13	0.26	0.35	0.53	0.09	0.13	1.48
	S	0.11	0.32	0.26	0.32	0.54	0.32	1.87
	SSW	0.07	0.25	0.42	0.55	0.22	0.32	1.83
	SW	0.07	0.18	0.48	0.40	0.22	0.37	1.71
	WSW	0.15	0.15	0.45	0.29	0.22	0.33	1.58
	W	0.05	0.16	0.38	0.26	0.15	0.38	1.37
	WNW	0.14	0.13	0.21	0.21	0.17	0.31	1.15
	NW	0.19	0.24	0.14	0.21	0.21	0.25	1.23
	NNW	0.24	0.29	0.45	0.35	0.15	0.05	1.52
	Total	**2.23**	**2.82**	**3.88**	**3.63**	**2.19**	**2.67**	**17.4**

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	2 < u ≤ 3	3 < u ≤ 4	4 < u ≤ 5	5 < u ≤ 6	u > 6	Total
		Frequency (%) at 10 m Height						
C	N	0.13	0.00	0.00	0.00	0.00	0.00	0.13
	NNE	0.05	0.00	0.00	0.00	0.00	0.00	0.05
	NE	0.03	0.02	0.02	0.00	0.00	0.00	0.08
	ENE	0.13	0.02	0.00	0.00	0.00	0.00	0.15
	E	0.08	0.02	0.00	0.00	0.00	0.00	0.10
	ESE	0.07	0.09	0.02	0.02	0.00	0.00	0.21
	SE	0.14	0.13	0.03	0.05	0.01	0.00	0.35
	SSE	0.17	0.00	0.02	0.00	0.00	0.00	0.19
	S	0.05	0.01	0.02	0.03	0.01	0.00	0.13
	SSW	0.01	0.01	0.00	0.01	0.02	0.06	0.11
	SW	0.05	0.01	0.03	0.03	0.02	0.06	0.21
	WSW	0.08	0.02	0.06	0.11	0.08	0.14	0.49
	W	0.05	0.01	0.05	0.01	0.02	0.06	0.19
	WNW	0.06	0.00	0.00	0.02	0.01	0.06	0.15
	NW	0.13	0.05	0.03	0.09	0.16	0.31	0.76
	NNW	0.16	0.03	0.02	0.00	0.00	0.01	0.23
	Total	**1.36**	**0.43**	**0.32**	**0.39**	**0.34**	**0.68**	**3.53**
D	N	0.09	0.00	0.11	0.45	0.24	0.06	0.95
	NNE	0.18	0.05	0.13	0.17	0.02	0.00	0.55
	NE	0.30	0.38	0.43	0.10	0.00	0.00	1.21
	ENE	0.32	0.32	0.24	0.01	0.00	0.00	0.89
	E	0.39	0.14	0.13	0.08	0.06	0.10	0.89
	ESE	0.46	0.31	0.47	0.32	0.13	0.02	1.70
	SE	1.24	0.72	1.08	0.39	0.13	0.15	3.71
	SSE	0.49	0.15	1.05	1.16	0.41	0.16	3.42
	S	0.33	0.16	0.91	1.04	0.70	0.64	3.78
	SSW	0.10	0.07	0.55	0.55	0.46	0.25	1.97
	SW	0.09	0.06	0.29	0.57	0.39	0.81	2.20
	WSW	0.02	0.02	0.30	0.43	0.34	0.94	2.05
	W	0.07	0.06	0.34	0.39	0.33	0.94	2.12
	WNW	0.11	0.01	0.41	0.48	0.38	0.40	1.79
	NW	0.15	0.06	0.56	0.82	0.62	0.86	3.06
	NNW	0.14	0.00	0.50	0.59	0.37	0.23	1.83
	Total	**4.49**	**2.49**	**7.50**	**7.56**	**4.55**	**5.55**	**32.1**

Stability Class	Wind Direction (wind blowing from)	Wind Speed, u (m/s)						
		u ≤ 2	**2 < u ≤ 3**	**3 < u ≤ 4**	**4 < u ≤ 5**	**5 < u ≤ 6**	**u > 6**	**Total**
		Frequency (%) at 10 m Height						
E	N	0.22	0.13	0.22	0.00	0.00	0.00	0.56
	NNE	0.25	0.17	0.14	0.00	0.00	0.00	0.56
	NE	0.63	0.33	0.03	0.00	0.00	0.00	0.99
	ENE	0.66	0.18	0.06	0.00	0.00	0.00	0.90
	E	0.53	0.11	0.00	0.00	0.00	0.00	0.64
	ESE	0.86	0.57	0.06	0.00	0.00	0.00	1.48
	SE	1.67	0.65	0.01	0.00	0.00	0.00	2.33
	SSE	0.62	0.61	0.13	0.00	0.00	0.00	1.35
	S	0.43	0.53	0.18	0.00	0.00	0.00	1.14
	SSW	0.10	0.22	0.14	0.00	0.00	0.00	0.46
	SW	0.17	0.18	0.09	0.00	0.00	0.00	0.45
	WSW	0.11	0.05	0.05	0.00	0.00	0.00	0.21
	W	0.15	0.18	0.06	0.00	0.00	0.00	0.39
	WNW	0.09	0.21	0.06	0.00	0.00	0.00	0.35
	NW	0.15	0.18	0.01	0.00	0.00	0.00	0.34
	NNW	0.18	0.33	0.17	0.00	0.00	0.00	0.68
	Total	**6.82**	**4.62**	**1.39**	**0.00**	**0.00**	**0.00**	**12.83**
F	N	0.64	0.45	0.00	0.00	0.00	0.00	1.08
	NNE	0.63	0.17	0.00	0.00	0.00	0.00	0.80
	NE	0.88	0.14	0.00	0.00	0.00	0.00	1.02
	ENE	0.99	0.08	0.00	0.00	0.00	0.00	1.07
	E	0.98	0.16	0.00	0.00	0.00	0.00	1.14
	ESE	0.95	0.18	0.00	0.00	0.00	0.00	1.13
	SE	1.42	0.29	0.00	0.00	0.00	0.00	1.70
	SSE	1.03	0.41	0.00	0.00	0.00	0.00	1.44
	S	0.84	0.34	0.00	0.00	0.00	0.00	1.19
	SSW	0.73	0.34	0.00	0.00	0.00	0.00	1.07
	SW	0.23	0.15	0.00	0.00	0.00	0.00	0.38
	WSW	0.35	0.07	0.00	0.00	0.00	0.00	0.42
	W	0.23	0.21	0.00	0.00	0.00	0.00	0.43
	WNW	0.40	0.24	0.00	0.00	0.00	0.00	0.64
	NW	0.70	0.17	0.00	0.00	0.00	0.00	0.87
	NNW	0.68	0.38	0.00	0.00	0.00	0.00	1.06
	Total	**11.7**	**3.77**	**0.00**	**0.00**	**0.00**	**0.00**	**15.5**
Grand Total		**30.6**	**19.5**	**17.7**	**14.7**	**8.11**	**9.35**	**100**

APPENDIX C: 2022 DETAILED DOSE CALCULATION RESULTS

Table 73 - Dose to Representative Persons Located at BR1

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	6.45E-04	7.41E-07	7.34E-06	5.07E-10	5.37E-11	9.30E-09	3.02E-03	2.14E-01	2.74E-01	4.92E-01
Adult	Cobalt-60	8.09E-07	3.07E-08	7.74E-06	3.44E-04	2.67E-03	0.00E+00	1.56E-03	6.27E-06	2.49E-06	4.60E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-03	0.00E+00	0.00E+00	2.16E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	7.14E-03	1.50E-02
Adult	Tritium oxide	5.55E-01	0.00E+00	9.81E-03	1.07E-02	0.00E+00	0.00E+00	8.44E-04	2.50E-01	1.70E-02	8.43E-01
Adult	Iodine, mixed fission products	1.90E-04	1.28E-05	0.00E+00	0.00E+00	1.98E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-04
Adult	Noble Gases	0.00E+00	1.73E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-01
Adult	**Total**	**5.56E-01**	**1.73E-01**	**9.83E-03**	**1.11E-02**	**2.69E-03**	**7.81E-03**	**7.58E-03**	**4.64E-01**	**2.98E-01**	**1.53E+00**
Child	Carbon-14	9.20E-04	7.41E-07	4.03E-06	5.07E-10	1.16E-10	1.08E-07	1.81E-03	2.42E-01	2.26E-01	4.71E-01
Child	Cobalt-60	1.15E-06	3.07E-08	9.97E-06	3.44E-04	2.67E-03	0.00E+00	2.20E-03	1.57E-05	4.57E-06	5.25E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-04	0.00E+00	0.00E+00	6.92E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	1.58E-03	9.45E-03
Child	Tritium oxide	6.60E-01	0.00E+00	4.88E-03	8.93E-03	0.00E+00	0.00E+00	4.72E-04	2.23E-01	1.83E-02	9.16E-01
Child	Iodine, mixed fission products	4.26E-04	1.28E-05	0.00E+00	0.00E+00	1.98E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.58E-04
Child	Noble Gases	0.00E+00	1.73E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-01
Child	**Total**	**6.61E-01**	**1.73E-01**	**4.90E-03**	**9.28E-03**	**2.69E-03**	**7.87E-03**	**5.18E-03**	**4.65E-01**	**2.46E-01**	**1.58E+00**
Infant	Carbon-14	6.28E-04	7.41E-07	0.00E+00	4.17E-11	1.99E-10	2.37E-07	1.24E-03	1.98E-01	2.66E-01	4.66E-01
Infant	Cobalt-60	8.46E-07	3.99E-08	0.00E+00	4.03E-06	3.47E-03	0.00E+00	1.84E-03	1.69E-05	5.89E-06	5.34E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	0.00E+00	0.00E+00	2.69E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	5.99E-04	1.08E-02
Infant	Tritium oxide	4.55E-01	0.00E+00	0.00E+00	1.89E-04	0.00E+00	0.00E+00	3.38E-04	2.11E-01	3.13E-02	6.99E-01

Infant	Iodine, mixed fission products	5.09E-04	1.66E-05	0.00E+00	0.00E+00	2.59E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.51E-04
Infant	Noble Gases	0.00E+00	2.24E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.24E-01
Infant	**Total**	**4.56E-01**	**2.24E-01**	**0.00E+00**	**1.93E-04**	**3.50E-03**	**1.02E-02**	**3.68E-03**	**4.10E-01**	**2.98E-01**	**1.41E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products.

Table 74 - Dose to Representative Persons Located at BR17

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	2.96E-04	3.40E-07	3.37E-06	4.56E-10	1.11E-11	9.30E-09	3.02E-03	9.74E-02	1.47E-01	2.48E-01
Adult	Cobalt-60	6.60E-07	2.50E-08	7.74E-06	3.44E-04	3.41E-03	0.00E+00	1.56E-03	7.54E-06	2.93E-06	5.34E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-03	0.00E+00	0.00E+00	2.16E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	7.14E-03	1.50E-02
Adult	Tritium oxide	4.53E-01	0.00E+00	9.81E-03	1.07E-02	0.00E+00	0.00E+00	8.44E-04	1.11E-01	1.69E-02	6.03E-01
Adult	Iodine, mixed fission products	1.55E-04	1.04E-05	0.00E+00	0.00E+00	1.76E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-04
Adult	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Adult	**Total**	**4.54E-01**	**1.41E-01**	**9.82E-03**	**1.11E-02**	**3.43E-03**	**7.81E-03**	**7.58E-03**	**2.08E-01**	**1.71E-01**	**1.01E+00**
Child	Carbon-14	4.22E-04	3.40E-07	1.85E-06	4.56E-10	2.40E-11	1.08E-07	1.81E-03	1.09E-01	1.47E-01	2.58E-01
Child	Cobalt-60	9.42E-07	2.50E-08	9.97E-06	3.44E-04	3.41E-03	0.00E+00	2.20E-03	1.89E-05	5.24E-06	5.99E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-04	0.00E+00	0.00E+00	6.92E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	1.58E-03	9.45E-03
Child	Tritium oxide	5.39E-01	0.00E+00	4.88E-03	8.93E-03	0.00E+00	0.00E+00	4.72E-04	1.07E-01	1.83E-02	6.79E-01
Child	Iodine, mixed fission products	3.47E-04	1.04E-05	0.00E+00	0.00E+00	1.77E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.76E-04
Child	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Child	**Total**	**5.40E-01**	**1.41E-01**	**4.89E-03**	**9.28E-03**	**3.43E-03**	**7.87E-03**	**5.18E-03**	**2.16E-01**	**1.67E-01**	**1.09E+00**
Infant	Carbon-14	2.88E-04	3.40E-07	0.00E+00	2.09E-11	4.09E-11	2.37E-07	1.24E-03	8.71E-02	2.12E-01	3.00E-01
Infant	Cobalt-60	6.91E-07	3.26E-08	0.00E+00	4.03E-06	4.43E-03	0.00E+00	1.84E-03	2.02E-05	6.47E-06	6.31E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	0.00E+00	0.00E+00	2.69E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	5.99E-04	1.08E-02
Infant	Tritium oxide	3.72E-01	0.00E+00	0.00E+00	1.89E-04	0.00E+00	0.00E+00	3.38E-04	1.04E-01	3.13E-02	5.08E-01
Infant	Iodine, mixed fission products	4.16E-04	1.36E-05	0.00E+00	0.00E+00	2.30E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.52E-04

Infant	Noble Gases	0.00E+00	1.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-01
Infant	**Total**	**3.73E-01**	**1.83E-01**	**0.00E+00**	**1.93E-04**	**4.46E-03**	**1.02E-02**	**3.68E-03**	**1.91E-01**	**2.43E-01**	**1.01E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment.
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 75 - Dose to Representative Persons Located at BR25

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.56E-04	4.09E-07	4.06E-06	4.65E-10	1.94E-11	9.30E-09	3.02E-03	1.22E-01	1.69E-01	2.95E-01
Adult	Cobalt-60	7.26E-07	2.75E-08	7.74E-06	3.44E-04	2.74E-03	0.00E+00	1.56E-03	6.34E-06	2.51E-06	4.67E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-03	0.00E+00	0.00E+00	2.16E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	7.14E-03	1.50E-02
Adult	Tritium oxide	5.02E-01	0.00E+00	9.81E-03	1.07E-02	0.00E+00	0.00E+00	8.44E-04	2.10E-01	1.70E-02	7.50E-01
Adult	Iodine, mixed fission products	1.71E-04	1.15E-05	0.00E+00	0.00E+00	1.83E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E-04
Adult	Noble Gases	0.00E+00	1.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-01
Adult	**Total**	**5.02E-01**	**1.56E-01**	**9.82E-03**	**1.11E-02**	**2.76E-03**	**7.81E-03**	**7.58E-03**	**3.32E-01**	**1.93E-01**	**1.22E+00**
Child	Carbon-14	5.07E-04	4.09E-07	2.23E-06	4.65E-10	4.22E-11	1.08E-07	1.81E-03	1.43E-01	1.61E-01	3.06E-01
Child	Cobalt-60	1.04E-06	2.75E-08	9.97E-06	3.44E-04	2.74E-03	0.00E+00	2.20E-03	1.59E-05	4.60E-06	5.32E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-04	0.00E+00	0.00E+00	6.92E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	1.58E-03	9.45E-03
Child	Tritium oxide	5.96E-01	0.00E+00	4.88E-03	8.93E-03	0.00E+00	0.00E+00	4.72E-04	2.04E-01	1.83E-02	8.33E-01
Child	Iodine, mixed fission products	3.83E-04	1.15E-05	0.00E+00	0.00E+00	1.83E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.13E-04
Child	Noble Gases	0.00E+00	1.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-01
Child	**Total**	**5.97E-01**	**1.56E-01**	**4.89E-03**	**9.28E-03**	**2.76E-03**	**7.87E-03**	**5.18E-03**	**3.47E-01**	**1.81E-01**	**1.31E+00**
Infant	Carbon-14	3.46E-04	4.09E-07	0.00E+00	2.45E-11	7.19E-11	2.37E-07	1.24E-03	1.26E-01	2.21E-01	3.48E-01
Infant	Cobalt-60	7.59E-07	3.58E-08	0.00E+00	4.03E-06	3.57E-03	0.00E+00	1.84E-03	1.70E-05	5.92E-06	5.44E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	0.00E+00	0.00E+00	2.69E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	5.99E-04	1.08E-02
Infant	Tritium oxide	4.11E-01	0.00E+00	0.00E+00	1.89E-04	0.00E+00	0.00E+00	3.38E-04	2.15E-01	3.13E-02	6.58E-01
Infant	Iodine, mixed fission products	4.59E-04	1.50E-05	0.00E+00	0.00E+00	2.39E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04
Infant	Noble Gases	0.00E+00	2.02E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-01
Infant	**Total**	**4.12E-01**	**2.02E-01**	**0.00E+00**	**1.93E-04**	**3.59E-03**	**1.02E-02**	**3.68E-03**	**3.40E-01**	**2.53E-01**	**1.23E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 76 - Dose to Representative Persons Located at BR27

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.56E-04	4.09E-07	5.70E-06	4.73E-10	1.94E-11	9.30E-09	3.02E-03	1.44E-01	1.69E-01	3.17E-01
Adult	Cobalt-60	7.26E-07	2.75E-08	5.35E-05	3.47E-04	2.00E-03	0.00E+00	1.56E-03	7.25E-06	2.99E-06	3.97E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-03	0.00E+00	0.00E+00	2.16E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	7.14E-03	1.50E-02
Adult	Tritium oxide	5.02E-01	0.00E+00	1.33E-02	1.08E-02	0.00E+00	0.00E+00	8.44E-04	1.77E-01	1.70E-02	7.20E-01
Adult	Iodine, mixed fission products	1.71E-04	1.15E-05	0.00E+00	0.00E+00	1.74E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-04
Adult	Noble Gases	0.00E+00	1.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-01
Adult	**Total**	**5.02E-01**	**1.56E-01**	**1.33E-02**	**1.11E-02**	**2.01E-03**	**7.81E-03**	**7.58E-03**	**3.21E-01**	**1.93E-01**	**1.21E+00**
Child	Carbon-14	5.07E-04	4.09E-07	3.13E-06	4.73E-10	4.22E-11	1.08E-07	1.81E-03	1.58E-01	1.61E-01	3.21E-01
Child	Cobalt-60	1.04E-06	2.75E-08	6.89E-05	3.47E-04	2.00E-03	0.00E+00	2.20E-03	1.80E-05	5.35E-06	4.64E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-04	0.00E+00	0.00E+00	6.92E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	1.58E-03	9.45E-03
Child	Tritium oxide	5.96E-01	0.00E+00	6.60E-03	8.96E-03	0.00E+00	0.00E+00	4.72E-04	1.67E-01	1.83E-02	7.98E-01
Child	Iodine, mixed fission products	3.83E-04	1.15E-05	0.00E+00	0.00E+00	1.74E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.12E-04
Child	Noble Gases	0.00E+00	1.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-01
Child	**Total**	**5.97E-01**	**1.56E-01**	**6.67E-03**	**9.31E-03**	**2.01E-03**	**7.87E-03**	**5.18E-03**	**3.25E-01**	**1.81E-01**	**1.29E+00**
Infant	Carbon-14	3.46E-04	4.09E-07	0.00E+00	3.22E-11	7.19E-11	2.37E-07	1.24E-03	1.29E-01	2.21E-01	3.51E-01
Infant	Cobalt-60	7.59E-07	3.58E-08	0.00E+00	8.30E-06	2.59E-03	0.00E+00	1.84E-03	1.96E-05	6.57E-06	4.47E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	0.00E+00	0.00E+00	2.69E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	5.99E-04	1.08E-02
Infant	Tritium oxide	4.11E-01	0.00E+00	0.00E+00	2.18E-04	0.00E+00	0.00E+00	3.38E-04	1.66E-01	3.13E-02	6.10E-01
Infant	Iodine, mixed fission products	4.59E-04	1.50E-05	0.00E+00	0.00E+00	2.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.96E-04
Infant	Noble Gases	0.00E+00	2.02E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-01
Infant	**Total**	**4.12E-01**	**2.02E-01**	**0.00E+00**	**2.27E-04**	**2.62E-03**	**1.02E-02**	**3.68E-03**	**2.95E-01**	**2.53E-01**	**1.18E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 77 - Dose to Representative Persons Located at BR32

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.56E-04	4.09E-07	9.36E-06	5.56E-10	5.95E-11	9.30E-09	3.02E-03	1.44E-01	1.69E-01	3.17E-01
Adult	Cobalt-60	6.07E-07	2.30E-08	1.13E-04	3.67E-04	5.20E-03	0.00E+00	1.56E-03	1.18E-05	5.23E-06	7.26E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-03	0.00E+00	0.00E+00	2.16E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	7.14E-03	1.50E-02
Adult	Tritium oxide	4.16E-01	0.00E+00	1.83E-02	1.09E-02	0.00E+00	0.00E+00	8.44E-04	1.77E-01	1.70E-02	6.40E-01
Adult	Iodine, mixed fission products	1.43E-04	9.60E-06	0.00E+00	0.00E+00	1.45E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-04
Adult	Noble Gases	0.00E+00	1.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-01
Adult	**Total**	**4.16E-01**	**1.30E-01**	**1.84E-02**	**1.13E-02**	**5.22E-03**	**7.81E-03**	**7.58E-03**	**3.21E-01**	**1.93E-01**	**1.11E+00**
Child	Carbon-14	5.07E-04	4.09E-07	5.14E-06	5.56E-10	1.29E-10	1.08E-07	1.81E-03	1.58E-01	1.61E-01	3.21E-01
Child	Cobalt-60	8.66E-07	2.30E-08	1.46E-04	3.67E-04	5.20E-03	0.00E+00	2.20E-03	2.94E-05	9.03E-06	7.96E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-04	0.00E+00	0.00E+00	6.92E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	1.58E-03	9.45E-03
Child	Tritium oxide	4.95E-01	0.00E+00	9.10E-03	9.07E-03	0.00E+00	0.00E+00	4.72E-04	1.67E-01	1.83E-02	6.98E-01
Child	Iodine, mixed fission products	3.19E-04	9.60E-06	0.00E+00	0.00E+00	1.45E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-04
Child	Noble Gases	0.00E+00	1.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-01
Child	**Total**	**4.95E-01**	**1.30E-01**	**9.25E-03**	**9.44E-03**	**5.22E-03**	**7.87E-03**	**5.18E-03**	**3.25E-01**	**1.81E-01**	**1.17E+00**
Infant	Carbon-14	3.46E-04	4.09E-07	0.00E+00	3.79E-11	2.20E-10	2.37E-07	1.24E-03	1.29E-01	2.21E-01	3.51E-01
Infant	Cobalt-60	6.35E-07	2.99E-08	0.00E+00	9.05E-06	6.76E-03	0.00E+00	1.84E-03	3.19E-05	9.77E-06	8.66E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	0.00E+00	0.00E+00	2.69E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	5.99E-04	1.08E-02
Infant	Tritium oxide	3.41E-01	0.00E+00	0.00E+00	1.35E-04	0.00E+00	0.00E+00	3.38E-04	1.66E-01	3.13E-02	5.39E-01
Infant	Iodine, mixed fission products	3.82E-04	1.25E-05	0.00E+00	0.00E+00	1.90E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.13E-04
Infant	Noble Gases	0.00E+00	1.68E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Infant	**Total**	**3.42E-01**	**1.68E-01**	**0.00E+00**	**1.44E-04**	**6.78E-03**	**1.02E-02**	**3.68E-03**	**2.95E-01**	**2.53E-01**	**1.08E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 78 - Dose to Representative Persons Located at BR48

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	5.94E-04	6.83E-07	6.79E-06	5.00E-10	5.37E-11	9.30E-09	3.02E-03	2.17E-01	2.56E-01	4.76E-01
Adult	Cobalt-60	1.33E-06	5.03E-08	7.74E-06	3.44E-04	6.53E-03	0.00E+00	1.56E-03	1.40E-05	5.32E-06	8.47E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-03	0.00E+00	0.00E+00	2.16E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	7.14E-03	1.50E-02
Adult	Tritium oxide	9.17E-01	0.00E+00	9.81E-03	1.07E-02	0.00E+00	0.00E+00	8.44E-04	1.88E-01	1.73E-02	1.14E+00
Adult	Iodine, mixed fission products	3.12E-04	2.10E-05	0.00E+00	0.00E+00	3.51E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-04
Adult	Noble Gases	0.00E+00	2.84E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-01
Adult	**Total**	**9.18E-01**	**2.84E-01**	**9.83E-03**	**1.11E-02**	**6.57E-03**	**7.81E-03**	**7.58E-03**	**4.05E-01**	**2.80E-01**	**1.93E+00**
Child	Carbon-14	8.48E-04	6.83E-07	3.73E-06	5.00E-10	1.16E-10	1.08E-07	1.81E-03	2.44E-01	2.15E-01	4.62E-01
Child	Cobalt-60	1.89E-06	5.03E-08	9.97E-06	3.44E-04	6.53E-03	0.00E+00	2.20E-03	3.52E-05	8.81E-06	9.14E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.92E-04	0.00E+00	0.00E+00	6.92E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	1.58E-03	9.45E-03
Child	Tritium oxide	1.09E+00	0.00E+00	4.88E-03	8.93E-03	0.00E+00	0.00E+00	4.72E-04	1.80E-01	1.85E-02	1.30E+00
Child	Iodine, mixed fission products	6.98E-04	2.10E-05	0.00E+00	0.00E+00	3.51E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.54E-04
Child	Noble Gases	0.00E+00	2.84E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.84E-01
Child	**Total**	**1.09E+00**	**2.84E-01**	**4.90E-03**	**9.28E-03**	**6.57E-03**	**7.87E-03**	**5.18E-03**	**4.24E-01**	**2.35E-01**	**2.07E+00**
Infant	Carbon-14	5.79E-04	6.83E-07	0.00E+00	3.88E-11	1.99E-10	2.37E-07	1.24E-03	2.05E-01	2.58E-01	4.64E-01
Infant	Cobalt-60	1.39E-06	6.54E-08	0.00E+00	4.03E-06	8.50E-03	0.00E+00	1.84E-03	3.75E-05	9.55E-06	1.04E-02
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.69E-04	0.00E+00	0.00E+00	2.69E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	5.99E-04	1.08E-02
Infant	Tritium oxide	7.52E-01	0.00E+00	0.00E+00	1.89E-04	0.00E+00	0.00E+00	3.38E-04	1.85E-01	3.15E-02	9.69E-01
Infant	Iodine, mixed fission products	8.35E-04	2.73E-05	0.00E+00	0.00E+00	4.58E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.08E-04
Infant	Noble Gases	0.00E+00	3.67E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.67E-01
Infant	**Total**	**7.54E-01**	**3.67E-01**	**0.00E+00**	**1.93E-04**	**8.54E-03**	**1.02E-02**	**3.68E-03**	**3.89E-01**	**2.90E-01**	**1.82E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 79 - Dose to Representative Persons Located at BF8

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	5.92E-06	4.63E-10	1.94E-11	9.30E-09	2.93E-03	1.90E-01	2.54E-01	4.48E-01
Adult	Cobalt-60	4.00E-07	1.52E-08	9.29E-05	3.41E-04	1.73E-03	0.00E+00	1.52E-03	1.63E-05	4.66E-06	3.70E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E-03	0.00E+00	0.00E+00	2.09E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	3.72E-02	1.06E-02	0.00E+00	0.00E+00	8.18E-04	3.57E-01	2.23E-02	7.00E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	1.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**3.73E-02**	**1.09E-02**	**1.74E-03**	**7.81E-03**	**7.35E-03**	**5.47E-01**	**2.91E-01**	**1.26E+00**
Child	Carbon-14	5.53E-04	4.46E-07	3.25E-06	4.63E-10	4.22E-11	1.08E-07	1.76E-03	2.21E-01	1.86E-01	4.09E-01
Child	Cobalt-60	5.71E-07	1.52E-08	1.20E-04	3.41E-04	1.73E-03	0.00E+00	2.13E-03	3.86E-05	7.04E-06	4.37E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.71E-04	0.00E+00	0.00E+00	6.71E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	1.85E-02	8.82E-03	0.00E+00	0.00E+00	4.58E-04	3.55E-01	1.69E-02	7.22E-01
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	1.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.28E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**1.86E-02**	**9.16E-03**	**1.74E-03**	**7.87E-03**	**5.02E-03**	**5.76E-01**	**2.06E-01**	**1.23E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.16E-11	7.19E-11	2.37E-07	1.20E-03	2.00E-01	1.87E-01	3.89E-01
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	2.25E-03	0.00E+00	1.78E-03	4.32E-05	7.03E-06	4.08E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.61E-04	0.00E+00	0.00E+00	2.61E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.28E-04	3.91E-01	2.20E-02	6.36E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.35E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**2.26E-03**	**1.02E-02**	**3.57E-03**	**5.91E-01**	**2.10E-01**	**1.15E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 80 - Dose to Representative Persons Located at BF14

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	4.73E-04	5.44E-07	6.84E-06	4.75E-10	1.94E-11	9.30E-09	2.93E-03	3.01E-01	3.03E-01	6.07E-01
Adult	Cobalt-60	6.07E-07	2.30E-08	9.29E-05	3.41E-04	1.95E-03	0.00E+00	1.52E-03	1.74E-05	5.03E-06	3.93E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E-03	0.00E+00	0.00E+00	2.09E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	4.16E-01	0.00E+00	3.72E-02	1.06E-02	0.00E+00	0.00E+00	8.18E-04	3.67E-01	2.25E-02	8.53E-01
Adult	Iodine, mixed fission products	1.43E-04	9.60E-06	0.00E+00	0.00E+00	1.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-04
Adult	Noble Gases	0.00E+00	1.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-01
Adult	**Total**	**4.17E-01**	**1.30E-01**	**3.73E-02**	**1.09E-02**	**1.97E-03**	**7.81E-03**	**7.35E-03**	**6.67E-01**	**3.40E-01**	**1.62E+00**
Child	Carbon-14	6.75E-04	5.44E-07	3.75E-06	4.75E-10	4.22E-11	1.08E-07	1.76E-03	3.14E-01	2.16E-01	5.33E-01
Child	Cobalt-60	8.66E-07	2.30E-08	1.20E-04	3.41E-04	1.95E-03	0.00E+00	2.13E-03	4.11E-05	7.58E-06	4.60E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.71E-04	0.00E+00	0.00E+00	6.71E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	4.95E-01	0.00E+00	1.85E-02	8.82E-03	0.00E+00	0.00E+00	4.58E-04	3.35E-01	1.70E-02	8.74E-01
Child	Iodine, mixed fission products	3.19E-04	9.60E-06	0.00E+00	0.00E+00	1.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.44E-04
Child	Noble Gases	0.00E+00	1.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-01
Child	**Total**	**4.96E-01**	**1.30E-01**	**1.86E-02**	**9.16E-03**	**1.97E-03**	**7.87E-03**	**5.02E-03**	**6.49E-01**	**2.36E-01**	**1.55E+00**
Infant	Carbon-14	4.61E-04	5.44E-07	0.00E+00	2.63E-11	7.19E-11	2.37E-07	1.20E-03	2.52E-01	2.08E-01	4.61E-01
Infant	Cobalt-60	6.35E-07	2.99E-08	0.00E+00	0.00E+00	2.54E-03	0.00E+00	1.78E-03	4.59E-05	7.48E-06	4.38E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.61E-04	0.00E+00	0.00E+00	2.61E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	3.41E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.28E-04	3.33E-01	2.21E-02	6.96E-01
Infant	Iodine, mixed fission products	3.82E-04	1.25E-05	0.00E+00	0.00E+00	1.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.14E-04
Infant	Noble Gases	0.00E+00	1.68E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-01
Infant	**Total**	**3.42E-01**	**1.68E-01**	**0.00E+00**	**7.24E-05**	**2.56E-03**	**1.02E-02**	**3.57E-03**	**5.84E-01**	**2.31E-01**	**1.34E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 81 - Dose to Representative Persons Located at BF16

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	2.96E-04	3.40E-07	4.91E-06	4.50E-10	1.11E-11	9.30E-09	2.93E-03	1.25E-01	2.02E-01	3.30E-01
Adult	Cobalt-60	6.60E-07	2.50E-08	9.29E-05	3.41E-04	3.17E-03	0.00E+00	1.52E-03	2.14E-05	6.36E-06	5.14E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.09E-03	0.00E+00	0.00E+00	2.09E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	4.53E-01	0.00E+00	3.72E-02	1.06E-02	0.00E+00	0.00E+00	8.18E-04	2.24E-01	2.25E-02	7.48E-01
Adult	Iodine, mixed fission products	1.55E-04	1.04E-05	0.00E+00	0.00E+00	1.73E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-04
Adult	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Adult	**Total**	**4.54E-01**	**1.41E-01**	**3.73E-02**	**1.09E-02**	**3.18E-03**	**7.81E-03**	**7.35E-03**	**3.49E-01**	**2.39E-01**	**1.25E+00**
Child	Carbon-14	4.22E-04	3.40E-07	2.69E-06	4.50E-10	2.40E-11	1.08E-07	1.76E-03	1.40E-01	1.53E-01	2.96E-01
Child	Cobalt-60	9.42E-07	2.50E-08	1.20E-04	3.41E-04	3.17E-03	0.00E+00	2.13E-03	5.09E-05	9.50E-06	5.82E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.71E-04	0.00E+00	0.00E+00	6.71E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	5.39E-01	0.00E+00	1.85E-02	8.82E-03	0.00E+00	0.00E+00	4.58E-04	2.08E-01	1.70E-02	7.92E-01
Child	Iodine, mixed fission products	3.47E-04	1.04E-05	0.00E+00	0.00E+00	1.74E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.75E-04
Child	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Child	**Total**	**5.40E-01**	**1.41E-01**	**1.86E-02**	**9.16E-03**	**3.18E-03**	**7.87E-03**	**5.02E-03**	**3.48E-01**	**1.73E-01**	**1.25E+00**
Infant	Carbon-14	2.88E-04	3.40E-07	0.00E+00	1.64E-11	4.09E-11	2.37E-07	1.20E-03	1.15E-01	1.65E-01	2.81E-01
Infant	Cobalt-60	6.91E-07	3.26E-08	0.00E+00	0.00E+00	4.12E-03	0.00E+00	1.78E-03	5.65E-05	9.12E-06	5.97E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.61E-04	0.00E+00	0.00E+00	2.61E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	3.72E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.28E-04	2.03E-01	2.21E-02	5.97E-01
Infant	Iodine, mixed fission products	4.16E-04	1.36E-05	0.00E+00	0.00E+00	2.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.52E-04
Infant	Noble Gases	0.00E+00	1.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-01
Infant	**Total**	**3.73E-01**	**1.83E-01**	**0.00E+00**	**7.24E-05**	**4.14E-03**	**1.02E-02**	**3.57E-03**	**3.17E-01**	**1.88E-01**	**1.08E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products.

Table 82 - Dose to Representative Persons Located at BSF2

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	4.83E-06	4.62E-10	1.94E-11	9.30E-09	1.31E-02	6.23E-01	5.55E-01	1.19E+00
Adult	Cobalt-60	4.00E-07	1.52E-08	0.00E+00	3.41E-04	1.30E-03	0.00E+00	6.80E-03	1.23E-05	3.46E-06	8.46E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.38E-03	0.00E+00	0.00E+00	9.38E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	8.89E-03	1.06E-02	0.00E+00	0.00E+00	3.67E-03	6.14E-01	5.08E-02	9.59E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	9.80E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**8.90E-03**	**1.09E-02**	**1.31E-03**	**7.81E-03**	**3.30E-02**	**1.24E+00**	**6.20E-01**	**2.28E+00**
Child	Carbon-14	5.53E-04	4.46E-07	2.65E-06	4.62E-10	4.22E-11	1.08E-07	7.89E-03	7.31E-01	5.32E-01	1.27E+00
Child	Cobalt-60	5.71E-07	3.99E-08	0.00E+00	4.03E-06	1.30E-03	0.00E+00	9.57E-03	3.12E-05	8.24E-06	1.09E-02
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.01E-03	0.00E+00	0.00E+00	3.01E-03
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	4.42E-03	8.82E-03	0.00E+00	0.00E+00	2.05E-03	6.16E-01	5.75E-02	1.01E+00
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	9.82E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**4.43E-03**	**8.83E-03**	**1.31E-03**	**7.87E-03**	**2.25E-02**	**1.35E+00**	**5.93E-01**	**2.39E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.15E-11	7.19E-11	2.37E-07	5.38E-03	6.09E-01	7.21E-01	1.34E+00
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	1.70E-03	0.00E+00	8.00E-03	3.17E-05	1.41E-05	9.75E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-03	0.00E+00	0.00E+00	1.17E-03
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	1.47E-03	6.36E-01	9.94E-02	9.59E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.28E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**1.71E-03**	**1.02E-02**	**1.60E-02**	**1.24E+00**	**8.21E-01**	**2.43E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 83 - Dose to Representative Persons Located at BSF3

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	4.83E-06	4.62E-10	1.94E-11	9.30E-09	1.31E-02	5.74E-01	5.55E-01	1.14E+00
Adult	Cobalt-60	4.00E-07	1.52E-08	0.00E+00	3.41E-04	1.74E-03	0.00E+00	6.80E-03	1.59E-05	4.43E-06	8.89E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.38E-03	0.00E+00	0.00E+00	9.38E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	8.89E-03	1.06E-02	0.00E+00	0.00E+00	3.67E-03	4.32E-01	5.08E-02	7.77E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	1.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**8.90E-03**	**1.09E-02**	**1.75E-03**	**7.81E-03**	**3.30E-02**	**1.01E+00**	**6.20E-01**	**2.05E+00**
Child	Carbon-14	5.53E-04	4.46E-07	2.65E-06	4.62E-10	4.22E-11	1.08E-07	7.89E-03	6.69E-01	5.32E-01	1.21E+00
Child	Cobalt-60	5.71E-07	1.52E-08	0.00E+00	3.41E-04	1.74E-03	0.00E+00	9.57E-03	4.03E-05	1.05E-05	1.17E-02
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.01E-03	0.00E+00	0.00E+00	3.01E-03
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	4.42E-03	8.82E-03	0.00E+00	0.00E+00	2.05E-03	4.15E-01	5.75E-02	8.11E-01
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	1.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.28E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**4.43E-03**	**9.16E-03**	**1.75E-03**	**7.87E-03**	**2.25E-02**	**1.08E+00**	**5.93E-01**	**2.13E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.15E-11	7.19E-11	2.37E-07	5.38E-03	5.30E-01	7.21E-01	1.26E+00
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	2.26E-03	0.00E+00	8.00E-03	4.10E-05	1.80E-05	1.03E-02
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-03	0.00E+00	0.00E+00	1.17E-03
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	1.47E-03	3.81E-01	9.94E-02	7.04E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.35E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**2.27E-03**	**1.02E-02**	**1.60E-02**	**9.11E-01**	**8.21E-01**	**2.09E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 84 - Dose to Representative Persons Located at BDF1

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	2.96E-04	3.40E-07	2.88E-06	4.50E-10	1.11E-11	9.30E-09	3.28E-03	1.99E-01	2.20E-01	4.22E-01
Adult	Cobalt-60	6.60E-07	2.50E-08	0.00E+00	3.41E-04	2.98E-03	0.00E+00	1.70E-03	1.31E-05	5.20E-06	5.04E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-03	0.00E+00	0.00E+00	2.34E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	4.53E-01	0.00E+00	6.94E-03	1.06E-02	0.00E+00	0.00E+00	9.17E-04	2.24E-01	4.13E-02	7.37E-01
Adult	Iodine, mixed fission products	1.55E-04	1.04E-05	0.00E+00	0.00E+00	1.71E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-04
Adult	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Adult	**Total**	**4.54E-01**	**1.41E-01**	**6.95E-03**	**1.09E-02**	**3.00E-03**	**7.81E-03**	**8.24E-03**	**4.23E-01**	**2.75E-01**	**1.33E+00**
Child	Carbon-14	4.22E-04	3.40E-07	1.58E-06	4.50E-10	2.40E-11	1.08E-07	1.97E-03	2.28E-01	1.50E-01	3.80E-01
Child	Cobalt-60	9.42E-07	2.50E-08	0.00E+00	3.41E-04	2.98E-03	0.00E+00	2.39E-03	3.24E-05	1.32E-05	5.76E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-04	0.00E+00	0.00E+00	7.52E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	5.39E-01	0.00E+00	3.45E-03	8.82E-03	0.00E+00	0.00E+00	5.13E-04	2.09E-01	5.56E-02	8.16E-01
Child	Iodine, mixed fission products	3.47E-04	1.04E-05	0.00E+00	0.00E+00	1.72E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.75E-04
Child	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Child	**Total**	**5.40E-01**	**1.41E-01**	**3.46E-03**	**9.16E-03**	**3.00E-03**	**7.87E-03**	**5.63E-03**	**4.36E-01**	**2.09E-01**	**1.36E+00**
Infant	Carbon-14	2.88E-04	3.40E-07	0.00E+00	1.64E-11	4.09E-11	2.37E-07	1.34E-03	1.81E-01	1.29E-01	3.12E-01
Infant	Cobalt-60	6.91E-07	3.26E-08	0.00E+00	0.00E+00	3.88E-03	0.00E+00	2.00E-03	3.28E-05	2.41E-05	5.94E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	0.00E+00	0.00E+00	2.93E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	3.72E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.68E-04	1.89E-01	1.06E-01	6.67E-01
Infant	Iodine, mixed fission products	4.16E-04	1.36E-05	0.00E+00	0.00E+00	2.24E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.51E-04
Infant	Noble Gases	0.00E+00	1.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-01
Infant	**Total**	**3.73E-01**	**1.83E-01**	**0.00E+00**	**7.24E-05**	**3.90E-03**	**1.02E-02**	**4.01E-03**	**3.70E-01**	**2.37E-01**	**1.18E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 85 - Dose to Representative Persons Located at BDF9

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	3.77E-06	4.62E-10	0.00E+00	9.30E-09	3.28E-03	2.74E-01	3.55E-01	6.33E-01
Adult	Cobalt-60	4.00E-07	1.52E-08	0.00E+00	3.41E-04	1.47E-03	0.00E+00	1.70E-03	6.56E-06	2.63E-06	3.52E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-03	0.00E+00	0.00E+00	2.34E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	6.94E-03	1.06E-02	0.00E+00	0.00E+00	9.17E-04	3.14E-01	3.51E-02	6.39E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**6.95E-03**	**1.09E-02**	**1.48E-03**	**7.81E-03**	**8.24E-03**	**5.89E-01**	**4.04E-01**	**1.39E+00**
Child	Carbon-14	5.53E-04	4.46E-07	2.07E-06	4.62E-10	0.00E+00	1.08E-07	1.97E-03	3.20E-01	3.76E-01	6.99E-01
Child	Cobalt-60	5.71E-07	1.52E-08	0.00E+00	3.41E-04	1.47E-03	0.00E+00	2.39E-03	1.62E-05	6.66E-06	4.22E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-04	0.00E+00	0.00E+00	7.52E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	3.45E-03	8.82E-03	0.00E+00	0.00E+00	5.13E-04	3.07E-01	4.18E-02	6.84E-01
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	1.00E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**3.46E-03**	**9.16E-03**	**1.48E-03**	**7.87E-03**	**5.63E-03**	**6.27E-01**	**4.21E-01**	**1.48E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.15E-11	0.00E+00	2.37E-07	1.34E-03	2.68E-01	5.55E-01	8.25E-01
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	1.91E-03	0.00E+00	2.00E-03	1.65E-05	1.22E-05	3.94E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	0.00E+00	0.00E+00	2.93E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.68E-04	3.13E-01	7.51E-02	6.11E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.31E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.74E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**1.92E-03**	**1.02E-02**	**4.01E-03**	**5.81E-01**	**6.31E-01**	**1.56E+00**

Note:

1. All doses reported in units of microsieverts per year

2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment

3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 86 - Dose to Representative Persons Located at BDF12

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	2.96E-04	3.40E-07	2.88E-06	4.50E-10	1.11E-11	9.30E-09	3.28E-03	1.99E-01	2.20E-01	4.22E-01
Adult	Cobalt-60	6.60E-07	2.50E-08	0.00E+00	3.41E-04	3.01E-03	0.00E+00	1.70E-03	1.32E-05	5.24E-06	5.07E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-03	0.00E+00	0.00E+00	2.34E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	4.53E-01	0.00E+00	6.94E-03	1.06E-02	0.00E+00	0.00E+00	9.17E-04	2.24E-01	4.13E-02	7.37E-01
Adult	Iodine, mixed fission products	1.55E-04	1.04E-05	0.00E+00	0.00E+00	1.72E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-04
Adult	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Adult	**Total**	**4.54E-01**	**1.41E-01**	**6.95E-03**	**1.09E-02**	**3.02E-03**	**7.81E-03**	**8.24E-03**	**4.23E-01**	**2.75E-01**	**1.33E+00**
Child	Carbon-14	4.22E-04	3.40E-07	1.58E-06	4.50E-10	2.40E-11	1.08E-07	1.97E-03	2.28E-01	1.50E-01	3.80E-01
Child	Cobalt-60	9.42E-07	2.50E-08	0.00E+00	3.41E-04	3.01E-03	0.00E+00	2.39E-03	3.26E-05	1.33E-05	5.79E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-04	0.00E+00	0.00E+00	7.52E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	5.39E-01	0.00E+00	3.45E-03	8.82E-03	0.00E+00	0.00E+00	5.13E-04	2.09E-01	5.56E-02	8.16E-01
Child	Iodine, mixed fission products	3.47E-04	1.04E-05	0.00E+00	0.00E+00	1.72E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.75E-04
Child	Noble Gases	0.00E+00	1.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.41E-01
Child	**Total**	**5.40E-01**	**1.41E-01**	**3.46E-03**	**9.16E-03**	**3.02E-03**	**7.87E-03**	**5.63E-03**	**4.36E-01**	**2.09E-01**	**1.36E+00**
Infant	Carbon-14	2.88E-04	3.40E-07	0.00E+00	1.64E-11	4.09E-11	2.37E-07	1.34E-03	1.81E-01	1.29E-01	3.12E-01
Infant	Cobalt-60	6.91E-07	3.26E-08	0.00E+00	0.00E+00	3.91E-03	0.00E+00	2.00E-03	3.31E-05	2.43E-05	5.97E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	0.00E+00	0.00E+00	2.93E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	3.72E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.68E-04	1.89E-01	1.06E-01	6.67E-01
Infant	Iodine, mixed fission products	4.16E-04	1.36E-05	0.00E+00	0.00E+00	2.24E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.52E-04
Infant	Noble Gases	0.00E+00	1.83E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-01
Infant	**Total**	**3.73E-01**	**1.83E-01**	**0.00E+00**	**7.24E-05**	**3.93E-03**	**1.02E-02**	**4.01E-03**	**3.70E-01**	**2.37E-01**	**1.18E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 87 - Dose to Representative Persons Located at BDF13

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	3.77E-06	4.62E-10	0.00E+00	9.30E-09	3.28E-03	2.51E-01	2.73E-01	5.28E-01
Adult	Cobalt-60	4.00E-07	1.52E-08	0.00E+00	3.41E-04	1.14E-03	0.00E+00	1.70E-03	5.26E-06	1.61E-06	3.19E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-03	0.00E+00	0.00E+00	2.34E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	6.94E-03	1.06E-02	0.00E+00	0.00E+00	9.17E-04	2.24E-01	3.48E-02	5.49E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	9.61E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**6.95E-03**	**1.09E-02**	**1.15E-03**	**7.81E-03**	**8.24E-03**	**4.75E-01**	**3.22E-01**	**1.19E+00**
Child	Carbon-14	5.53E-04	4.46E-07	2.07E-06	4.62E-10	0.00E+00	1.08E-07	1.97E-03	2.90E-01	1.70E-01	4.63E-01
Child	Cobalt-60	5.71E-07	1.52E-08	0.00E+00	3.41E-04	1.14E-03	0.00E+00	2.39E-03	1.30E-05	2.39E-06	3.89E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-04	0.00E+00	0.00E+00	7.52E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	3.45E-03	8.82E-03	0.00E+00	0.00E+00	5.13E-04	2.09E-01	4.10E-02	5.85E-01
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	9.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**3.46E-03**	**9.16E-03**	**1.15E-03**	**7.87E-03**	**5.63E-03**	**4.99E-01**	**2.14E-01**	**1.15E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.15E-11	0.00E+00	2.37E-07	1.34E-03	2.30E-01	1.17E-01	3.49E-01
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	1.48E-03	0.00E+00	2.00E-03	1.32E-05	2.07E-06	3.50E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	0.00E+00	0.00E+00	2.93E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.68E-04	1.89E-01	7.34E-02	4.85E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.26E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**1.50E-03**	**1.02E-02**	**4.01E-03**	**4.19E-01**	**1.92E-01**	**9.60E-01**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 88 - Dose to Representative Persons Located at BDF14

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	3.77E-06	4.62E-10	0.00E+00	9.30E-09	3.28E-03	2.74E-01	3.55E-01	6.33E-01
Adult	Cobalt-60	4.00E-07	1.52E-08	0.00E+00	3.41E-04	9.45E-04	0.00E+00	1.70E-03	4.47E-06	1.82E-06	2.99E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-03	0.00E+00	0.00E+00	2.34E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	6.94E-03	1.06E-02	0.00E+00	0.00E+00	9.17E-04	3.14E-01	3.48E-02	6.39E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	9.37E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**6.95E-03**	**1.09E-02**	**9.54E-04**	**7.81E-03**	**8.24E-03**	**5.89E-01**	**4.04E-01**	**1.38E+00**
Child	Carbon-14	5.53E-04	4.46E-07	2.07E-06	4.62E-10	0.00E+00	1.08E-07	1.97E-03	3.20E-01	3.76E-01	6.99E-01
Child	Cobalt-60	5.71E-07	1.52E-08	0.00E+00	3.41E-04	9.45E-04	0.00E+00	2.39E-03	1.11E-05	4.63E-06	3.69E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-04	0.00E+00	0.00E+00	7.52E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	3.45E-03	8.82E-03	0.00E+00	0.00E+00	5.13E-04	3.07E-01	4.10E-02	6.83E-01
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	9.39E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**3.46E-03**	**9.16E-03**	**9.54E-04**	**7.87E-03**	**5.63E-03**	**6.27E-01**	**4.20E-01**	**1.48E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.15E-11	0.00E+00	2.37E-07	1.34E-03	2.68E-01	5.55E-01	8.25E-01
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	1.23E-03	0.00E+00	2.00E-03	1.12E-05	8.53E-06	3.25E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	0.00E+00	0.00E+00	2.93E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.68E-04	3.13E-01	7.34E-02	6.10E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.22E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**1.24E-03**	**1.02E-02**	**4.01E-03**	**5.81E-01**	**6.30E-01**	**1.56E+00**

Note:

1. All doses reported in units of microsieverts per year

2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment

3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 89 - Dose to Representative Persons Located at BDF15

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	3.88E-04	4.46E-07	3.77E-06	4.62E-10	0.00E+00	9.30E-09	3.28E-03	2.74E-01	3.55E-01	6.33E-01
Adult	Cobalt-60	4.00E-07	1.52E-08	0.00E+00	3.41E-04	1.13E-03	0.00E+00	1.70E-03	5.20E-06	2.10E-06	3.17E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.34E-03	0.00E+00	0.00E+00	2.34E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	1.43E-02	2.21E-02
Adult	Tritium oxide	2.71E-01	0.00E+00	6.94E-03	1.06E-02	0.00E+00	0.00E+00	9.17E-04	3.14E-01	3.48E-02	6.39E-01
Adult	Iodine, mixed fission products	9.43E-05	6.35E-06	0.00E+00	0.00E+00	9.59E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-04
Adult	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Adult	**Total**	**2.72E-01**	**8.57E-02**	**6.95E-03**	**1.09E-02**	**1.14E-03**	**7.81E-03**	**8.24E-03**	**5.89E-01**	**4.04E-01**	**1.39E+00**
Child	Carbon-14	5.53E-04	4.46E-07	2.07E-06	4.62E-10	0.00E+00	1.08E-07	1.97E-03	3.20E-01	3.76E-01	6.99E-01
Child	Cobalt-60	5.71E-07	1.52E-08	0.00E+00	3.41E-04	1.13E-03	0.00E+00	2.39E-03	1.29E-05	5.34E-06	3.88E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-04	0.00E+00	0.00E+00	7.52E-04
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	3.11E-03	1.10E-02
Child	Tritium oxide	3.23E-01	0.00E+00	3.45E-03	8.82E-03	0.00E+00	0.00E+00	5.13E-04	3.07E-01	4.10E-02	6.83E-01
Child	Iodine, mixed fission products	2.11E-04	6.35E-06	0.00E+00	0.00E+00	9.61E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E-04
Child	Noble Gases	0.00E+00	8.57E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.57E-02
Child	**Total**	**3.23E-01**	**8.57E-02**	**3.46E-03**	**9.16E-03**	**1.14E-03**	**7.87E-03**	**5.63E-03**	**6.27E-01**	**4.20E-01**	**1.48E+00**
Infant	Carbon-14	3.78E-04	4.46E-07	0.00E+00	2.15E-11	0.00E+00	2.37E-07	1.34E-03	2.68E-01	5.55E-01	8.25E-01
Infant	Cobalt-60	4.19E-07	1.97E-08	0.00E+00	0.00E+00	1.46E-03	0.00E+00	2.00E-03	1.30E-05	9.81E-06	3.49E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-04	0.00E+00	0.00E+00	2.93E-04
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	1.20E-03	1.14E-02
Infant	Tritium oxide	2.23E-01	0.00E+00	0.00E+00	7.24E-05	0.00E+00	0.00E+00	3.68E-04	3.13E-01	7.34E-02	6.10E-01
Infant	Iodine, mixed fission products	2.52E-04	8.25E-06	0.00E+00	0.00E+00	1.25E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.73E-04
Infant	Noble Gases	0.00E+00	1.11E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01
Infant	**Total**	**2.23E-01**	**1.11E-01**	**0.00E+00**	**7.24E-05**	**1.48E-03**	**1.02E-02**	**4.01E-03**	**5.81E-01**	**6.30E-01**	**1.56E+00**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 90 - Dose to Representative Persons Located at BHF1

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	5.01E-05	5.76E-08	1.19E-05	2.55E-10	7.59E-11	1.56E-09	1.48E-03	4.28E-02	2.53E-02	6.97E-02
Adult	Cobalt-60	1.11E-07	4.22E-09	1.41E-04	4.57E-05	4.61E-03	0.00E+00	1.65E-04	2.19E-05	6.80E-06	4.99E-03
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.27E-03	0.00E+00	0.00E+00	6.27E-03
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-03	0.00E+00	0.00E+00	0.00E+00	7.81E-03
Adult	Tritium oxide	6.96E-02	0.00E+00	6.73E-02	2.28E-03	0.00E+00	0.00E+00	2.45E-03	1.09E-01	2.61E-02	2.77E-01
Adult	Iodine, mixed fission products	2.62E-05	1.76E-06	0.00E+00	0.00E+00	2.61E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.06E-05
Adult	Noble Gases	0.00E+00	2.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.43E-02
Adult	**Total**	**6.97E-02**	**2.43E-02**	**6.75E-02**	**2.33E-03**	**4.61E-03**	**7.81E-03**	**1.04E-02**	**1.52E-01**	**5.15E-02**	**3.90E-01**
Child	Carbon-14	7.14E-05	5.76E-08	6.55E-06	2.55E-10	1.65E-10	1.82E-08	1.33E-03	4.73E-02	2.32E-02	7.19E-02
Child	Cobalt-60	1.59E-07	4.22E-09	1.81E-04	4.57E-05	4.61E-03	0.00E+00	3.47E-04	5.42E-05	1.31E-05	5.25E-03
Child	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.01E-03	0.00E+00	0.00E+00	3.01E-03
Child	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-03	0.00E+00	0.00E+00	0.00E+00	7.87E-03
Child	Tritium oxide	8.28E-02	0.00E+00	3.35E-02	1.90E-03	0.00E+00	0.00E+00	2.05E-03	1.02E-01	3.13E-02	2.53E-01
Child	Iodine, mixed fission products	5.87E-05	1.76E-06	0.00E+00	0.00E+00	2.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.31E-05
Child	Noble Gases	0.00E+00	2.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.43E-02
Child	**Total**	**8.29E-02**	**2.43E-02**	**3.37E-02**	**1.95E-03**	**4.61E-03**	**7.87E-03**	**6.73E-03**	**1.49E-01**	**5.45E-02**	**3.65E-01**
Infant	999	4.87E-05	5.76E-08	0.00E+00	4.83E-11	2.81E-10	3.99E-08	9.04E-04	3.88E-02	3.02E-02	7.00E-02
Infant	Cobalt-60	1.16E-07	5.48E-09	0.00E+00	1.12E-05	6.00E-03	0.00E+00	2.90E-04	5.91E-05	1.70E-05	6.37E-03
Infant	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-03	0.00E+00	0.00E+00	1.17E-03
Infant	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	0.00E+00	0.00E+00	0.00E+00	1.02E-02
Infant	Tritium oxide	5.71E-02	0.00E+00	0.00E+00	4.98E-04	0.00E+00	0.00E+00	1.47E-03	9.82E-02	5.40E-02	2.11E-01
Infant	Iodine, mixed fission products	7.02E-05	2.29E-06	0.00E+00	0.00E+00	3.41E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.59E-05
Infant	Noble Gases	0.00E+00	3.15E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.15E-02
Infant	**Total**	**5.72E-02**	**3.15E-02**	**0.00E+00**	**5.09E-04**	**6.00E-03**	**1.02E-02**	**3.84E-03**	**1.37E-01**	**8.43E-02**	**3.31E-01**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

Table 91 - Dose to Representative Persons Located at BEC

Age Class	Radionuclide	Air Inhalation	Air Immersion	Water Ingestion	Water Immersion	Soil (ingestion and external)	Sediment (ingestion and external)	Fish Ingestion	Plant Ingestion	Animal Ingestion	Total
Adult	Carbon-14	6.80E-05	7.82E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.81E-05
Adult	Cobalt-60	1.52E-07	5.76E-09	0.00E+00	0.00E+00	7.60E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.61E-04
Adult	Cesium-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Adult	Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Adult	Tritium oxide	1.04E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-01
Adult	Iodine, mixed fission products	3.57E-05	2.40E-06	0.00E+00	0.00E+00	4.03E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.21E-05
Adult	Noble Gases	0.00E+00	3.25E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E-02
Adult	**Total**	**1.04E-01**	**3.25E-02**	**0.00E+00**	**0.00E+00**	**7.65E-04**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**1.38E-01**

Note:

1. All doses reported in units of microsieverts per year
2. Dose associated with cesium-137 includes dose due to external exposure to progeny of cesium-137 in air, water, soil, and sediment
3. Dose associated with tritium oxide includes dose incurred via ingestion of organically bound tritium in fish, plant produce and animal products

APPENDIX D: RADIOLOGICAL ENVIRONMENTAL MONITORING PROFICIENCY TESTING

As explained in Section 6.1.7, acceptance criteria for the Eckert & Ziegler Analytics Proficiency Testing are:

$$\frac{(V_L + 1\sigma_L)}{V_A} \geq 0.75 \text{ AND } \frac{(V_L - 1\sigma_L)}{V_A} \leq 1.2$$

Where:
V_L = Bruce Power Health Physics Laboratory value
σ_L = S_L, Bruce Power Health Physics Laboratory one sigma uncertainty value
V_A = Analytics Supplier value

Table 92 - 2022 Eckert & Ziegler Analytics Test Results for Tritium in Water

Quarter	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
1	5.32E+02	6.25E+00	5.28E+02	102%	100%
2	3.66E+02	6.61E+00	3.77E+02	99%	95%
3	4.50E+02	3.98E+00	4.61E+02	98%	97%
4	2.17E+01	2.73E+00	2.04E+01	120%	93%

Table 93 - 2022 Eckert & Ziegler Analytics Test Results for Gross Beta in Water

Quarter	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
1	9.39E+00	6.30E-01	8.21E+00	122%	107%
2	9.60E+00	6.50E-01	9.63E+00	106%	93%
3	7.84E+00	5.28E-01	8.70E+00	96%	84%
4	9.80E+00	6.58E-01	1.02E+01	103%	90%

Table 94 - 2022 Eckert & Ziegler Analytics Test Results for Iodine in Milk

Quarter	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
1	3.62E+00	5.48E-01	3.58E+00	117%	86%
2	3.19E+00	1.48E-01	3.35E+00	100%	91%
3	3.43E+00	3.13E-01	3.48E+00	107%	89%
4	3.62E+00	3.01E-01	3.52E+00	112%	94%

Table 95 - 2022 Eckert & Ziegler Analytics Test Results for Gamma in a Filter

Radionuclide	Bruce Power Value V_L (Bq)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Cerium-141	5.35E+00	3.44E-01	5.15E+00	111%	97%
Cobalt-58	5.03E+00	2.25E-01	5.28E+00	99%	91%
Cobalt-60	6.34E+00	1.95E-01	6.66E+00	98%	92%
Chromium-51	1.01E+01	8.58E-01	1.07E+01	102%	86%
Cesium-134	4.19E+00	1.13E-01	4.39E+00	98%	93%
Cesium-137	4.74E+00	2.12E-01	5.01E+00	99%	90%
Iron-59	4.54E+00	1.87E-01	4.54E+00	104%	96%
Manganese-54	5.69E+00	2.49E-01	5.78E+00	103%	94%
Zinc-65	6.54E+00	3.14E-01	7.00E+00	98%	89%

Table 96 - 2022 Eckert & Ziegler Analytics Test Results for Iodine-131 in a Cartridge

Radionuclide	Bruce Power Value V_L (Bq)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
Iodine-131	3.16E+00	2.74E-01	3.11E+00	110%	93%

Table 97 - 2022 Eckert & Ziegler Analytics Test Results for Gamma in Milk

Quarter	Radionuclide	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
1	Cerium-141	2.32E+00	2.84E-01	2.39E+00	109%	85%
1	Cobalt-58	5.62E+00	1.48E-01	6.07E+00	95%	90%
1	Cobalt-60	1.07E+01	1.87E-01	1.12E+01	97%	94%
1	Chromium-51	1.20E+01	6.96E-01	1.26E+01	101%	90%
1	Cesium-134	6.29E+00	1.45E-01	6.74E+00	95%	91%
1	Cesium-137	7.89E+00	1.98E-01	8.26E+00	98%	93%
1	Iron-59	6.52E+00	1.57E-01	6.84E+00	98%	93%
1	Iodine-131	3.62E+00	5.48E-01	3.58E+00	117%	86%
1	Manganese-54	5.87E+00	1.52E-01	6.07E+00	99%	94%
1	Zinc-65	8.64E+00	2.41E-01	9.12E+00	97%	92%
2	Cerium-141	6.14E+00	2.31E-01	6.34E+00	100%	93%
2	Cobalt-58	5.30E+00	1.45E-01	5.86E+00	93%	88%
2	Cobalt-60	1.06E+01	1.90E-01	1.11E+01	97%	93%
2	Chromium-51	1.58E+01	8.08E-01	1.57E+01	106%	95%
2	Cesium-134	7.28E+00	1.16E-01	7.84E+00	94%	91%
2	Cesium-137	8.75E+00	2.18E-01	9.32E+00	96%	92%
2	Iron-59	6.69E+00	1.50E-01	7.16E+00	96%	91%
2	Iodine-131	3.19E+00	1.48E-01	3.35E+00	100%	91%
2	Manganese-54	1.00E+01	2.46E-01	1.05E+01	98%	93%
2	Zinc-65	1.25E+01	3.24E-01	1.35E+01	95%	90%
3	Cerium-141	5.55E+00	3.65E-01	5.95E+00	99%	87%
3	Cobalt-58	6.22E+00	2.82E-01	6.99E+00	93%	85%
3	Cobalt-60	9.05E+00	3.01E-01	9.61E+00	97%	91%
3	Chromium-51	1.58E+01	1.31E+00	1.69E+01	101%	86%
3	Cesium-134	8.24E+00	2.57E-01	9.34E+00	91%	85%
3	Cesium-137	7.64E+00	3.34E-01	8.20E+00	97%	89%

Quarter	Radionuclide	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
3	Iron-59	5.87E+00	2.41E-01	6.40E+00	95%	88%
3	Iodine-131	3.43E+00	3.13E-01	3.48E+00	107%	89%
3	Manganese-54	9.73E+00	4.16E-01	1.05E+01	97%	89%
3	Zinc-65	1.29E+01	5.83E-01	1.38E+01	98%	89%
4	Cerium-141	8.16E+00	5.22E-01	8.31E+00	104%	92%
4	Cobalt-58	7.58E+00	3.30E-01	8.52E+00	93%	85%
4	Cobalt-60	1.01E+01	3.02E-01	1.07E+01	97%	91%
4	Chromium-51	1.59E+01	1.25E+00	1.72E+01	100%	85%
4	Cesium-134	6.49E+00	1.67E-01	7.09E+00	94%	89%
4	Cesium-137	7.46E+00	3.24E-01	8.09E+00	96%	88%
4	Iron-59	6.79E+00	2.62E-01	7.32E+00	96%	89%
4	Iodine-131	3.62E+00	3.01E-01	3.52E+00	112%	94%
4	Manganese-54	8.72E+00	3.72E-01	9.33E+00	97%	90%
4	Zinc-65	1.06E+01	4.83E-01	1.13E+01	98%	89%

Table 98 - 2022 Eckert & Ziegler Analytics Test Results for Gamma in Water

Quarter	Analyte	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
1	Cerium-141	2.58E+00	6.03E-01	2.82E+00	113%	70%
1	Cobalt-58	7.19E+00	2.03E-01	7.15E+00	103%	98%
1	Cobalt-60	1.36E+01	2.44E-01	1.31E+01	106%	102%
1	Chromium-51	1.55E+01	1.17E+00	1.48E+01	113%	97%
1	Cesium-134	8.14E+00	1.67E-01	7.94E+00	105%	100%
1	Cesium-137	9.65E+00	2.58E-01	9.74E+00	102%	96%
1	Iron-59	8.02E+00	2.17E-01	8.05E+00	102%	97%
1	Iodine-131	2.84E+00	5.32E-01	3.24E+00	104%	71%
1	Manganese-54	7.08E+00	1.98E-01	7.16E+00	102%	96%
1	Zinc-65	1.04E+01	3.16E-01	1.07E+01	100%	94%
2	Cerium-141	5.60E+00	2.66E-01	5.14E+00	114%	104%
2	Cobalt-58	4.75E+00	1.53E-01	4.75E+00	103%	97%
2	Cobalt-60	9.20E+00	1.73E-01	8.96E+00	105%	101%
2	Chromium-51	1.38E+01	8.85E-01	1.27E+01	116%	102%
2	Cesium-134	6.45E+00	2.84E-01	6.35E+00	106%	97%
2	Cesium-137	7.51E+00	2.07E-01	7.55E+00	102%	97%
2	Iron-59	5.85E+00	1.72E-01	5.80E+00	104%	98%
2	Iodine-131	3.72E+00	1.93E-01	3.37E+00	116%	105%
2	Manganese-54	8.78E+00	2.33E-01	8.48E+00	106%	101%
2	Zinc-65	1.10E+01	3.59E-01	1.10E+01	103%	97%
3	Cerium-141	4.97E+00	3.91E-01	4.67E+00	115%	98%
3	Cobalt-58	5.22E+00	2.81E-01	5.48E+00	100%	90%
3	Cobalt-60	7.37E+00	2.84E-01	7.54E+00	102%	94%
3	Chromium-51	1.43E+01	1.41E+00	1.32E+01	119%	98%
3	Cesium-134	7.01E+00	2.36E-01	7.32E+00	99%	92%
3	Cesium-137	6.54E+00	3.15E-01	6.43E+00	107%	97%

Quarter	Analyte	Bruce Power Value V_L (Bq/L)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/L)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
3	Iron-59	4.62E+00	2.60E-01	5.02E+00	97%	87%
3	Iodine-131	2.98E+00	3.84E-01	3.26E+00	103%	80%
3	Manganese-54	8.19E+00	3.87E-01	8.19E+00	105%	95%
3	Zinc-65	1.07E+01	7.89E-01	1.08E+01	106%	91%
4	Cerium-141	8.91E+00	6.23E-01	8.27E+00	115%	100%
4	Cobalt-58	8.32E+00	3.88E-01	8.48E+00	103%	94%
4	Cobalt-60	1.06E+01	3.35E-01	1.07E+01	102%	96%
4	Chromium-51	1.68E+01	1.70E+00	1.71E+01	108%	88%
4	Cesium-134	6.96E+00	2.24E-01	7.05E+00	102%	96%
4	Cesium-137	7.58E+00	3.53E-01	8.05E+00	99%	90%
4	Iron-59	7.62E+00	3.31E-01	7.29E+00	109%	100%
4	Iodine-131	4.00E+00	4.77E-01	3.56E+00	126%	99%
4	Manganese-54	9.62E+00	4.30E-01	9.29E+00	108%	99%
4	Zinc-65	1.15E+01	5.68E-01	1.12E+01	107%	97%

Table 99 - 2022 Eckert & Ziegler Analytics Test Results for Gamma in Soil

Quarter	Analyte	Bruce Power Value V_L (Bq/kg)	1 Standard Deviation (S_L)	Eckert & Ziegler Analytics Value V_A (Bq/kg)	$(V_L+S_L)/V_A$	$(V_L-S_L)/V_A$
1	Cerium-141	4.60E+00	2.26E-01	3.83E+00	126%	114%
1	Cobalt-58	8.88E+00	2.36E-01	9.71E+00	94%	89%
1	Cobalt-60	1.71E+01	2.88E-01	1.79E+01	97%	94%
1	Chromium-51	1.98E+01	9.61E-01	2.01E+01	103%	94%
1	Cesium-134	1.01E+01	2.31E-01	1.08E+01	95%	91%
1	Cesium-137	1.48E+01	3.57E-01	1.59E+01	95%	91%
1	Iron-59	1.01E+01	2.52E-01	1.09E+01	95%	90%
1	Manganese-54	9.19E+00	2.37E-01	9.73E+00	97%	92%
1	Zinc-65	1.37E+01	3.51E-01	1.46E+01	96%	91%
2	Cerium-141	7.51E+00	3.52E-01	7.22E+00	109%	99%
2	Cobalt-58	6.27E+00	2.06E-01	6.68E+00	97%	91%
2	Cobalt-60	1.20E+01	2.56E-01	1.26E+01	97%	93%
2	Chromium-51	1.76E+01	1.17E+00	1.79E+01	105%	92%
2	Cesium-134	8.61E+00	1.68E-01	8.93E+00	98%	95%
2	Cesium-137	1.24E+01	3.78E-01	1.33E+01	96%	90%
2	Iron-59	7.64E+00	2.20E-01	8.16E+00	96%	91%
2	Manganese-54	1.13E+01	3.59E-01	1.19E+01	98%	92%
2	Zinc-65	1.45E+01	4.33E-01	1.54E+01	97%	92%
3	Cerium-141	9.63E+00	6.22E-01	1.05E+01	98%	86%
3	Cobalt-58	1.04E+01	4.42E-01	1.24E+01	88%	81%
3	Cobalt-60	1.54E+01	4.66E-01	1.70E+01	93%	88%
3	Chromium-51	2.67E+01	1.97E+00	2.98E+01	96%	83%
3	Cesium-134	1.41E+01	3.52E-01	1.65E+01	87%	83%
3	Cesium-137	1.50E+01	6.66E-01	1.72E+01	91%	83%
3	Iron-59	9.84E+00	3.56E-01	1.13E+01	90%	84%
3	Manganese-54	1.63E+01	7.29E-01	1.85E+01	92%	84%

Quarter	**Analyte**	**Bruce Power Value V_L (Bq/kg)**	**1 Standard Deviation (S_L)**	**Eckert & Ziegler Analytics Value V_A (Bq/kg)**	**$(V_L+S_L)/V_A$**	**$(V_L-S_L)/V_A$**
3	Zinc-65	2.15E+01	9.72E-01	2.44E+01	92%	84%
4	Cerium-141	1.34E+01	8.42E-01	1.28E+01	111%	98%
4	Cobalt-58	1.24E+01	5.38E-01	1.31E+01	99%	91%
4	Cobalt-60	1.54E+01	4.49E-01	1.65E+01	96%	91%
4	Chromium-51	2.70E+01	1.94E+00	2.64E+01	110%	95%
4	Cesium-134	9.84E+00	2.60E-01	1.09E+01	93%	88%
4	Cesium-137	1.41E+01	6.30E-01	1.51E+01	98%	90%
4	Iron-59	1.08E+01	3.70E-01	1.13E+01	99%	92%
4	Manganese-54	1.40E+01	6.29E-01	1.43E+01	102%	93%
4	Zinc-65	1.66E+01	6.93E-01	1.74E+01	99%	91%

APPENDIX E: LAKE WATER QUALITY SAMPLE RESULTS

Where no value is provided for the screening criteria in Tables A1 and A2, it means that no criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

Dissolved oxygen is temperature dependent. For the purposes of this report, a temperature of 15°C was considered to derive the Provincial Water Quality Objective guideline of 6 mg/L.

Un-ionized ammonia (NH_3) is calculated from measurements of total ammonia (NH_3 + NH_4^+), temperature and pH according to [R-166]. Ammonia concentrations reported in mg/L NH_3 units were converted to mg/L NH_3-N units by multiplying by 0.82247.

Table 100 - The results of water quality samples taken from 1 m below the lake surface on July 6, 2022 from 5 long-term monitoring locations in Lake Huron. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Specific Conductivity	µS/cm	No value	Not applicable	260	350	420	280	240
pH	No unit	6.5 – 8.5	Provincial Water Quality Objective	8.61	8.49	8.47	8.37	8.49
Temperature	°C	No value	Not applicable	25.4	22.6	20.0	17.5	16.7
Dissolved Oxygen (DO)	mg/L	6	Provincial Water Quality Objective	9.95	10.2	9.19	10.3	9.71
Total Ammonia-N	µg/L	No value	Not applicable	885	922	862	600	570
Un-ionized ammonia (NH_3-N)	µg/L	15.6	Canadian Council of Ministers of the Environment	170	119	89.9	43.0	49.8
Total Phosphorous	µg/L	20	Provincial Water Quality Objective	3.0	4.7	6.5	2.0	5.4
Total Dissolved Solids	mg/L	No value	Not applicable	147	127	120	81	108
Hardness ($CaCO_3$)	mg/L	No value	Not applicable	92.6	96.3	95.8	92.6	94.1
Total Suspended Solids	mg/L	No value	Not applicable	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity (Total as $CaCO_3$)	mg/L	No value	Not applicable	79.9	81.0	81.7	81.6	81.4
Nitrite (NO_2^--N)	µg/L	60	Canadian Council of Ministers of the Environment	<0.010	<0.010	<0.010	<0.010	<0.010

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Chloride	mg/L	120	Canadian Council of Ministers of the Environment	7.91	8.00	7.92	7.81	7.83
Nitrate (NO_3^--N)	mg/L	2.93	Canadian Council of Ministers of the Environment	0.276	0.281	0.328	0.255	0.269
Sulphate (SO_4^{2-})	mg/L	No value	Not applicable	14.7	16.7	14.6	14.7	14.7
Fluoride	µg/L	120	Canadian Council of Ministers of the Environment	73	77	73	70	70
Total Aluminum	µg/L	75	Provincial Water Quality Objective	7.8	5.1	9.0	6.1	5.3
Total Antimony	µg/L	6	Canada Guidelines for Canadian Drinking Water Quality and Ontario Drinking Water Standards (O.Reg. 169/03)	0.10	0.11	0.11	0.11	0.11
Total Arsenic	µg/L	5	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.50	0.51	0.53	0.51	0.49
Total Barium	µg/L	1000	Ontario Drinking Water Standards (O.Reg. 169/03)	1.48	1.42	1.48	1.49	1.45
Total Boron	µg/L	200	Provincial Water Quality Objective	14	14	15	13	14
Total Cadmium	µg/L	0.15	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005	<0.005	<0.005

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Chromium III	µg/L	8.9	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium VI	µg/L	1	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50	<0.50	<0.50
Total Chromium	µg/L	50	Ontario Drinking Water Standards (O.Reg. 169/03) and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper	µg/L	2.21 to 2.29	Canadian Council of Ministers of the Environment	0.77	0.69	0.57	0.60	0.67
Total Iron	µg/L	300	Health Canada Guidelines for Canadian Drinking Water Quality	12	<10	10	<10	<10
Total Lead	µg/L	2.88 to 3.03	Canadian Council of Ministers of the Environment	0.095	0.155	<0.050	<0.050	<0.050
Total Mercury	µg/L	0.026	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005	<0.005	<0.005
Total Molybdenum	µg/L	No value	Not applicable	0.486	0.479	0.493	0.508	0.514
Total Nickel	µg/L	25	Provincial Water Quality Objective	0.71	<0.50	<0.50	<0.50	<0.50

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Total Selenium	µg/L	1	Canadian Council of Ministers of the Environment	0.107	0.118	0.107	0.096	0.102
Total Uranium	µg/L	5	Provincial Water Quality Objective	0.224	0.224	0.223	0.223	0.227
Total Vanadium	µg/L	6	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50
Total Zinc	µg/L	10.8 to 12.5	Canadian Council of Ministers of the Environment	<3.0	3.8	<3.0	<3.0	<3.0
F1 (C6-C10)	µg/L	No value	Not applicable	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	µg/L	No value	Not applicable	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	µg/L	No value	Not applicable	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	µg/L	No value	Not applicable	<250	<250	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	µg/L	No value	Not applicable	<250	<250	<250	<250	<250
Reached Baseline at C50	No unit	No value	Not applicable	Yes	Yes	Yes	Yes	Yes
Benzene	µg/L	1	Ontario Drinking Water Standards (O.Reg. 169/03)	<0.50	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	µg/L	8	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50
o-Xylene	µg/L	No value	Not applicable	<0.30	<0.30	<0.30	<0.30	<0.30
p+m-Xylene	µg/L	No value	Not applicable	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	µg/L	0.8	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Xylene (Total)	µg/L	2	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50
Morpholine	µg/L	4	Provincial Water Quality Objective	2.6	2.0	<1.0	<1.0	<1.0
Hydrazine	µg/L	26	Notice requiring the preparation and implementation of pollution prevention plans in respect of hydrazine related to the electricity sector, https://canadagazette.gc.ca/rp-pr/p1/2018/2018-11-10/html/sup1-eng.html.	Not analyzed	Not analyzed	Not analyzed	Not analyzed	Not analyzed
Phenol	µg/L	1	Provincial Water Quality Objective	1.3	1.3	<1.0	<1.0	<1.0

Table 101 - The results of water quality samples taken from 1 m below the lake surface on October 4, 2022 from 5 long-term monitoring locations in Lake Huron. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Specific Conductivity	µS/cm	No value	Not applicable	330	280	280	380	250	300
pH	No unit	6.5 – 8.5	Provincial Water Quality Objective	8.6	8.4	8.4	8.4	8.3	8.4
Temperature	°C	No value	Not applicable	26.2	23.2	23.2	18.4	15.0	15.4
Dissolved Oxygen (DO)	mg/L	6	Provincial Water Quality Objective	7.28	8.28	8.28	8.2	8.94	Not recorded
Total Ammonia-N	µg/L	No value	Not applicable	31.1	46.2	138	21.9	14.4	270
Un-ionized ammonia (NH_3-N)	µg/L	15.6	Canadian Council of Ministers of the Environment	5.68	5.37	16.0	1.86	0.667	16.0
Total Phosphorous	µg/L	20	Provincial Water Quality Objective	21.4	25.6	10.1	7.6	3.9	8
Total Dissolved Solids	mg/L	No value	Not applicable	125	114	119	117	120	113
Hardness ($CaCO_3$)	mg/L	No value	Not applicable	101	98.9	101	99.6	101	99.8
Total Suspended Solids	mg/L	No value	Not applicable	4.7	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity (Total as $CaCO_3$)	mg/L	No value	Not applicable	77.7	78.7	88.2	80.9	81.1	79.8

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Nitrite (NO_2^--N)	µg/L	60	Canadian Council of Ministers of the Environment	<10	<10	<10	<10	<10	<10
Chloride	mg/L	120	Canadian Council of Ministers of the Environment	11.8	9.97	11.9	10.2	11.6	11.6
Nitrate (NO_3^--N)	mg/L	2.93	Canadian Council of Ministers of the Environment	0.900	0.272	0.458	0.232	0.238	0.239
Sulphate (SO_4^{2-})	mg/L	No value	Not applicable	18.4	14.8	23.2	16.0	15.4	15.2
Fluoride	µg/L	120	Canadian Council of Ministers of the Environment	88	81	82	71	72	79
Total Aluminum	µg/L	75	Provincial Water Quality Objective	33.4	11.3	48.4	23.7	15.8	15.1

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Total Antimony	µg/L	6	Canada Guidelines for Canadian Drinking Water Quality and Ontario Drinking Water Standards (O.Reg. 169/03)	0.19	0.13	0.16	0.13	0.16	0.14
Total Arsenic	µg/L	5	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.59	0.55	0.57	0.55	0.58	0.51
Total Barium	µg/L	1000	Ontario Drinking Water Standards (O.Reg. 169/03)	1.70	1.58	1.71	1.60	1.67	1.63
Total Boron	µg/L	200	Provincial Water Quality Objective	15	14	16	15	16	16
Total Cadmium	µg/L	0.16	Canadian Council of Ministers of the Environment	0.0127	0.0094	0.0154	0.0094	0.0191	0.0119

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Chromium III	µg/L	8.9	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.58	0.67	0.56	<0.50	<0.50	<0.50
Chromium VI	µg/L	1	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.58	0.67	0.56	<0.50	<0.50	<0.50
Total Chromium	µg/L	50	Ontario Drinking Water Standards (O.Reg. 169/03) and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper	µg/L	2.34 to 2.38	Canadian Council of Ministers of the Environment	1.58	1.16	1.49	0.92	3.15	1.70

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Total Iron	µg/L	300	Health Canada Guidelines for Canadian Drinking Water Quality	60	15	63	36	19	20
Total Lead	µg/L	3.14 to 3.22	Canadian Council of Ministers of the Environment	10.5	0.216	4.49	1.93	0.328	0.244
Total Mercury	µg/L	0.026	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Molybdenum	µg/L	No value	Not applicable	0.52	0.56	0.52	0.51	0.54	0.53
Total Nickel	µg/L	25	Provincial Water Quality Objective	0.78	0.75	0.70	0.53	1.1	0.66
Total Selenium	µg/L	1	Canadian Council of Ministers of the Environment	0.11	0.11	0.12	0.11	0.11	0.10
Total Uranium	µg/L	5	Provincial Water Quality Objective	0.25	0.25	0.25	0.25	0.25	0.26
Total Vanadium	µg/L	6	Provincial Water Quality Objective Not applicable	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Total Zinc	µg/L	11.3 to 13.0	Canadian Council of Ministers of the Environment	13.9	5.2	19.8	7.8	13.1	7.0
F1 (C6-C10)	µg/L	No value	Not applicable	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	µg/L	No value	Not applicable	<25	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	µg/L	No value	Not applicable	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	µg/L	No value	Not applicable	<250	<250	<250	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	µg/L	No value	Not applicable	<250	<250	<250	<250	<250	<250
Reached Baseline at C50	No unit	No value	Not applicable	Yes	Yes	Yes	Yes	Yes	Yes
Benzene	µg/L	1	Ontario Drinking Water Standards (O.Reg. 169/03)	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	µg/L	8	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
o-Xylene	µg/L	No value	Not applicable	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
p+m-Xylene	µg/L	No value	Not applicable	0.47	<0.40	<0.40	<0.40	<0.40	<0.40
Toluene	µg/L	0.8	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	µg/L	2	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Morpholine	µg/L	4	Provincial Water Quality Objective	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Parameter	Unit	Lowest Screening Criteria Value	Source of Screening Criteria	Bruce A Discharge LWQ1	Bruce B Discharge LWQ2	Bruce B Discharge LWQ2 (duplicate)	Baie du Doré LWQ5	North Reference Location LWQ7	South Reference Location LWQ8
Hydrazine	µg/L	26	Notice requiring the preparation and implementation of pollution prevention plans in respect of hydrazine related to the electricity sector, https://canadagazette.gc.ca/rp-pr/p1/2018/2018-11-10/html/sup1-eng.html.	1.0	0.9	Not analyzed	1.3	7.1	0.8
Phenol	µg/L	1	Provincial Water Quality Objective	3.1	4.5	4.9	2.2	<1.0	1.8

Table 102 - The range and number of water quality measurements taken from 5 long-term monitoring locations in Lake Huron between 2017 and 2022.

Parameter	Unit	Historical Trend (2017 to 2022) Range (min to max)	Historical Trend (2017 to 2022) Number of observations	Historical Trend (2017 to 2022) Number of exceedances (if applicable)
Specific Conductivity	µS/cm	188 to 615	40	Not applicable
pH	No unit	7.5 to 9.0	57	8
Temperature	°C	1.8 to 31.0	57	Not applicable
Dissolved Oxygen (DO)	mg/L	6.7 to 19.0	51	0
Total Ammonia-N	µg/L	<10 to 922	76	Not applicable
Un-ionized ammonia (NH_3-N)	µg/L	<Detect to 305	76	15
Total Phosphorous	µg/L	3.3 to 28.0	71	5
Total Dissolved Solids	mg/L	30 to 216	68	Not applicable
Hardness ($CaCO_3$)	mg/L	90 to 101	58	Not applicable
Total Suspended Solids	mg/L	<1.0 to 4.7	71	Not applicable
Alkalinity (Total as $CaCO_3$)	mg/L	78.0 to 88.2	68	Not applicable
Nitrite (NO_2^--N)	µg/L	<10 to <50	71	0
Chloride	mg/L	6.5 to 11.9	68	0
Nitrate (NO_3^--N)	mg/L	0.2 to 0.9	68	0
Sulphate (SO_4^{2-})	mg/L	13.0 to 23.2	68	Not applicable
Fluoride	µg/L	<100 to 150	68	2
Total Aluminum	µg/L	<5.0 to 62.0	71	0
Total Antimony	µg/L	0.10 to 0.19	11	0
Total Arsenic	µg/L	0.49 to 0.59	71	0
Total Barium	µg/L	1.42 to 1.71	11	0
Total Boron	µg/L	11.00 to 21.00	71	0
Total Cadmium	µg/L	<0.005 to 0.02	71	0
Chromium III	µg/L	<5.0 to 0.6	17	0
Chromium VI	µg/L	<0.5 to 0.6	68	0

Parameter	Unit	Historical Trend (2017 to 2022) Range (min to max)	Historical Trend (2017 to 2022) Number of observations	Historical Trend (2017 to 2022) Number of exceedances (if applicable)
Total Chromium	µg/L	<0.5 to 0.7	71	0
Total Copper	µg/L	<0.9 to 3.2	71	1
Total Iron	µg/L	<10 to 63	71	0
Total Lead	µg/L	<0.05 to 10.5	71	2
Total Mercury	µg/L	<0.005	71	0
Total Molybdenum	µg/L	0.48 to 0.56	11	Not applicable
Total Nickel	µg/L	<0.5 to 6.8	71	0
Total Selenium	µg/L	0.10 to 0.12	11	0
Total Uranium	µg/L	0.22 to 0.26	11	0
Total Vanadium	µg/L	<0.5	11	0
Total Zinc	µg/L	<0.2 to 130	71	9
F1 (C6-C10)	µg/L	<25	68	Not applicable
F1 (C6-C10) - BTEX	µg/L	<25	68	Not applicable
F2 (C10-C16 Hydrocarbons)	µg/L	<100	68	Not applicable
F3 (C16-C34 Hydrocarbons)	µg/L	<250	68	Not applicable
F4 (C34-C50 Hydrocarbons)	µg/L	<250	68	Not applicable
Reached Baseline at C50	No unit	Not applicable	68	Not applicable
Benzene	µg/L	<0.20	68	0
Ethylbenzene	µg/L	<0.20	68	0
o-Xylene	µg/L	<0.20	68	Not applicable
p+m-Xylene	µg/L	<0.40	68	Not applicable
Toluene	µg/L	<0.20	68	0
Xylene (Total)	µg/L	<0.40	68	0
Morpholine	µg/L	<1.0 to 2.6	63	0
Hydrazine	µg/L	<0.2 to 7.1	55	0
Phenol	µg/L	<1.0 to 4.9	17	0

APPENDIX F: ON-SITE SURFACE WATER SAMPLE RESULTS

Where no value is provided for the screening criteria in Tables B1 to B11, it means that no criteria are available to assess risk to receptors; often because the parameter is not associated with acute or chronic toxicity.

Dissolved oxygen is temperature dependent. For the purposes of this report, a temperature of 15°C was considered to derive the Provincial Water Quality Objective guideline of 6 mg/L.

Un-ionized ammonia (NH_3) is calculated from measurements of total ammonia (NH_3 + NH_4^+), temperature and pH according to [R-166]. Ammonia concentrations reported in mg/L NH_3 units were converted to mg/L NH_3-N units by multiplying by 0.82247.

Table 103 - The results of surface water quality samples taken in 2022 from Stream C – Upstream (Background) SW1. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Upstream (Background) SW1 17-Mar-22	Stream C – Upstream (Background) SW1 9-May-22	Stream C – Upstream (Background) SW1 7-Jul-22	Stream C – Upstream (Background) SW1 17-Aug-22	Stream C – Upstream (Background) SW1 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	401	402	543	233	220
pH	6.5-8.5	No unit	Provincial Water Quality Objective	8.3	8.4	8.4	8.3	8.5
Temperature	No value	°C	Not applicable	1.1	8.7	7.1	8.9	8.0
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	11.7	8.7	7.1	8.9	8.5
Total Ammonia-N	No value	µg/L	Not applicable	56.0	21.6	121.0	72.9	35.9
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	46.1	17.8	99.5	60.0	29.5
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	96.4	15.1	28.4	29.0	17.0
Total Dissolved Solids	No value	mg/L	Not applicable	198.0	282.0	290.0	311.0	313.0
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	179.0	260.0	278.0	315.0	286.0

Parameter	Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Upstream (Background) SW1 17-Mar-22	Stream C – Upstream (Background) SW1 9-May-22	Stream C – Upstream (Background) SW1 7-Jul-22	Stream C – Upstream (Background) SW1 17-Aug-22	Stream C – Upstream (Background) SW1 9-Nov-22
Dissolved Organic Carbon	No value	mg/L	Not applicable	4.1	4.2	5.9	6.3	4.2
Total Suspended Solids	No value	mg/L	Not applicable	33.6	5.0	14.0	3.9	3.7
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	158.0	259.0	250.0	298.0	282.0
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<10	<10	<10	<10
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	20.7	Not analyzed	30.4	18.3	21.5
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	1.1	<0.020	0.0	0.8	0.2
Sulphate (SO_4^{2-})	No value	mg/L	Not applicable	5.1	4.2	4.2	1.8	4.0
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	165.0	283.0	30.7	325.0	257.0
Total Aluminum	75	µg/L	Provincial Water Quality Objective	2230	93.0	14.3	37.0	36.6
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.10	<0.10	<0.10	<0.10	<0.10

Parameter	Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Upstream (Background) SW1 17-Mar-22	Stream C – Upstream (Background) SW1 9-May-22	Stream C – Upstream (Background) SW1 7-Jul-22	Stream C – Upstream (Background) SW1 17-Aug-22	Stream C – Upstream (Background) SW1 9-Nov-22
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.7	0.3	0.5	0.6	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	22.7	17.0	1.8	15.4	15.3
Total Boron	200	µg/L	Provincial Water Quality Objective	11.0	130.0	16.0	14.0	12.0
Total Cadmium	0.26	µg/L	Canadian Council of Ministers of the Environment	0.03	0.01	0.01	<0.005	<0.005
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	3.6	<0.5	0.7	<0.5	<0.50
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	<0.5	0.7	<0.5	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.5	<0.5	<0.5	<0.5	<0.50
Total Copper	3.89	µg/L	Canadian Council of Ministers of the Environment	2.9	<0.5	1.9	0.9	<0.50
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	2540	461	438	562	429

Parameter	Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Upstream (Background) SW1 17-Mar-22	Stream C – Upstream (Background) SW1 9-May-22	Stream C – Upstream (Background) SW1 7-Jul-22	Stream C – Upstream (Background) SW1 17-Aug-22	Stream C – Upstream (Background) SW1 9-Nov-22
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	1.0	0.1	0.3	0.1	0.1
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.3	0.2	0.2	0.1	0.1
Total Nickel	25	µg/L	Provincial Water Quality Objective	3.0	<0.5	0.9	<0.5	<0.50
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.1	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.5	0.5	0.4	0.2	0.4
Total Vanadium	6	µg/L	Provincial Water Quality Objective	3.8	<0.5	0.7	<0.5	<0.50
Total Zinc	20	µg/L	Provincial Water Quality Objective	8.4	<3.0	9.7	<3.0	<3.0
F1 (C6-C10)	No value	µg/L	Not applicable	Not analyzed	<25	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	Not analyzed	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250	<250	<250

Parameter	Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Upstream (Background) SW1 17-Mar-22	Stream C – Upstream (Background) SW1 9-May-22	Stream C – Upstream (Background) SW1 7-Jul-22	Stream C – Upstream (Background) SW1 17-Aug-22	Stream C – Upstream (Background) SW1 9-Nov-22
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	Not analyzed	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	Not analyzed	<0.50	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	Not analyzed	<0.30	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	Not analyzed	<0.40	<0.4	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	Not analyzed	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	Not analyzed	<0.50	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	<1.0	<1.0	13.2	<1.0

Table 104 - The results of surface water quality samples taken in 2022 from Stream C – Downstream SW2. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Downstream SW2 17-Mar-22	Stream C – Downstream SW2 9-May-22	Stream C – Downstream SW2 7-Jul-22	Stream C – Downstream SW2 17-Aug-22	Stream C – Downstream SW2 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	658	591	645	551	259
pH	6.5-8.5	No unit	Provincial Water Quality Objective	8.2	8.4	8.3	8.7	8.4
Temperature	No value	°C	Not applicable	1.5	8.7	8.7	8.2	5.0
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	14.2	8.7	8.7	8.2	9.6
Total Ammonia-N	No value	µg/L	Not applicable	82.0	26.7	236	191	46.6
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	1.2	1.1	8.0	13.7	1.3
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	42.0	6.2	42.6	23.4	17.8
Total Dissolved Solids	No value	mg/L	Not applicable	294	286	270	318	336
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	202	259	291	300	283
Dissolved Organic Carbon	No value	mg/L	Not applicable	4.1	5.6	5.9	6.4	5.2

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Downstream SW2 17-Mar-22	Stream C – Downstream SW2 9-May-22	Stream C – Downstream SW2 7-Jul-22	Stream C – Downstream SW2 17-Aug-22	Stream C – Downstream SW2 9-Nov-22
Total Suspended Solids	No value	mg/L	Not applicable	18.2	<3.0	12.2	13.3	5.7
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	191	252	281	287	268
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<10	<10	<10	<10
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	55.1	Not analyzed	13.4	27.2	29.9
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.8	<0.084	<0.020	0.03	0.1
Sulphate (SO_4^{2-})	No value	mg/L	Not applicable	7.9	5.6	2.8	4.3	6.8
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	214	289	29.3	310	242
Total Aluminum	75	µg/L	Provincial Water Quality Objective	957	44.8	11.0	101	7.7
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.1	<0.10	<0.10	<0.10	<0.10
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.4	0.3	0.6	0.5	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	16.7	15.5	1.7	16.2	16.1
Total Boron	200	µg/L	Provincial Water Quality Objective	14	14	16	15	14

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Downstream SW2 17-Mar-22	Stream C – Downstream SW2 9-May-22	Stream C – Downstream SW2 7-Jul-22	Stream C – Downstream SW2 17-Aug-22	Stream C – Downstream SW2 9-Nov-22
Total Cadmium	0.28	µg/L	Canadian Council of Ministers of the Environment	0.0148	<0.005	0.0123	0.0067	0.0062
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50	<0.50	<0.50
Total Copper	4	µg/L	Canadian Council of Ministers of the Environment	1.7	0.5	2.0	1.5	1.1
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	1060	127	986	292	283
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.4	0.1	0.2	0.2	0.1
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.3	0.3	0.1	0.2	0.2
Total Nickel	25	µg/L	Provincial Water Quality Objective	1.5	<0.5	0.6	0.6	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Downstream SW2 17-Mar-22	Stream C – Downstream SW2 9-May-22	Stream C – Downstream SW2 7-Jul-22	Stream C – Downstream SW2 17-Aug-22	Stream C – Downstream SW2 9-Nov-22
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.1	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.6	0.6	0.2	0.4	0.5
Total Vanadium	6	µg/L	Provincial Water Quality Objective	1.7	<0.5	0.5	0.7	<0.50
Total Zinc	20	µg/L	Provincial Water Quality Objective	10.4	<3.0	11.5	4.7	3.2
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	0.50	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	0.81	<0.50	<0.50	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Stream C – Downstream SW2 17-Mar-22	Stream C – Downstream SW2 9-May-22	Stream C – Downstream SW2 7-Jul-22	Stream C – Downstream SW2 17-Aug-22	Stream C – Downstream SW2 9-Nov-22
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	<1.0	<1.0	21.9	1.3

Table 105 - The results of surface water quality samples taken in 2022 from the Eastern Drainage Ditch SW3. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Eastern Drainage Ditch SW3 17-Mar-22	Eastern Drainage Ditch SW3 17-Aug-22	Eastern Drainage Ditch SW3 9-Nov-22
Specific Conductivity	No value	μS/cm	Not applicable	293	516	1000
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.1	8.3	8.8
Temperature	No value	°C	Not applicable	5.0	6.8	10.0
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	8.1	6.8	9.1
Total Ammonia-N	No value	μg/L	Not applicable	107	165	898
Un-ionized ammonia (NH_3-N)	15.6	μg/L	Canadian Council of Ministers of the Environment	1.7	4.1	86.7
Total Phosphorous	20	μg/L	Provincial Water Quality Objective	18.7	9.4	10.2
Total Dissolved Solids	No value	mg/L	Not applicable	996	999	922
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	346	242	296
Dissolved Organic Carbon	No value	mg/L	Not applicable	4.8	5.6	4.5
Total Suspended Solids	No value	mg/L	Not applicable	27.0	4.3	23.1
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	216	190	257
Nitrite (NO_2^--N)	60	μg/L	Canadian Council of Ministers of the Environment	<50	<50	<50
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	728	538	454

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Eastern Drainage Ditch SW3 17-Mar-22	Eastern Drainage Ditch SW3 17-Aug-22	Eastern Drainage Ditch SW3 9-Nov-22
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.3	<0.1	0.1
Sulphate (SO_4^{2-})	No value	mg/L		25.9	19.4	23.7
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	370	332	456
Total Aluminum	75	µg/L	Provincial Water Quality Objective	272	<30.0	7.2
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<1.0	<0.1	0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<1.0	<0.1	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	54.3	59.7	58.8
Total Boron	200	µg/L	Provincial Water Quality Objective	<100	<100	38.0
Total Cadmium	0.37	µg/L	Canadian Council of Ministers of the Environment	<0.05	<0.005	0.008
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<5.0	<0.50	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Eastern Drainage Ditch SW3 17-Mar-22	Eastern Drainage Ditch SW3 17-Aug-22	Eastern Drainage Ditch SW3 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Total Copper	4	µg/L	Canadian Council of Ministers of the Environment	<5.0	<5.0	1.1
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	540	126	50
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	<0.5	<0.5	0.2
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.8	1.4	1.5
Total Nickel	25	µg/L	Provincial Water Quality Objective	<5.0	<5.0	1.2
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	<0.5	<0.5	0.2
Total Uranium	5	µg/L	Provincial Water Quality Objective	1.3	1.7	2.0
Total Vanadium	6	µg/L	Provincial Water Quality Objective	16.2	<5.0	5.0

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Eastern Drainage Ditch SW3 17-Mar-22	Eastern Drainage Ditch SW3 17-Aug-22	Eastern Drainage Ditch SW3 9-Nov-22
Total Zinc	20	µg/L	Provincial Water Quality Objective	38.0	<30.0	10.7
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	<5.0	<1.0

Table 106 - The results of surface water quality samples taken in 2022 from the Heavy Water Lands Drainage SW4. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Heavy Water Lands Drainage SW4 17-Mar-22	Heavy Water Lands Drainage SW4 17-Aug-22	Heavy Water Lands Drainage SW4 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	1320	1990	897
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.2	8.3	8.7
Temperature	No value	°C	Not applicable	6.2	8.3	11.1
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	8.7	8.3	8.6
Total Ammonia-N	No value	µg/L	Not applicable	1120	20.7	41.0
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	21.3	0.6	3.6
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	10.9	12.2	3.6
Total Dissolved Solids	No value	mg/L	Not applicable	571	910	798
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	176	286	288
Dissolved Organic Carbon	No value	mg/L	Not applicable	2.0	3.2	2.2
Total Suspended Solids	No value	mg/L	Not applicable	15.4	10.1	3.1
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	131	237	249

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Heavy Water Lands Drainage SW4 17-Mar-22	Heavy Water Lands Drainage SW4 17-Aug-22	Heavy Water Lands Drainage SW4 9-Nov-22
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<50	<50	<50
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	311	469	332
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.3	<0.1	0.2
Sulphate (SO_4^{2-})	No value	mg/L		20.0	44.2	39.0
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	700	1120	1260
Total Aluminum	75	µg/L	Provincial Water Quality Objective	255	76.4	1.98
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.2	<0.1	0.2
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.3	<0.1	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	42.1	86.7	81.4
Total Boron	200	µg/L	Provincial Water Quality Objective	55.0	130	166
Total Cadmium	0.25	µg/L	Canadian Council of Ministers of the Environment	0.018	<0.005	0.009
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.9	<0.50	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Heavy Water Lands Drainage SW4 17-Mar-22	Heavy Water Lands Drainage SW4 17-Aug-22	Heavy Water Lands Drainage SW4 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Total Copper	3.83	µg/L	Canadian Council of Ministers of the Environment	1.7	<5.0	1.0
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	302	183	34.0
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.4	<0.5	<0.050
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	2.3	3.6	4.9
Total Nickel	25	µg/L	Provincial Water Quality Objective	1.2	<5.0	0.8
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.4	0.5	0.6
Total Uranium	5	µg/L	Provincial Water Quality Objective	2.6	4.4	5.2
Total Vanadium	6	µg/L	Provincial Water Quality Objective	0.9	<5.0	0.6
Total Zinc	20	µg/L	Provincial Water Quality Objective	16.7	<30.0	7.6

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Heavy Water Lands Drainage SW4 17-Mar-22	Heavy Water Lands Drainage SW4 17-Aug-22	Heavy Water Lands Drainage SW4 9-Nov-22
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	1.3	2.1

Table 107 - The results of surface water quality samples taken in 2022 from SW5. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW5 17-Mar-22	SW5 17-Aug-22	SW5 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	1250	1480	680
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.2	8.5	8.8
Temperature	No value	°C	Not applicable	2.8	4.3	12.0
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	11.0	4.3	8.2
Total Ammonia-N	No value	µg/L	Not applicable	97.0	954.0	153.0
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	1.4	32.8	18.4
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	12.3	22.9	19.2
Total Dissolved Solids	No value	mg/L	Not applicable	510	633	817
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	157	182	262
Dissolved Organic Carbon	No value	mg/L	Not applicable	2.5	8.4	5.7
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	6.1	5.1
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	127	140	187
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<50	<50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW5 17-Mar-22	SW5 17-Aug-22	SW5 9-Nov-22
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	249	316	398
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.4	<0.1	<0.1
Sulphate (SO_4^{2-})	No value	mg/L		21.0	24.4	44.1
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	420	735	782
Total Aluminum	75	µg/L	Provincial Water Quality Objective	147	84.9	110
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.1	0.2	<0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.2	1.1	0.4
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	25.8	51.2	65.3
Total Boron	200	µg/L	Provincial Water Quality Objective	<10	27	15
Total Cadmium	0.23	µg/L	Canadian Council of Ministers of the Environment	0.01	<0.005	0.007
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.6	<0.5	<0.5

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW5 17-Mar-22	SW5 17-Aug-22	SW5 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	<0.5	<0.5
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.5	<0.5	<0.5
Total Copper	3.48	µg/L	Canadian Council of Ministers of the Environment	1.4	1.0	2.6
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	163	276	130
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.2	0.1	0.1
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.9	1.2	1.5
Total Nickel	25	µg/L	Provincial Water Quality Objective	0.6	0.9	1.0
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.7	0.4	1.5
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.5	0.8	<0.5
Total Zinc	20	µg/L	Provincial Water Quality Objective	27.8	4.2	12.7

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW5 17-Mar-22	SW5 17-Aug-22	SW5 9-Nov-22
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	1.7	2.8

Table 108 - The results of surface water quality samples taken in 2022 from SW6. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW6 17-Mar-22	SW6 17-Aug-22	SW6 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	756	1290	484
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.2	8.4	8.6
Temperature	No value	°C	Not applicable	6.8	5.6	8.5
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	10.7	5.6	11.2
Total Ammonia-N	No value	µg/L	Not applicable	64.0	38.2	77.9
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	1.3	1.3	4.7
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	5.4	17.4	6.9
Total Dissolved Solids	No value	mg/L	Not applicable	348	580	429
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	204	261	294
Dissolved Organic Carbon	No value	mg/L	Not applicable	2.8	6.2	3.8
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	9.1	4.6
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	182	199	246
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<50	<10

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW6 17-Mar-22	SW6 17-Aug-22	SW6 9-Nov-22
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	100	217	63.1
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.2	<0.1	<0.02
Sulphate (SO_4^{2-})	No value	mg/L		17.6	48.4	38.4
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	637	851	929
Total Aluminum	75	µg/L	Provincial Water Quality Objective	73.1	54.4	20.3
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.1	0.1	0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.2	0.5	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	21.6	53.6	31.4
Total Boron	200	µg/L	Provincial Water Quality Objective	<10.0	43.0	17.0
Total Cadmium	0.29	µg/L	Canadian Council of Ministers of the Environment	0.008	<0.005	<0.005
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	2.7	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW6 17-Mar-22	SW6 17-Aug-22	SW6 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	2.7	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Total Copper	4	µg/L	Canadian Council of Ministers of the Environment	0.8	1.0	0.8
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	78.0	212	79.0
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.1	0.1	0.7
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.8	1.4	1.2
Total Nickel	25	µg/L	Provincial Water Quality Objective	0.5	0.7	<0.50
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.2	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	1.1	0.7	1.8
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.5	0.5	<0.5
Total Zinc	20	µg/L	Provincial Water Quality Objective	16.3	5.6	5.9

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW6 17-Mar-22	SW6 17-Aug-22	SW6 9-Nov-22
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	2.4	2.5

Table 109 - The results of surface water quality samples taken in 2022 from SW7. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW7 17-Mar-22	SW7 17-Aug-22	SW7 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	1440	1850	420
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.0	8.1	8.8
Temperature	No value	°C	Not applicable	4.0	7.2	8.0
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	9.1	7.2	9.9
Total Ammonia-N	No value	µg/L	Not applicable	107	67.2	60.5
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	1.3	1.2	5.4
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	5.8	10.4	3.7
Total Dissolved Solids	No value	mg/L	Not applicable	648	857	820
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	268	273	338
Dissolved Organic Carbon	No value	mg/L	Not applicable	4.6	7.6	5.9
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	6.9	<3.0
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	242	204	293
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<50	<50	<50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW7 17-Mar-22	SW7 17-Aug-22	SW7 9-Nov-22
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	282	431	322
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.2	<0.1	<0.100
Sulphate (SO_4^{2-})	No value	mg/L		17.4	12.8	27.7
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	270	449	659
Total Aluminum	75	µg/L	Provincial Water Quality Objective	22.7	19.0	12.7
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.1	<0.1	0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.2	0.3	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	19.8	40.0	36.6
Total Boron	200	µg/L	Provincial Water Quality Objective	38.0	28.0	40.0
Total Cadmium	0.36	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW7 17-Mar-22	SW7 17-Aug-22	SW7 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Total Copper	4	µg/L	Canadian Council of Ministers of the Environment	0.5	0.5	0.7
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	81.0	669	247
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.1	<0.05	<0.05
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.4	0.4	0.6
Total Nickel	25	µg/L	Provincial Water Quality Objective	<0.5	0.9	0.7
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.4	0.2	0.9
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.5	<0.5	<0.5
Total Zinc	20	µg/L	Provincial Water Quality Objective	<3.0	20.0	17.3

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW7 17-Mar-22	SW7 17-Aug-22	SW7 9-Nov-22
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	1.7	1.9

Table 110 - The results of surface water quality samples taken in 2022 from SW8. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW8 17-Mar-22	SW8 17-Aug-22	SW8 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	2120	430	1710
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.1	8.6	8.6
Temperature	No value	°C	Not applicable	1.6	10.6	7.5
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	8.8	10.6	9.0
Total Ammonia-N	No value	µg/L	Not applicable	134	265	90.3
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	1.5	20.8	5.6
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	6.5	41.8	7.4
Total Dissolved Solids	No value	mg/L	Not applicable	953	492	820
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	229	232	340
Dissolved Organic Carbon	No value	mg/L	Not applicable	3.7	5.9	5.8
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	50.7	5.7
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	181	205	259
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<50	10.0	<50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW8 17-Mar-22	SW8 17-Aug-22	SW8 9-Nov-22
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	484	184	310
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.3	0.3	0.3
Sulphate (SO_4^{2-})	No value	mg/L		23.4	16.4	24.9
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	270	885	616
Total Aluminum	75	µg/L	Provincial Water Quality Objective	70.1	338	39.3
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.1	0.2	0.3
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.2	0.7	0.3
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	23.3	31.8	35.3
Total Boron	200	µg/L	Provincial Water Quality Objective	22.0	29.0	38.0
Total Cadmium	0.32	µg/L	Canadian Council of Ministers of the Environment	0.01	0.05	0.001
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	0.90	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW8 17-Mar-22	SW8 17-Aug-22	SW8 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	0.90	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Total Copper	4	µg/L	Canadian Council of Ministers of the Environment	0.8	2.2	2.4
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	97.0	1070	304
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.1	0.5	0.1
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.5	0.9	0.5
Total Nickel	25	µg/L	Provincial Water Quality Objective	0.5	1.4	0.8
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.5	0.3	0.8
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.50	1.3	<0.50
Total Zinc	20	µg/L	Provincial Water Quality Objective	15.6	32.0	17.2

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	SW8 17-Mar-22	SW8 17-Aug-22	SW8 9-Nov-22
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<25	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	1.8	1.3

Table 111 - The results of surface water quality samples taken in 2022 from the Former Sewage Lagoon. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Former Sewage Lagoon 07-Apr-22	Former Sewage Lagoon 17-Aug-22	Former Sewage Lagoon 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	266	166	1020
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.6	9.9	8.7
Temperature	No value	°C	Not applicable	9.1	8.5	9.0
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	9.1	9.0	8.5
Total Ammonia-N	No value	µg/L	Not applicable	247	92.3	68.5
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	15.2	50.8	4.9
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	16.3	48.4	19.6
Total Dissolved Solids	No value	mg/L	Not applicable	143	60.0	123
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	122	60.7	103
Dissolved Organic Carbon	No value	mg/L	Not applicable	5.9	11.9	8.9
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	21.2	<3.0
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	133	51.7	107

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Former Sewage Lagoon 07-Apr-22	Former Sewage Lagoon 17-Aug-22	Former Sewage Lagoon 9-Nov-22
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<200	<10
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	1.08	<10.0	1.6
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	0.073	<0.400	<0.020
Sulphate (SO_4^{2-})	No value	mg/L		<0.30	<6.00	<0.30
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	310	<400	393
Total Aluminum	75	µg/L	Provincial Water Quality Objective	28.8	79.4	56.6
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.3	0.4	0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.3	0.6	0.5
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	13.9	11.3	15.3
Total Boron	200	µg/L	Provincial Water Quality Objective	<10	<10	<10
Total Cadmium	0.1	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Former Sewage Lagoon 07-Apr-22	Former Sewage Lagoon 17-Aug-22	Former Sewage Lagoon 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Total Copper	2	µg/L	Canadian Council of Ministers of the Environment and Site Specific Target Level	0.6	<0.5	<0.5
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	29.0	51.0	27.0
Total Lead	1.69	µg/L	Canadian Council of Ministers of the Environment	0.1	<0.05	<0.050
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.3	0.4	0.4
Total Nickel	25	µg/L	Provincial Water Quality Objective	<0.5	<0.5	<0.50
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	<0.05	0.1	<0.05
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.2	0.1	0.1
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.5	<0.5	<0.50
Total Zinc	4.18	µg/L	Canadian Council of Ministers of the Environment	<3.0	<3.0	<3.0

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	Former Sewage Lagoon 07-Apr-22	Former Sewage Lagoon 17-Aug-22	Former Sewage Lagoon 9-Nov-22
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<100	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	280.0	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	1.5	1.5

Table 112 - The results of surface water quality samples taken in 2022 from the B31 Pond. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B31 Pond 07-Apr-22	B31 Pond 17-Aug-22	B31 Pond 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	777	486	625
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.5	8.4	8.7
Temperature	No value	°C	Not applicable	8.1	9.0	7.4
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	8.1	6.9	9.0
Total Ammonia-N	No value	µg/L	Not applicable	119	47.2	532
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	5.2	1.8	34.5
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	13.0	40.8	10.5
Total Dissolved Solids	No value	mg/L	Not applicable	361	224	301
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	213	108	162
Dissolved Organic Carbon	No value	mg/L	Not applicable	3.3	12.4	3.8
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	27.6	3.9
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	186	84.9	141
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<10	<10

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B31 Pond 07-Apr-22	B31 Pond 17-Aug-22	B31 Pond 9-Nov-22
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	110	69.6	74.0
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	<0.020	<0.020	0.5
Sulphate (SO_4^{2-})	No value	mg/L		12	16.1	16.4
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	307	338	279
Total Aluminum	75	µg/L	Provincial Water Quality Objective	24.1	64.2	19.3
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	0.1	0.2	0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.2	0.6	0.4
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	19.7	22.8	21.0
Total Boron	200	µg/L	Provincial Water Quality Objective	27.0	125.0	43.0
Total Cadmium	0.17	µg/L	Canadian Council of Ministers of the Environment	0.008	<0.005	<0.005
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	0.80

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B31 Pond 07-Apr-22	B31 Pond 17-Aug-22	B31 Pond 9-Nov-22
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	0.8
Total Copper	2	µg/L	Site Specific Target Level	1.7	2.0	1.9
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	44.0	146	98.0
Total Lead	3.51	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.7
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.5	0.4	0.9
Total Nickel	25	µg/L	Provincial Water Quality Objective	<0.5	<0.5	<0.5
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	0.1	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.9	0.2	0.7
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.5	0.7	0.6
Total Zinc	17.9	µg/L	Canadian Council of Ministers of the Environment	4.4	3.4	6.0
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<100	<25	<25

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B31 Pond 07-Apr-22	B31 Pond 17-Aug-22	B31 Pond 9-Nov-22
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	<1.0	<1.0

Table 113 - The results of surface water quality samples taken in 2022 from the B16 Pond. Screening criteria chosen are the most conservative available. The screening criteria for aluminum varies and is calculated on a per sample basis using pH measured at the time of sampling event. The screening criteria for total cadmium, total copper, total lead and total nickel vary with hardness and are calculated on a per sample basis using hardness measured at the time of sampling event. The screening criteria for zinc varies and is calculated on a per sample basis using hardness, pH and Dissolved Organic Carbon measured at time of sampling event.

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B16 Pond 07-Apr-22	B16 Pond Duplicate 07-Apr-22	B16 Pond 17-Aug-22	B16 Pond 9-Nov-22
Specific Conductivity	No value	µS/cm	Not applicable	1570	1600	1730	890
pH	6.5-8.5	No units	Provincial Water Quality Objective	8.3	8.3	8.4	8.7
Temperature	No value	°C	Not applicable	10.0	10.0	6.9	8.5
Dissolved Oxygen	6	mg/L	Provincial Water Quality Objective	10.0	10.0	8.5	8.9
Total Ammonia-N	No value	µg/L	Not applicable	92.1	159.0	45.3	153
Un-ionized ammonia (NH_3-N)	15.6	µg/L	Canadian Council of Ministers of the Environment	3.5	6.1	1.7	11.0
Total Phosphorous	20	µg/L	Provincial Water Quality Objective	12.7	12.9	29.4	12.3
Total Dissolved Solids	No value	mg/L	Not applicable	536	533	783	601
Hardness ($CaCO_3$)	No value	mg/L	Not applicable	195	194	246	219
Dissolved Organic Carbon	No value	mg/L	Not applicable	4.5	4.7	18.2	10.2
Total Suspended Solids	No value	mg/L	Not applicable	<3.0	<3.0	12.3	3.5
Alkalinity (Total as $CaCO_3$)	No value	mg/L	Not applicable	166	160	169	179

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B16 Pond 07-Apr-22	B16 Pond Duplicate 07-Apr-22	B16 Pond 17-Aug-22	B16 Pond 9-Nov-22
Nitrite (NO_2^--N)	60	µg/L	Canadian Council of Ministers of the Environment	<10	<10	<50	<50
Chloride	120	mg/L	Canadian Council of Ministers of the Environment	235	237	430	292
Nitrate (NO_3^--N)	2.93	mg/L	Canadian Council of Ministers of the Environment	<0.020	0.45	<0.10	<0.10
Sulphate (SO_4^{2-})	No value	mg/L		7.62	7.8	<1.50	7.9
Fluoride	120	µg/L	Canadian Council of Ministers of the Environment	195	208	338	302
Total Aluminum	75	µg/L	Provincial Water Quality Objective	45.9	47.2	45.6	14.7
Total Antimony	6	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.1	<0.1	<0.1	0.1
Total Arsenic	5	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	0.2	0.2	0.6	0.4
Total Barium	1000	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	14.1	14.1	26.6	22.9
Total Boron	200	µg/L	Provincial Water Quality Objective	<10	<10	17.0	12.0
Total Cadmium	0.27	µg/L	Canadian Council of Ministers of the Environment	0.007	<0.005	<0.005	<0.005

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B16 Pond 07-Apr-22	B16 Pond Duplicate 07-Apr-22	B16 Pond 17-Aug-22	B16 Pond 9-Nov-22
Total Chromium	50	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03 and Health Canada Guidelines for Canadian Drinking Water Quality	<0.50	<0.50	<0.50	<0.50
Chromium III	8.9	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	Not analyzed	Not analyzed	<0.50	<0.50
Chromium VI	1	µg/L	Provincial Water Quality Objective and Canadian Council of Ministers of the Environment	<0.50	<0.50	<0.50	<0.50
Total Copper	4	µg/L	Canadian Council of Ministers of the Environment	1.0	0.9	0.6	0.6
Total Iron	300	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality	247	251	529	114
Total Lead	5	µg/L	Health Canada Guidelines for Canadian Drinking Water Quality and Provincial Water Quality Objective	0.2	0.2	0.1	<0.050
Total Mercury	0.026	µg/L	Canadian Council of Ministers of the Environment	<0.005	<0.005	<0.005	<0.005
Total Molybdenum	40	µg/L	Provincial Water Quality Objective	0.3	0.3	0.3	0.6
Total Nickel	25	µg/L	Provincial Water Quality Objective	<0.5	<0.5	<0.5	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B16 Pond 07-Apr-22	B16 Pond Duplicate 07-Apr-22	B16 Pond 17-Aug-22	B16 Pond 9-Nov-22
Total Selenium	1	µg/L	Canadian Council of Ministers of the Environment	<0.05	<0.05	0.1	0.1
Total Uranium	5	µg/L	Provincial Water Quality Objective	0.4	0.4	0.3	0.9
Total Vanadium	6	µg/L	Provincial Water Quality Objective	<0.5	<0.5	<0.5	<0.50
Total Zinc	Varies	µg/L	Varies	4.4	<3.0	<3.0	7.4
F1 (C6-C10)	No value	µg/L	Not applicable	<25	<25	<25	<25
F1 (C6-C10) - BTEX	No value	µg/L	Not applicable	<100	<100	<25	<25
F2 (C10-C16 Hydrocarbons)	No value	µg/L	Not applicable	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	No value	µg/L	Not applicable	<250	<250	<250	<250
Reached Baseline at C50	No value	No units	Not applicable	Yes	Yes	Yes	Yes
Benzene	1	µg/L	Ontario Drinking Water Standards, O.Reg. 169/03	<0.50	<0.50	<0.50	<0.50
Ethylbenzene	8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50
o-Xylene	No value	µg/L	Not applicable	<0.30	<0.30	<0.30	<0.30
p+m-Xylene	No value	µg/L	Not applicable	<0.40	<0.40	<0.40	<0.40
Toluene	0.8	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	2	µg/L	Provincial Water Quality Objective	<0.50	<0.50	<0.50	<0.50

Parameter	Lowest Screening Criteria Value	Unit	Source of Screening Criteria	B16 Pond 07-Apr-22	B16 Pond Duplicate 07-Apr-22	B16 Pond 17-Aug-22	B16 Pond 9-Nov-22
Phenol	1	µg/L	Provincial Water Quality Objective	<1.0	<1.0	1.5	<1.0

Table 114 - The range and number of water quality measurements taken from on-site surface water monitoring locations at Bruce Power between 2017 and 2022.

Parameter	Unit	Historical Trend (2017 – 2022) Range (min to max)	Historical Trend (2017 – 2022) Number of observations	Historical Trend (2017 – 2022) Number of exceedances (if applicable)
Specific Conductivity	µS/cm	111 to 2120	74	Not applicable
pH	No unit	6.7 to 9.9	80	2
Temperature	°C	-0.2 to 23.3	64	Not applicable
Dissolved Oxygen	mg/L	4.3 to 15.5	67	4
Total Ammonia-N	µg/L	<50 to 30000	71	Not applicable
Un-ionized ammonia (NH_3-N)	µg/L	<1.0 to 2971	71	13
Total Phosphorous	µg/L	<3 to 230	81	26
Total Dissolved Solids	mg/L	70 to 1000	74	Not applicable
Hardness ($CaCO_3$)	mg/L	53 to 346	71	Not applicable
Dissolved Organic Carbon	mg/L	2.8 to 18.2	47	Not applicable
Total Suspended Solids	mg/L	1.0 to 50.7	84	Not applicable
Alkalinity (Total as $CaCO_3$)	mg/L	57 to 298	74	Not applicable
Nitrite (NO_2^--N)	µg/L	<10 to <200	71	0
Chloride	mg/L	1.8 to 728.0	62	27
Nitrate (NO_3^--N)	mg/L	<0.03 to 1.09	71	0
Sulphate (SO_4^{2-})	mg/L	<1 to 48	64	Not applicable
Fluoride	µg/L	150 to 1300	71	67
Total Aluminum	µg/L	7.3 to 2230.0	85	32
Total Antimony	µg/L	<0.1 to 0.4	78	0
Total Arsenic	µg/L	0.2 to 1.1	78	0
Total Barium	µg/L	1.6 to 86.7	85	0
Total Boron	µg/L	<10 to 166.0	78	0
Total Cadmium	µg/L	<0.003 to 0.046	85	0
Total Chromium	µg/L	<0.5 to 25.0	85	0
Chromium III	µg/L	<0.5 to 11.2	62	1
Chromium VI	µg/L	0.3 to 0.5	74	0
Total Copper	µg/L	<0.001 to 8.9	85	13
Total Iron	µg/L	30 to 2540	85	28
Total Lead	µg/L	<0.005 to 1.0	85	0
Total Mercury	µg/L	<0.005 to <0.1	84	0
Total Molybdenum	µg/L	0.2 to 6.0	85	Not applicable
Total Nickel	µg/L	0.3 to 4.0	85	0
Total Selenium	µg/L	0.1 to 3.0	78	8
Total Uranium	µg/L	0.1 to 5.2	85	1
Total Vanadium	µg/L	0.2 to 20.5	85	4
Total Zinc	µg/L	<2.0 to 45.0	85	34
F1 (C6-C10)	µg/L	<20 to <25	80	Not applicable
F1 (C6-C10) - BTEX	µg/L	<25	63	Not applicable
F2 (C10-C16 Hydrocarbons)	µg/L	<100	81	Not applicable
F3 (C16-C34 Hydrocarbons)	µg/L	<100 to <250	81	Not applicable

Parameter	Unit	Historical Trend (2017 – 2022) Range (min to max)	Historical Trend (2017 – 2022) Number of observations	Historical Trend (2017 – 2022) Number of exceedances (if applicable)
F4 (C34-C50 Hydrocarbons)	µg/L	<100 to <250	81	Not applicable
Reached Baseline at C50	No unit	Not applicable	64	Not applicable
Benzene	µg/L	<0.2 to <0.5	70	0
Ethylbenzene	µg/L	<0.2 to <0.5	70	0
o-Xylene	µg/L	<0.2 to <0.3	70	Not applicable
p+m-Xylene	µg/L	<0.4 to 0.8	70	Not applicable
Toluene	µg/L	<0.2 to 0.4	70	0
Xylene (Total)	µg/L	<0.4 to 0.8	70	0
Phenol	µg/L	<1.0 to 21.9	47	19