From: Virtue,Robyn-Lynne [CEAA]
Sent: March 25, 2013 11:18 AM
To: 'Gunter Muecke'; Jamie.;; DGR Review / Examen DFGP [CEAA]
Subject: OPG report on Lake Huron

Hello Panel Members,

As per your request, I have attached Ontario Power Generation's report titled "DGR – Protecting Lake Huron" for you review.

Thank you,
Robyn

OPG's DEEP GEOLOGIC REPOSITORY PROJECT

For Low & Intermediate Level Waste

DGR: Protecting Lake Huron

ONTARIO POWER GENERATION

PREFACE

Ontario Power Generation (OPG) has completed a four-year program of scientific investigations, analyses and studies to assess the ability of OPG's Deep Geologic Repository (DGR) to safely isolate and contain low and intermediate level waste (L&ILW).

The results of the studies, found in the Environmental Impact Statement, conclude that the DGR is not likely to result in any significant residual adverse effects to human health or the environment, including Lake Huron and the Great Lakes.

This assessment, as it pertains to Lake Huron and the Great Lakes, is based on the following evidence:

- The proposed location of the DGR is about one kilometre inland from the shore of Lake Huron;
- The proposed DGR will put waste 680 metres below ground surface in low permeability limestone rock beneath a blanketing 200-metre-thick layer of low permeability shale. These rock formations provide multiple natural barriers to isolate and contain the waste;
- Most of the L&ILW has short-lived radionuclides, which will decay in and around the repository;
- A small volume of waste contains longer-lived radionuclides. Some of these radionuclides can move towards the surface over thousands of years through slow processes like diffusion. Most of these would decay before reaching surface;
- The deepest point of Lake Huron in the Bruce nuclear site area is at a depth of about 180 metres, such that the laterally extensive multiple natural rock barriers isolate the DGR from Lake Huron;
- The proposed DGR site is located in an area characterized by low seismic activity;
- Studies of pore water extracted from the rock at 680 metres indicate that this rock porewater is highly saline and ancient – that it has been resident for millions of years;
- The maximum calculated dose under a wide range of plausible scenarios is more than one hundred thousand times less than the 0.3 mSv/a public dose criterion – essentially negligible; and
- Much of the waste is already safely managed on an interim basis on the Bruce nuclear site; the DGR provides a safer location for the long term.

The Protecting Lake Huron Report explores how these multiple lines of evidence provide confidence in the long-term safety of the DGR concept. We hope you find it helpful. And for more information about the DGR Project, please visit **www.opg.com/dgr** or contact **www.dgrinfo@opg.com**.

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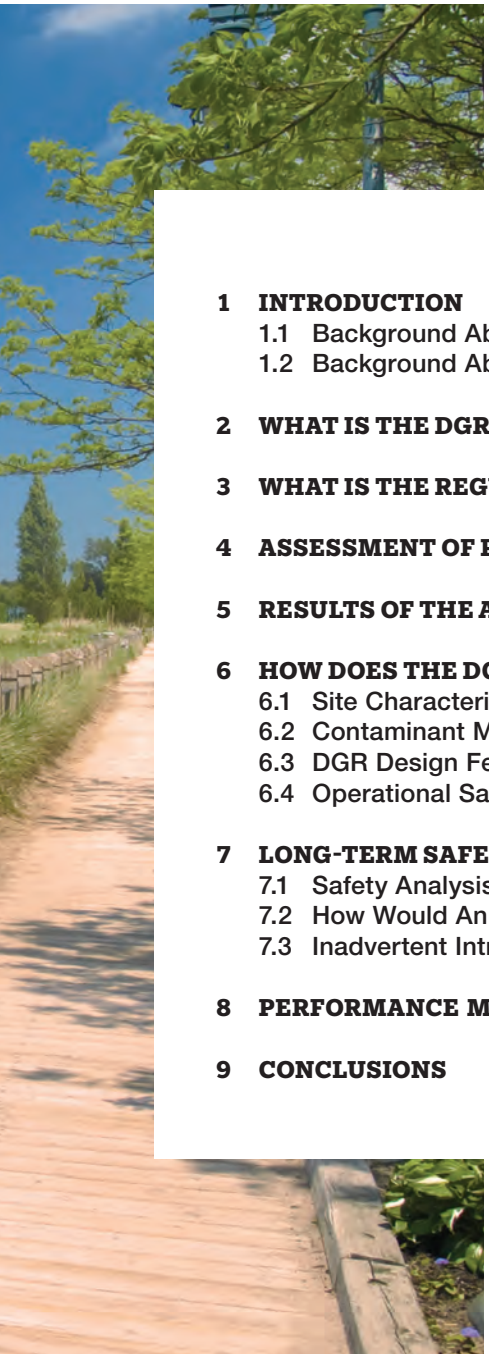
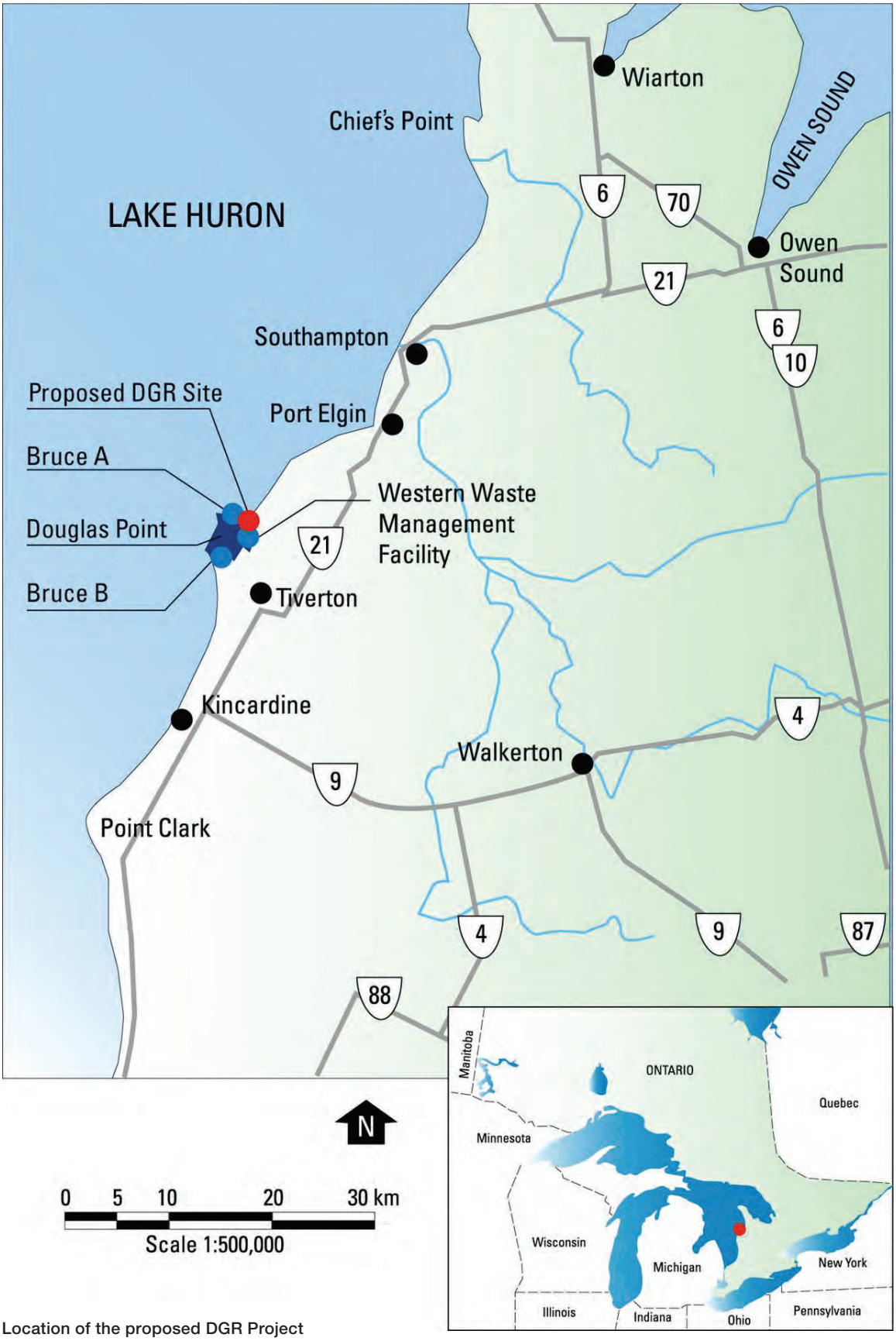




Location of the proposed DGR Project

1 INTRODUCTION

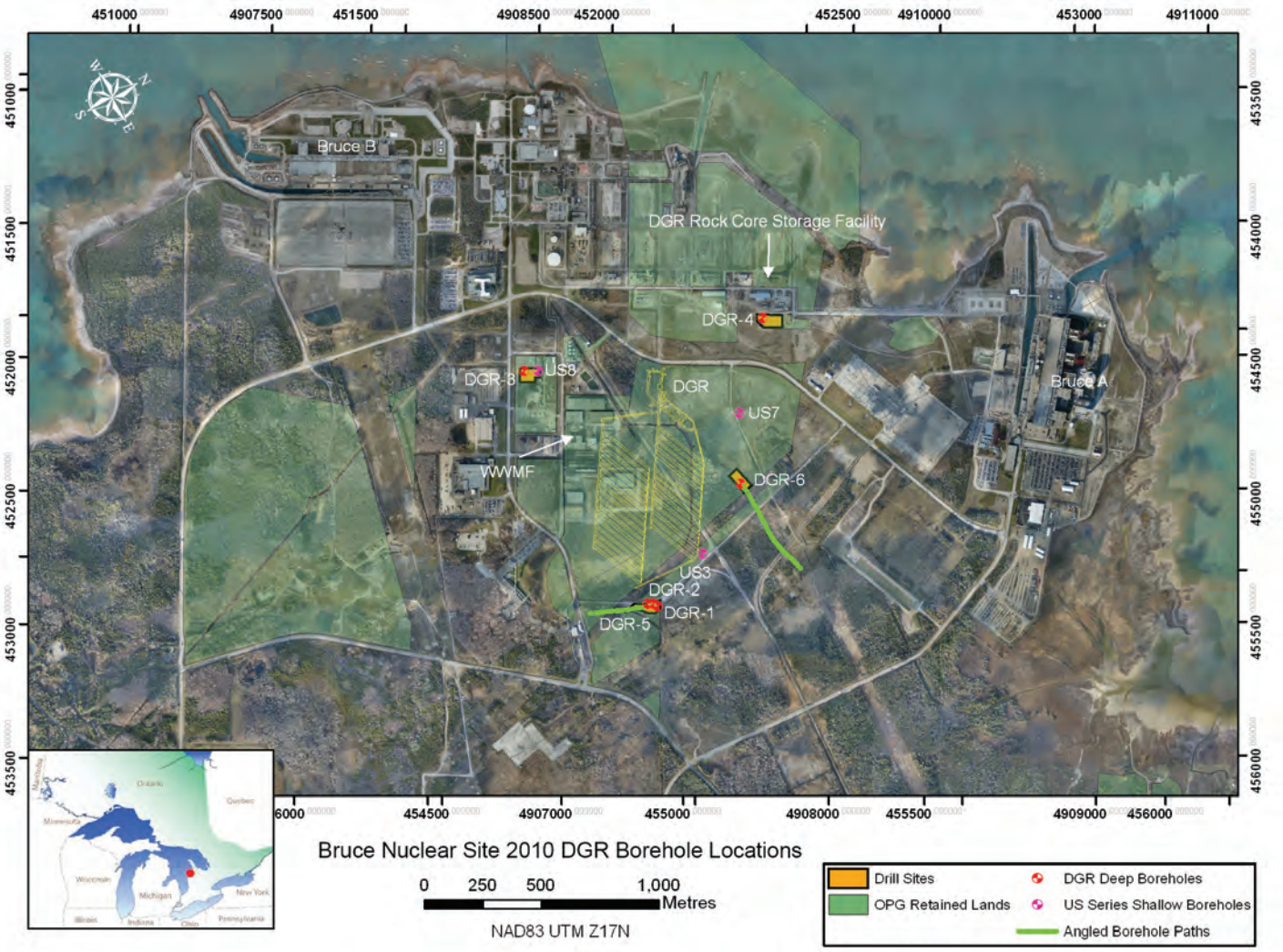
Ontario Power Generation (OPG) is undergoing a multi-year planning and regulatory approvals process for a deep geologic repository (DGR), for the long-term management of low and intermediate level waste (L&ILW) from OPG-owned or -operated nuclear generating stations, at the Bruce nuclear site. Currently, the L&ILW produced as a result of the operation of OPG-owned or -operated nuclear generating stations is safely managed in interim storage facilities at OPG's Western Waste Management Facility (WWMF) located on the Bruce nuclear site in the Municipality of Kincardine, near Tiverton. Although current storage practices are safe and could be continued safely for many decades, OPG's long-term plan is to manage these wastes in a long-term management facility, the DGR.

The proposed DGR Project would take the L&ILW stored at surface and place it in low permeability limestone approximately 680 m underground adjacent to the WWMF. Several technologies were considered for the long-term management of the waste. The DGR was selected because it is consistent with best international practice and provides the highest margin of safety. This project is supported by the Municipality of Kincardine and all of the other municipalities in Bruce County. The DGR will be located about one kilometre inland from Lake Huron, which is one of the Great Lakes.

OPG is committed to ensuring that the integrity of Lake Huron and the protection of its uses are a focal point in the environmental assessment (EA) process for the DGR Project. The regulatory approvals process has used a step-wise process to gather information about the existing environment of the project area, including characteristics of the underlying geology. This information was utilized to complete extensive assessments of the potential of the DGR to impact the environment during normal events and postulated extreme events, such as accidents and malfunctions.

The Environmental Impact Statement (EIS) for the DGR Project concluded that with the implementation of the identified mitigation measures, the DGR Project is not likely to result in any significant residual adverse effects on the environment.

Throughout the EA process there was considerable public interest in the potential for the DGR Project to affect Lake Huron. As a result, this document was prepared to provide a summary of the existing uses of Lake Huron, introduce the proposed DGR Project, consolidate the results of the effects assessment and describe the natural and engineered features of the DGR Project that will mitigate any potential effects of the DGR Project and in doing so protect Lake Huron and the Great Lakes.



Overview of the Bruce nuclear site and the location and underground footprint of the DGR.

1.1 BACKGROUND ABOUT LAKE HURON

The Great Lakes, including Lake Huron, are among the largest freshwater resources in the world. Lake Huron is the second largest of the Great Lakes, with a surface area of approximately 60,000 km^2 and a shoreline length of approximately 6,200 km. The average depth is 59 m, while the maximum depth is 229 m at a location near Sault Ste. Marie. The maximum depth in the vicinity of the Bruce nuclear site is approximately 180 m. To the west and northwest, Lake Huron stretches uninterrupted for approximately 130 km. The nearest land across the lake is Port Hope, Michigan, approximately 98 km southwest of the Bruce nuclear site.

On Lake Huron, ice normally begins to form in harbours and shallow-water areas in early December with ice fields and concentrated brash (i.e., accumulation of floating ice fragments, formed by breakage of other ice forms) forming in early January. The central part of Lake Huron normally does not freeze over in winter, but drifting patches of thin ice may be present from early February until mid-March.

The Great Lakes' water levels have fluctuated throughout history. The record high and low water levels generally coincide with climatic events such as the Dust Bowl of the 1930s, a multi-continental severe drought in 1964 and the most recent El Niño of 1997. Nearshore current direction in the vicinity of the Bruce nuclear site is predominantly parallel to the shoreline with a north-eastern direction being the most common. Currents to the southwest also occur but on a less frequent basis.

Lake Huron serves many functions for both Ontario and Michigan. Municipal, commercial and recreational uses of Lake Huron in the vicinity of the Bruce nuclear site include drinking water intakes, discharge of treated municipal waste water, parks, Aboriginal reserve lands, commercial and recreational fishing, recreational boating, and swimming.

Lake Huron shoreline.

A Source of Drinking Water

Many towns and cities obtain their municipal drinking water from intakes in Lake Huron, including downstream communities on the U.S. and Canadian sides of the lake. The Municipality of Kincardine has two separate water systems for the urban areas, one for the community of Tiverton and one serving the former town of Kincardine and the shoreline properties north to Inverhuron, including Inverhuron Provincial Park.

The Kincardine Water Treatment Plant (WTP) draws water from Lake Huron. In Saugeen Shores, the Southampton WTP draws its raw water from Lake Huron and provides water to both Southampton and Port Elgin. It also provides water to the Chippewas of Saugeen First Nation and MacGregor Point Provincial Park. The communities of Scott Point and Underwood have municipal wells. In addition, there are a series of communal wells along the lakeshore.

On the Bruce nuclear site, both the Bruce A and Bruce B nuclear generating stations draw once-through cooling water from the lake, and discharge the water at a slightly elevated temperature back into Lake Huron. In addition, all of the stormwater on the site is collected via a network of drainage ditches, which ultimately discharge to Lake Huron.

As part of the DGR EA, in 2007 and 2009 surface water quality samples were analyzed from collection points both in the inland streams and in Lake Huron. In addition, lake water quality has been monitored as part of studies dating back to the 1960s. Bruce Power reports radiological surface water quality as part of their Annual Monitoring Program as mandated by their Canadian Nuclear Safety Commission (CNSC) licence requirements. Table 1 provides a brief summary of the lake water quality in the vicinity of the Bruce nuclear site. Contaminant levels are generally lower than concentrations found elsewhere in the lower Great Lakes, and within water quality objectives.

Table 1: Summary of Lake Huron Water Quality

Parameter	Existing Quality
Radiological Parameters	Concentrations of radionuclides measured from grab samples of treated water collected at water supply plants are several orders of magnitude below the drinking water standard. Tritium concentrations in surface water within the site are higher than background (i.e., provincial monitoring locations) but well within the standards.
Nitrogen and Phosphates	Generally lower than concentrations found in the lower Great Lakes and within water quality objectives.
Metals	Generally within the water quality objectives and guidelines. Some nearshore minor exceedances from historic industrial activities.
Dissolved Solids	Well within the water quality objectives and guidelines. Concentrations in the nearshore are similar to further offshore.

Water quality sampling is completed to establish baseline conditions.

Kincardine Harbour

Ecological Habitat

Lake Huron and the surrounding shoreline provide habitat for a variety of terrestrial and aquatic species. There are both open-lake and deep coldwater habitats that support many species of fish, including rare and endangered species, and coastal habitats, including significant wetlands.

Within Lake Huron, near the Bruce nuclear site, there are two main aquatic habitats, the near shore and offshore. The nearshore habitat consists mainly of rocky areas that are exposed to the wind and wave action of the Lake Huron shoreline, and sheltered bays such as the Baie du Doré located to the north of the Bruce nuclear site, which provide a more constant environment, protected from wave and current action. Baie du Doré is recognized as a Provincially Significant Wetland. Offshore habitat consists of the deep, cool, open waters of Lake Huron.

The EA work program included a number of field studies to characterize the habitats within, and in the vicinity of, the Bruce nuclear site. Various aquatic and terrestrial species were identified that could use Lake Huron and the embayments.

Most deepwater species make use of the nearshore areas only during spawning and prefer offshore deeper waters, particularly during the warmer summer months. Fish found in the nearshore areas such as the inner, protected portion of the Baie du Doré are generally warmwater species.

The Lake Huron shoreline also supports a number of significant, rare, uncommon and endangered species both provincially and in Bruce County. The significant habitats in the vicinity of the Bruce nuclear site include Inverhuron Provincial Park, MacGregor Point Provincial Park, Baie du Doré Provincially Significant Wetland and Scott Point Area of Natural and Scientific Interest.

Fisheries

Lake Huron supports both commercial and recreational fisheries. The most common fish species caught by recreational anglers on Lake Huron are smelt, perch, smallmouth bass and pike. The lake whitefish fishery operated by the Saugeen Ojibway Nation (SON) is of local importance.

Tourism

The Lake Huron shoreline is recognized for its diverse natural beauty. The tourism industry is one of the most important business sectors of the economy in the area. One-third of Kincardine residents go fishing and boating at least occasionally. In addition to the many beaches and the scenic shoreline, Lake Huron boasts other tourist attractions, including:

- Inverhuron Provincial Park;
- MacGregor Point Provincial Park;
- Brucedale Conservation Area;
- historic lighthouses;
- marinas; and
- recreational boating and fishing.

Many cottages and seasonal residences are also located along the shoreline. As part of the EA, a number of surveys were completed to characterize how residents and tourists use local attractions and participate in recreational activities.

The DGR mobile exhibit is utilized at many local events including Sauble Beach Sandfest.

1.2 BACKGROUND ABOUT L&ILW

OPG has operated a facility, the Western Waste Management Facility (WWMF), for management of L&ILW at the Bruce nuclear site for nearly 40 years. Waste currently stored at the surface in low level storage buildings (LLSBs) or in-ground containers would be emplaced in the DGR.

Low level waste consists of industrial items and materials such as clothing, tools, equipment and refurbishment waste such as heat exchangers and steam generators which have become contaminated with low levels of radioactivity. Intermediate level waste consists primarily of used reactor components and resins used to clean the reactor water circuits.

Approximately 80 per cent of the waste package volume to be emplaced in the DGR is low level waste. These wastes are dominated by relatively short-lived radionuclides. The key intermediate level waste forms with long-lived radionuclides are primarily Zircaloy pressure tubes. Zircaloy is corrosion resistant and will degrade very slowly over a million-year timescale.

The total amount of radioactivity remaining in the repository after about 10,000 years is predicted to be less than that occurring naturally in the overlying shale rock proposed to enclose the DGR.

Low level waste is received at the WWMF.

Intermediate level waste is inserted into an in-ground storage container at the WWMF.

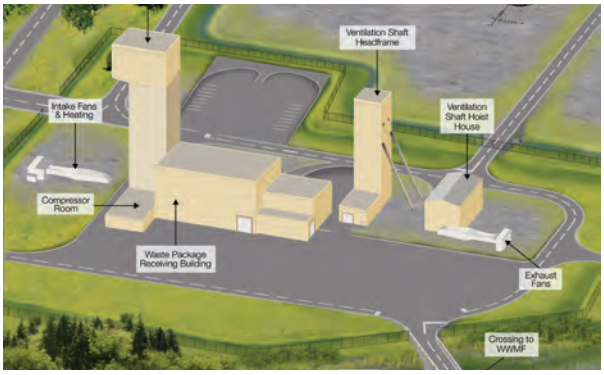
2 WHAT IS THE DGR PROJECT?

The DGR Project is a deep geologic repository for the long-term management of L&ILW currently stored in interim facilities at the WWMF, as well as that produced from the operation of OPG-owned or -operated generating stations. A licence is being sought for a DGR with a design capacity of nominally 200,000 m^3 of L&ILW.

The DGR Project comprises both surface and underground facilities to be constructed over a period of five to seven years. The underground facilities include two shafts, several access tunnels, and a number of emplacement rooms and support facilities including ventilation and maintenance rooms. The underground DGR facilities will be constructed in limestone bedrock (Cobourg Formation) at a depth of approximately 680 m beneath the Bruce nuclear site. The overall underground arrangement enables infrastructure to be kept in close proximity to the main shaft, while keeping the L&ILW emplacement areas away from normally occupied and high traffic areas.

The surface DGR facilities, which include the waste package receiving building, main and ventilation shaft headframes, compressor room, intake fans and heating, hoist house, and emergency generator, will be located on OPG-retained land on the Bruce nuclear site at a distance of approximately one km inland from the Lake Huron shoreline. The surface structures will be grouped in close proximity to facilitate operations and maintenance activities, and provide a compact footprint. Waste rock piles for the total excavated volume of rock will be accommodated to the north-east of the two shafts.

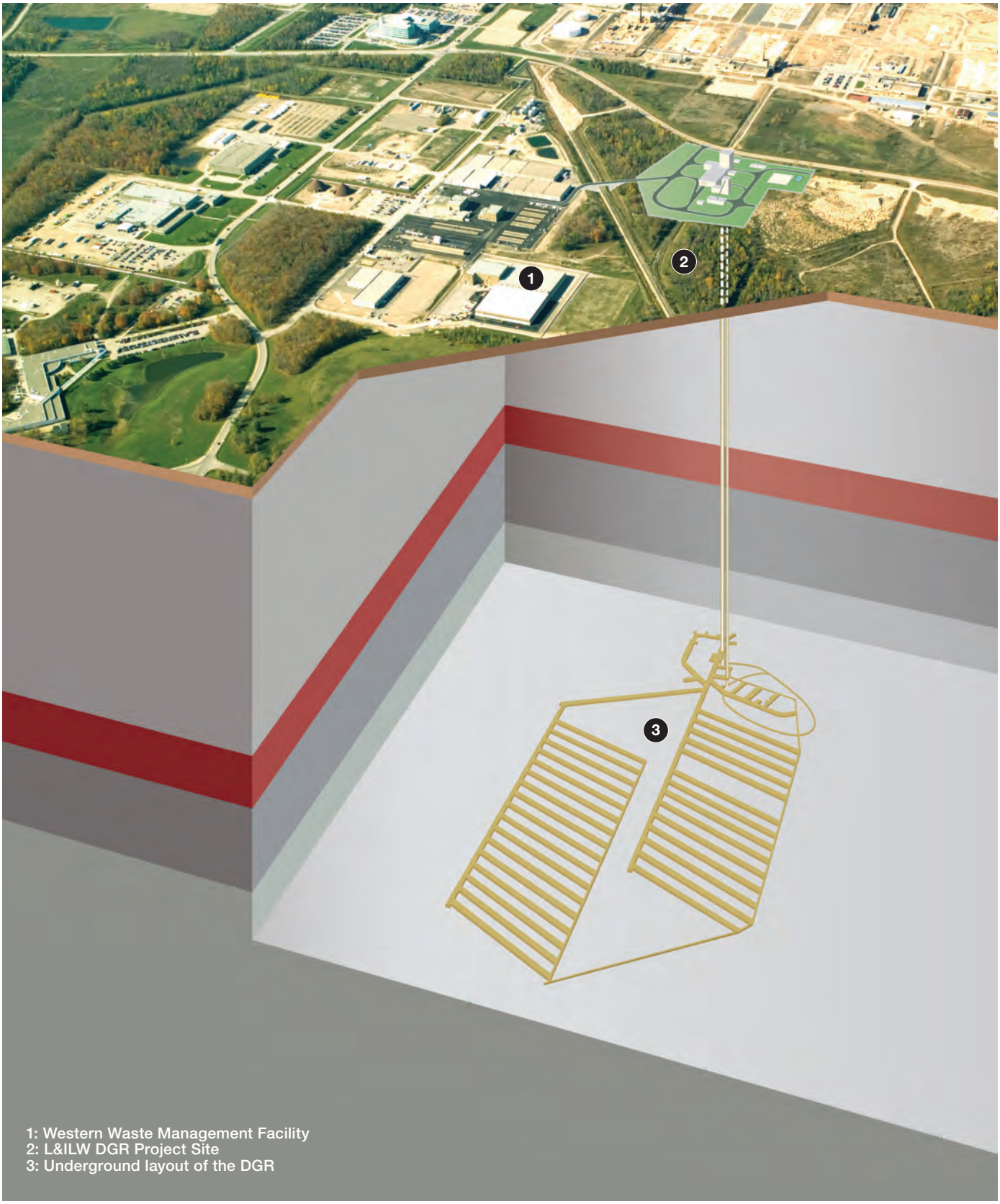
A stormwater management system of ditches and a pond will be provided to control the outflow of runoff from the site before release into an existing network of ditches on the Bruce nuclear site, and ultimately Lake Huron. The discharge will be monitored to confirm it meets certificate of approval requirements.



Layout of the DGR surface facilities.


Intermediate level waste emplacement room.


Low level waste emplacement room.

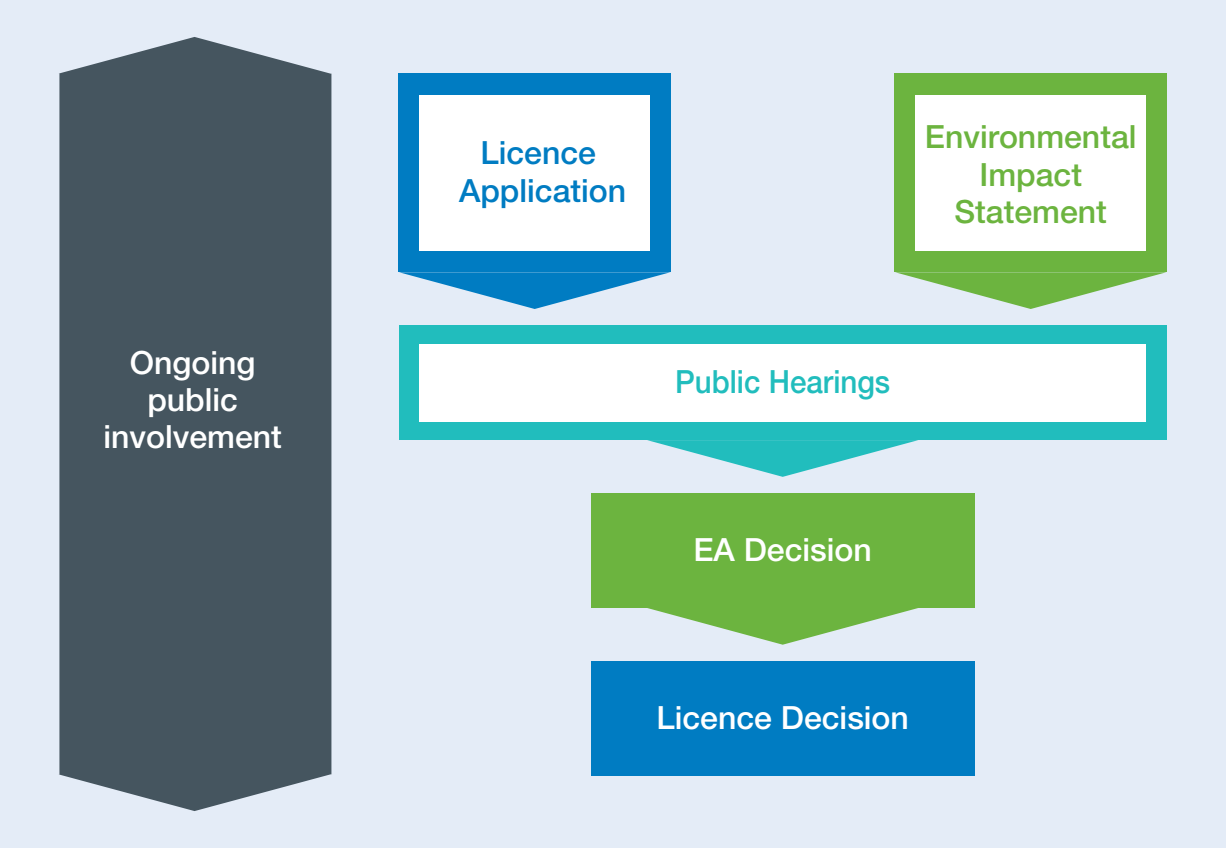


The DGR Project: aerial view of the existing Western Waste Management Facility and the surface and underground layout of the DGR.

3 WHAT IS THE REGULATORY APPROVALS PROCESS FOR THE DGR PROJECT?

The Canadian Nuclear Safety Commission (CNSC) regulates the licensing, monitoring and inspection of nuclear facilities in Canada, including radioactive waste management facilities. The CNSC uses a comprehensive licensing system that covers the entire life cycle of a geologic repository from site preparation to construction, operation, decommissioning (closure), abandonment and long-term performance. This approach requires a separate licence at each stage.

The CNSC can make a licensing decision on a geologic repository only after the completion of an environmental assessment (EA) of the project. EAs are used to identify the potential effects of a project, identify possible mitigation measures and predict whether there are likely to be any significant adverse residual effects. EAs examine elements such as surface water quality, long-term environmental impacts, human health, use of land and resources, Aboriginal interests, and physical and cultural heritage. The public has the opportunity to participate and be heard throughout the EA and the licensing processes.



The EA and licensing process allows for ongoing public involvement for the DGR Project.

The DGR Project was referred to a joint review panel in 2007 given the public concerns, possibility of adverse effects, and the first-of-a-kind nature of the project. The review panel consists of three experts appointed, based on their knowledge and expertise, to ensure the EA is conducted, convene a public hearing, and submit its recommendations to the federal Minister of the Environment and to the responsible authorities (i.e., the CNSC) for their consideration in subsequent licence decision-making.

CNSC experts and technical specialists also conduct a thorough technical assessment of information submitted by the applicant in support of the application. This assessment is carried out with input from other federal and provincial government departments and agencies for regulating health and safety, environmental protection, emergency preparedness, occupational health and safety, radiation protection, physical design, operations and management systems.

A licence application for a geologic repository must address the requirements and regulations pursuant to the Nuclear Safety and Control Act. In addition to the environmental assessment and licensing process, the DGR Project is subject to a number of regulatory, permitting and licensing processes, administered by the various levels of government. All permits and approvals for the facility will be obtained prior to the start of activities for which they are required.

A variety of other agencies are in place and have a role in protecting the Great Lakes from adverse effects. Fisheries and Oceans Canada, Environment Canada, the Ontario Ministry of the Environment and local Conservation Authorities each have a role in the environmental assessment process and in ensuring projects will have no significant adverse effects on Lake Huron.

In addition to agencies that have an approval role, there are organizations that provide an oversight role. The International Joint Commission was established under the 1909 Boundary Waters Treaty to assist governments in balancing their interests when authorizing uses on the boundary waters. Agreements such as the Canada-U.S. Air Quality Agreement and the Great Lakes Water Quality Agreement also provide means to address concerns relating to the Great Lakes. In addition, there are many local interest groups and non-governmental organizations in Canada and the U.S. that have an interest in the activities on Lake Huron and provide input to these agencies.

4 ASSESSMENT OF POTENTIAL EFFECTS ON LAKE HURON

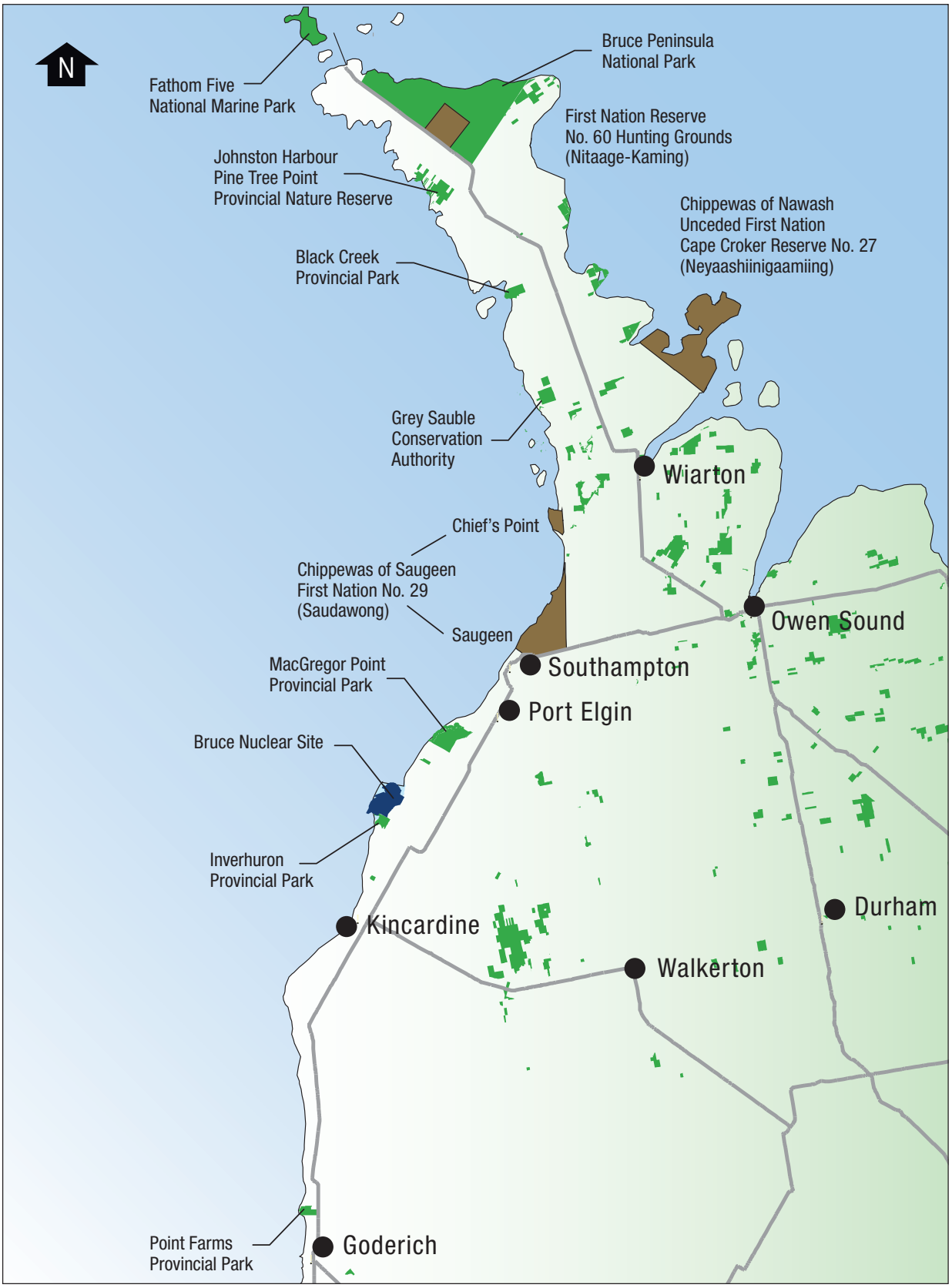
An environmental assessment (EA) of the DGR Project was undertaken in order to characterize the potential effects of the project in a thorough, traceable and stepwise manner. The results of the scientific studies are documented in OPG's Deep Geologic Repository for Low and Intermediate Level Waste Environmental Impact Statement (EIS), which was submitted to the CNSC (for the Joint Review Panel) as part of the regulatory approvals process for the project. The EIS considers the potential effects of the site preparation and construction, operations, decommissioning, abandonment and long-term performance of the DGR Project.

The EIS, which has been issued for public review and will be the subject of a public hearing, concludes that the DGR Project is not likely to result in any significant residual adverse effects on the environment.

The EIS describes the DGR Project, the existing environmental conditions on the Bruce nuclear site, and assesses the likely effects of the DGR Project on the environment. The EIS also includes an assessment of likely cumulative effects of the DGR Project in combination with other past, present or reasonably foreseeable projects, as required. It describes the effects for normal conditions and as a result of malfunctions, accidents and malevolent acts. The EIS also describes and assesses the likely effects of the environment on the DGR Project, and of the project on climate change, and renewable and non-renewable resources.

Potential effects of the DGR Project on the environment were considered through the use of Valued Ecosystem Components (VECs). VECs are features of the environment that are considered to be important by the proponent, public, scientists and/or government. For the DGR Project environmental assessment, Lake Huron is a VEC.

Amphibian counts establish baseline conditions and provide a basis on which to predict potential effects.



Features along the Lake Huron Shoreline are depicted.

A number of different potential interactions between the DGR Project and Lake Huron were considered in the environmental assessment including:

- changes in **drinking and lake water quality**, including radiological and non-radiological effects;
- changes in **soil quality or groundwater movement or quality**;
- effects on **habitat availability and quality** for both aquatic and terrestrial species using Lake Huron;
- changes in fish populations and potential effects of these changes on the **commercial, recreational and Aboriginal fisheries**;
- how changes related to the project, such as changes in water quality or changes in views and vistas, may affect **tourism** and the **use and enjoyment** of the Lake Huron shoreline for recreational purposes; and
- how the DGR Project may affect **traditional Aboriginal rights and interests**.

For each of these individual aspects, potential interactions of the DGR Project with the environment were identified and described. Then effects associated with the project were predicted using qualitative and quantitative methods to determine if there could be any potential adverse effects on the environment. Where possible, effects were reduced or eliminated using technically feasible mitigation measures. In the EIS, these individual changes and effects are combined to determine whether a measurable cumulative effect on Lake Huron may occur.

The Lake Huron water quality was assessed through consideration of the surface water quality VEC, overburden groundwater quality VEC and shallow bedrock groundwater quality VEC.

The effects to recreational uses of Lake Huron were considered through the tourism VEC. The SON operates a commercial whitefish fishery on Lake Huron. The potential effect to the commercial whitefish fishery was considered through the VEC traditional use of land and resources.

Radiological effects on Lake Huron were considered through exposures to humans (members of the public), benthic invertebrates, aquatic vegetation, benthic fish, pelagic fish, aquatic birds and aquatic mammals.

Indicator VECs for Lake Huron VEC.

5 RESULTS OF THE ASSESSMENT

The EIS concludes that the DGR is expected to safely contain and isolate the L&ILW from humans and nonhuman biota, including during the abandonment and long-term performance phase. No significant residual adverse effects on Lake Huron are expected as a result of the DGR Project. The following statements support this conclusion.

The DGR is separated from the surface environment by a nominal depth of 680 m and by multiple, laterally extensive layers of low permeability sedimentary rock which provide passive safety.

The properties of the host rock and shaft seals will limit the movement of radioactivity to extremely slow rates. The amount of contaminants reaching the surface or Lake Huron is negligible, and would occur far into the future.

Most of the L&ILW contains primarily shorter-lived radionuclides and the radioactivity will decay within a few hundred years, further reducing the amount of contaminants that could move from the DGR.

The DGR site is located within the tectonically stable interior of the North American continent, which is a region characterized by low rates of seismicity where large magnitude earthquakes are unlikely. The 450 million-year-old rock formations into which the proposed DGR would be excavated have remained stable through tectonic events, climate changes and glacial cycles and are expected to remain stable for millions of years into the future.

The salinity of the porewater at the repository depth indicates that the deep system is isolated from the shallow ground water system and that the porewaters have resided in the system for geologic time periods.

The deep groundwater system is ancient and stable with the transport of contaminants governed by diffusion, an extremely slow process.

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6 HOW DOES THE DGR PROTECT LAKE HURON?

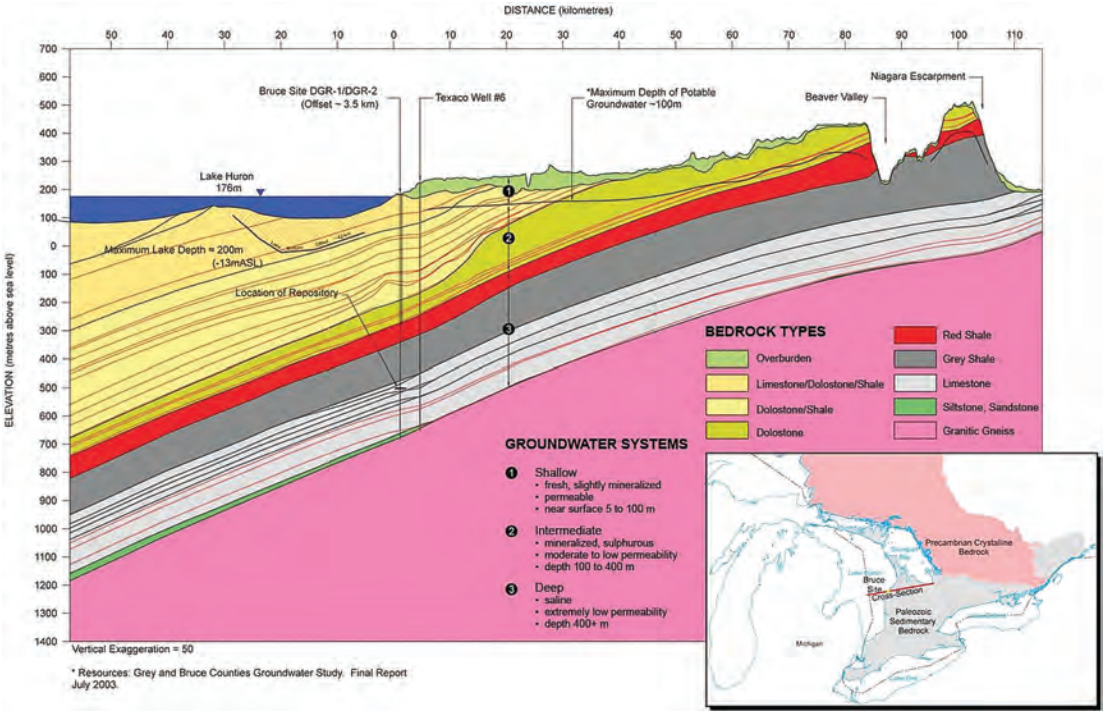
The DGR Project has been designed to minimize effects on the surrounding environment through the choice of host rock, design of the surface facilities and the decommissioning plan. The EIS thoroughly considers all of the potential effects of the project on Lake Huron, including normal operations and postulated malfunctions, accidents and malevolent acts for a time period out to a million years, and concludes that no significant residual adverse effects are likely.

During the site preparation and construction phases nuclear waste will not be on the site, hence there are no mechanisms by which radionuclides or contaminants could reach Lake Huron. During operations, radionuclides could be released in atmospheric emissions, underground water collection and surface runoff, as a result of potential accidents and malfunctions. Releases are monitored to confirm that they are within certificate of approval limits and, in the event that exceedances are identified, actions would be taken to prevent or treat the discharge so that it could be safely released.

After decommissioning of the DGR, there are only two potential pathways by which radionuclides or contaminants emplaced in the DGR could reach Lake Huron:

- through the enclosing rock mass; and
- up the shaft.

The ability of the DGR to provide long-term safety and protect Lake Huron is supported by the geologic characteristics of the site itself as well as qualitative arguments based on the characteristics of the site.



The location of the proposed DGR relative to Lake Huron.

6.1 SITE CHARACTERISTICS ISOLATE AND CONTAIN THE WASTE

The DGR is sited about one km inland from the Lake Huron shore. It is located at a depth of approximately 680 m (2230 feet) below ground surface within upper Ordovician limestone of the Cobourg Formation. Lake Huron, at a maximum depth of approximately 180 m in the vicinity of the Bruce nuclear site, is far more shallow than the DGR, and is isolated vertically from the emplacement rooms by low permeability rock formations where contaminant movement through the rock is controlled by diffusion. Diffusion, an extremely slow process, is preferred for long-term isolation and containment of nuclear waste.

Information gathered through deep borehole testing and multi-level instrumentation provides evidence that the bedrock formations hosting and enclosing the DGR at this depth possess extremely low permeabilities. This evidence, part of a larger body of evidence, includes:

- More than 100 borehole hydraulic tests;
- The characterization of groundwater and pore fluids within the bedrock formations; and
- The observance of under-pressured hydraulic conditions within the Ordovician sediments.

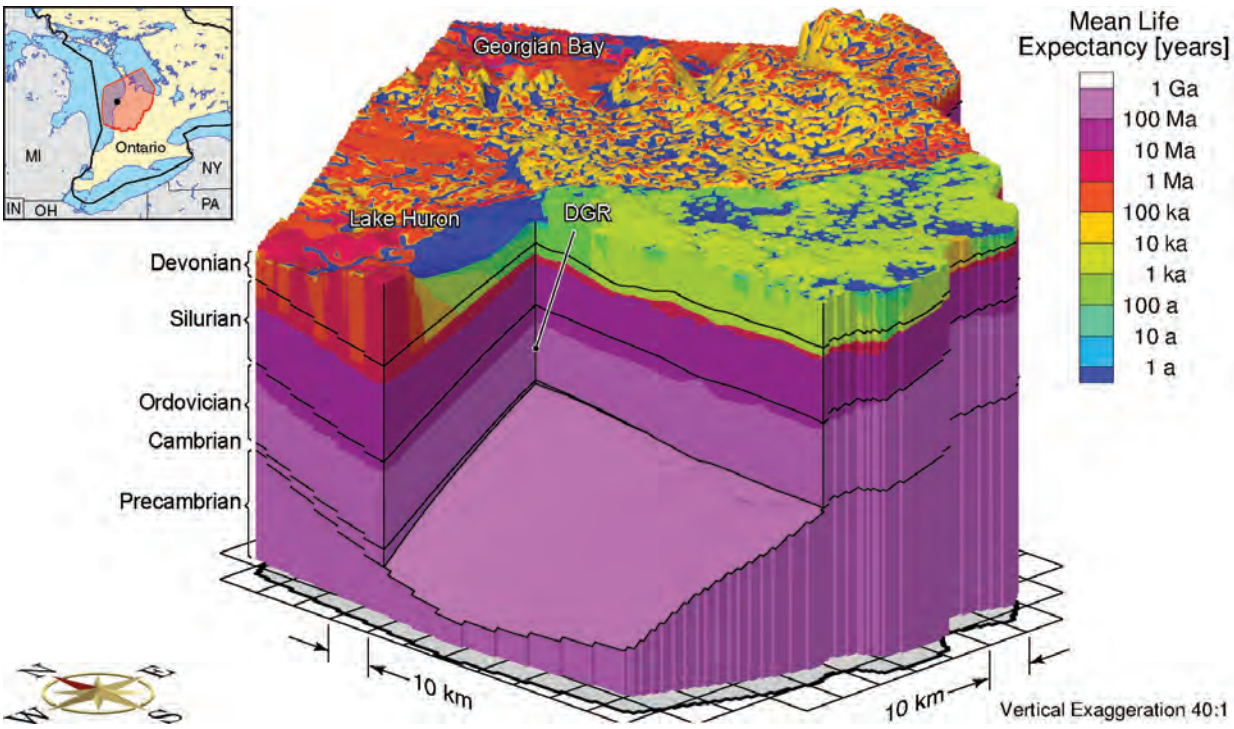
At the proposed repository, horizontal rock mass hydraulic conductivities are on the order of 10^{-14}m/sec. The confining Ordovician bedrock formations that over- (200 m) and underlie (150 m) the repository horizon have hydraulic conductivities ranging between 10^{-11} and 10^{-15} m/sec. The near-horizontal geometry and thickness of the bedrock formations, coupled with their low permeabilities and high salinity fluids, and underpressured hydraulic head conditions, provide strong evidence for a multiple natural barrier system to isolate and contain the L&ILW within the DGR.

The assertion of a diffusion-dominant transport regime is supported, in part, by the presence of laterally continuous, low permeability, multiple natural barriers enclosing the repository horizon. Geologic characterization studies revealed a deep-seated ancient, stable groundwater domain at the repository horizon in which transport mechanisms have remained diffusion-dominant despite geologic perturbations.

Deep borehole drilling provides site-specific data to characterize attributes of the geology beneath the Bruce nuclear site.

6.2 CONTAMINANT MOVEMENT THROUGH SITE MEDIA IS SLOW

In addition, a regional groundwater model was developed to provide an understanding of the potential transport pathways from the DGR to the biosphere, informed by the field observations. The model was used to describe the evolution of the system over time, including transient boundary conditions (e.g., glacial advances and retreats). The model covers approximately 18,000 km^2 including both on-shore and off-shore areas. The modelling also considered the potential effects of glaciation and effects on the groundwater system behavior. Modelling results estimate that the time for contaminants at the repository horizon to reach a receptor (for example, surface water of the upper groundwater) exceeds several million years.



Most of the L&ILW will decay in and around the DGR; a small amount of long-lived radionuclides will move very slowly through diffusion over hundreds of thousands of years

6.3 DGR DESIGN FEATURES

The DGR design incorporates a number of features to ensure safety during operations including:

- Waste packages will meet the DGR waste acceptance criteria;
- Robust waste packages made of concrete and steel will be used for higher activity ILW;
- Proximity of the DGR to the WWMF minimizes transfer distance and avoids movement of the waste off the Bruce nuclear site; and
- Shaft collar elevation is designed to prevent potential flooding from entering the DGR.

The DGR is expected to operate for 40 to 45 years, with waste being emplaced in the DGR for the first 35 to 40 years. Once the repository is full, and following a period of monitoring, it will be decommissioned. A licence will be required from the CNSC prior to OPG being able to proceed with decommissioning the DGR.

The DGR is designed such that the rooms are aligned with the principal rock stress direction to maximize opening stability. The width of the pillars between rooms has also been designed for stability.

Decommissioning includes the installation of an engineered seal running the length of the shafts. The seal will limit movement of contaminants through a series of layers engineered to align with the barrier bedrock formations. The shafts are sealed primarily with a durable, low-permeability bentonite/sand mixture that will swell and seal the shaft tight. An asphalt seal may be emplaced in the Ordovician shales to provide an independent self-sealing material, and concrete monolith and bulkheads will provide mechanical support as well as a further shaft seal barrier.

A robust intermediate level waste package is emplaced in the DGR.

6.4 OPERATIONAL SAFETY

OPG has safely managed low and intermediate level waste at surface for nearly 40 years. This experience will be directly transferable to the operations of the DGR Project.

All surface runoff and underground effluents from the project will be managed in a series of catchbasins and drainage ditches which will direct water to a stormwater management pond for treatment. Water discharges from the stormwater management pond will be directed to existing drainage ditches, and ultimately to Lake Huron. Monitoring will be conducted to confirm that the discharge meets all certificate of approval requirements. No discharges will be directed towards environmentally sensitive areas such as Stream C and Baie du Doré.

The preclosure safety assessment results indicate that small amounts of tritium and carbon-14 are expected to be released as offgassing from the waste packages in the DGR. This is consistent with current experience at the WWMF, where the packages are currently stored. The primary sources of radioactive emissions will be the ventilation shaft. Potential dose from these emissions are estimated to be similar to current low doses from the WWMF, where many of the wastes are currently located.

Once operations are complete, the DGR will be monitored for a period of time to ensure it is behaving as expected before the shafts are sealed and the facility decommissioned. Once the shafts are sealed, all emissions from the DGR will stop.

Is there potential for the DGR site to flood?

The assessment for potential coastal flooding considered maximum lake water level, storm surge, seiche, wind wave and wave uprush that could affect the DGR operational area inland of the Lake Huron shoreline.

In 80 years of record the maximum observed water-level was approximately 177.8 metres above sea level (masl) in 1986. The design-basis 500-year Lake Huron water level is predicted to be 178.6 masl. The planned elevation of the operation areas of the DGR Project site is at least 186 metres above sea level. Thus the freeboard above the peak static lake levels is at least 7 m and the risk of coastal flooding of the DGR Project site as a result of high lake levels is extremely small. The effect of transient flooding from storms was also considered. The combined effect of a maximum storm surge with seiche and wind could produce waves of 6 m height approaching the shoreline. Since the DGR facilities are about 1 km from the shoreline, wave uprush could wet parts of the site but would not flood the main facilities.

The potential for flooding of the site from severe rainfall or overflowing of nearby streams was also assessed. These are unlikely due to the nature of the local topography and the design of the stormwater management system. The DGR shaft collars are set to approximately 186 masl to avoid this flooding risk.

Tsunamis are long period gravity waves generated by seismic disturbances of the sea bottom or shore, or landslides resulting in a sudden displacement of the water surface with the resulting wave energy spreading outwards across the ocean or lake at high speed. The type of seismic conditions or landslide conditions that could generate a significant tsunami do not exist in the stable interior of the North American continent. No probable or definite tsunamis have been recorded for Lake Huron.

7 LONG-TERM SAFETY OF THE DGR

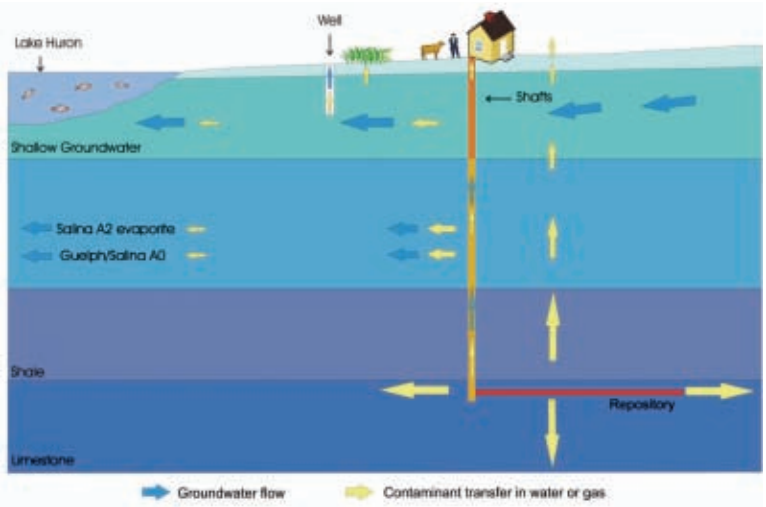
A postclosure assessment considered the safety of the expected evolution of the DGR system with time. It addressed the period following the closing and sealing of the DGR and looked far into the future. Because the future is uncertain, it looked at a range of potential likely to unlikely future scenarios. It considered the potential impacts to a family living and farming on the site in the future, as well as the potential impact to people living and fishing on Lake Huron.

7.1 SAFETY ANALYSIS

The Normal Evolution Scenario considers the likely future evolution of the repository and site following closure. Over the one-million-year timeframe, the scenario included waste and packaging degradation, gas generation and build-up, rockfall, earthquakes and eventually, glacial cycles.

Over timescales of many thousands of years, some longer-lived radionuclides may slowly migrate via the sealed shaft and geosphere into the shallow groundwater zone and then into the surface environment. By the time such migration occurs, considerable decay of the radionuclides will have taken place. So much so that the calculated impact in terms of public dose would be one hundred thousand times below the dose criterion (0.3 mSv per year), and essentially negligible. For comparison, the normal exposure due to natural background radioactivity is around 2 mSv per year.

Several disruptive "what if" scenarios examined the potential impacts of low-probability events leading to penetration of barriers and abnormal loss of containment, including human intrusion, severe shaft seal failure, poorly sealed borehole and vertical fault near the DGR. Only for the unlikely scenarios of human intrusion and severe shaft seal failure is there potential for significant doses. In these scenarios the peak impact applies only to someone living directly on top of the repository; impacts further afield are much smaller. In all cases the potential impacts become small on timescales around 60,000 to 100,000 years due to radioactive decay.



Pathways for radionuclide release: Any radionuclides that migrate away from the DGR will have decayed to a level which is many magnitudes below the regulatory rate and background level.

7.2 HOW WOULD AN EARTHQUAKE AFFECT THE DGR?

Southwestern Ontario and the Bruce region lie within the tectonically stable interior of the North American continent, a region characterized by low rates of seismicity. The historic seismicity record shows that there have been no seismic events exceeding a 5 magnitude in the past 180 years.

A Seismic Hazard Assessment of the Bruce nuclear site considered the influence on the DGR of earthquakes ranging up to 7.5 magnitude. The assessment concluded that earthquakes will not impact the safe operation or long-term ability of the DGR to safely isolate and contain L&ILW.

Flowerpots on the Bruce Peninsula provide evidence of low seismic activity.

7.3 INADVERTENT INTRUSION

Land use controls and societal records would prevent accidental drilling into the repository for some period of time. However, it is possible that at some time in the future, these would be forgotten and someone might drill into the DGR.

The most likely reasons for drilling are for wells for drinking water and resource extraction. Groundwater resources in the vicinity of the Bruce nuclear site are obtained from shallow overburden or bedrock wells extending to depths of approximately 100 m. With increasing depth, the quality of the groundwater lessens and the yields decrease.

Porewater at the repository depth is not potable because of high salinity content and the extremely low permeability bedrock formation cannot yield groundwater. This combination of extremely high salinities and low hydraulic conductivities in the rock surrounding the proposed DGR horizon would prevent or discourage deep drilling for groundwater resources.

Published studies, historical records and the results of the deep drilling program on the Bruce nuclear site strongly suggest that viable commercial oil and gas reserves do not exist. Commercially viable base metal deposits have not been identified in the study area. Therefore it is very unlikely that someone would drill into the DGR.

8 PERFORMANCE MONITORING

As part of the licence requirements for the DGR Project, OPG has designed and will implement a follow-up monitoring program to ensure that all mitigation measures are implemented and verify that the effects of the project on the environment are as predicted in the assessment. The CNSC will ensure that monitoring is implemented. The results of the follow-up monitoring will be made public on an annual basis.

The program includes monitoring of air quality as well as conventional contaminants and radionuclides in water emissions from the DGR project. A groundwater monitoring network established as part of the geoscience studies for the DGR Project will continue to be used for on-going monitoring.

The existing Radiological Environmental Monitoring Program, which monitors radionuclide concentrations in air, precipitation, water samples, (including fish, sediment and sand), terrestrial samples (including local produce, animal products and soil), and external gamma radiation will continue.

Once the DGR is full and emplacement activities are complete and prior to decommissioning and sealing the shafts, there will be a period of monitoring to ensure that the DGR is performing as expected. A period of institutional control, currently assumed to last up to 300 years, will follow the decommissioning. A Licence to Abandon issued by the CNSC may include conditions that would apply throughout the period of institutional control. Institutional controls will help prevent or reduce the likelihood of human actions inadvertently interfering with the waste or causing degradation of the safety features of the repository.

Westbay groundwater monitoring equipment provides data to ensure groundwater quality isn't compromised.

9 CONCLUSIONS

After more than four years of studies, investigations and analyses, the environmental impact statement concluded that the proposed DGR is not likely to have significant residual adverse effects on humans and the environment, including Lake Huron. The following evidence supports this conclusion.

The radionuclides in the waste will decay over time.

The laterally extensive low permeability sedimentary rock contains and isolates the DGR from Lake Huron.

The low permeability rock layers provide multiple natural barriers.

Contaminant movement is diffusion-dominant.

The rock porewater is highly saline and part of a stable ancient groundwater system.

The simple geology and long groundwater residence times provide confidence in the long-term predictions.

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