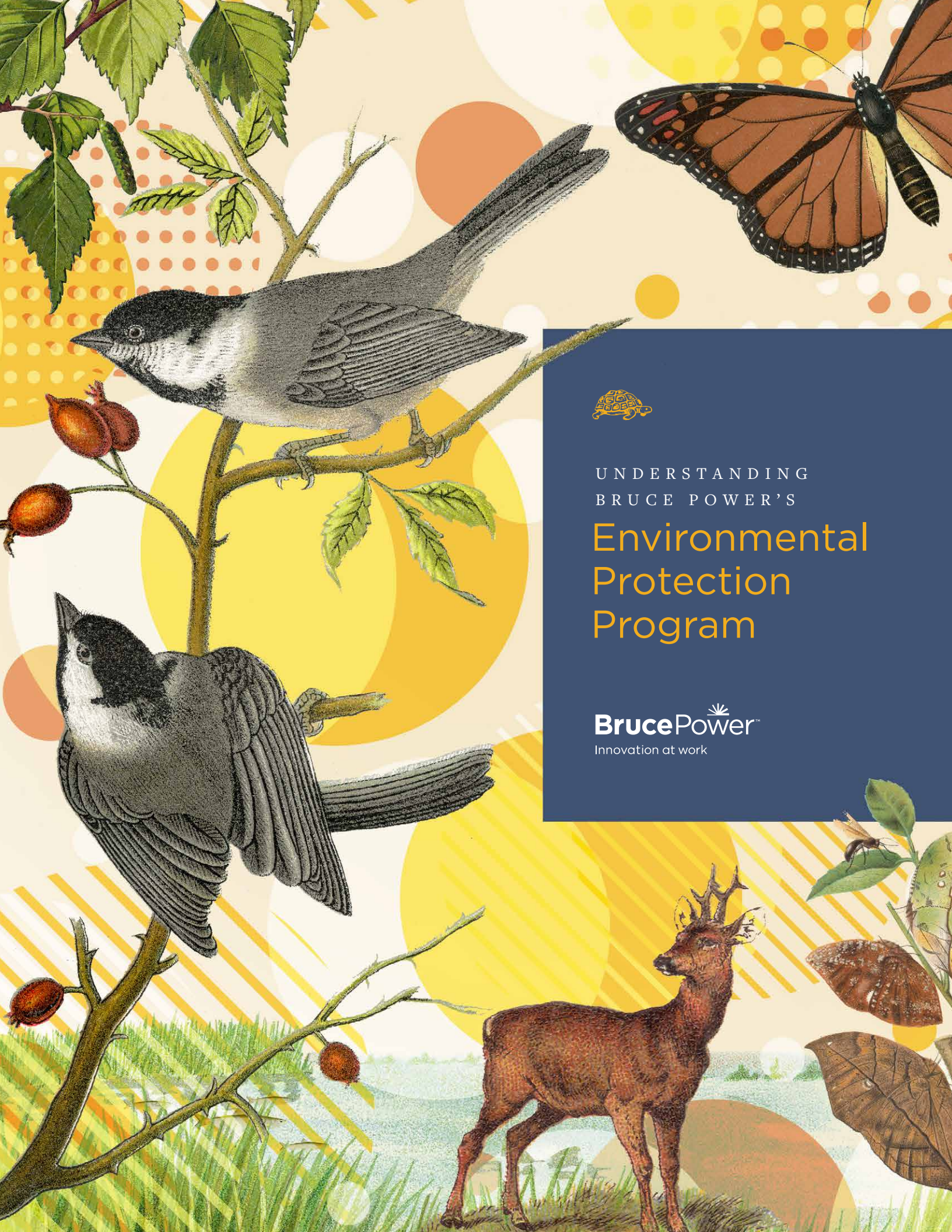

UNDERSTANDING
BRUCE POWER'S

Environmental Protection Program

BrucePower™
Innovation at work

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1

BACKGROUND ON

Environmental Assessment Monitoring for the Site

Environmental Assessment Studies

Bruce Power took over operations of the site in 2001 with the exception of Douglas Point, which is operated by Canadian Nuclear Laboratories, and the Western Waste Management Facility, which is operated by Ontario Power Generation.

Since 2001, a number of environmental assessment studies were conducted at key licensing and operational milestones under the 1992 Canadian Environmental Assessment Act. These have included the:

- 2002 Environmental Assessment Study Report for the Bruce A Units 3 & 4 Restart
- 2004 Environmental Assessment Study Report for the Bruce B New Fuel Project
- 2005 Environmental Assessment Study Report for the Bruce A Refurbishment Project (*Units 1 & 2 Restart*)
- 2008 Environmental Impact Statement for the Bruce New Nuclear Power Plant Project (*eventually withdrawn*)

With the completion of each of the above environmental assessments, progressively more environmental data has been collected for the site, and monitoring has continued to confirm that the approach used in the environmental assessments was sufficiently conservative and effects were negligible to low as predicted. Furthermore, Bruce Power has continued to study how Bruce A and Bruce B interact with the environment, both to support regulatory applications and address stakeholder and Indigenous peoples' interests. These studies have generally increased in scope and nature over time from earlier environmental assessments, commensurate with stakeholder expectations and industry best practices.

In addition, environmental monitoring at Bruce Power has continued to collect environmental data as part of regular operations. Results of Bruce Power's environmental monitoring are reported annually to the Canadian Nuclear Safety Commission (CNSC) in annual Environmental Protection Reports (e.g., Bruce Power 2016 and 2017), which are publicly available on brucepower.com (under Reports) and shared with stakeholders and partners. The CNSC and the Ontario Ministry of Labour also complete independent environmental monitoring around the site, and within Ontario. All of these studies demonstrate the site is operating as expected, and that risks to the environment and the health of a person are negligible to low.

Environmental monitoring at and around the site will continue during future operations to ensure cumulative effects are being monitored and assessed and will allow continual risk- based decision making related to potential effects on the environment to occur in a timely manner.

On Oct. 1, 2018, Bruce Power received a 10-year renewal of its Power Reactor Operating Licence (PROL) for Bruce Nuclear Generating Stations (the 'site') A and B Licence Number 18:00/2028 . The licence allows the site's eight units to operate through to Sept. 30, 2028, and outlines activities permitted and conditions that must be met during this period.

To support Bruce Power's licence renewal application, an Environmental Assessment (EA) under the Nuclear Safety and Control Act (NSCA) was conducted by the Canadian Nuclear Safety Commission (CNSC) to determine if Bruce Power had provided adequate protection of the environment and the health of people.

CNSC staff concluded that Bruce Power had, and will continue to, make adequate provision for the protection of the environment and the health of persons.

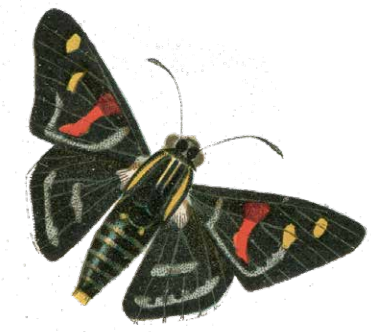
The purpose of the Environmental Protection Report (EPR) is to fulfill regulatory requirements on environmental protection in accordance with PROL Licence Condition 3.3, and CNSC Regulatory Document REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants, Section 3.5.

This EPR describes the effluent and environmental monitoring programs related to Bruce Power's operations. These programs, which are within Bruce Power's environmental management framework, are developed, implemented, periodically reviewed, and enhanced where possible, to ensure environmental protection.

Bruce Power recognizes that it resides in a community passionate about the protection of the environment, and continually engages with stakeholders and Indigenous communities to better understand their needs and expectations. The EPR includes a summary of Bruce Power's environmental protection, stewardship activities and beyond-compliance obligations that occur within the local communities. Consultation and collaboration with stakeholders and Indigenous communities provides the necessary framework to bridge knowledge gaps, and increase confidence in collective environmental decision making.

Environmental protection at Bruce Power is managed under the Environmental Management System (EMS), which encompasses effluent and emissions control and monitoring, environmental monitoring and assessment, and environmental risk assessment, to ensure the protection of the public and the environment. Monitoring of radiological, non-radiological (hazardous) substances, and assessing the effect on human and non-human biota forms the basis for demonstrating environmental protection at a nuclear facility. It ensures, through measurement, sampling and analysis, that the health of the environment and people are protected.

Years of study have unequivocally determined that the Bruce Power site does not pose environmental risk to the area's plants, animals and people.



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BRUCE POWER'S

Community Engagement and Investment

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.

Indigenous Community Engagement

The Bruce 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 (SON), 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 (SON), Georgian Bay Métis Nation of Ontario (MNO) and the Historic Saugeen Métis (HSM), and to leading by example in this community and industry.

Bruce Power is committed to working with all three local Indigenous communities (SON, MNO and HSM) on areas of environmental interest.

With respect to SON, there is a Joint Coastal Environmental Monitoring Program (CWMP) that will provide further data and insight for monitoring impacts to fish from thermal effluents and climate change. This involves monitoring the fish community along the shoreline and may involve vegetation and water quality parameters.

This monitoring has the potential to be expanded to monitoring beyond the local Bruce site to other areas of SON Territory. Bruce Power and SON have agreed to jointly pursue funding to implement any monitoring beyond the immediate vicinity of the site. This information will be collected along with Traditional Knowledge to incorporate SON values in terms of the fish community. A process has been developed to communicate thermal compliance events with SON.

Bruce Power is working jointly with MNO to develop an environmental monitoring plan. Based on ongoing dialogue, this monitoring plan will include a review and evaluation of MNO valued components and areas of concern and development of a monitoring plan for areas and species of interest related to thermal discharges. The plan will then be implemented and an adaptive management approach applied for continuous improvement. A process has been developed to communicate thermal compliance events with MNO.

Bruce Power continues to work with HSM and recently reviewed their draft engagement plan as it relates to their desired involvement in the thermal file. They have shared species of interest to their community and continue to work alongside Bruce Power to further enhance our evaluations and ensure the Métis focus is being put on ongoing evaluations. Bruce Power will continue to work with HSM to communicate the monitoring and results and address any questions as they arise. A process has been developed to communicate thermal compliance events with HSM.

Community Investment

Corporate Social Responsibility is a core value at Bruce Power. Since 2001, Bruce Power has been making an overall positive contribution to the region. Bruce Power's Community Investment fund has grown over the years and currently results in an annual giving of upwards of $2 million a year, through five funding streams: Community Investment & Sponsorship, Environment & Sustainability, Indigenous Community Investment, Gifts in Kind and Tripartite.

Bruce Power has contributed approximately $1.6 million to the local communities for environmental initiatives since 2015.

The following sections detail some of the community-related initiatives that Bruce Power has supported in recent years. The Environment & Sustainability (E&S) Fund for 2018 saw the distribution of around $400,000 among sponsorship, long term partnerships and events. Established in 2015 the E&S fund focuses allocation of resources to initiatives in the areas of:

- Conservation, Preservation
- Education, Awareness & Research and
- Restoration, Remediation, Quality Improvement

Priority is given to those initiatives within the Grey, Bruce and Huron counties, the local study area of our site environmental interactions. Bruce Power strives for as low as environmental impact as possible, this means that even when we are well within our regulatory limits, we continue to seek ways to drive our impact even lower, all while aligning support with broader provincial, national and global goals of sustainability. Over the years we have had special opportunities arise 2018 being one, which results in funds beyond the Environment & Sustainability fund being allocated.

Over the course of 2018 Bruce Power partnered with more than 15 organizations, to help the continued enhancement of the local environment. A report updating our overall sustainability efforts will be published in the later part of 2019.

Environmental Sustainability

Created in 2015, Bruce Power's Environment and Sustainability fund, since its inception has seen the distribution of about $1.6 million into more than 75 environmental projects, partnerships and initiatives mainly across Grey, Bruce and Huron counties. This fund focuses on the areas of conservation, restoration and education. Some of the key partnerships include:

- A partnership with the Lake Huron Fishing Club to advance the continued health of Lake Huron, including support to the elementary school educational Mini-Hatcheries Program, Maple Hill Fishway and Huron Tributary Stream projects.
- The protection of our watershed in partnership with Saugeen Valley Conservation Authority, with particular emphasis on education through programs like the DEER (Discover, Energize, Environmental Resources) program, which is offered to local schools and deals with various aspects of the local ecosystem as well as energy conservation, the Lockerby Dam projects and the Emerald Ash Borer Collaborative Trapping and Education Program.
- A Phragmites Management Plan and removal in partnership with the Invasive Phragmites Control Centre, the Lake Huron Centre for Coastal Conservation and the Municipality of Kincardine.

Bruce Power remains dedicated to promoting environmental stewardship and awareness, both throughout the local communities and in the greater Ontario region. In 2019, Bruce Power has continued to collaborate and realize success in terms of common environmental goals within the community.

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BRUCE POWER'S

Regulatory Framework

Bruce Power complies with relevant federal and provincial environmental legislation, regulations, and other requirements; specifically with regulations and programs that protect human health and the environment under the Canadian Environmental Protection Act and Nuclear Safety and Control Act. Bruce Power also complies with the Environmental Compliance Approvals and Permits issued by the Ministry of Environment, Conservation and Parks.

The CNSC Regulatory Document, REGDOC-2.9.1 Environmental Protection Environmental Principles, Assessments and Protection Measures describe the CNSC's principles for environmental protection for new and existing nuclear facilities. The CNSC has accepted the request from Bruce Power to move to the most recent version of this standard, REGDOC-2.9.1, version 1.1 (2017).

Environmental Framework

Registration to ISO 14001 Environmental Management Systems is a requirement of REGDOC-2.9.1, version 1.1 (2017). Bruce Power implements ISO 14001:2015 as the environmental framework and incorporates industry best standards (CSA N288 Series) to conduct effluent/environmental monitoring programs, achieve performance targets and drive continual improvement, to ensure environmental protection.

ISO 14001:2015 was released by the International Organization for Standardization on Sept. 15, 2015. It focuses on the Environmental Management System (EMS) being integrated throughout business processes to aid in the organization's knowledge and understanding of external and internal issues, identification of stakeholder needs and expectations, and identification of risks and opportunities impacting the organization and interested parties. The standard also focuses on leadership's commitment to environmental performance, protection of the environment beyond prevention of pollution, and adoption of a lifecycle approach when considering and evaluating its environmental aspects.

Bruce Power had a successful re-registration audit in 2017 to acquire certification to this enhanced version of the ISO 14001 standard. Bruce Power's ISO 14001:2015 surveillance audit was conducted by the external registrar, SAI Global, in the fall of 2018. The auditor determined that the management system is effectively implemented and meets the requirements of the standard. Bruce Power continues to maintain certification to ISO 14001. There were no non-conformances, several identified strengths and a few opportunities for improvement (OFIs), which, for the most part, provided recommendations to further enhance the identified strengths.

The strengths reflect Bruce Power's focus on environmental safety, including the demonstrated strong commitment from Bruce Power's management team to the Environmental Safety Pillar, as well as the knowledge and passion of environmental staff to drive improved performance.

The development of an enhanced and more aggressive Environmental Health Index was recognized as a leading tool to drive projects and activities, to prevent complacency, and to ensure improved future performance and environmental protection.

Based on the updates to the 2015 version of the ISO 14001 standard, Bruce Power has evaluated its environmental aspects from both a risk-based and an opportunity-based perspective. In this exercise, Bruce Power identified several opportunities

related to its environmental aspects, one of which met the threshold to be classified as a Significant Environmental Aspect (SEA). This SEA is titled 'Energy Production and Climate Change.' Bruce Power's operation (clean energy production) produces more than 6,400 megawatts (MW) of electricity and emits low carbon dioxide. Numerous studies have shown that life-cycle emissions from nuclear energy are comparable to other low carbon emitting sources of electricity, such as wind, solar, and hydro power.

Bruce Power increased its power generation outputs since returning Bruce A units to service, providing an additional 3,000 MW of carbon-free electricity to Ontario's grid since 2012, providing 70 per cent of the electricity Ontario needed to shut down its coal plants. As a result, 2015 was the first year with no coal fired electricity in Ontario, which has resulted in a 93 per cent reduction in Ontario's sulphur emissions and a drastic decrease in the number of smog days, which went from 53 days in 2005 to just two from 2014 to 2018.

Bruce Power continues to progress through its implementation of industry best codes, standards and guidelines; specifically for Canadian Standards Association (CSA) N288; Environmental Radiation Protection series. Canadian Standards Association (CSA) standards on Environmental Monitoring Programs (N288.4-10), Effluent Monitoring Programs (N288.5-11), and Environmental Risk Assessments (N288.6-12), were fully implemented by the end of 2018.

Prior to this, the current programs and activities on site had already demonstrated general compliance to these standards, however audits were conducted to identify any gaps, and continuous improvements were made to ensure that the standards are incorporated appropriately on a clause-by-clause basis.

An Environmental Risk Assessment (ERA) Report was completed, and an updated version that incorporates comments was submitted to the CNSC in December 2018. CNSC staff is satisfied that risks to the environment or human health for the continued operation of Bruce Power, including Major Component Replacement (MCR), are "low to negligible." CNSC concluded that the ERA Bruce Power conducted under the Nuclear Safety Control Act has, and will continue to, make adequate provision for the protection of the environment and the health of persons. Updates from routine environmental monitoring will be incorporated into the five-year ERA cycle and into these annual environmental protection reports.

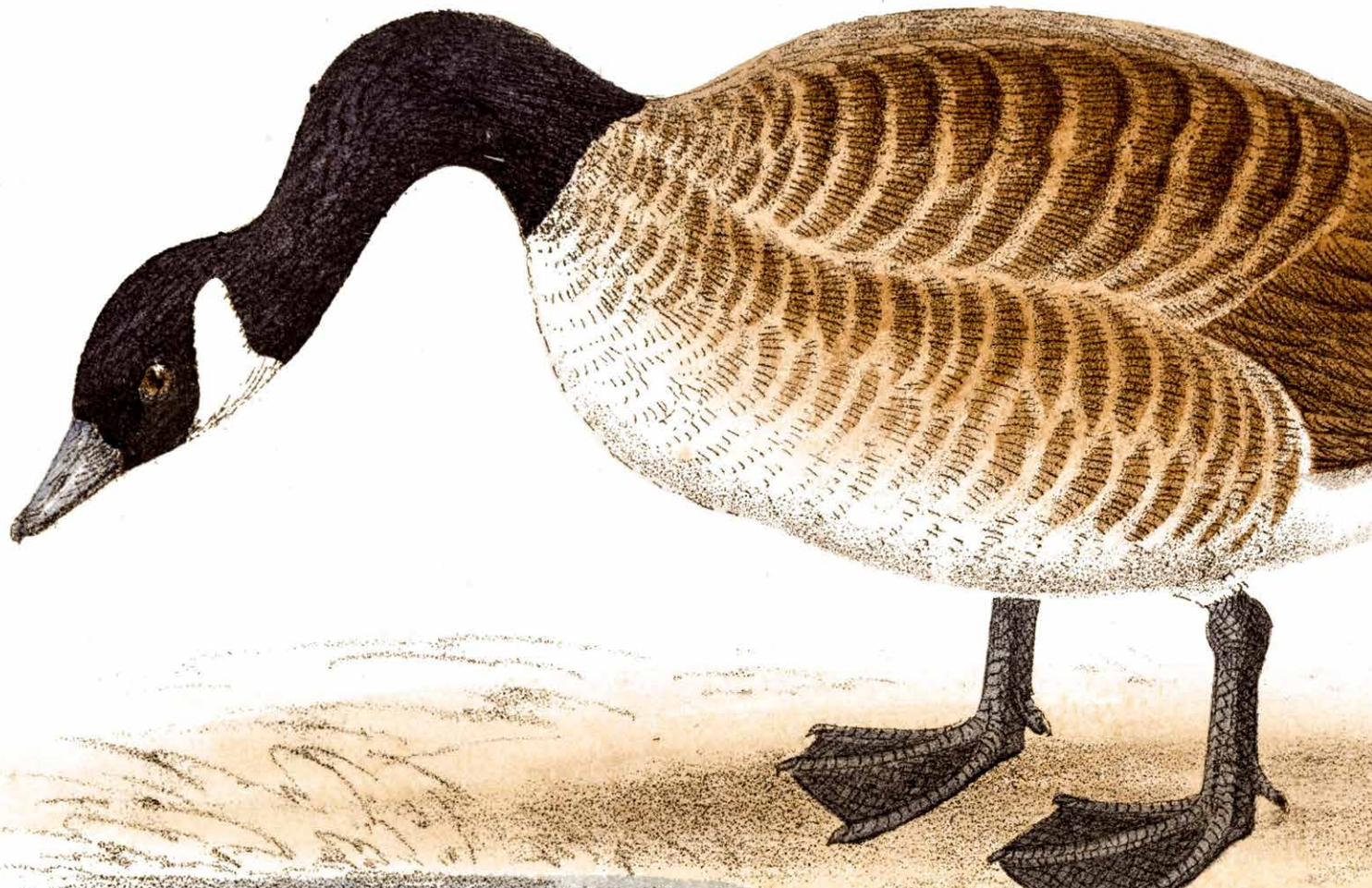
The ERA continues to demonstrate the operation of the Bruce Power site and associated life-extension activities, has not, and will not, result in significant adverse environmental effects as a result of exposure to radiological or non-radiological substances, for both human health (nearby residents and visitors) and for ecological health.

Consistent with similar assessments that have been conducted since 2001, the conclusions of the ERA include:
1) for human health: there are no radiological or non-radiological risks to members of the public near site or visitors to the on-site Indigenous spirit site
2) for ecological health: there are no radiological or non-radiological risks to wildlife or the environment, and all activities are within bounds and do not require more detailed assessment.

No interactions were identified that pose a risk to humans or the environment, and potential impact of future activities are anticipated to be similar to those of existing operations and, as a result, will not cause any significant adverse environmental impact.

Bruce Power is enhancing its exisitng groundwater monitoring program to align with CSA N288 standard on Groundwater Protection (N288.7-15). Monitoring shows there are no significant adverse impacts on groundwater as a result of facility operations. Bruce Power is working towards implementation of N288.7 by the end of 2020.

Bruce Power has initiate a voluntary implementation plan of CSA N288.8-17, establishing and implementing action levels for releases to the environment from nuclear facilities as discussed further below in the discussion of radiological effluent monitoring section. These revised levels will be more aggressive and will require reporting to the CNSC when releases exceed normal levels.



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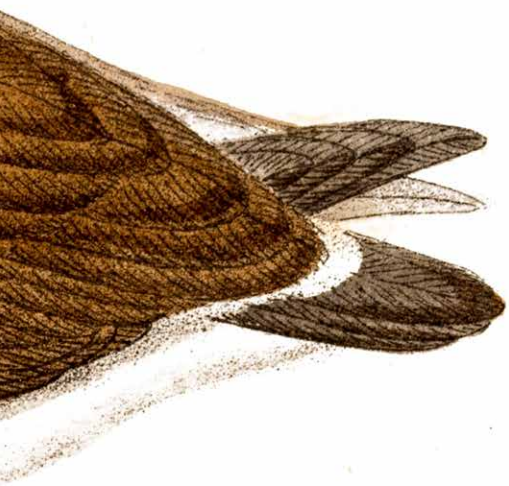
BRUCE POWER'S

Effluent Monitoring

Bruce Power's Effluent Monitoring Program demonstrates compliance with authorized release limits, the effectiveness of effluent control, data used to refine current modelling, and the meeting of stakeholder commitments. Radiological and conventional effluent from the Bruce A and B stations and Centre of Site facilities, including the Central Maintenance Facility (CMF), are monitored under the program. All airborne (tritium, noble gases, radioiodine, carbon-14, alpha, beta, and gamma particulates) and waterborne (tritium, carbon-14, and gross alpha, beta, and gamma particulates) radionuclide emissions are well below the regulatory limits and environmental action levels. All conventional effluents are controlled to meet regulatory and Environmental Compliance Approvals (ECA) limits. Ontario Power Generation's Western Waste Management Facility (WWMF), Kinectrics Tiverto, and Canadian Nuclear Laboratories' Douglas Point facility conduct independent effluent monitoring programs.



Radiological Effluent Monitoring

Derived Release Limits (DRLs) are set at the annual regulatory public dose limit of 1 mSv, and Environmental Action Levels (EALs) at Bruce Power are below DRLs, to ensure action is taken well before there is any emission that would significantly contribute to public dose. Environmental Action Levels are currently set at approximately 10 per cent of the DRLs for each radionuclide/radionuclide group. Environmental Action Levels, if reached, are reportable to the CNSC and require specific actions to be taken to promptly mitigate the release. In 2018, all airborne and waterborne emissions remain well below EALs and DRLs regulatory limits, and the dose to public remains negligible.

Furthermore, to ensure that EALs are never reached, Bruce Power has developed and implemented administrative limits, which are called Internal Investigation Levels (IILs). An IIL is set much lower than EALs at the upper range of normal releases (both airborne and waterborne) for each radionuclide/radionuclide group. If an IIL is exceeded, Bruce Power immediately begins an investigation to determine the cause and put corrective actions in place to ensure releases remain as low as possible.

Currently, Bruce Power is working toward the implementation of N288.8, which would include the development of more stringent EALs (approximately 1,000 times lower than current DRLs) that are more closely aligned with operational performance.

The CNSC's mandate is to protect the environment and the health, safety and security of people, and welcomes comments from stakeholders on specific documents and regulations. Bruce Power is always striving to represent industry-best practice and frequently requests to adopt new standards from the CNSC.

Radiological emissions change each year, based on facility activities such as maintenance outages, surplus baseload generation derates, and shutdowns to support electricity demand and refurbishment. Maintenance activities may cause higher emissions due to systems, which would otherwise remain closed, being opened for inspection and maintenance. Release points are heavily regulated, and Bruce Power routinely reports radiological airborne and waterborne effluent monitoring results in accordance with the CNSC licence.

Airborne emissions are primarily monitored through exhaust stacks at each station and the CMF. Bruce Power has high efficiency particulate and carbon air filters that reduce radionuclide releases to the environment and are tested annually.

For airborne radiological releases, a decrease in tritium was observed in 2018 at Bruce A and Bruce B compared to 2017. Airborne Carbon-14 emissions at Bruce B have significantly declined since 2010 and have remained relatively stable since, and Bruce A experienced a reduction in Carbon-14 emissions since 2015 with a further decrease in 2018.

Iodine emissions at Bruce B have been very low and stable over the long term; however, Bruce A experienced elevated emissions in 2012 and 2014. Improvements realized in Carbon-14 emissions can be attributed to an increased focus on resin management and a decrease in moderator cover gas purges, while an increased focus on the equipment monitoring and reliability of the exhaust stack filters has ensured the minimization of iodine emissions.

Waterborne emissions are monitored at a variety of sampling locations on site, in addition to each station's Condenser Cooling Water (CCW) duct prior to release to the environment. For waterborne emissions, tritium releases from Bruce B decreased since 2017, while Bruce A waterborne tritium emissions show a long-term, stable trend. Waterborne Carbon-14 emissions have decreased at Bruce A and Bruce B since 2015 due to an increased focus on resin management on reactor purification systems, and waterborne gamma emissions have remained stable over the long term, and the dose to public remains negligible.

Conventional Effluent Monitoring

For non-radiological emissions, Bruce Power is in compliance with all applicable provincial regulations, approvals, and permits. Bruce Power monitors effluent emission streams for conventional parameters including noise, halocarbons, greenhouse gases, and hydrazine. Conventional air emissions are controlled to meet regulatory requirements, prevent pollution, reduce emissions, and minimize environmental impacts. Bruce Power has an Environmental Compliance Approval (ECA) for air, which incorporates all non-radiological air emission sources on site, and is required to submit an Emission Summary and Dispersion Modelling (ESDM) report that reflects actual facility operations. All five modifications made in 2017 demonstrated compliance with the Point of Impingement (POI) concentration limits and the conditions of the ECA.

Bruce Power continues to comply with the ECA (Air) and regulations under the Environmental Protection Act. In accordance with the ECA (air), noise complaints received from Inverhuron during the spring and summer of 2018, were reported to the Ministry of Environment Conservation and Parks (MECP) District Office. Bruce Power initiated a project to install silencers on four deaerator vents at Bruce B, and continues to investigate opportunities to mitigate this impact via short- and long-term strategies. Short-term strategies include the installation of steam vent silencers. This project progressed significantly in 2018, with vent silencers installed in two of the four units, while a third was installed in early 2019, and the fourth scheduled for the Fall of 2019. Noise monitoring and assessments conducted between 2015 and 2018 demonstrate that Bruce Power's noise emissions remain in compliance with MECP limits.

In 2018, there were no immediately reportable halocarbon releases greater than 100 kg at site. Greenhouse gas emissions from site have trended downwards due to the shutdown of the Bruce Steam Plant in 2015, and remain below the federal and provincial greenhouse gas emission thresholds for reporting.

Conventional water emissions are also controlled, meeting licenses, permits, and regulations under the Environmental Protection Act (EPA) and the Ontario Water Resources Act. Bruce A and B have separate Environmental Compliance Approvals (Water), Permits to Take Water (PTTW) from the MECP, and report under Ontario's Effluent Monitoring and Effluent Limits (EMEL), demonstrating Bruce Power's commitment to protect the public and the environment.

There were four conventional water emissions moderate infractions in 2018. Two reportable EMEL events occurred at Bruce A; Unit 1 Pumphouse Inactive Drainage Sump EMEL acute lethality failure, and ALW EMEL acute lethality failure. There were no adverse effects on the natural environment as a result of these events.

The other reportable events were two ECA violations, one occurring at Bruce A Unit 1 boiler blowdown/feedwater ECA ammonia exceedance, and the other at Bruce B Unit 7 release valve passing ECA ammonia exceedance. In both instances an investigation was conducted, and corrective actions were promptly taken.

There were no EMEL events at Bruce B or Centre of Site, and no ECA events at Centre of Site in 2018.

5

BRUCE POWER'S

Environmental Monitoring

Health Canada, the Ontario Ministry of Labour, the CNSC and Bruce Power conduct environmental monitoring near the site. The CNSC's Independent Environmental Monitoring Program (IEMP) analyzes samples from the vicinity of nuclear facilities to monitor and ensure public health and environmental safety is maintained. IEMP sampling plan focuses on publicly accessible locations and in areas of interest identified in environmental risk assessments. Recent IEMP reports found that radioactive levels in the local environment around Bruce Power were well below available guidelines and CNSC reference levels.

Health Canada is another major participant in radiation monitoring. Fixed Point Surveillance (FPS) is a Health Canada initiative that provides a real-time radiation detection system across Canada to monitor radiation levels and better prepare the country in the unlikely event of a nuclear incident. In addition to the CNSC and Health Canada, the Ontario Ministry of Labour works in connection with public management agencies to provide early warning of possible radiation hazards to workers and to the public through its Radiation Protection Service. Its field service ensures legal safety requirements are met by employers in possession of radioactive materials.

The Environmental Monitoring Program is designed to meet the requirements of CSA N288.4-10 and monitors for conventional (non-radiological) contaminants, physical stressors, potential biological effects and pathways for both human and non-human biota. The objectives of the program are:

1) To demonstrate compliance with limits on the concentration of conventional contaminants and physical stressors in the environment or their effect on the environment.

2) To check on the effectiveness of contaminant and effluent control independently of the effluent monitoring program.

3) To verify predictions, refine models and reduce uncertainties in predictions made in the Environmental Risk Assessment (ERA).

Every year, Bruce Power monitors the environment surrounding its facility, including the level of radioactivity. Bruce Power uses various methods to gather the data that is used to determine the risk to the surrounding environment. Environmental Monitoring (EM) is an important part of environmental protection at a nuclear facility. It ensures, through measurement, sampling, and analysis, that the health of the environment and people are protected. Sampling and analysis of the local area gives Bruce Power verification that emissions result in low to negligible environmental risk and continues to verify environmental and human protection.

Radiological Environmental Monitoring

Radiological Environmental Monitoring (REM) is a key component of Bruce Power's extensive Environmental Monitoring Program. REM collects data from specific locations around Bruce Power, the province, information in the most recent site-specific survey, the Environmental Risk Assessment, with annual meteorological data to determine the public radiation dose associated with the operation of the Bruce Power site. The analytical results and public radiation dose reflects the output from Bruce Power facilities, as well as other facilities within and near the Bruce site that are owned by other parties, such as OPG, Kinectrics and Canadian Nuclear Laboratories. In this approach, the resulting levels of exposure and dose are representative of pre-cumulative Bruce site releases.

To help identify the extent of Bruce Power's impact on the environment, the following three types of locations are used: indicator locations used to assess potential doses to the public (on or near facility perimeters and areas of most significant public exposure); area near locations (further from indicator area but closer than 20 km); and area far locations (farther than 20 km). In addition to data accumulated from these three types of locations, OPG provides background provincial radiological levels in the environment that are not located near a nuclear facility or the Bruce Power site and these represent background levels.

Bruce Power's REM routinely monitors radionuclides, (such as tritium, carbon-14, iodine-131, beta radiation, and gamma) in media such as air, water, precipitation, aquatic samples (fish, sediment, sand, municipal water supply), and terrestrial samples (animal feed, eggs, milk, deer, fruit, berries, root, leafy and above ground vegetables, honey, grain, and soil).

Fish Monitoring

Bruce Power monitors the health of local fish populations by collecting samples of benthic (suckers) and pelagic (whitefish) fish species near the Bruce Power site, at a Bruce Power control site, and further afield at locations in Lake Huron away from Bruce Power. The analysis of two variety of species provides a comprehensive perspective of potential impacts for site operations on the lakebed (inhabited by benthic fish) through open water ecosystems (inhabited by pelagic fish). Sample collection for all species is conducted in the fall when adults are near shore to spawn, and are analyzed for potassium-40, cobalt-60, cesium-134, cesium-137, carbon-14, tritium oxide, and organically bound tritium (OBT).

In 2018, white suckers and round whitefish were sampled and the concentrations of carbon-14, potassium-40, and cesium-137 were below background levels; Cobalt-60 and Cesium-134 were below the level of detection. The concentration of tritium oxide in all pelagic fish tissue measured (i.e. round whitefish) was less than provincial background levels, however in benthic fish tissue (i.e. white suckers) measured near field were higher than provincial results, but far below the guideline/ reference level.

Air, Soil and Water Sampling

There are 10 air monitoring stations located in the vicinity of the Bruce site at varying distances and at locations covering all prominent landward wind directions. A steady stream of air quality data is gathered from these monitors. The annual average for tritium in air (measured in becquerels per metre-cubed) at sites closest to the Bruce site was 2.54 Bq/m3, which is far below the guideline/ reference level of 340 Bq/m3. Tritium is measured in drinking water at the water treatment facilities in Kincardine and Southampton, among other places, and the results are well below the provincial threshold limit of 7,000 becquerels per litre (Bq/L). The annual average in 2018 was 5 Bq/L in Kincardine and 9.9 Bq/L in Southampton, a small fraction of Bruce Power's community commitment of 100 Bq/L (annual average) at local water supply plants.

Soil and sediment samples are collected once every five years from various locations in the vicinity of the Bruce Power site and further afield along the Lake Huron shore. This frequency is industry best practice. Samples are tested for radionuclides Potassium-40, Cobalt-60, Cesium-134 and Cesium-137. All results from 2016 (sediment) and 2017 (soil) were either less than detection or below background levels.

In 2016, the CNSC Independent Environment Monitoring Program showed samples taken near site were between 1.5 and 3.8 Bq/kg dry weight, which is far below the guideline of 58.6 Bq/kg of dry weight soil.

In 2017, CNSC staff conducted a field inspection of Bruce Power's Radiological Environmental Monitoring (REM) program. The inspection assessed Bruce Power's compliance with regulatory requirements associated with environmental monitoring, as well as other areas as they relate to the monitoring. Based on the scope of the inspection, CNSC staff concluded that Bruce Power met all regulatory requirements. CNSC staff did not find evidence of unsafe operations that would result in undue risk to the health and safety of persons, the environment, or that would compromise respect for Canada's international obligations.

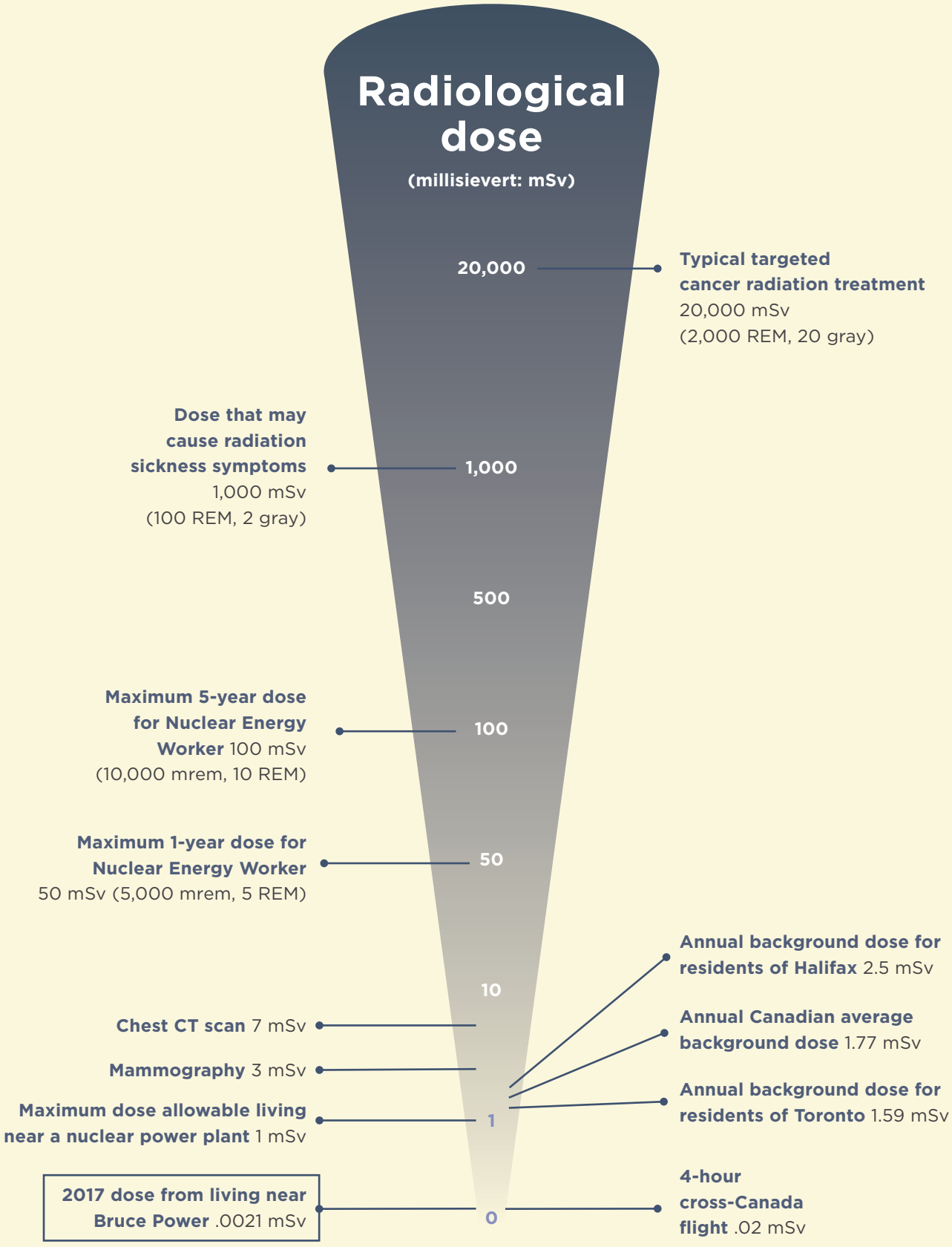
Dose to Public

Bruce Power's dose methodology provides a reliable and complete assessment of radiological dose to members of the public in the vicinity of its nuclear facilities. The dose is calculated by a third party using Integrated Model for the Probabilistic Assessment of Contaminant Transport (IMPACT) software, and takes into consideration representative environmental factors such as a person's local food (home garden and farmers' markets), water, and air intake in relation to proximity of Bruce Power facilities. The foundation of IMPACT is CSA N288.1 Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities and consists of an array of mathematical equations that describe the transfer of radioactive materials through the environment from either a point of release to a receptor (primarily but not limited to a member of the public) whose calculations are re-evaluated for accuracy and available data, in accordance with CSA guidance.

A site-specific survey is conducted routinely approximately every five years. The most recent survey was conducted in 2016 and included more than 260 respondents. This survey provides important information about the human, social, and natural environment surrounding the site. Bruce Power gathers information on meteorology, severe weather, land use, population, water usage, agriculture, recreation, food sources (how much of a person's diet is locally produced), daycares, before/after school programs, long term care homes, school boards, and parks within the vicinity of the Bruce site. The company uses the data to calculate an annual radiation dose to the public, perform periodic Environmental Risk Assessments, and calculate Derived Release Limits. This data is also used to inform the Environmental Monitoring Program design, and it is also important for Emergency Preparedness.

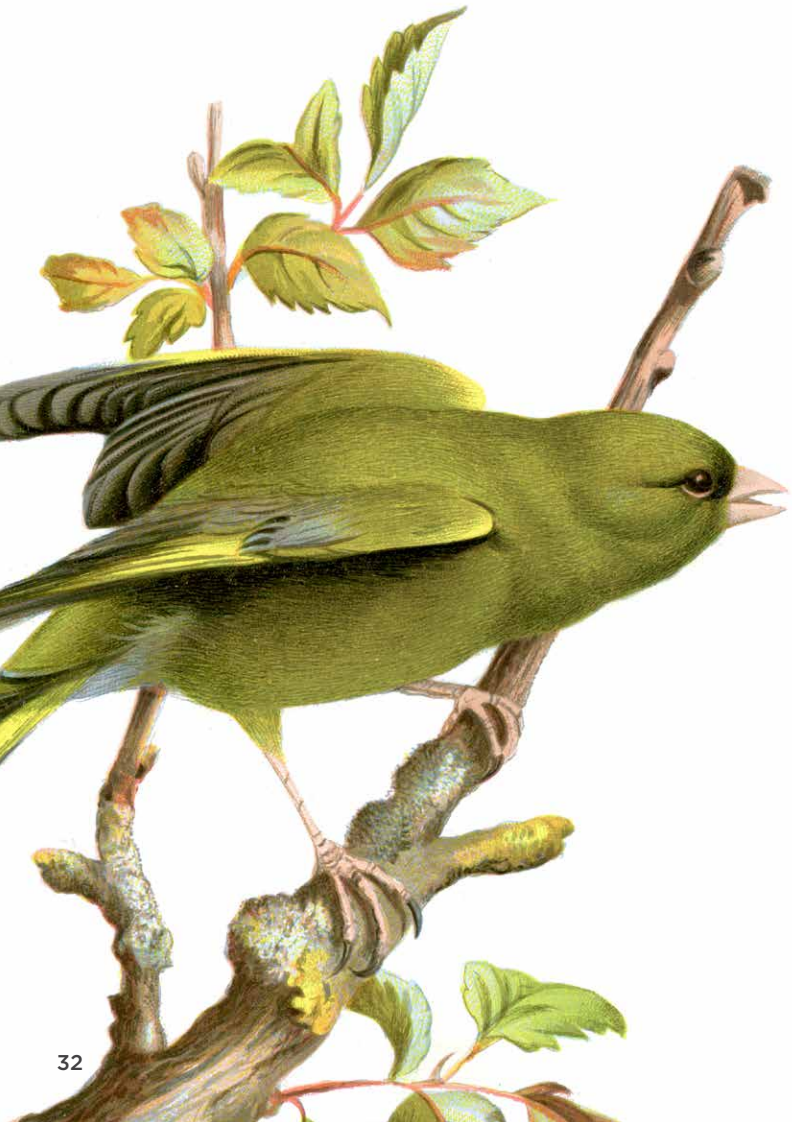
In the calculation of public doses for the Bruce Power site, statistically reliable data generated through site-specific radiological and environmental monitoring have been used as the basis for determining the concentrations of radionuclides in the various exposure media.

Bruce Power tracks the radiological dose to the public in the vicinity of its nuclear site. For the 27th consecutive year, Bruce Power's calculated dose to a member of the public is less than the 10 microsieverts (µSv) per year value that is regarded as the lower threshold for significance (de minimus). Dose to potential representative persons are calculated using IMPACT 5.5.2. The most recent site-specific survey results (2016 Site Specific Survey), 2018 meteorological data, effluent and environmental monitoring data for the Bruce site for 2018 are all taken into account for the calculation. The highest estimated dose for 2018 is 1.67 µSv, representing 0.17 per cent of the regulatory dose limit of 1,000 µSv/y. The estimated 1.67 µSv/y was received by a Bruce Subsistent Farmer (BSF) infant at location 3.


Radiological dose
(millisievert: mSv)
20,000
Typical targeted cancer radiation treatment 20,000 mSv (2,000 REM, 20 gray)
Dose that may cause radiation sickness symptoms 1,000 mSv (100 REM, 2 gray)
1,000
500
Maximum 5-year dose for Nuclear Energy Worker 100 mSv (10,000 mrem, 10 REM)
100
Maximum 1-year dose for Nuclear Energy Worker 50 mSv (5,000 mrem, 5 REM)
50
10
Chest CT scan 7 mSv
Mammography 3 mSv
Maximum dose allowable living near a nuclear power plant 1 mSv
1
2017 dose from living near Bruce Power .0021 mSv
0
Annual background dose for residents of Halifax 2.5 mSv
Annual Canadian average background dose 1.77 mSv
Annual background dose for residents of Toronto 1.59 mSv
4-hour cross-Canada flight .02 mSv

Conventional Environmental Monitoring

The program consists of a variety of sampling and monitoring efforts including, but not limited to, sampling of environmental media for potential contaminants, determining wildlife habitat and inventories on and near site (including species at risk) documenting wildlife interactions (i.e. structure and vehicle collisions), surveying fish spawning / nesting locations, lake temperature monitoring and impingement and entrainment monitoring.



Wildlife Monitoring

Ecological land classification, wildlife habitat, wildlife bioinventory, bat monitoring, breeding bird surveys, migratory bird surveys, creel, soil and sediment are on a cycle.

Vehicle-wildlife and bird-infrastructure collision monitoring began in 2017. Bruce Power initiated a standardized approach to collecting wildlife collision data at the site to improve understanding of collision risk to various species of wildlife occupying the site and local area. In addition to the regular surveys of six main road segments and two predominantly glass buildings, all incidental wildlife sightings by employees have been tracked and documented.

In conjunction with wildlife surveys, a database was initiated to record and track incidental reptile observation on site. The Wildlife-Vehicle Interaction survey continued in 2018 on a weekly basis, which helped to locate areas of higher density of reptiles both on and off site. This resulted in additional signage on County Rd. 20 and on Tie Road indicating the use of the areas by snakes and turtles in an effort to create better awareness and mitigate potential impacts.

Amphibians

Amphibians are monitored as an indicator for ecosystem health as they have a dual lifecycle (water and land) and are sensitive to pollutants during all life stages. Targeted nocturnal amphibian vocalization surveys were conducted in the spring and summer of 2018, following the Great Lakes Marsh Monitoring Program methodology. A total of three evening surveys covering the breeding stages of various species were completed in 2018. In addition to the targeted vocalization surveys, pedestrian surveys and incidental observations were also completed to document any potential amphibian breeding evidence (egg masses, larvae, spematophores, daytime calling, etc.).

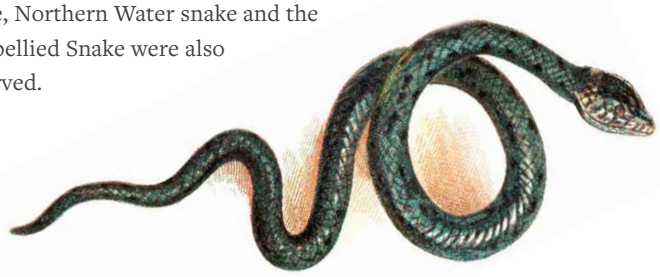
A total of six species of frogs were recorded during the amphibian vocalization surveys, consisting of Spring Peeper, Gray Tree Frog, Northern Leopard Frog, American Toad, Green Frog and Wood Frog (listed in order of abundance). This is consistent with the 2016 and 2017 surveys. Surveys continued in spring 2019.

Reptiles

Pedestrian surveys specific to reptiles have been conducted in 2016, 2017 and 2018 to locate and characterize the herpetofauna assemblage and to identify potential habitat. Collection methodology has consisted of turtle and snake habitat use at various life stages for overwintering, breeding, and foraging. This includes hibernacula, grassland, wetlands, and other surface water features. Field data was used to identify and characterize reptile habitat. Behavioural observations include basking or using cover for temperature regulation.

Targeted turtle basking surveys were conducted in late spring/early summer 2016 and continued with additional data collection in spring 2017 and spring 2018 to document turtle species use of habitat within the study area.

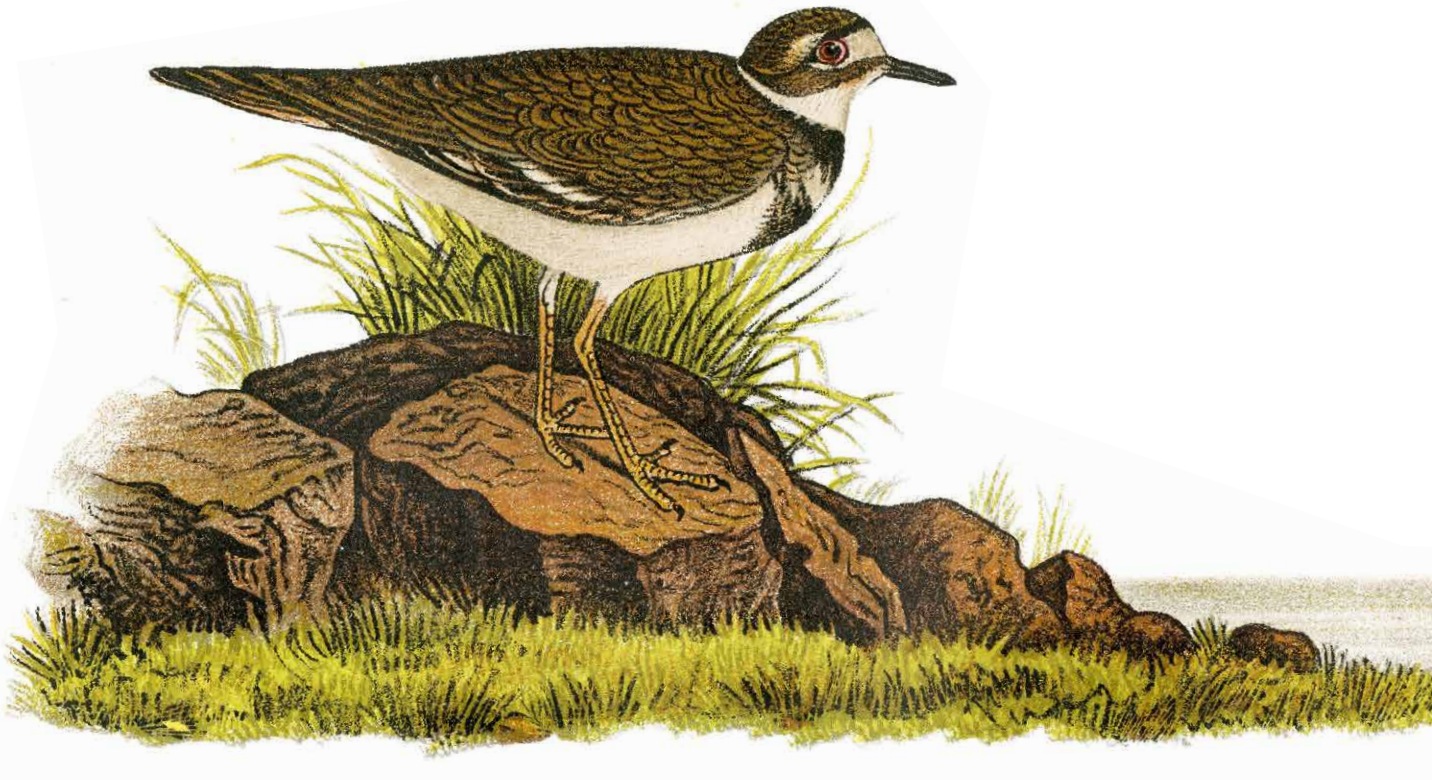
In 2018, reptiles identified included Midland Painted Turtle, Snapping Turtle, Dekay's Brownsnake, and Eastern Gartersnake. In 2017, Eastern Ribbon snake, Northern Water snake and the Red-bellied Snake were also observed.



Waterfowl and Shorebird

The shoreline of Bruce Power was surveyed on several occasions for waterfowl and shorebirds during 2016 and 2017. The shoreline was viewed from a set of nine viewpoints on the north side of Baie du Doré to the end of the road along the southern border of the Bruce Power site lands. Together these viewpoints cover most of the shoreline with very little overlap. Waterfowl and shorebirds were observed with binoculars or a spotting scope and species, number and age/sex information was recorded. The purpose of waterfowl and shorebird surveys is to record the surrounding area for overwintering, and potential stopover in significant wildlife habitat. Baie du Doré is classified as a provincially significant wetland by the Ministry of Natural Resources and Forestry. Bruce Power conducts surveys of waterfowl and shorebirds.

In 2016 and 2017 the waterfowl and shorebird surveys resulted in a total of 20 species and four unidentified species. Waterfowl were predominant with only one shorebird observed. This included species such as the Mute Swan, Mallard, Greater Scaup, Bufflehead, Common Merganser, Pied-billed Grebe, Great Blue Heron, Belted Kingfisher and Bald Eagle. No specific waterfowl shorebird surveys were completed in 2018, however during Bald Eagle surveys, additional bird species were recorded as incidental observations. These include Ring-billed Gull (Larus delawarensis), Herring Gull (Larus argentatus), Great Black Back Gull (Larus marinus), Redhead (Aythya Americana), Canada Goose (Branta Canadensis), Scaup sp. (Aythya sp.), Common Merganser (Mergus merganser) Common Goldeneye (Bucephala clangula) and Mute Swans (Cygnus olor).



Winter Raptor

Data was collected to monitor habitat use by Bald Eagles (Haliaeetus leucocephalus) and other raptors in the vicinity of the Bruce Power site. Bald eagles are currently listed as 'Special Concern' in Ontario and are an important indicator of ecosystem health. Wildlife investigations included effort in winter 2018/19 to document the extent and use of wintering habitat for raptors in general, and Bald Eagle specifically. Surveys for this study were completed throughout the late fall/winter period including the months of November 2018 through February 2019.

Combinations of roadside and pedestrian surveys were used to access survey areas. Care was taken to avoid unnecessary disturbance to wildlife (e.g. wintering deer) in this vulnerable time of year, and as such, surveys were conducted from suitable vantage points.

General raptor surveys targeted a combination of forest edges and open habitat. The seven observation sites remained the same as the 2016-17 locations. The highest observations of Bald Eagles occurred on Feb. 20, 2019, when 45 raptors were documented across all sites. Station #6 (southeast section of Baie du Doré) observed more Bald Eagles than any other station, totaling 26 individuals.

Raptor wintering areas were surveyed on three visits in early 2018. Surveys were conducted in the same manner as those in 2016 – 2017 in open or meadow areas adjacent to woodlots, by scanning the trees and the ground, watching for movement for 20 to 30 minutes at each location.

Raptor wintering areas were surveyed on three visits in early 2018. Surveys were conducted in the same manner as those in the prior two years, in open or meadow areas that were adjacent to woodlots, typically by scanning the trees and the ground and watching for movement for 20 to 30 minutes at each location.

Stream C Redd

The presence and success of spawning salmonids indicates the watercourse has the necessary environmental conditions to promote healthy spawning/hatching and rearing, including substrate, temperature and flow regimes. Spawning salmonids move up streams and make an impression in coble clearing gravel to form a nest, called a red. Redd count monitoring takes place in the early spring and the late fall, when local salmonid populations begin upstream migrations into their chosen cool- and cold-water spawning streams. Redd surveys are a tool for assessing the productivity and health of a watercourse. Redd surveys provide a population and species diversity estimate.

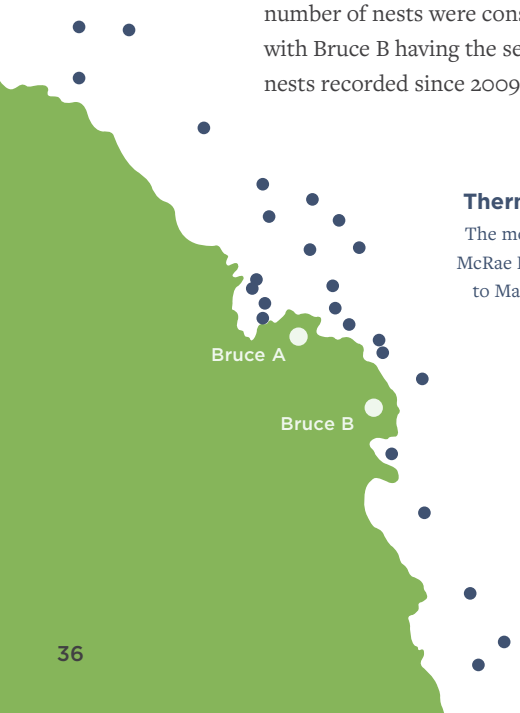
A total of three spring and five fall surveys were completed in 2018. Fewer surveys were completed in spring due to several days of high and turbid water impeding visibility. Thirty Rainbow Trout redds were recorded in the spring. In the fall, 10 Chinook salmon and 27 Coho salmon redds were observed. In comparison a total of four spring and fall surveys were completed in 2017. Spring surveys resulted in a total of four active Rainbow Trout redds, and the fall surveys resulted in a total of 20 active redds, four Chinook salmon and 16 Coho salmon.

Smallmouth Bass Nesting

Smallmouth bass have consistently nested in the Bruce A and Bruce B discharge channels and in the nearby Baie du Doré. After the fertilized eggs are deposited, the adult males remain to guard the nest until the dispersal of fry. As this species is directly exposed to thermal discharge for a number of weeks (adults guarding a sensitive life stage (developing embryos)), it is considered a valued ecosystem component and has received in-depth monitoring since 2009.

Smallmouth bass nesting surveys continued in 2018 at Bruce A and Bruce B discharge channels and in Baie du Doré. Temperature loggers were placed at each location and nests were monitored throughout the season (late April to mid-July) to observe nest development and success.

Monitoring results have shown that nests are observed in consistent geographic locations each year and that nesting is successful at all three locations. Nests are monitored from the egg stage through risen fry, with fry dispersal indicative of successful completion of the nesting stage. Surveys in 2018 showed that the total number of nests were consistent with previous years, with Bruce B having the second highest number of nests recorded since 2009.



Thermal Logger Locations
The monitoring stations span from McRae Point, south of the Bruce site, to MacGregor Point to the north.

The number of successful nests at each location remains high. The assessment of many years of monitoring is that environmental factors play a larger role in nesting success rates than site operations.

This monitoring program demonstrates these areas are suitable habitat for Smallmouth Bass during its most vulnerable and immobile life stage and that this species continues to be successful during thermal conditions present as a result of normal operations at Bruce Power.

Lake Interactions

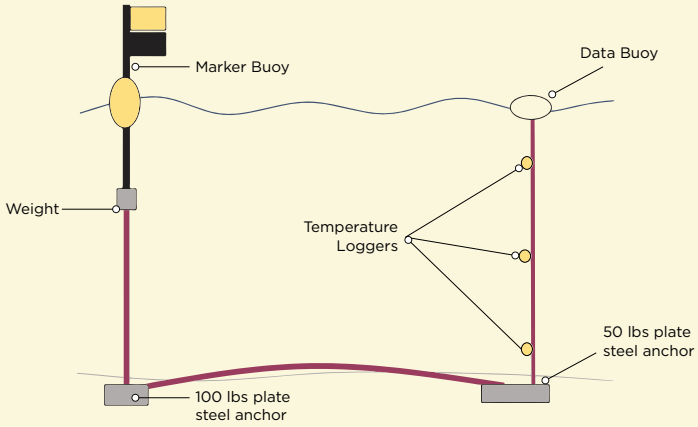
The water temperature at Baie du Doré is predominantly due to shallow depths rather than a contribution from Bruce A discharge. Conservative benchmarks that are species and lifestage specific along with multiple years of data conclude that thermal effluent has little to no risk to fish.

Thermal Emissions

Bruce Power uses the cold water of Lake Huron in once-through cooling systems to remove excess heat generated during electricity production. Water is drawn in at deep, offshore intakes and pumped through Condenser Cooling Water systems where heat is transferred; the warm water is then returned to the lake via the Bruce A and B discharge channels. Discharges from the Bruce A channel are directed to the north and into relatively shallow waters, which generally remain above eight-metre depths for a distance of about two kilometres. Discharges from the Bruce B channel are directed to the north and into generally deeper waters than at Bruce A. These warmer discharges have the potential to affect aquatic biota and habitat and are monitored annually.

Thermal Logger Details

Bruce Power has implemented a monitoring network of loggers since 2011, which builds on historic monitoring.



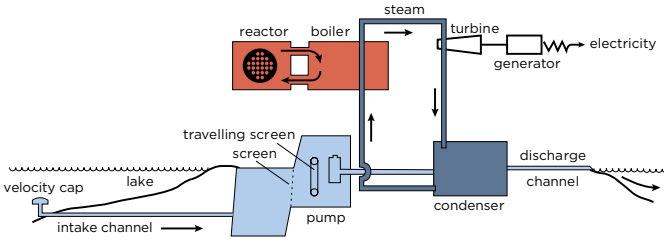
The discharge temperatures from Bruce A and B are regulated through Environmental Compliance Approvals (ECAs) issued by the Ontario Ministry of Environment Conservation and Parks (MECP). The ECAs for Bruce A and B stipulate maximum temperature increases between the intake and discharge. For Bruce A, the ECA also specifies maximum discharge temperature. This limit has not changed since it was established in 1979; however average water temperatures in the Great Lakes have increased over the last four decades, challenging Bruce Power's ability in recent years to provide electricity to the province while remaining in compliance with the ECA, especially during the summer months when energy demand is greatest. During the last five years (2013-17), Bruce Power has operated under two temporary amendments of the ECA that permitted operational flexibility during the peak ambient temperature window (June 15-September 30). During this 108-day period, operational flexibility allowed for a 2.3 C increase in effluent temperature limit for up to 30 aggregate days, and for no more than 15 consecutive days for each event. In 2018, Bruce Power applied for and received a longer term amendment to the ECA for operational flexibility for a period of five years. It expires December 2023.

Physical monitoring of the lake temperature and water currents have been carried out both pre- and post-operations at Bruce Power, in support of Environmental Assessments monitoring requirements and ECA conditions. Since 2012, Bruce Power has continuously monitored year-round lake temperatures and current velocity in the nearshore aquatic environment. Deployment of a number of temperature monitoring sites (25-38) occur each year.

Thermal Effects Mitigation

There are already a number of mitigation measures incorporated into the facility design to minimize thermal effects. These have been considered inherently as part of previous EAs and within the ERA framework. The location of Bruce Power, situated on the Douglas Point headland, was strategically selected because of its high energy zone with access to cold, deep water. The headland juts into Lake Huron, providing an optimal feature to promote 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. The placement and orientation of the intake and outfall structures at each station effectively minimize the physical (flow and temperature) and ecological (fish response) changes to the water body.

Bruce Power continues to identify and evaluate potential mitigation strategies that would further reduce thermal impact on the environment, if deemed necessary to prevent adverse effects under future environmental constraints, such as climate change. Additionally, Bruce Power is conducting a mitigation review in 2019. Several alternatives have already been considered, including increased flow rates, cooling basins, recirculation of water from intake forebays, redirected discharges and cooling towers. Of these alternatives, some would decrease the size of the plume at the expense of increasing impact to fish. At this time, the studies completed by Bruce Power, consultants, and independent research professionals, suggest that existing mitigation measures incorporated into the design of the facility are best available technology economically achievable (BATEA). These findings are further supported by the detailed quantitative risk assessment for thermal effects, which indicates that Bruce Power's impact to the Lake Huron fishery is very low, and additional mitigation measures are not currently warranted.



Impingement – happens when adult fish and larger juveniles become trapped against water intake screens.

Entrainment – happens when small organisms, like eggs and small juveniles, fit through the water intake screens.

Impingement and Entrainment

The Bruce Power generating station uses cold, deep Lake Huron water in a once-through cooling system to cool the power stations and supply other operational needs. More than 99.95 per cent of the lake water is immediately returned to the lake through surface discharges. The remainder is used for boiler make-up water and sanitary and domestic uses, and is eventually returned to the lake after domestic wastewater is treated.

Bruce Power operations do not damage fish habitat, but some adults, juveniles and eggs are drawn into the stations with the lake cooling water. Adult fish and larger juveniles become trapped against water intake screens, the resulting fish loss is called 'impingement.' Organisms small enough to fit through the intake screens (eggs and small juveniles) travel through the cooling system and back out to the lake. This fish loss is called 'entrainment.'

Extensive monitoring is conducted at Bruce Power on a continuous basis to document and quantify fish losses. Impingement sampling is done daily at all Bruce A and Bruce B units, and two years of intensive entrainment monitoring occurred in 2013 and '14. Daily impingement sampling will continue into the future, and another round of entrainment sampling at Bruce A and Bruce B is planned for 2023-24, which is anticipated to be a condition of Bruce Power's Fisheries Act Authorization. Future monitoring is closely following guidance provided in the recently published CSA Standard N288.9-18, which incorporates internationally recognized best practices for impingement and entrainment monitoring.

Recent modelling work with lake currents has shown the maximum area that has the potential to influence entrainment by drawing fish eggs and small larvae (<5mm) towards each intake is 0.15 km2. Beyond this area, the influence of the water intakes is overcome by natural lake currents. Further, water is discharged through channels that were constructed to dissipate velocity and thermal effluent, and thereby mitigate physical and ecological impacts. Velocity modeling of the discharge waters shows that operations do not displace fish eggs and larvae away from critical habitat. This was studied historically by Ontario Hydro and more recently by Bruce Power.

The nearshore currents primarily travel in a north to northeast direction, parallel with the shoreline, and the currents are weakest in the spring when the majority of eggs and young larvae are present.

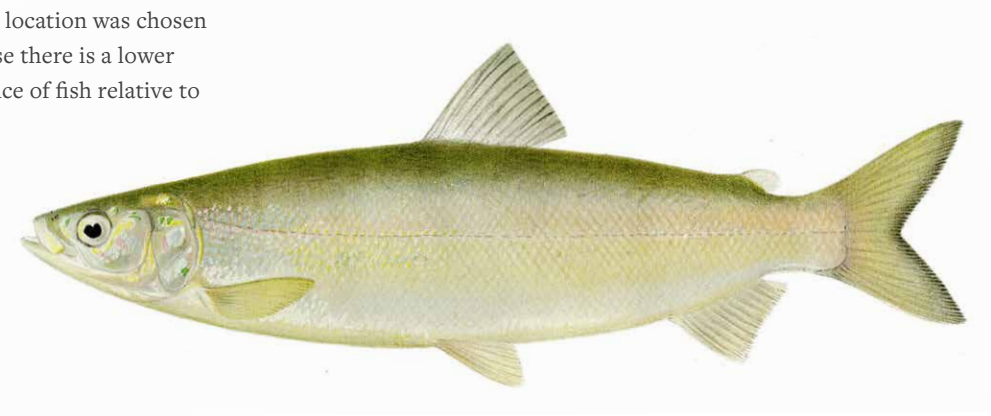
Fish Mitigation

Impingement and entrainment are minimized at Bruce Power using a series of avoidance and mitigation strategies that have been in place since the beginning of operations. The station is situated on the Douglas Point Headland, which is a high-energy location that extends out into Lake Huron with a sharp drop in the lake bottom. This physical landform is characterized by intense wind, waves and ice scouring, and this limits the formation of fish spawning beds. The headland location was chosen for the nuclear station because there is a lower species richness and abundance of fish relative to other areas in Lake Huron.

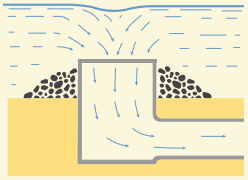
Mitigation strategies are working successfully, and fish losses are reduced to small levels by taking into account environmental, societal, economic, and practical considerations. The estimated average loss of fish at Bruce Power due to impingement and entrainment is 2,400 kg of age-1 equivalent fish annually, or 2,050 kg of fish/year expressed using the Habitat Productivity Index. This amount is small, and similar to the amount of fish harvested by a single commercial fishing vessel on the Great Lakes over one to two days.

Deepwater Intakes

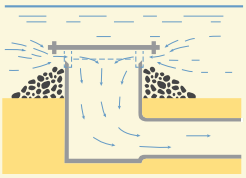
The cooling water intakes sit on the lake bottom, far offshore in the deep water, and this helps to avoid impingement and entrainment. The Bruce A intake is 11 metres deep and 550 m offshore, while the Bruce B intake is 14 m deep and 830 m offshore. This far exceeds the minimum required distance of 244 m that is set by the United States' Environmental Protection Agency. Velocity caps are installed over the water intakes at Bruce A and Bruce B, and these reduce fish loss by slowing down the speed of water entering the intakes and changing from a vertical velocity to a horizontal velocity that fish can more readily sense. This results in juvenile and adult fish avoiding the area and therefore fewer individuals are drawn into the intake channel and drawn into the station.



No Cap
Vertical flow traps fish



Capped Intake
Fish can exit a horizontal flow



Velocity caps remain an industry best practice to mitigate fish loss.

Velocity Caps

A chain-rope barrier hangs from the perimeter of the Bruce B velocity cap like a curtain and deters influxes of schooling fish like gizzard shad, rainbow smelt, and alewife. This barrier was shown to be more effective and practical to maintain than other deterrent systems such as rigid fences, strobe lights or air bubbles. Bruce A does not have a chain-rope curtain because the cap was not engineered to withstand the additional weight of the chain, especially during the winter when frazil ice can form and add substantially more weight.

Significant efforts have been made in recent years to verify and ensure that effects on fish and fish habitat from water taking and discharging are properly mitigated. All past Environmental Assessments (EAs) and Environmental Risk Assessments (ERAs) have concluded that station operations do not have a significant adverse impact on local fish populations, or on the local fishery.

This is supported by scientific reviews that show the effects of impingement and entrainment on fish populations and communities are minor compared to other impacts, such as invasive species, overfishing, habitat destruction, and pollution, all of which have a far greater impact on freshwater ecosystems.

As part of the Fisheries Act Authorization, Bruce Power is offsetting its fish losses so there is no net loss of fish productivity as a result of station operations.

This consists of strategies used to offset all fish losses incurred by site operations. Bruce Power has and will continue to provide funds to the OMNRF that will be used to augment their rehabilitation programs. Additionally, Bruce Power is partnering with the Lake Huron Fishing Club and the Municipality of Brockton to complete a partial removal of the Truax Dam on the Saugeen River in Walkerton, Ontario. The dam has long been identified as a major barrier to upstream passage of fish. A partial removal will allow fish passage while maintaining a recreational area for the town.

Monitoring of the fish community began in 2018 and will continue. This consisted of habitat assessments in the main river, both near and farther from the dam location as well as in the associated tributaries. Electrofishing was also completed at all sites. The work is being done following the before-after-control-impact approach. Monitoring will continue post dam removal, being planned for August/September 2019. Results will be analyzed to quantify the biomass gained from the project, predicted to be much larger than that lost via station operations. This work is further supplemented using videographic surveys, redd counts and radiotelemetry to obtain a larger picture of fish movement within the Saugeen River.

6

BRUCE POWER'S

Groundwater Protection and Monitoring

The CNSC and MECP administer groundwater management at nuclear facilities through the application of the Nuclear Safety and Control Act and the Environmental Protection Act. The main objective of the Bruce Power Groundwater Monitoring Program is to evaluate the groundwater quality and conditions at subject wells.

Groundwater Monitoring Program

To monitor groundwater for radiological contaminants (tritium), five groundwater monitoring wells are located at each station between the reactor and the lake, which are sampled semi-annually. Studies confirm that no unmonitored tritium from normal site operations has released into the surrounding environment through groundwater. Additional monitoring is done on site at monitoring wells and off site at residential and municipal wells measuring tritium and gross beta.

As part of regular operations, the Bruce Power site uses hazardous substances (radiological and chemical) that are potential sources of groundwater contamination. Some older facilities do not have secondary containment to catch leaks and overflow and reroute it back into holding tanks that prevent environmental exposure. An Environmental Risk Assessment (ERA) states that the underground movement of contaminants will resolve themselves without intervention. However, groundwater monitoring is required to ensure that contaminant plume migrations follow the long-term prediction of no adverse effects to the environment through groundwater.

Bruce Power has a comprehensive groundwater monitoring program in place, which was developed from studies that took place in the 1990s. OPG began a program to voluntarily perform environmental site assessments at all OPG (then Ontario Hydro) owned facilities in 1995. In 1997, MECP issued a Director's Order requiring Environmental Site Assessment (ESA) plans to be developed to investigate specific sites within specified timelines. In 1998, Ontario Hydro Nuclear (OHN) instituted an Integrated Improvement Plan to assess OHN contaminated lands. Phase I ESA was completed in January 2000, and a Phase II ESA was completed in March 2001. As an outcome of these assessments, a plan was made and implemented to address impacts from past activities.

Additionally, areas were identified for long-term monitoring. This formed the basis of Bruce Power's current groundwater monitoring program. Since the birth of the program, 15 subject sites are actively monitored based on their risk of environmental impact.

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BRUCE POWER'S

Waste Management

Bruce Power manages many different forms of waste, including: hazardous waste (oils, chemicals, lighting lamps and ballasts – some of these are recycled), recyclable waste (glass, plastic, metal, cardboard, paper, wood, batteries, and electronics), organic waste (compost), and landfill waste.

Bruce Power also manages radioactive waste in partnership with Ontario Power Generation (OPG).

Conventional Waste Management and Reduction

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 because, 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 lifecycle approach in that we reduce waste at the consumer level, generate less waste at the company level, find opportunities to reuse products (on- and off-site donations, auctions, etc.), 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 a number of 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.

The total amount of conventional waste produced in the last three years at Bruce Power has remained relatively constant. In 2018, 1,967 metric tons of conventional waste was generated, which was nearly identical to the 2016 value and a 9.6 per cent increase from the 2017 total value. On a per capita basis, there is an encouraging downward trend in the amount of waste generated per person, which indicates that waste reduction measures employed across the company are successful. The waste generated in 2017 and 2018 was 13 per cent and 15 per cent below the rate generated in 2016, respectively.

Radioactive Waste Management and Reduction

Radioactive waste volumes are managed and minimized through effective material management, decontamination and segregation techniques, and by using the principles of reduce, reuse, and recycle whenever possible. Radioactive wastes are processed in a safe, environmentally responsible manner that recognizes key factors such as 'As Low As Reasonably Achievable' (ALARA) principles, environmental footprint reduction, and full compliance with regulatory requirements.

In 2017, overall low level radioactive waste volumes were eight per cent less than planned, resulting in the highest percentage of volume reduction for low-level waste in recent years. Bruce Power will continue to focus on improved waste minimization and prevention initiatives to continue this trend through 2018.

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BRUCE POWER'S

Environmental Risk Assessment and Predictive Effects Assessment

Since 2000, activities undertaken at the site have been subject to environmental protection and assessment under the Nuclear Safety and Control Act. To support licence renewal, Bruce Power prepared and submitted an Environmental Risk Assessment (ERA) and Predictive Effects Assessment (PEA) in 2017 and this was updated and resubmitted in December 2018.

An ERA is a systematic process used to quantify and characterize the risk posed by contaminants and stressors on the environment. The objective of an ERA is to evaluate the risk to humans and the environment from potential effects from the site operation (in this case, the continued operation of Bruce A and B, including Major Component Replacement, life extension) and to recommend further action or assessment based on the results. The ERA uses a tiered approach starting from a broad evaluation using protective generic parameters and a high degree of conservatism (precautionary approach, overestimated risk) and, in areas where potential risk is identified, progressively developing the assessment towards a more precise analysis (site-specific, realistic and more detailed parameters) with conservatism removed.

The 2017 ERA builds upon previous Environmental Assessments (including the 2015 ERA and Screening Level Assessment).

The ERA provides an understanding of the effect of operation on the environment by analyzing the data collected by the monitoring programs (effluent, environmental, and groundwater). All of the programs follow a systematic approach that results in evaluated aver a spatial and temporal scale. The ERA represents the culmination of decades of environmental monitoring at the site. The ERA was prepared by Bruce Power to support the CNSC's completion of the EA under the Nuclear Safety Control Act and licence renwal. The ERA was prepared to determine and evaluated using existing monitoring and assessment data.

Bruce Power's ERA was developed using widely accepted procedures and best practices in the nuclear industry for pathway analysis, exposure and dose derivation, and risk characterization. The guiding document for development of the ERA was the Canadian Standards Association (CSA) Standard N288.6-12, ERA at Class I Nuclear Facilities and Uranium Mines and Mills. This CSA Standard incorporates best practices used in Canada and internationally.

The ERA included a Predictive Effects Assessment (PEA) to help define potential effects before an activity is initiated in order to ensure that potential effects that could occur are acceptable. The approach applied in the PEA was a modification to the tiered assessment process defined in CSA Standard N288.6-12.

The PEA considered the future operation of the site until 2064, however, was most focused on activities within the next 5–10 years, as per the ERA life cycle.

Overall, the ERA concluded that the risk from existing and future physical stressors, and from radiological and non-radiological releases to the environment from the Bruce Power site, is generally low to negligible. Potential environmental effects of future activities are anticipated to be similar to those of existing operations and/or those observed during the refurbishment of Units 1 and 2. Furthermore, current Environmental Monitoring Programs are robust and will be maintained. Consideration of cumulative effects and changes in climate in the long term, are described further below.

Cumulative Effects

The Bruce site is composed of operations and facilities from Ontario Power Generation, Bruce Power, Hydro One and Canadian Nuclear Laboratories. Additionally, Kinectrics and Seven Acres have operations and facilities in the vicinity of the Bruce site.

Bruce Power acknowledges the need to address the cumulative environmental effect of multiple stressors when and where it is warranted. 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. Where cumulative stressor results are available, none have been found to result in measureable impact at the levels emitted from site operations.

Thus 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. Where cumulative stressor results are available, none have been found to result in measureable impact at the levels emitted from site operations or facilities. More than 40 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.

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Climate change

Bruce Power continually considers climate change in relation to long-term planning, as well as in response to concerns raised by First Nation, Métis and non-Indigenous community members.

This approach has evolved with the current state of the science and best practices. In accordance with Federal- Provincial-Territorial Committee on Climate Change and Environmental Assessment [FPTCCCEA, 2003] guidance, climate change is considered from two perspectives:

- How the operations affects climate change (*through the reduction in emissions of greenhouse gases*).
- How a changing climate affects operations (*through changes in the expected weather patterns and extreme events*).

Assessments have been conducted since 2004, in which encompass life extension and major component replacement of Bruce Power nuclear units. Nuclear energy provides a less carbon-intensive power source than fossil fuel-based sources. Even with the consideration of short-term construction emissions,

the emissions of greenhouse gases (GHGs) are very small or negligible in comparison to the Ontario power sector's total emissions. As noted in the assessments, there are long-term benefits of reduced GHG emissions during operation due to the displacement of higher carbon intensity fossil fuel derived power.

Bruce Power has also long considered the vulnerability of its operations, and the surrounding environment, to climate change. This started with the New Fuel Project EA, and continues with Bruce Power currently incorporating climate change considerations as part of the ERA and PEA process to support long-term planning, through understanding of conditions.

In general, recent current climate norms and trends (between 1981 and 2010) suggest that current climate is likely to become warmer with shifting precipitation regimes over time. The observed rate of decadal change is much less than the seasonal variability currently experienced at site. This implies the changing climate under current conditions is occurring very gradually and not likely to have an acute impact.

Further work to assess the temperature changes associated with combined operational and atmospheric effects under projected climate change conditions is being carried out and will continue to be refined with the support of ongoing physical and biological effects monitoring data. Where the potential for significant adverse effects due to climate change is identified, suitable operational mitigation measures will be identified and implemented as required.

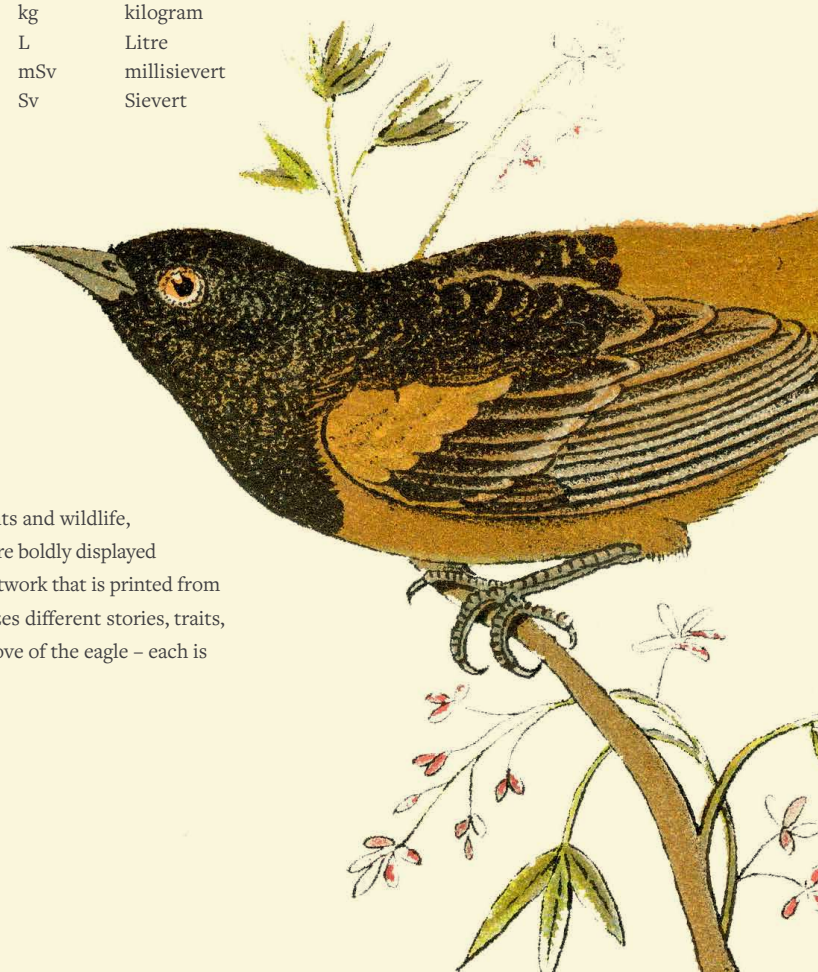
In addition, Bruce Power is currently discussing climate studies with the CANDU Owners Group (COG). Bruce Power also recently established a partnership with the Council of the Great Lakes Region to help evaluate the effects of climate change in the longer term at an ecological and socio-economic level for the region.

List of Acronyms and Abbreviations

ALARA	As Low As Reasonably Achievable
CCW	Condenser Cooling Water
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DFO	Fisheries and Oceans Canada
DRL	Derived Release Limit
EA	Environmental Assessment
EA FUP	Environmental Assessment Follow-Up
EAL	Environmental Action Level
ECA	Environmental Compliance Approval
EM	Environmental Monitoring
EMS	Environmental Management System
ERA	Environmental Risk Assessment
ESA	Environmental Site Assessment
FPS	Fixed Point Surveillance
GHG	Greenhouse Gas
HC	Health Canada
HSM	Historic Saugeen Métis
ISO	International Organization for Standardization
LWF	Lake Whitefish
MCR	Major Component Replacement
MECP	Ministry of the Environment, Conservation and Parks
MNO	Métis Nation of Ontario
MOL	Ministry of Labour
MW	Megawatts
NCs	Non-Conformances
NSCA	Nuclear Safety Control Act
OBT	Organically Bound Tritium
OFI	Opportunities for Improvement
OMNRF	Ontario Ministry of Natural Resources and Forestry
OPG	Ontario Power Generation
PCB	Polychlorinated Biphenyl
POI	Point Of Impingement
PROL	Power Reactor Operating Licence
PTTW	Permit to Take Water
REM	Radiological Environmental Monitoring
RWF	Round Whitefish
SEA	Significant Environmental Aspects
SON	Saugeen Ojibway Nation
SWH	Significant Wildlife Habitat
WCTF	Waste Chemical Transfer Facility
WSP	Water Supply Plant
µSv	mi=crosievert
Bq	becquerel
Gy	Gray
kg	kilogram
L	Litre
mSv	millisievert
Sv	Sievert

About the Artwork

The Bruce Power site is home to more than 500 species of plants and wildlife, so it is fitting that we pay homage to these unique animals that are boldly displayed on the pages of this book. The illustrations are lithographs, an artwork that is printed from a stone block onto paper. Each animal represents and symbolizes different stories, traits, personalities and values – from the courage of the bear, to the love of the eagle – each is strongly connected to our natural environment.



Learn more

Learn more about Bruce Power's Environmental Programs at **https://bit.ly/2BydkaS.**

Bruce Power
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