Summary of the Bruce Power Environmental Risk Assessment

Background

The impacts of Bruce Power operations and associated activities to execute life extension work are very well understood through a number of well-documented reviews. Overall, the impacts of the site on the surrounding environment are very low and do not cause any significant adverse environmental impact as concluded in this ERA and many past reviews. By demonstrating the minimal impacts of the facility and meeting other requirements associated with safe operation, Bruce Power has been granted Licences to operate on an incremental basis by the Canadian Nuclear Safety Commission (CNSC).

The design and use of mitigation technologies have been implemented to minimize impacts to the greatest extent possible. The Bruce sites 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. Bruce Power has measured and evaluated the results of the past activities in relation to Bruce A restart of Units 3 & 4 and Refurbishment of Units 1 & 2; this extensive evaluation program has positioned us well to predict the potential impacts of Major Component Replacement (MCR) activities This experience, and improved processes and materials, has further enhanced the rigour of our current Environmental Risk Assessment (ERA) Process. Prior Environmental Assessments (EA) and Follow-up Monitoring Programs confirmed that there were no unreasonable risks to the natural environment from either restart or refurbishment work. The ERA included an evaluation of the MCR operational scenario; with this and our normal operations out to 2064 the ERA concluded:

- For human health there are no radiological or non-radiological risk to members of the public near Site or visitors to the on-site Indigenous burial ground
- For ecological health, there are no radiological or non-radiological risk to wildlife or the environment
- All activities are within bounds and do not require further Tier 3 assessment
- No interactions were identified that pose a risk to humans or the environment
- Potential impacts of future activities are anticipated to be similar to those of existing and predicted operations and as a result would not cause any significant adverse environmental impact
- Current environmental monitoring programs are sufficient and will be maintained

The ERA process is meant to provide an on-going analysis of a company's interaction with the environment enhancing oversight from the previous process where a single EA and follow-up program would have been required. Allowing for annual touch points through our Environmental Monitoring Program as well as an in-depth review every 5 years, both which are stringently reviewed by regulatory bodies.

Bruce Power complies with Federal Regulations, programs, and standards, which protect human health and the environment under the Nuclear Safety and Control Act. The Class I Nuclear Facilities Regulations under the Nuclear Safety and Control Act set out requirements related to environmental protection that must be met. The General Nuclear Safety and Control Regulations 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 and into the environment as a result of the licensed activity.

Monitoring is executed to fulfill regulatory requirements on environmental protection in accordance with the Licence Condition 3.3 of the Bruce A and Bruce B Power Reactor Operating Licence. Monitoring encompasses the following specific areas: effluent and emissions control (releases), an Environmental Management System (EMS), provisions for protection of the public and the natural environment, which is commensurate with risk evaluated in the ERA. As such, the Environmental Monitoring Report describes the effluent and environmental monitoring related to the Bruce Power's operations. Monitoring includes radiological and non-radiological hazards and quantifies the effect on human and non-human biota.

Radiological and non-radiological emissions from the Site are well within regulatory limits and requirements, which are set to protect the public and environment. With respect to non-radiological emissions, Bruce Power is in compliance with applicable Provincial regulations, approvals, and permits. With respect to radiological airborne emissions and liquid releases, derived release limits (DRLs) have been developed by Bruce Power to ensure release limits to the environment will not exceed the annual regulatory public dose limit of 1 mSv; furthermore, Bruce Power has established action levels that are set at approximately 10% of the DRLs. Action levels, if reached, could indicate a loss of effectiveness of containment and effluent control and the need for specific actions to be taken and reported to the CNSC. In 2016, all releases were below the DRLs and action levels.

As a result, for the 25th consecutive year Bruce Power's calculated dose to a member of the public is less than the 10 µSv/y value that is regarded as the lower threshold for significance (the de minimus).

The CNSC, when considering relicensing, has an obligation through the Nuclear Safety and Control Act to consider whether an application will, in carrying on that activity, 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, the following environmental protection regulatory documents and CSA standards are relevant to the CNSC's regulatory framework for environmental compliance:

- CAN/CSA ISO 14001 Environmental Management Systems – Requirements with Guidance for Use
- CSA N288.1-14 Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities

- CSA N288.4-10, Environmental Monitoring Program at Class I nuclear facilities and uranium mines and mills
- CSA N288.5-11, Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills
- CSA N288.6-12, Environmental Risk Assessments at Class I nuclear facilities and uranium mines and mills
- CSA N288.7-15, Groundwater Protection Programs at Class I nuclear facilities and uranium mines and mills

An annual review of environment monitoring is completed. As part of the review, the inherent uncertainties and assumptions are evaluated to determine if further monitoring or supplementary studies are needed as part of continual improvement. This is reported through the annual Environmental Monitoring Program (EMP) findings.

Comprehensive environmental monitoring programs have been in place for nearly 40 years, since the pre-construction phases of Bruce A and Bruce B. This monitoring continued throughout construction and operation phases and several comprehensive assessments have been conducted over the years to ensure ongoing on-site and off-site environmental protection. This includes the Bruce Power Development Ecological Effects Review (OPG 2000), monitoring associated with EAs completed since 2001 under the Canadian Environmental Assessment Act (e.g., for the Restart of Bruce A), as well as associated EA follow-up programs, environmental permitting and environmental monitoring. In the last 20 years alone these have included:

- 2017 Environmental Quantitative Risk Assessment
- Annual Environmental Assessment Follow-up Monitoring Reports for Unit 1&2 Restart (2007-2015)
- Annual Environmental Monitoring Program Reports (pre 2001 to present)
- 2015 Environmental Quantitative Risk Assessment
- 2008 Environmental Impact Statement for the Bruce New Nuclear Power Plant Project
- 2006 EA Study Report for the Bruce A Refurbishment Project (Units 1&2 Restart)
- 2004 EA Study Report for the Bruce B New Fuel Project
- 2001 EA Study Report for the Bruce A Units 3&4 Restart
- 2000 Bruce Nuclear Power Development Ecological Effects Review
- 1999 Bruce B Environmental Effects Report for Units 5-8
- 1998 Phase 1 Environmental Site Assessment for the Bruce Heavy Water Plant
- 1997 Phase 1 Environmental Assessment Bruce Nuclear Power Development
- 1997 Bruce Used Fuel Dry Storage Facility Environmental Assessment

Over the past 15 years Bruce Power has gained a significant amount of experience in the restart and refurbishment of its CANDU reactors. Work to define the activities to be undertaken during the next licensing period, including MCR activities, is underway. It is anticipated that a number of valuable lessons learned will be applied as MCR activities progress. The applicable Bruce Power environmental management programs, along with how they may evolve through MCR and continued station operations. Overall, potential environmental effects of future activities are anticipated to be similar to those associated with the existing operations.

Environmental protection for nuclear facilities and activities is done in accordance with the Nuclear Safety and Control Act and the regulations made under it. Expectations for environmental protection considerations as part of licence applications are outlined in CNSC's REGDOC-2.9.1 Environmental Principles, Assessments and Protection Measures. The Environmental Risk Assessment (ERA) supports environmental protection throughout the regulatory lifecycle of a facility or activity and forms the basis of an EA under the Nuclear Safety and Control Act. This ERA is one document of many others submitted as part of the overall licence application.

The first ERA under was submitted to the CNSC in February 2015 as part of the implementation of CSA Standard N288.6-12. The 2015 ERA was the first iteration under the new standard (the first edition of CSA N288.6 was in 2012) and was submitted for the purposes of discussing environmental risks in terms of the tiered approach (Tier 1, 2, 3). The CNSC reviewed the 2015 ERA and determined that it met the requirements of N288.6-12 and with 3 recommendations, all of which have been incorporated into the June 2017 ERA and further explained in the October ERA supplement. The recommendations were: 1) Bruce Power initiate a dialogue with Indigenous groups on country foods; 2) include a discussion on morpholine exposure route uncertainties; and 3) identify any monitoring needs to fill data gaps, to validate modeling results and to verify major assumptions to reduce uncertainty in future human and ecological assessments. Details supporting these recommendations were provided in 24 comments and responses to these comments are contained in Appendix L of the June 2017 ERA.

The ERA was prepared in accordance with the Preliminary Quantitative Risk Assessment (PQRA) approach described in CSA Standard N288.6-12. The purpose of the ERA is to systematically identify potential risks to either human health or the environment as a result of historical and ongoing operations at the Site (i.e., those from the Bruce Nuclear Facility), including determination of the magnitude and extent of the potential effects associated with the Site. The ERA considers potential modifications to the current monitoring commitments for the Site while upholding the requirements described in CSA Standard N288.4-10 entitled Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills and CSA Standard 288.5-11 entitled Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills. The primary intent of this examination is to provide a risk-based rationale for the relative priority of monitoring for effects or sampling specific media for analysis as part of Environmental Monitoring. As per its Environmental Management System, Bruce Power strives to continually improve the Environmental Protection Program. Predominantly, this refers to environmental and effluent monitoring which are based on CSA

Standards N288.4-10 and N288.5-11, respectively. As required by these Standards, Bruce Power routinely reviews, assesses and as necessary, revises its environmental and effluent monitoring design and processes. The ERA is one of the inputs to this routine review and assessment, and therefore will be considered as necessary as part of the review and assessment process. Any corrective action that is identified will be managed in accordance with existing adaptive management procedures at Site.

A Predictive Effects Assessment (PEA) has also been prepared to demonstrate consideration of environmental protection during future site activities, including MCR activities. The PEA, essentially a predictive ERA, has been prepared following the guidance of CSA N288.6-12 (see B-REP-03443-29JUN2017-02). It provides sufficient information to the CNSC to support their preparation of an EA under the Nuclear Safety Control Act as indicated in REGDOC-2.9.1. The information provided in the PEA is as per the known status of projects as of June 1, 2017. Existing environmental monitoring will be retained as required to confirm predictions and be reported through the annual Environmental Monitoring Program (EMP) findings, which have been in place since 2001.

One of the benefits of using the ERA construct is the regular check-in points with regulators and the public as an ERA reoccurs every 5 years on an ongoing basis. This gives all parties an opportunity to contribute and identify concerns. This process allows for the identification of emerging trends and identifies any new risks that may arise, which is a further enhancement from past assessment processes. Indigenous groups and other members of the public had the opportunity to participate in and provide feedback on many of these recent impact assessments and will continue to do so in the future. We are actively engaging and providing Indigenous groups and the public opportunities to discuss topics of interest such as thermal effluent and impingement and entrainment of fish. However, this dialogue is not new and the company's future operations will not different from what has been experienced and monitored since 2001 and the company is confident in its conclusions and will continue to monitor and confirm the facility operates within these limits.

As outlined earlier, prior Environmental Assessments are a one-time process, are only triggered when a major change to operations is proposed, and predictions are verified with a follow-up monitoring program that does not need to follow the construct of the CSA N288 suite. The new process combines the one-time rigour of the previous process with an ongoing requirement that continually verifies performance in a number of important areas. This includes issues of concern to Indigenous groups, such as impacts on Lake Whitefish specifically and Lake Huron generally.

In recent years, Bruce Power has further enhanced its understanding of its physical, thermal, and impingement and entrainment impacts on fish and Lake Huron through comprehensive monitoring, research and broad engagement in this area of study. This has gone well beyond what required as part of this process but the company recognized the importance of this issue and has demonstrated leadership, responsiveness and thoroughness in this regard.

Avoidance and mitigation measures in place at Bruce A and Bruce B have minimized impingement and entrainment losses to the greatest extent possible based on very effective designs that minimize the impact of the plant on the environment and the water and fishery specifically. Large-diameter velocity caps slow the water velocity entering the intake to ~15 cm/s, and thereby significantly reduce the magnitude of fish impingement. This technology meets the requirements established under section 316(b) of the US EPA's Clean Water Act for power generating facilities. Although there are no comparable Canadian regulations that provide prescriptive requirements for power generating facilities, velocity caps remain an industry best practice which is in place at Bruce Power.

Fish entrainment is also reduced via slowed velocities at the intake using the cap compared to not having this measure in place. Velocity modeling of the discharge waters has shown that we are not displacing fish eggs and larvae away from critical habitat. The maximum area surrounding the water intakes that has the potential to influence entrainment of fish eggs and larvae ≤5 mm long by drawing them towards the intake is <0.13 km^2. The entrainment of eggs and larvae is unaffected by avoidance technologies such as lights or sounds because these life stages are not motile. Alternative mitigation technologies to further reduce impingement and entrainment have been considered (i.e. bubble curtain, wedgewire screens, lights, sounds), but none are more effective and suitable for the Site than the existing velocity caps. A discussion of this is found in the Fisheries Act Authorization application that has been shared with Indigenous groups.

Values of annual losses for all fish species equate to ~3300kg of biomass lost from the lake annually, which is equivalent to a good day or two of harvest by a commercial vessel. Using the Foregone Fishery Yield Model, impingement and entrainment losses of local commercial species (Lake Whitefish, Lake Trout, Walleye, and Yellow Perch) equates to ~1% of the SON's annual total catch limit for Lake Whitefish alone in the Lake Huron Fisheries Management Zone 1.

The Bruce A and Bruce B intakes are situated offshore, in deep water to provide cold water for once-through cooling. Almost all of this water (>99.95%) is returned to the lake at the discharge channels. The channels were designed and constructed to dissipate thermal effluents to mitigate physical (flow, temperature) and ecological (fish response to thermal effluent) changes to a minimum. Effluents are direct towards the natural along shore water currents and their physical footprint is kept to a minimum (i.e. nozzle jet at Bruce B). These design considerations were used to reduce the impact of the thermal discharge to the environment and based on analysis and years of operating experience demonstrate a minimal effect on the environment.

There are a number of other mitigation technologies possible that may lower the potential effects of thermal effluents to the lake. Of these options, some would decrease the size of the plume (at the expense of increasing the temperature), while others would lower the temperature of the waters entering the lake. Options include altering the intake or outfall structure, changing operational mechanisms such as flow rate or water circulation and using external cooling systems such as cooling basins or towers. These mitigation strategies have been considered by Bruce Power and shared with regulators and community groups. Overall, it was determined by Bruce Power that these additional steps were not feasible due to potential for negative environmental impacts, minimal benefit in terms of thermal effluent dissipation and space limitations. What we have learned from years of environmental monitoring data and a number of environmental assessments is that there is a low risk to local fish species from thermal discharge and the alternate cooling technologies are not warranted or feasible.

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. As climate change prediction models become more advanced and/or the environment changes, the ERA will continue to be updated to determine how and if such change impacts the operation of Bruce Power's facilities and, if required, review what changes are necessary to ensure continued environmental protection.

Finally, Bruce Power acknowledges the need to address the cumulative environmental effect of multiple stressors when and where it is warranted. In recent years the effect of multiple stressors has been examined in Lake Whitefish. For example, current research suggests that negative effects of exposure to morpholine and gamma radiation or to heat shock and morpholine are only observed when Lake Whitefish are exposed to levels substantially higher (unrealistic levels tested to elicit a response) than those present in the waters surrounding Bruce Power.

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. 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. 40 years of operations of the Bruce site and continued monitoring has provided empirical evidence of little to no risk to the local environment.

A SUMMARY OF THE OCTOBER ERA SUPPLEMENT

Bruce Power recognizes the importance of the surrounding communities; since its inception it has committed to being a good neighbour and never takes the communities support for granted. Bruce Power also recognizes the fact its nuclear facility lies within the boundaries of traditional territories of Indigenous communities. As such, over the past 16 years the company has worked extensively with the both non-Indigenous and Indigenous communities to evaluate, collaborate, and enhance items of interest in the areas of society, economics, environment, and culture. Bruce Power has always sought to also provide information about its operations in a manner that is understandable and adjusts these as requested through the engagement process.

In June 2017, as part of the overall licence renewal application package, an Environmental Risk Assessment (ERA) was submitted to the Canadian Nuclear Safety Commission (CNSC) for review and comment (i.e., the June 2017 ERA). Prior to this submission in 2016 Bruce Power launched its *Road Ahead* communication strategy which included a publication providing the most up to date information on MCR and licence renewal at that time. Interaction with both Indigenous and Non-Indigenous communities took place, some of the efforts included an engagement session, public attitude surveys as well as a webinar. On July 6, 2017, following the submission to the CSNC, the licence application package which includes the ERA was made available on our corporate website (http://www.brucepower.com/licencerenewal2018/). Later that month a formal letter and a copy of the entire licence package including the ERA and proposed engagement plans were sent to Saugeen Ojibway Nation (SON), Métis Nation of Ontario (MNO) and Historic Saugeen Métis (HSM). Throughout 2017 Bruce Power has continued to dialogue with both local non-Indigenous and Indigenous communities, through a variety of avenues. Recognizing that both non-Indigenous and Indigenous communities have varying rights and interests, requiring different levels of engagement.

Bruce Power is committed to continuous improvement as feedback and new information is received, and has been continuing to update the ERA studies throughout 2017. Updates have been made to the ERA to be responsive to conformity comments from the CNSC as well as information noted as outstanding in the June 2017 version (e.g., spring biodiversity studies, 2016 Statistic Canada data). Bruce Power has taken additional steps to seek further understanding on traditional land use, way of life and traditional knowledge via dialogue with Indigenous communities as well as the review of publically available information. Where applicable this information has been incorporated into the ERA. As information in this area grows the ERA will be updated.

Additional information provided in the October ERA supplement was intended to enhance the June 2017 version of the ERA, and does not change any conclusions of the ERA. The ERA continues to demonstrate that the operation of the Bruce Nuclear Facility has not resulted in significant adverse environmental effects or adverse effects on human health. To demonstrate responsiveness and share information related to ERA activities, a "redline" version of the ERA is provided in Enclosure 1 for supplementary information (i.e., the October ERA supplement). The "redline" indicates text changes between the June 2017 version and the supplementary updates in October 2017 which are indicated with red underlined font for ease of visualizing the updated information. The following sections summarize the changes made to the ERA between June and October 2017, with key new inserted text provided below. A summary of the updates is provided in Table 1, which demonstrates where detail was added, however none of this further review changes the overall conclusion of no unreasonable risk to human or ecological health for non-radiological, physical or radiological stressors.

Where there may be inconsistencies in baseline information in the ERA summaries, the October ERA supplement is the most recent. The conclusions in the predictive effects assessment (PEA) still stand, and there are no material changes to the approach to future site activities, including Major Component Replacement, at this time. As such, an October supplement to the PEA was not needed.

- **Table 1: Summary of updates provided in the October ERA supplement by Section**

Section	Description of change made	Overall outcome
1.0	More detail added regarding previous environmental assessments and context.	Further detail added. No change to overall conclusions.
1.1	Comments regarding the predictive effects assessment (PEA) added.	Further detail added. No change to overall conclusions.
1.3	Issues of concern for the Indigenous communities (SON, MNO and HSM) were updated.	Further detail added. No change to overall conclusions.
1.5	Information already provided in the PEA was included in a new section of the Introduction summarizing ongoing environmental monitoring and effluent monitoring activities. These subsections include the Environmental Management System, Spills and Contaminated Lands, Effluent Monitoring, Environmental Monitoring, Groundwater Protection and Future Standards and Regulations	Further detail added. No change to overall conclusions.
1.6.2	Discussion of the output of the Independent Environmental Monitoring Program was added.	Further detail added. No change to overall conclusions.
2.2.2	Meteorological information updated to include wind, temperature	Further detail added. No change

Section	Description of change made	Overall outcome
	and precipitation.	to overall conclusions.
2.2.5	Plant communities updated to include information collected in 2017.	Further detail added. No change to overall conclusions.
2.2.6	Update to list of mammals, amphibians and terrestrial species at risk observed on site.	Further detail added. No change to overall conclusions.
2.2.7	Aquatic species at risk updated to include Deepwater Sculpin. More information added regarding supplementary whitefish research studies.	Further detail added. No change to overall conclusions.
2.2.8	2016 Statistics Canada data included.	Further detail added. No change to overall conclusions.
2.3.1	Additional information added to areas of previous environmental investigation.	Further detail added. No change to overall conclusions.
3.4.1	Additional rationale for including hydrazine as a COPC.	Further detail added. No change to overall conclusions.
3.4.2	Clarification regarding 2016 ESDM report.	Further detail added. No change to overall conclusions.
3.4.6	Incorporation of storm water data that became available in 2017.	No change to overall conclusions.
4.1.2.8	Information regarding noise monitoring done in February 2017 was included.	Further detail added. No change to overall conclusions.
5.1.1	Clarification on how reptiles and amphibians were assessed.	Further detail added. No change to overall conclusions.
5.1.1	Species at risk were specified in Table 11. Aquatic VECs were included in Table 12. Species of interest to Indigenous communities were included in Table 12. Receptor descriptions were correspondingly updated.	Further detail added. No change to overall conclusions.
5.1.5	Ecological conception model updated to include physical stressors.	Further detail added. No change to overall conclusions.
5.4.2	Corrections made to Table 40.	No change to overall conclusions.
5.3.1	An expanded summary of research studies on Whitefish was	Further detail added. No change

Section	Description of change made	Overall outcome
	included.	to overall conclusions.
5.3, 5.4	Further clarification or justification of the assessment of thermal effects, impingement and entrainment, habitat alteration and direct mortality was added.	Further detail added. No change to overall conclusions.
5.3.5, 5.4.8	Results from impingement and entrainment modeling were included. Tables were updated to include previously unidentified individuals. A description of the intakes and outfalls were provided. An analysis of uncertainty was added.	Further detail added. No change to overall conclusions.
5.4.5.2	Deepwater Sculpin were assessed in regards to impact from impingement and entrainment.	No change to overall conclusions.
6.1.1.2, 6.2.5,	Further description was added to the hunter/fisherman receptor. Tables and calculations for this receptor were updated.	Further detail added. No change to overall conclusions.
6	All references to CSA Standard N288.1-4 were updated.	No change to overall conclusions.
7	Updated parameters from the ERICA Tool were updated to the most recent version.	No change to overall conclusions.
7.1.1.1, 7.2.5.2, 7.4.1	Red fox chosen as representative of small mammals. Consideration of this species specifically included throughout.	No change to overall conclusions.
7.1.1.2, 7.2.4.2, 7.2.5.2, 7.4.1	On-site waterbody Stream C was added to assess tritium concentrations. Further assessment was carried out and included where applicable.	No change to overall conclusions.
8.1.1	A comprehensive summary of impact from physical stressors was added.	Further detail added. No change to overall conclusions.
8.4	A Forward-Looking Recommendations section was added.	Further detail added. No change to overall conclusions.