NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

The Use of Natural Analogues in Building Stakeholder Confidence in Canada's Plan for the Long-Term Management of Used Nuclear Fuel

Natural Analogues Working Group, Prague, Czech Republic
NWMO –Alec Blyth

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About the NWMO

NWMO: Who We Are

- Formed in 2002 as required by *Nuclear Fuel Waste Act*
- Funded by Canada's nuclear energy corporations
- Operates on a not-for-profit basis

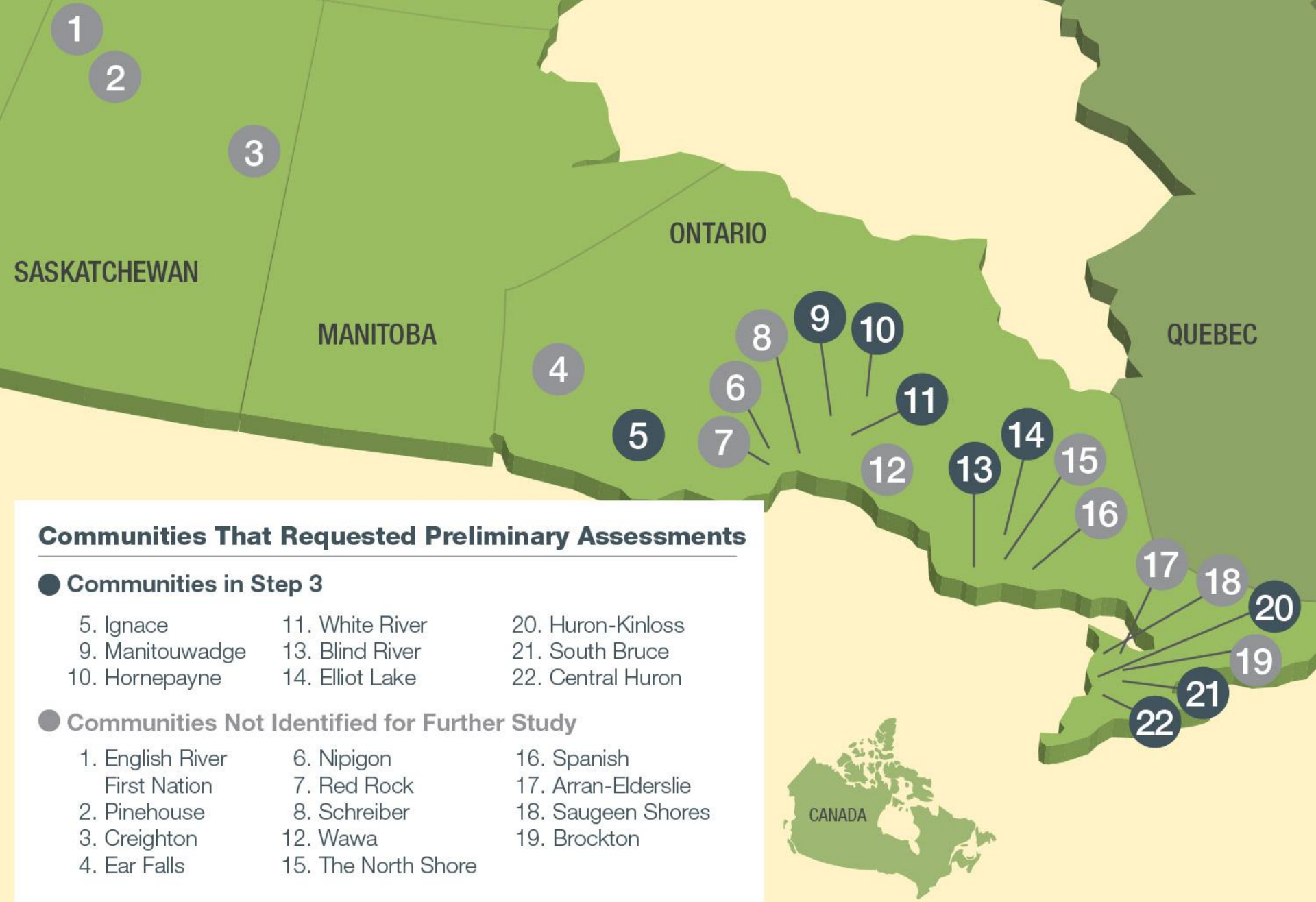
Our mission is to develop and implement collaboratively with Canadians, a management approach for the long-term care of Canada's used nuclear fuel that is socially acceptable, technically sound, environmentally responsible, and economically feasible.

Site Selection Process: Initiated May 2010

Seeking an informed and willing host with a suitable geologic formation

- Developed through two-year public dialogue
- Multi-stage technical and socio-economic assessment approach
- Phased process over many years
- Communities expressed interest to participate
- Communities can choose to leave the process

The project will only proceed with interested community, First Nation and Métis communities and surrounding municipalities working in partnership.



Communities That Requested Preliminary Assessments

Communities in Step 3

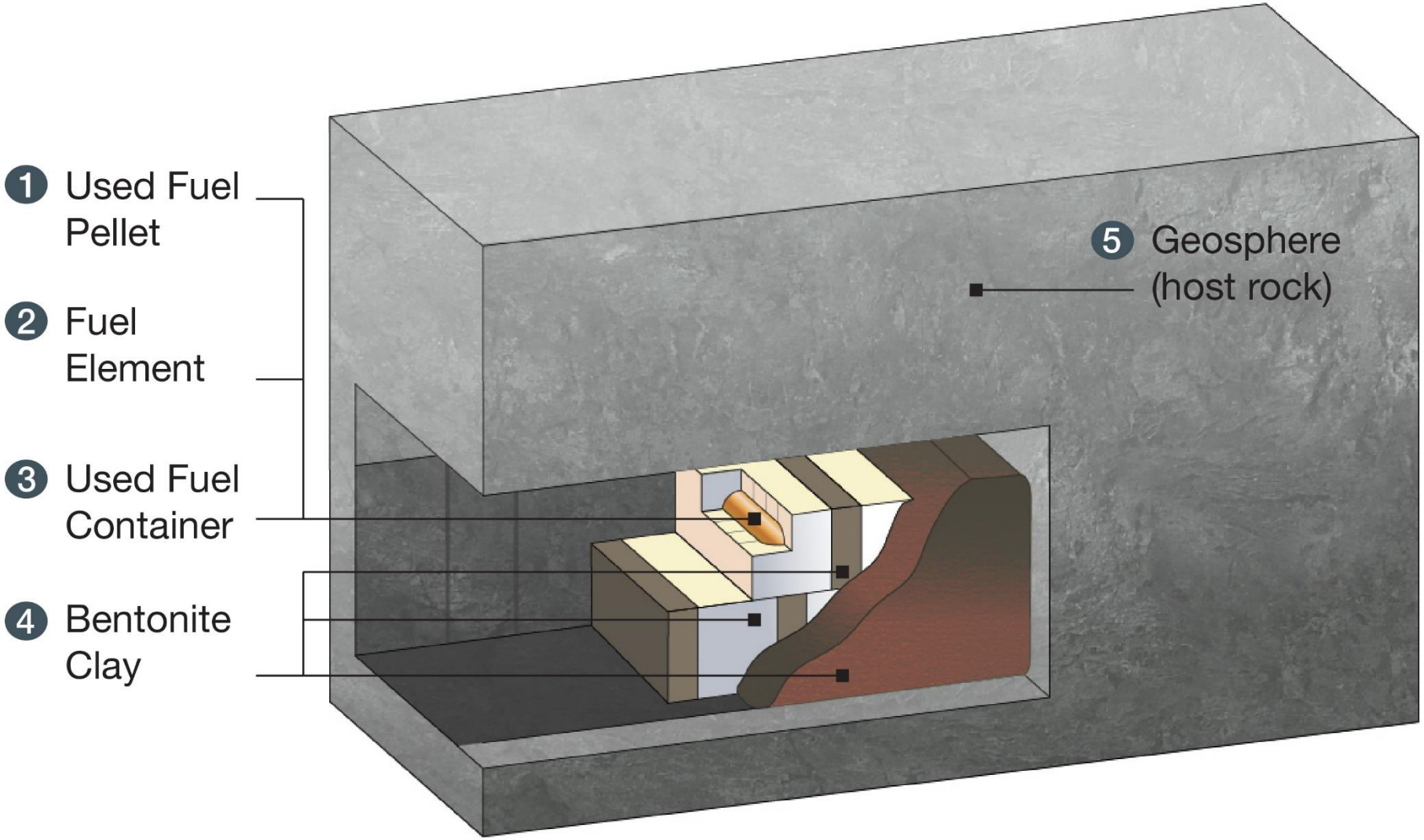
5. Ignace
9. Manitouwadge
10. Hornepayne
11. White River
13. Blind River
14. Elliot Lake
20. Huron-Kinloss
21. South Bruce
22. Central Huron

Communities Not Identified for Further Study

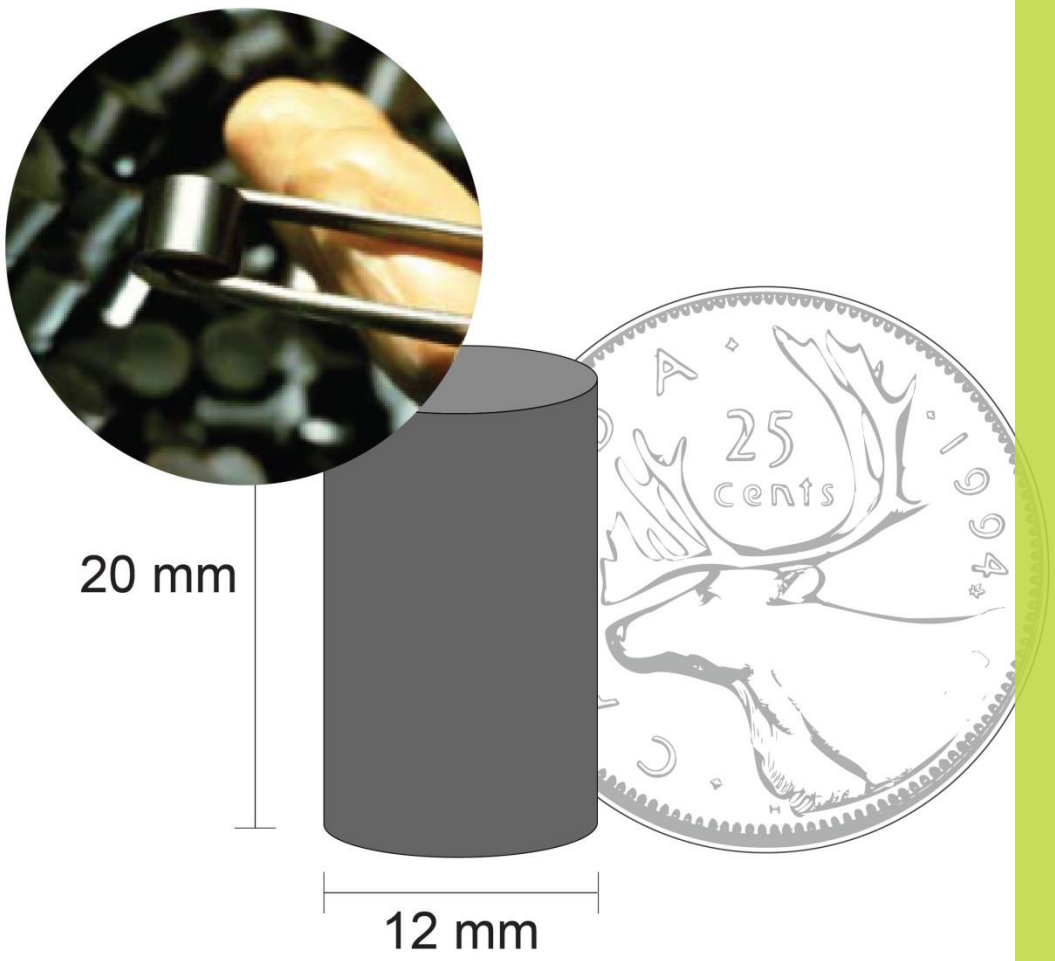
1. English River First Nation
2. Pinehouse
3. Creighton
4. Ear Falls
6. Nipigon
7. Red Rock
8. Schreiber
12. Wawa
15. The North Shore
16. Spanish
17. Arran-Elderslie
18. Saugeen Shores
19. Brockton

Safety and Security

Multiple Barriers to Contain and Isolate

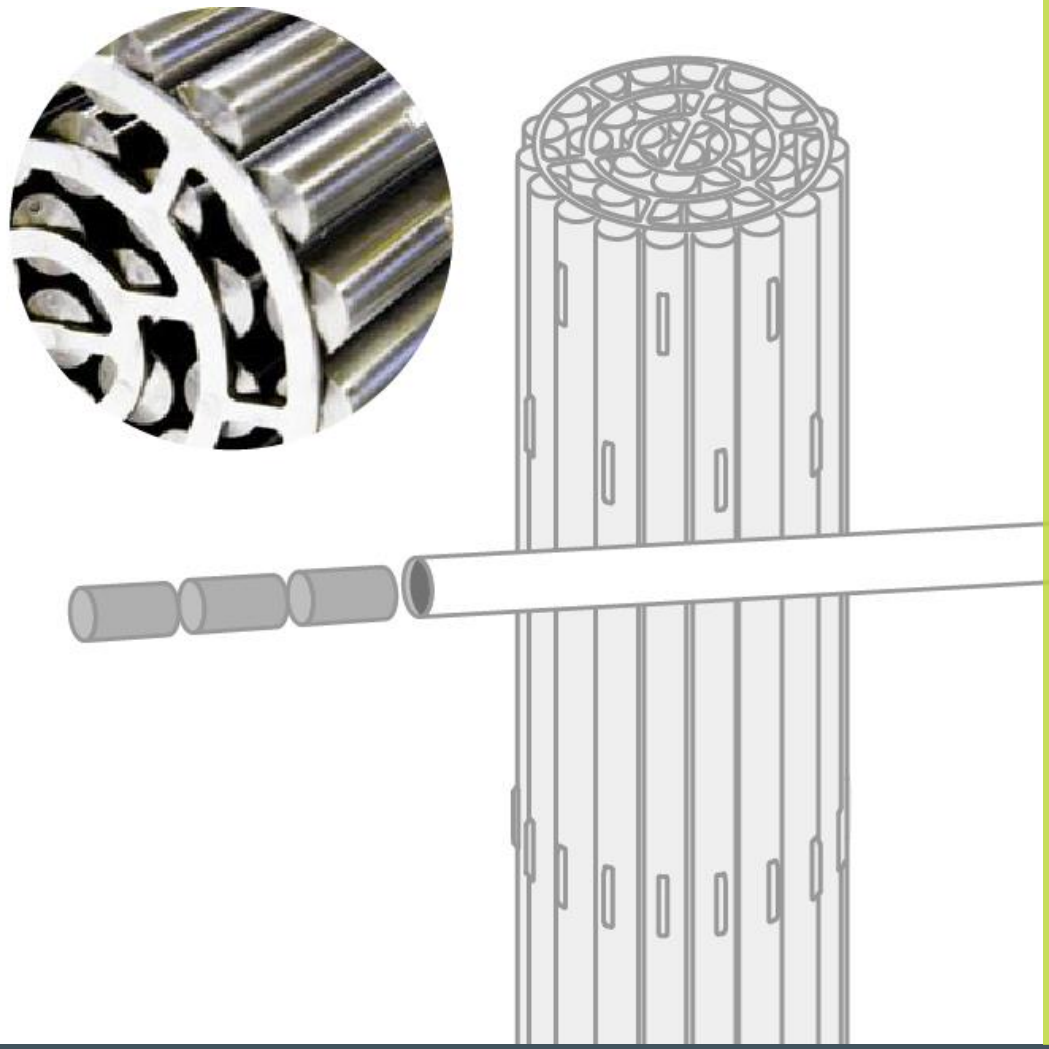


Barrier #1: Fuel Pellet



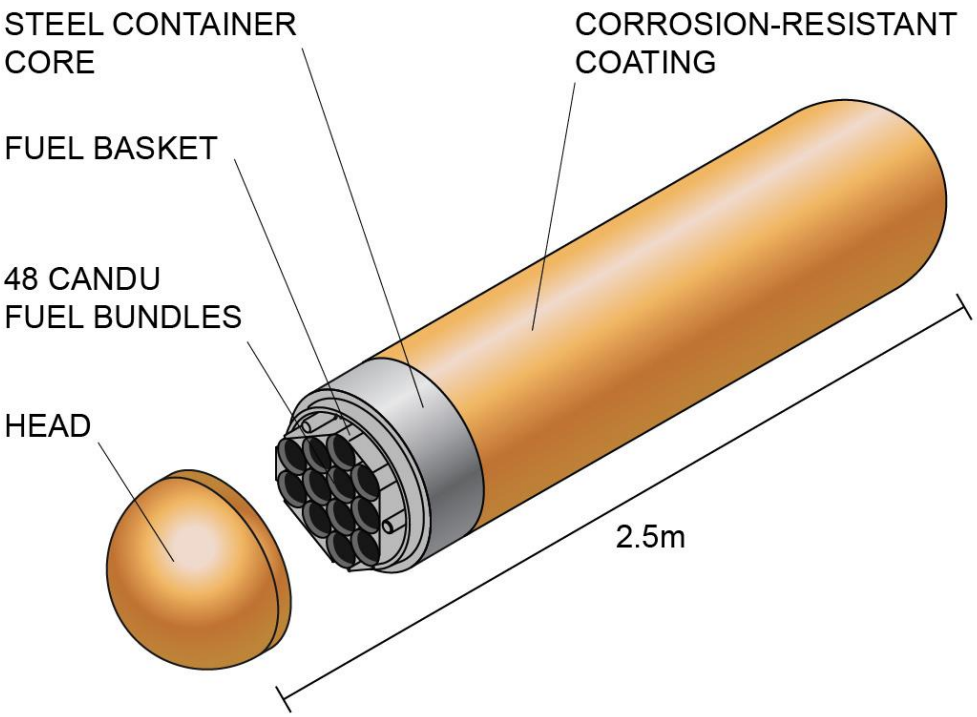
- **High density ceramic**
- **Extremely durable**
- **Does not readily dissolve**

Barrier #2: Zircaloy Fuel Elements



- **Used fuel pellets are held in sealed tubes**
- **Zircaloy metal is extremely strong**
- **Zircaloy metal is corrosion-resistant**

Barrier #3: Used Fuel Container

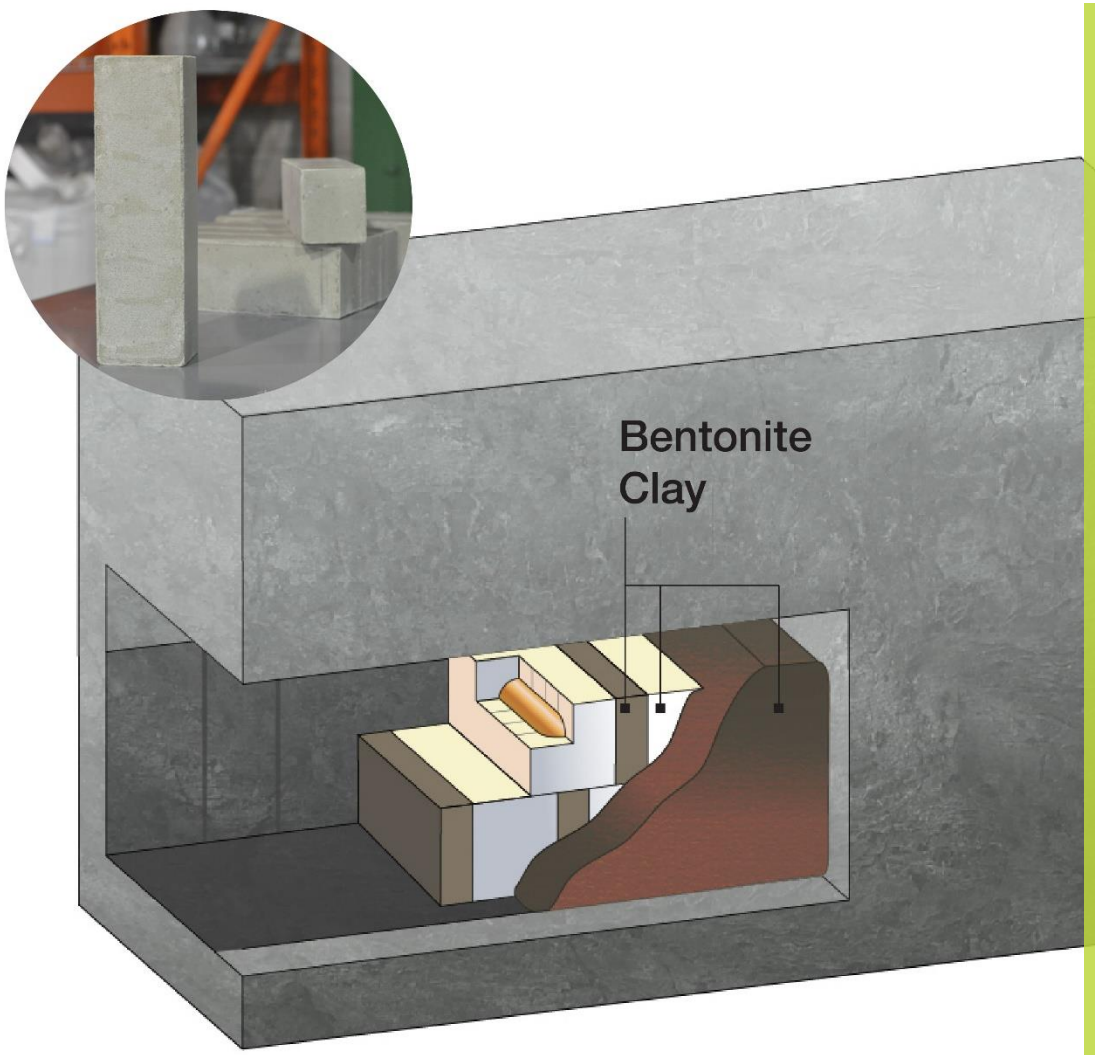


- **Durable & long-lived deep underground**
- **Strong steel core**
- **Corrosion-resistant copper coating**

Copper: Natural Analogue

- Copper sheets in mudstones from South Devon, England
- Formed 200 million years ago
- Show little corrosion
- Copper remained stable for millions of years within clay-rich mudstone

Barrier #4: Bentonite Clay

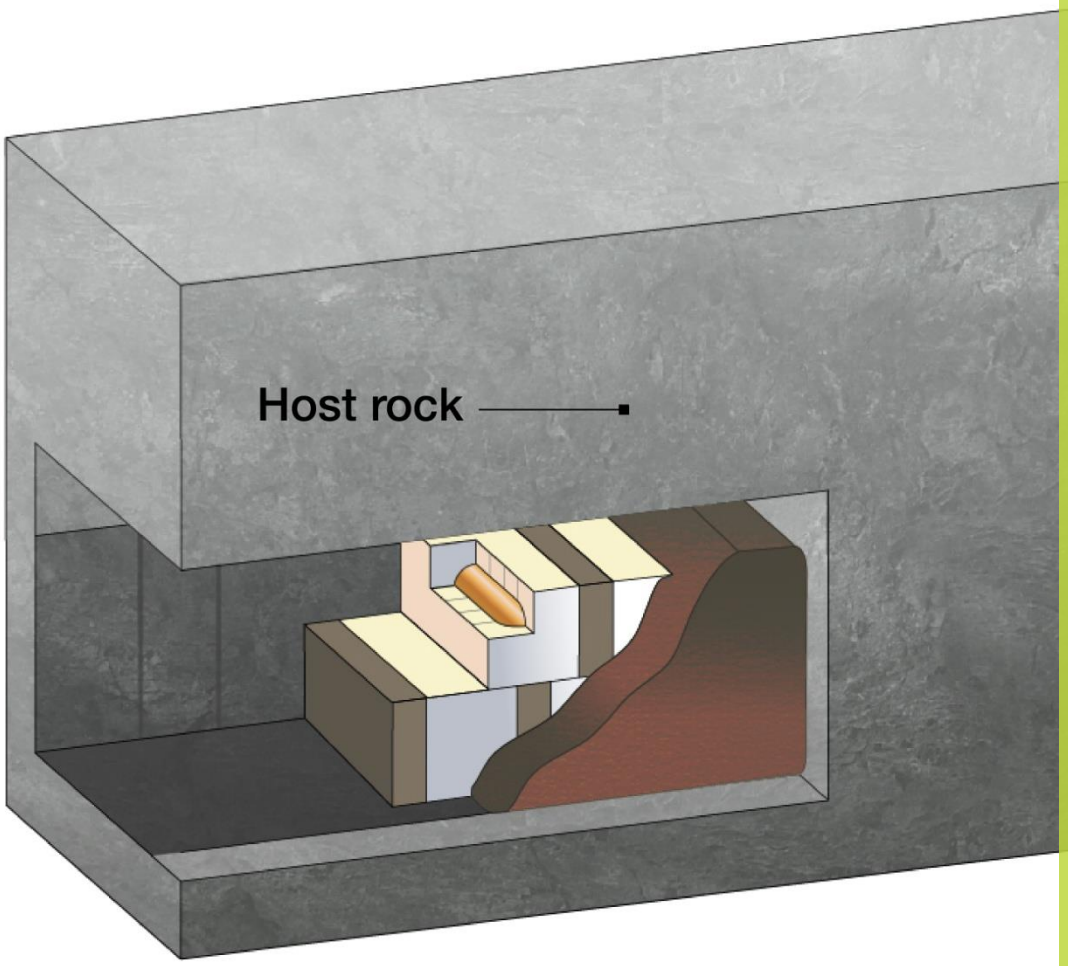


- Formed millions of years ago
- Natural swelling clay material, fills void spaces
- Reduces minute flow of groundwater
- If container fails, clay minerals act like a sponge

Clay: Natural Analogue

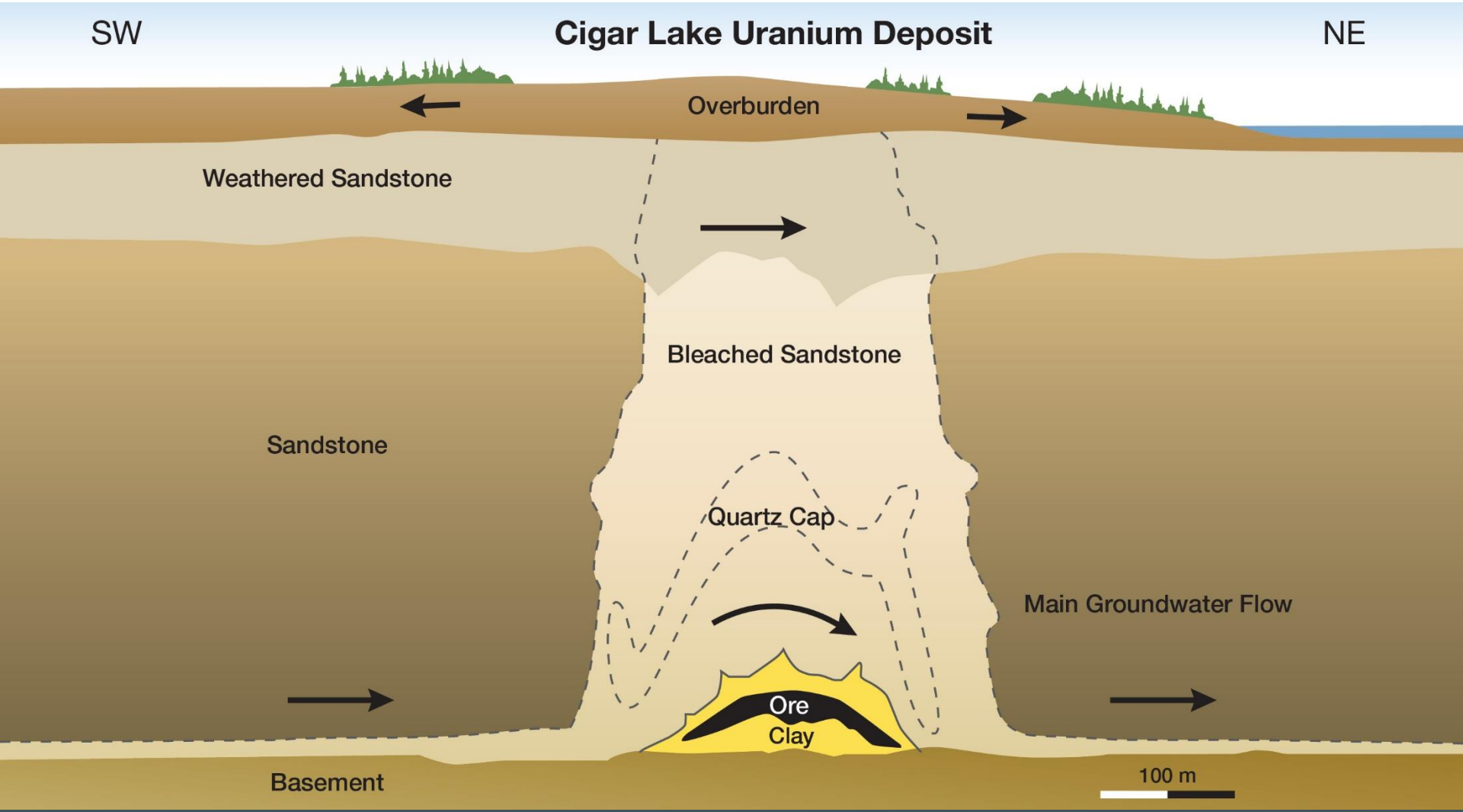
- The sequoia-like trees in Dunarobba forest, Italy, were buried in clay for 1½ million years
- They are still made of wood and have not decomposed

Barrier #5: Geosphere (Host Rock)



- **Natural barrier**
- **Protects repository from surface events (natural & human)**
- **Isolates used fuel for very long times**

Geosphere: Natural Analogue



Safety analysis approach

Reference Case Scenario

- Assumes people living off the land, close to the repository (drinking and irrigation waters from local wells, farming, crops & livestock)
- Assumes some used fuel containers defective from the beginning

Worse Case (Unlikely) Scenarios

- Used fuel more soluble in water
- Containers defect more important
- All containers fail with time
- Sealing materials more permeable

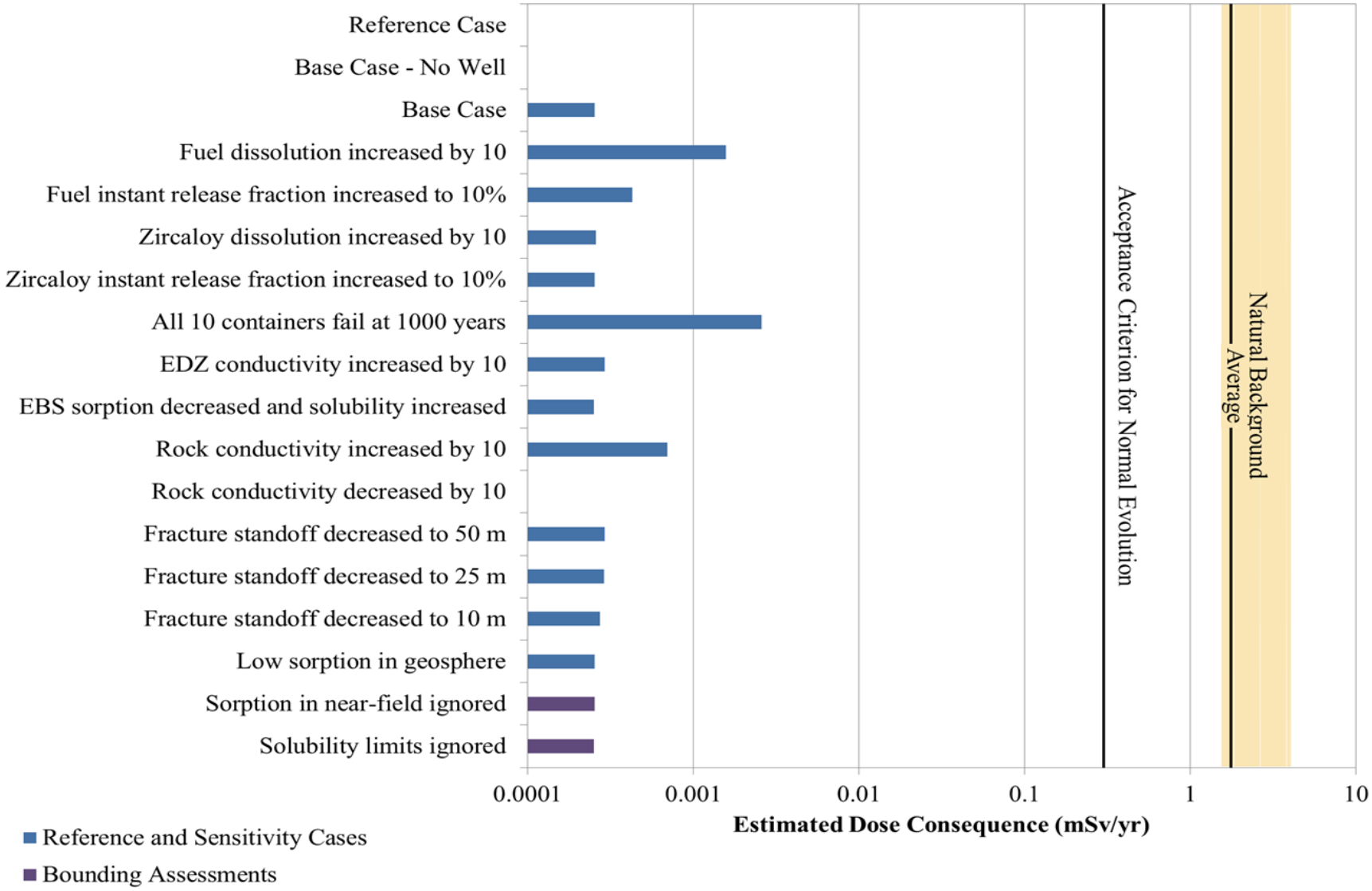
Disruptive Event Scenarios

- Disruptive Scenarios were identified by examination of Features, Events and Processes that could affect repository system and its evolution.
- Seven Disruptive Scenarios were identified

1) Inadvertent Human Intrusion
2) Repository Seals Failure
3) Partially Sealed Repository
4) Poorly Sealed Borehole
5) Undetected Fault
6) Container Failure
7) All Containers Fail

- Other potential Disruptive Scenarios were ruled out on various grounds (e.g., no volcanic activity in area, far from coast, no minerals at site) or very low probability leading to low calculated risks (e.g., meteor strike).
- Similar scenarios have been identified in other international programs.

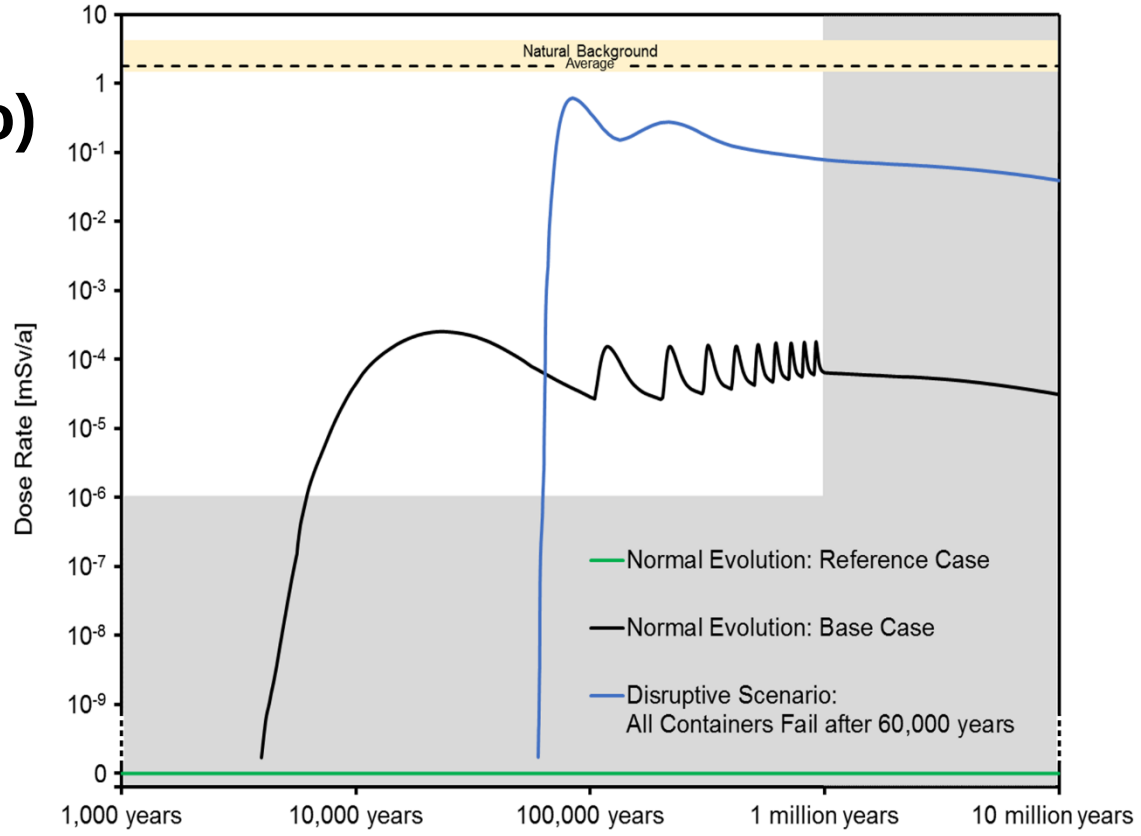
Radiological Dose Consequences



Radiological Dose Consequences

All Containers Fail (Disruptive Scenario)

- Unlikely event leading to abnormal loss of containment
- Maximum impact is 0.63 mSv/a
- I-129 remains the dominant dose contributor



Conclusions around using Natural Analogs to Convey Confidence in Safety

- Each of the Multi-Barrier components are described and compared with analogues in nature that are easy to understand.
- Emphasis is on describing local examples of these analogues.
- The copper and geosphere analogues resonate with First Nations groups and fits well with their traditional knowledge.
- The independent and cumulative nature of the multi-barrier components, each with examples of how nature treats these materials, is effective in conveying safety in the project
- Robust modelling of radiological dose consequences, including very extreme disruptive scenarios sends a strong message about safety

Questions?