

Safe and Secure: Nuclear Waste Storage

Where would be the best location in Canada to place a Deep Geological Repository (DGR) for Canada's spent nuclear fuel (nuclear waste)?



overview

LESSON CONTEXT

The Nuclear Waste Management Organization (NWMO) was established in 2002 by Canada's nuclear electricity generators to develop with Canadians a management approach for the long-term care of Canada's used nuclear fuel. The NWMO is currently working collaboratively with interested Canadians to develop a fair process to select a site for a Deep Geological Repository (DGR).

LEARNING GOALS

- Understand the geological characteristics required to safely host a DGR for Canada's used nuclear fuel.
- Select a location for a DGR and justify the selection.
- Select, integrate and synthesize information using an electronic atlas (The Atlas of Canada).

LEARNING ACTIVITIES

In this lesson, students will learn which criteria will determine where a DGR could be located and then will research Canadian geology and geography to determine and recommend a location for a DGR.

BIG IDEAS

Many locations in the Canadian Shield would be suitable for a DGR (i.e. granite bedrock, low mineral value, low ground water movement, far from post-glacial faulting, etc.).

assessment & evaluation

PRIOR KNOWLEDGE AND SKILLS

- Familiarity with concept of waste
- Familiarity with Canada's geography and geology
- Experience locating legitimate information using internet sources
- Experience working in cooperative small groups.

SUCCESS CRITERIA

- Students understand criteria for choosing a DGR site
- Students select and use appropriate maps
- Students effectively use information-gathering skills

ASSESSMENT STRATEGIES

- Collection of student maps
- Written explanation justifying selection of given DGR site



time

90-105

MINUTES PLUS TIME
OUTSIDE OF CLASS



subjects

SCIENCE
EARTH SCIENCE
GEOLOGY
GEOGRAPHY



skills

CRITICAL THINKING
COLLABORATION
COMMUNICATION

resources & materials required

  **BLM – Deep Geological Repository Assignment** – one per student

  **BLM – Deep Geological Repository Rubric** – one per student

 Curriculum alignment

- [Natural Resources Canada – The Atlas of Canada](#)
- LCD projector or interactive whiteboard
- Electronic devices with internet access

minds-on

 30 MINUTES

- Brainstorm with the students sources of waste in their everyday lives. This could include solid waste (garbage, litter, food scraps, sewage, etc.), liquid waste (sewage, shampoos and soaps down drain, cleaning products, etc.) and gaseous waste (carbon dioxide, sulfur dioxide, etc.). Students may list toxic or hazardous wastes. Hazardous wastes include:
 - » carcinogenic (cause cancer);
 - » ignitable (flammable);
 - » corrosive (eat away at something);
 - » toxic;
 - » explosive; and
 - » radioactive.
- After uranium is used in a nuclear reactor, it becomes used nuclear fuel. Show students the NWMO “Safely Managing Used Nuclear Fuel in Canada” [video](#) (5 min. 49 sec.) during which students should be encouraged to take notes. The video shows how used nuclear fuel is stored and includes information about both short-term storage and Canada’s plan for the long-term storage of nuclear fuel.
- Based on the information in the video, discuss the criteria for the planned DGR. This should include:
 - » *Hosted by an informed and willing community*
 - » *Requires a land area of approximately 2 x 3 km*
 - » *Will need surface buildings (will use a small portion of land area)*
 - » *Constructed approximately 500 m underground*
 - » *Excavated tunnels*
 - » *Rooms constructed in stable rock*
 - » *Monitored for an extended period of time*
 - » *Fuel accessible so it could someday be retrieved*



DID YOU KNOW?

In Canada, “high-level nuclear waste” refers to used nuclear reactor fuel, sometimes referred to as “spent nuclear fuel” or “nuclear fuel waste.” Strictly speaking, discharged power reactor fuel in Canada is neither “waste” nor “spent,” since it retains a significant energy potential; however, since reprocessing of used power reactor fuel is not currently practiced in Canada, the terminology does have meaning in the context of current Canadian nuclear operations.

- In addition, in 1998 the Canadian Nuclear Fuel Waste Management Program (CNFWMP) proposed that the fuel be placed:
 - » in granite rock of the Canadian Shield;
 - » in intrusions called batholiths (geologically stable for one to two billion years);
 - » in areas of low mineral value (low economic value); and
 - » in areas with low ground-water movement.
- Today, Canada's long-term nuclear used fuel management program is currently administered by the [NWMO](#), established in November 2002 under the *Nuclear Fuel Waste Act* (June 2002). Oversight of the NWMO is provided by [Natural Resources Canada](#), which has also set up a [Nuclear Fuel Waste Bureau](#) to enhance public participation in the decision-making process.

IMPLEMENTATION OPTION

- If necessary, review strategies for taking notes during videos.

action

 15 MINUTES PLUS RESEARCH TIME OUTSIDE CLASS

- Explain that the NWMO is currently working collaboratively with interested Canadians to develop a fair process to select a site for a DGR. In small groups, students will go through a similar process themselves.
- Provide each student with a copy of the **Deep Geological Repository Assignment BLM** and have each student read over the criteria for the location of a DGR, which will help guide their research.

IMPLEMENTATION OPTIONS

- Depending on what topics have been discussed in class, criteria for the DGR can be modified to suit student prior knowledge and curricula.
- It may be necessary to explore how to locate pertinent maps and use the map features on [The Atlas of Canada](#) with the students before the assignment. Students will be able to use this site to find all of the maps that they need to complete the assignment. When looking at the maps you can zoom in, zoom out, zoom to regions and get more information about each map.

consolidation

 45 MINUTES

- Each group will take turns presenting their chosen location. The groups must show their maps and explain their rationale for choosing the location based on the given criteria. Questions for each group can include:
 - » *Do you see any problems with your proposed location?*
 - » *What might be some advantages of your chosen location?*
 - » *What is the closest community to your proposed location?*
- Continue with a class discussion about the societal reactions to the concept of a DGR. Questions for discussion can include:
 - » *Why is it important that the closest community be "willing" to host the DGR?*
 - » *Why might people be concerned about a DGR nearby?*
 - » *How would you feel if your community was considering hosting a DGR?*
 - » *Although NWMO's planned DGR is considered scientifically sound, it is considered by some to be socially unacceptable. Why do you think this is the case?*
 - » *Do you think a DGR will ever be considered a socially acceptable choice for the long-term disposal for Canada's used nuclear fuel?*



DID YOU KNOW?

Batholiths are large bodies of intrusive igneous rock that have more than 100 m² of surface exposure.

extensions

- Students could present their findings in a town hall format (see the **Flying the Radioactive Skies** lesson) and have other groups role-play being members of a community which could potentially host the DGR.
- Ontario Power Generation currently has a proposed DGR in Kincardine, Ontario. Have students research the plans for this facility. What type of waste do they plan to store there? When is it supposed to become active? How did this community participate in the selection process?
- DGR's do exist in other countries. Have students find out which other countries have such repositories, what geological formations they are located in, their projected in-services dates or their closure dates.
- Not all DGR's store used nuclear fuel. Have students research the other types of nuclear waste stored (or propose to be stored) in these sites.

additional resources

CANADIAN NUCLEAR ASSOCIATION WEB PAGES

- [Waste production](#)
- [Waste regulations](#)
- [Storage solutions](#)
- [Long-term disposal](#)

RELATED TEACHNUCLEAR LESSON PLANS

- [Keeping the Genie in the Bottle: Nuclear Non-Proliferation](#)

background information

[Retrieved August 2019]

- [Waste Management – Canadian Nuclear FAQ](#)

Frequently asked questions are answered on nuclear science and technology in Canada, including: how high-level nuclear waste is managed in Canada, how low-level radioactive waste managed in Canada, and what nature tells us about nuclear waste disposal.

- [Safely Managing Used Nuclear Fuel in Canada – Nuclear Waste Management Organization \(video\)](#)

This 5-minute video explains in depth the plans for safely managing Canada's used nuclear fuel.

- [About Adaptive Phased Management – Nuclear Waste Management Organization](#)

In June 2007 the Federal Government of Canada named the plan for the long-term management of Canada's used fuel Adaptive Phased Management (APM).

- [The Deep Geologic Repository – Ontario Power Generation](#)

Ontario Power Generation (OPG), with the support of the local community, has proposed the construction and operation of a DGR for the long-term storage of low- and intermediate-level nuclear waste on lands adjacent to the Western Waste Management Facility in Kincardine, Ontario.

- [Radioactive Waste: Myths and Realities – World Nuclear Association](#)

A number of pervasive myths regarding both radiation and radioactive waste are debunked using industry facts.

- [Radioactive Waste Management – World Nuclear Association](#)

Information about different types of nuclear waste, managing and disposing of high-level waste from used fuel, and natural precedents for geological disposal of nuclear waste.