



Developing a Safety Case for Ontario Power Generation's L&ILW Deep Geologic Repository

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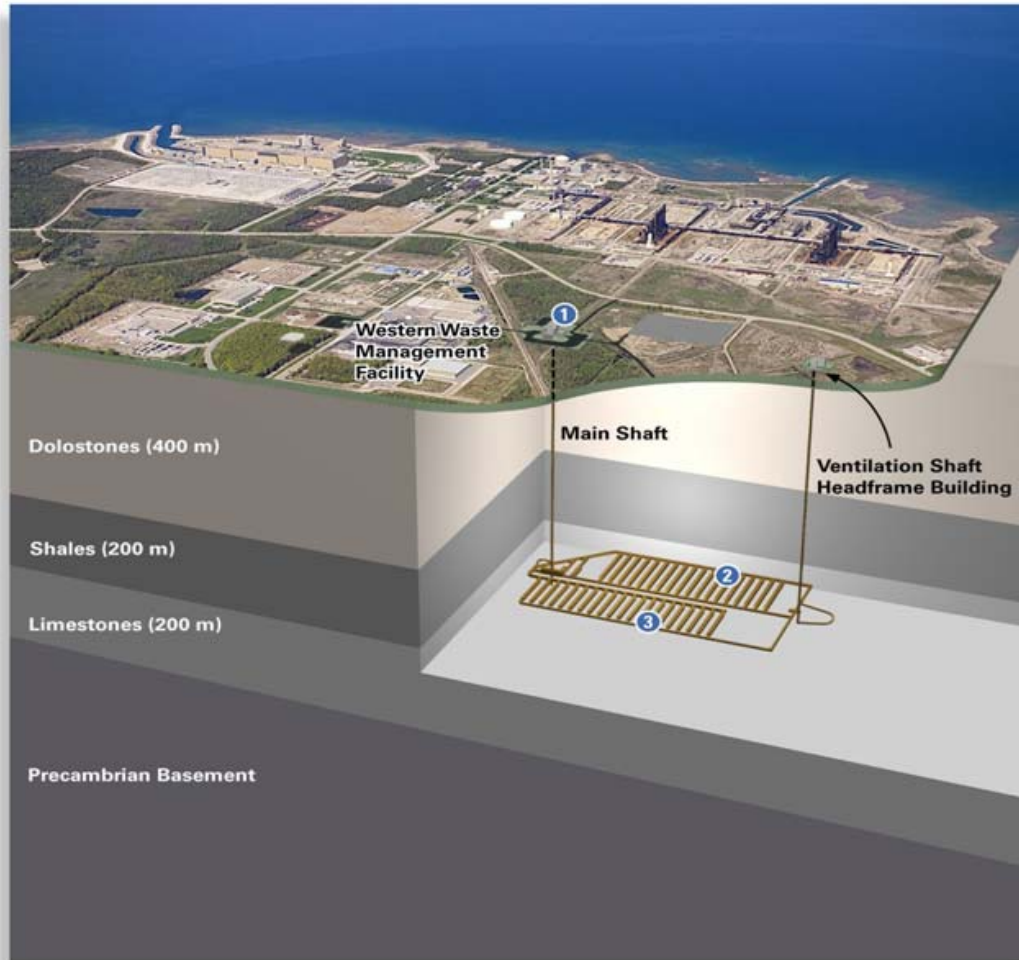
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Safety Cases for the Deep Disposal of
Radioactive Waste: Where do we stand?
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**ONTARIOPOWER
GENERATION**

Background

- OPG proposes to build a Deep Geologic Repository for low and intermediate level radioactive waste at the Bruce site in the Municipality of Kincardine, Ontario, Canada
- More info: www.opg.com/dgr
- DGR proposal currently in the regulatory approvals phase
 - EA scoping hearing held October 2006
- This paper presents an overview of the DGR proposal and a summary of the Safety Case as currently developed

Overview of DGR



Regulatory Context

- Canada's National Framework for Radioactive Waste Management - waste producers responsible for waste management facilities, within the licensing system
- Issue of a licence first requires a decision under the Canadian Environmental Assessment Act
- Nuclear Safety and Control Act and regulations - licences are required to prepare a site, construct, operate, decommission and abandon a nuclear facility
- Further guidance given in CNSC regulatory documents, esp. P-290 and G-320

Approach to the Safety Case - 1

- Overall objective: protect human health and the environment now and in the future
- Safety objectives:
 - Isolation of the waste away from the biosphere
 - Long-term containment of the waste to allow radioactive decay
 - Retardation and attenuation of radionuclide migration to the surface
 - Design and location to minimize uncertainty in long-term safety
- DGR Safety Strategy consistent with NEA Safety Case approach

Approach to the Safety Case - 2

- High level arguments:
 1. Site geoscientific attributes provide several independent lines of evidence which together suggest that the safety objectives can be achieved with a high degree of assurance
 2. The repository can be built and operated safely using proven technologies. The wastes are those safely handled at existing storage facilities.
 3. Postclosure dose estimates are very small because:
 - mass transport of contaminants through the host rock is diffusion limited
 - construction of the repository will not change the overall diffusion-dominated environment
 - earthquakes, glaciation or other natural events will not disrupt the repository
 - gases generated by corroding wastes are safely retained, and disperse slowly
 - the repository is safe from inadvertent human intrusion
- These arguments will be tested and supported in ongoing work in an integrated, iterative process

Siting of the DGR

- DGR to be located at the Bruce site in the Municipality of Kincardine, on the eastern shore of Lake Huron
 - Bruce site has been the location of nuclear activities since 1960
- Location resulted from an approach to OPG in 2002 by the Municipality of Kincardine
- Study of options for long-term management of L&ILW resulted in choice of DGR concept in 2004
- Host Community Agreement was signed between OPG and the Municipality of Kincardine

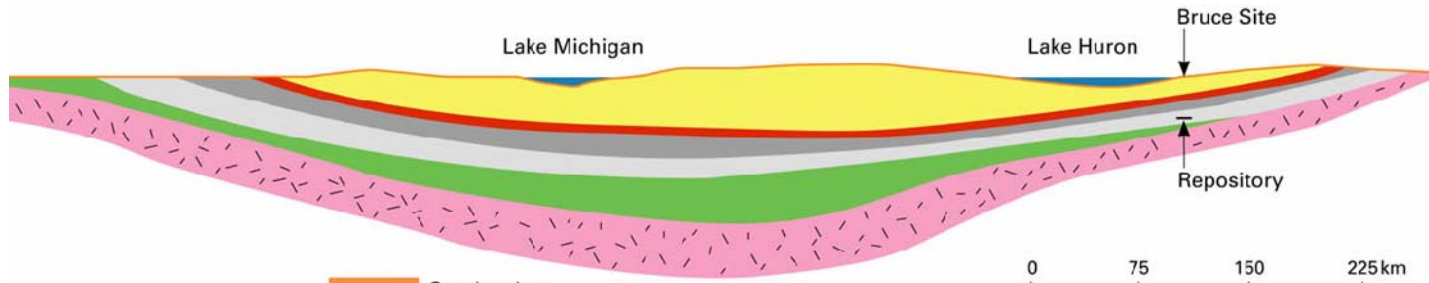
Wastes to be Emplaced in DGR

- L&ILW produced by OPG-owned nuclear generating stations
 - Contaminated industrial items – rags, protective clothing etc.
 - ion-exchange resins and filters
 - used reactor components
- Major nuclides in as-received waste:
 - operational L&ILW - ^{60}Co , ^3H and ^{137}Cs
 - refurbishment/retube - ^{94}Nb
- Total activity estimated as 16 000 TBq
- ^{129}I and ^{14}C of most relevance to long term safety

Conceptual Engineering Design

- Conceptual design consistent with experience in underground structures in similar sedimentary formations
- Iterative design process
- Long-term containment provided primarily by the rock mass and repository shaft seals
 - no additional engineered containment
 - easier to monitor and retrieve in short-term
 - easier for gas handling in long-term
- Wastes are emplaced in a range of steel containers. Some ILW is also placed in concrete shielding overpacks.

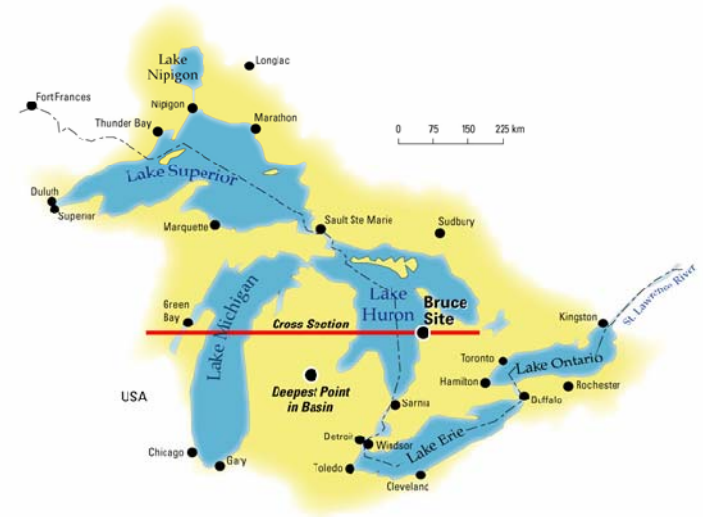
Site Characterization



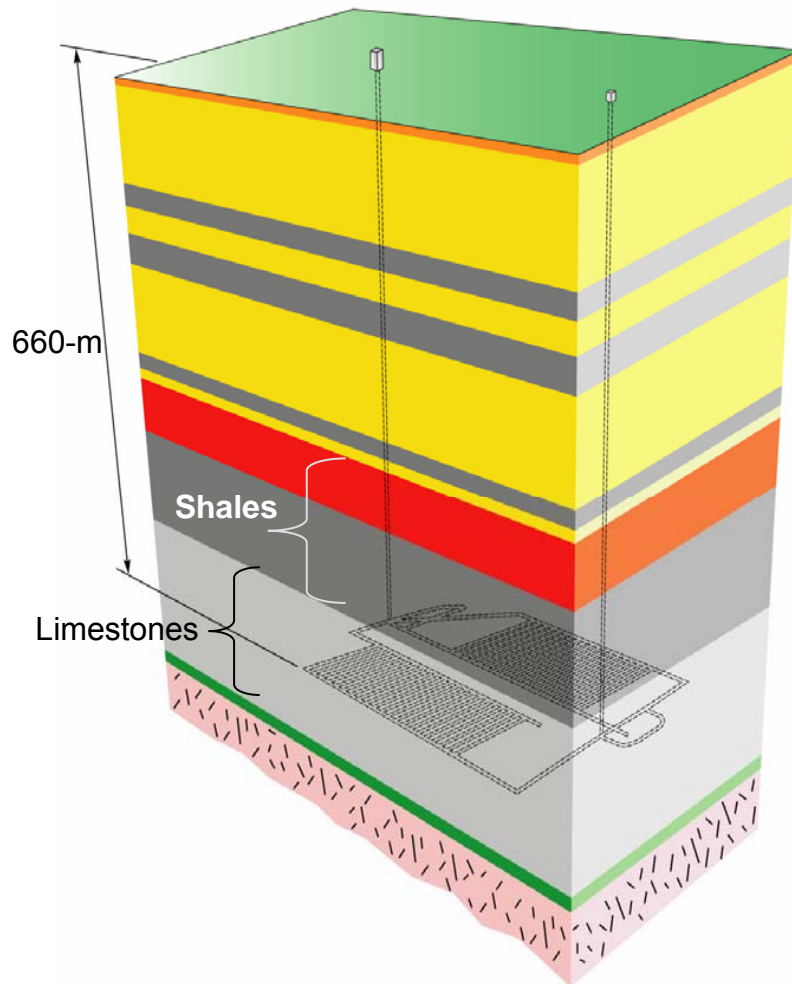
- Overburden
- Dolostone*
- Red Shale
- Grey Shale
- Limestone
- Siltstone, Sandstone
- Granitic Gneiss

* includes evaporites in some parts of basin

0 75 150 225 km
Vertical Exaggeration 20:1



Bruce Site Geosphere Attributes



- Deep horizontally-layered shale and argillaceous limestones
- Ordovician age (450 million years old)
- Structurally simple, undeformed
- Host limestone is ~200 m thick
- Overlying shale is ~200 m thick
- Extremely low permeability ($\sim 10^{-19} \text{ m}^2$)
- Saline groundwaters (100-200 g/L)
- Groundwater is stable/old (million years)
- Survived multiple glaciations
- Shallow groundwater resources isolated

Site Characterization

- Geoscientific Site Characterisation Plan (3 Phases)
 - test the validity, or otherwise, of the assumed characteristics
 - Complemented by studies aimed at developing a Geosynthesis, and building confidence in site suitability and the Safety Case
 - Oversight by an international Geoscience Review Group
 - Current status:
 - 2-D seismic survey
 - 2 deep boreholes started end-2006
 - installation of enhanced borehole seismograph network
 - refurbishment of existing shallow on-site bedrock monitoring wells
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Long-term Safety Assessment - 1

- Provides a quantitative measure of performance to demonstrate compliance with radiological protection and other criteria
- Generally follow the IAEA ISAM methodology
- Iterative approach
- Previous preliminary/scoping studies indicated:
 - Doses from LLW are many orders of magnitude below criteria
 - I-129 doses from all L&ILW are well below criteria
 - Gases predicted to be retained safely, and even if released the estimated doses (C-14) are low
- Currently conducting Version 0 pre- and post-closure assessment

Long-term Safety Assessment - 2

- *Reference / Normal Evolution Scenario* considers the expected evolution of the site. Include both constant present-day climate and a glaciation based climate.
- *Human Intrusion Scenario* considers the hypothetical inadvertent disruption of the wastes
- *Disruptive/failure scenarios* including ‘what-if’ cases
- *Preclosure safety assessment*

Conclusions

- Understanding of the DGR setting developed to date, together with the results of preliminary assessments, gives confidence:
 - that the site possesses favourable geological and hydrogeological characteristics for isolation of the waste
 - that there are a number of complementary arguments supporting the conclusion that isolation will be achieved, and
 - that a robust safety assessment can be carried out demonstrating that the DGR will meet regulatory criteria for protection of human health and the environment.
- Over several years, an integrated, stepwise program of site characterization and complementary studies, linked to safety assessment, will be used to test and refine this understanding and to build confidence in the Safety Case.