

# URANIUM MINE WASTE MANAGEMENT AND REGULATION

Presented by: the Canadian Nuclear Safety Commission

In collaboration with the ministère de l'Énergie et des Ressources Naturelles  
and the ministère du Développement Durable, de l'Environnement et de la  
Lutte contre les changements climatiques



Québec 

# Presentation outline

- Definition of tailings and waste rock
- CNSC regulatory requirements
- Canadian long-term management methods and environmental performance
- Sources of uncertainty associated with uranium tailings and waste rock management
- Conclusions



# Tailings and waste rock

## Tailings

- Generated by ore crushing and milling operations
- Contain reagents and waste water used in milling the ore
- Contain metals, radionuclides and reactive products of the process (e.g. arsenic and radium)



## Waste rock

- Residual rock resulting from ore excavation

## Tailings and waste rock

- Exposure to water and air: acid or neutral mine drainage: mobilization of metals and radioactive elements
- Necessary to characterize and evaluate concentrations and the long-term changes in the substances mobilized

KeyLake  
example



# Uranium tailings management: provincial framework – Quebec

If a uranium mine were developed in Quebec, the regulatory framework for uranium tailings management would be the same way as that for other mining operations in Quebec.

The following regulatory and administrative requirements would apply:

- *Mining Act* (c. M-13.1)
- *Regulation respecting mineral substances other than petroleum, natural gas and brine* (c. M-13.1, r. 2)
- *Environment Quality Act* (c. Q-2) and associated regulations, including the *Regulation respecting environmental impact assessment and review* (c. Q-2, r. 23)
- *Directive 019 sur l'industrie minière* (MDDELCC)



# Uranium tailings management: provincial framework – Quebec

## **Best practices guide**

- Guidelines and instructions for preparing the plan and general requirements for the remediation of Quebec mine sites (by the ministère de l'Énergie et des Ressources naturelles)

# Federal Framework: CNSC regulatory requirements

## **CNSC requirements:**

- *Nuclear Safety and Control Act*
- *General Nuclear Safety and Control Regulations*
- *Uranium Mines and Mills Regulations*
- *P-290 – Policy on Managing Radioactive Waste*
- *RD/GD 370 – Management of Uranium Mine Waste Rock and Mill Tailings*

## **Other federal requirements:**

- *Canadian Environmental Assessment Act, 2012*
- *Fisheries Act*
- *Metal Mining Effluent Regulations*



# National and international best practices guides

- *Guidelines for the Assessment of Alternatives for Mine Waste Disposal* (Environment Canada, 2011)
- *Environmental Code of Practice for Metal Mines* (Environment Canada, 2009)
- *Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials* (NEDEM 1.20.1, Natural Resources Canada, 2009)
- *Management of Radioactive Wastes from the Mining and Milling of Ores* (WS-G-1.2, AIEA, 2002)
- *Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities* (European Commission, 2009)
- *Best Practices in Environmental Management of Uranium Mining* (NF-T-1.2, AIEA, 2010)



# Tailings management: example of Elliot Lake



Disposal in a valley with water cover



Above-surface installation with water cover or dry cover

In Canada, methods have progressed over the years:

1. From disposal in natural pools or water bodies, to
2. Containment in above-surface facilities with water cover or dry cover, to
3. Disposal in pits



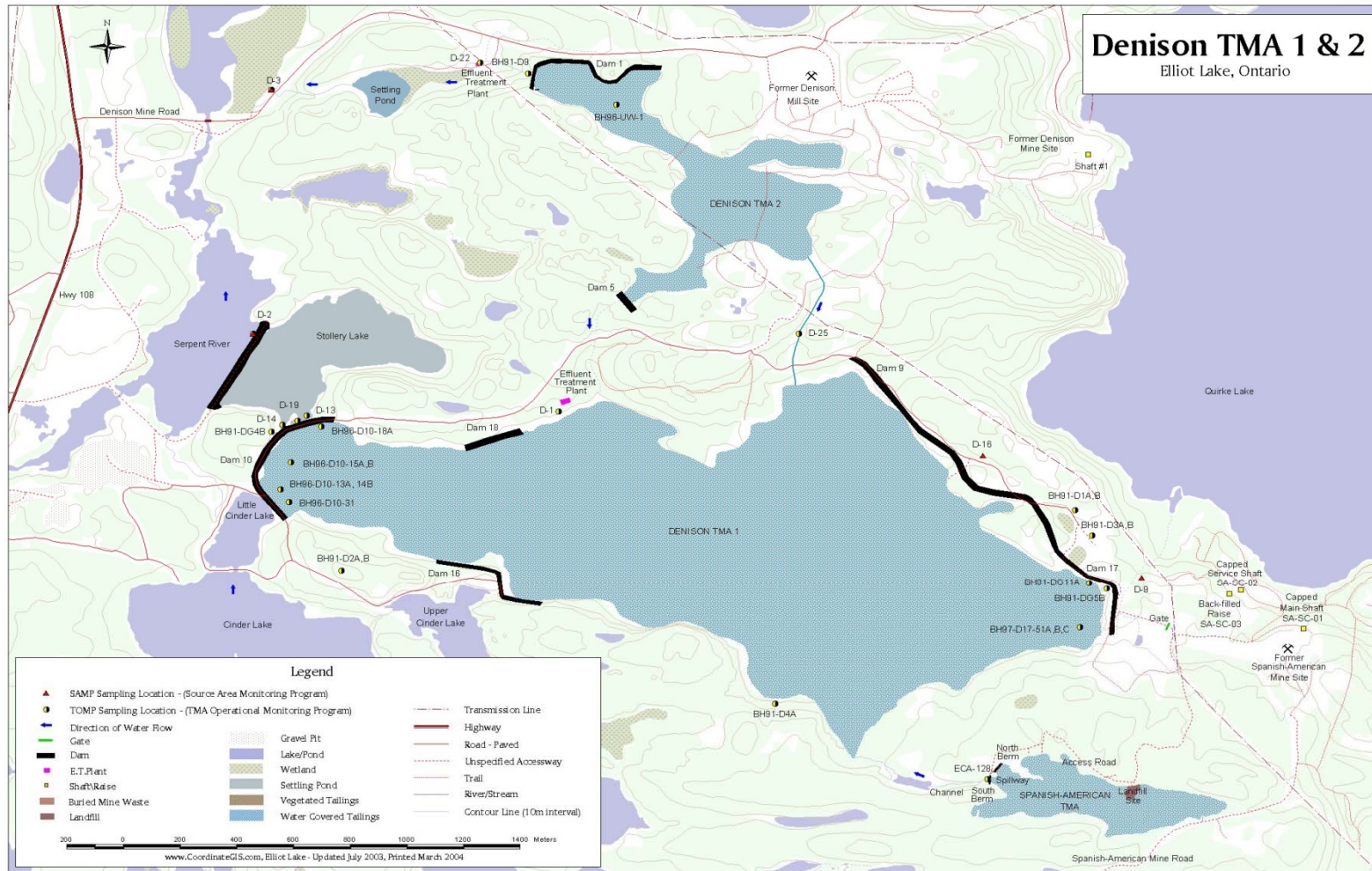


# Elliot Lake's Example :Management of potentially acid-generating tailings and water cover

1. Disposal of tailings in a valley, lake or basin; containment structures at low points
2. On completion of operations, the containment structures are improved to ensure their stability under anticipated loading conditions, including seismic loading
3. Water cover to minimize acid generation



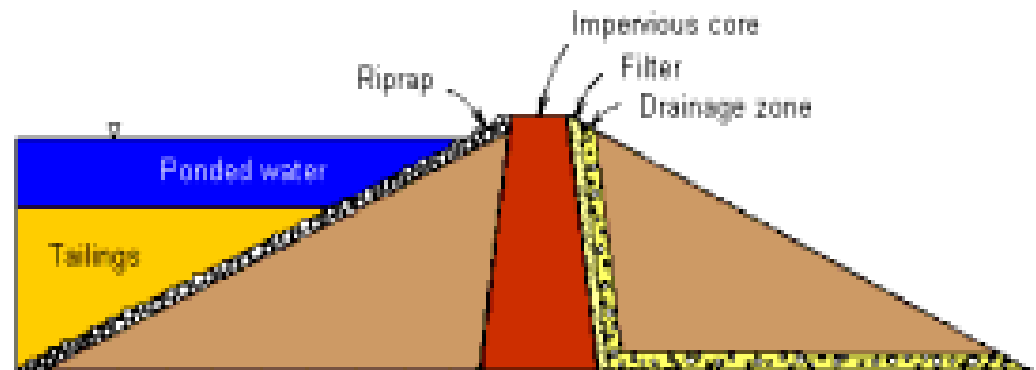
# Past practices: Elliot Lake's Example



# Valley impoundments: Elliot Lake's example



Water-retention type dam for tailings storage

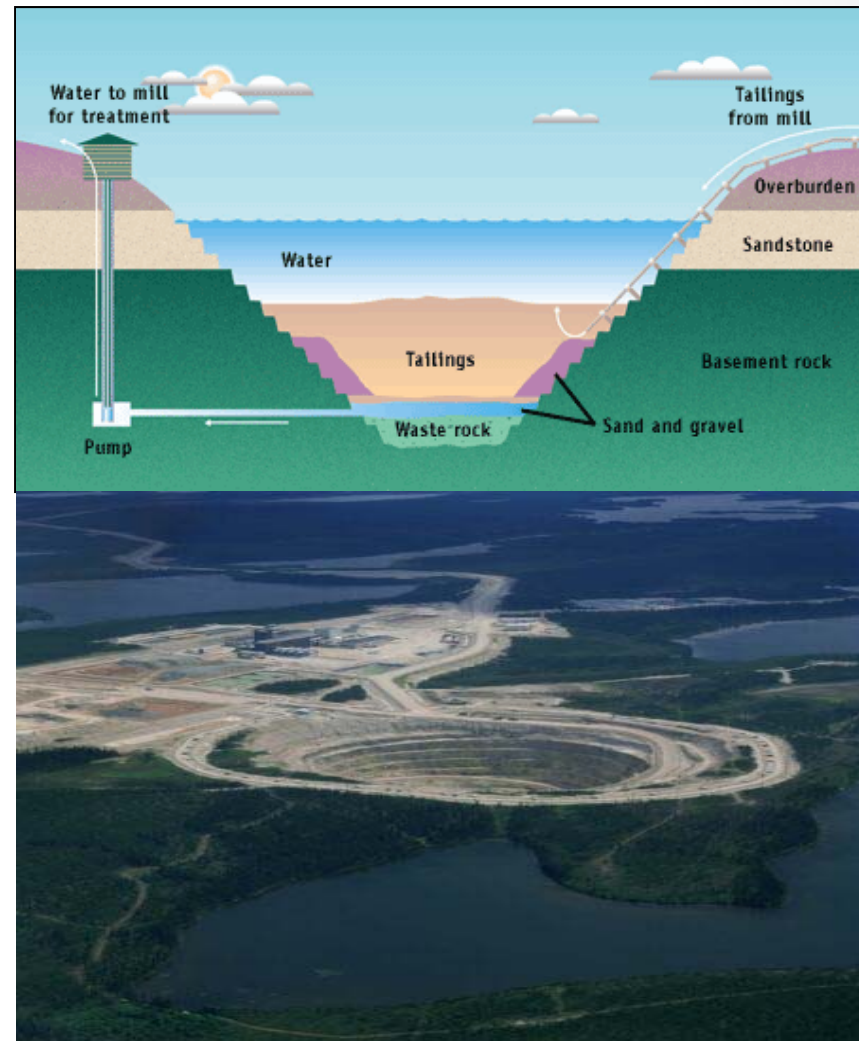


- Containment structure with impervious core designed in accordance with the Canadian Dam Association
- Static and seismic stability must be demonstrated
- Inspected annually by consulting engineers and CNSC staff



# In-pit tailings management: McClellan Lake's example

- Contaminated water from the tailings are pumped and treated during disposal
- After decommissioning:
  - tailings have low permeability
  - groundwater flow through the tailings will be low
  - a cover isolates the tailings from the surface or lake re-established in the rest of the pit



# In-pit tailings management

## Contaminated water pumping station



Example of Key Lake



# Waste rock management

## Non-acid generating classified waste rock

- Stockpiled on the surface
- Relatively stable
- Can be used as construction material

## Potentially acid-generating classified waste rock

- Potentially mineralized or acidic
- Require a well-studied management method to protect the environment (RD/GD 370)
- Short-term storage on the surface and water treatment
- Long term:
  - Dry cover to reduce infiltration
  - In-pit disposal
  - Disposal in shafts and galleries



Potentially acid-generating waste rock to be backfilled into the adjacent pit – Example of McClean Lake



Surface management with cover designed to limit water infiltration and exposure to oxygen – Example of Cluff Lake



# Surface and groundwater protection

- All tailings and waste rock management facilities authorized by the CNSC must protect surface and groundwater, during their construction and operation and following closure
- Containment structures and/or natural barriers between tailings and the environment limit contaminant dispersal
- Groundwater at the mine site limits must meet the applicable criteria
- Surface water at the receiving environment must meet the applicable criteria for the protection of plants and animals, as well as the criteria for drinking water quality, if the water is used for that purpose



# Surface and groundwater protection (cont'd)

CNSC licence applicants must:

- Characterize the hydrogeology and hydrology of the site
- Propose tailings containment structures and natural barriers to limit the release of contaminants
- Assess the short- and long-term impact on surface and groundwater and ensure that all applicable criteria are met
- Implement an environmental monitoring program

All of the above activities are verified by CNSC staff



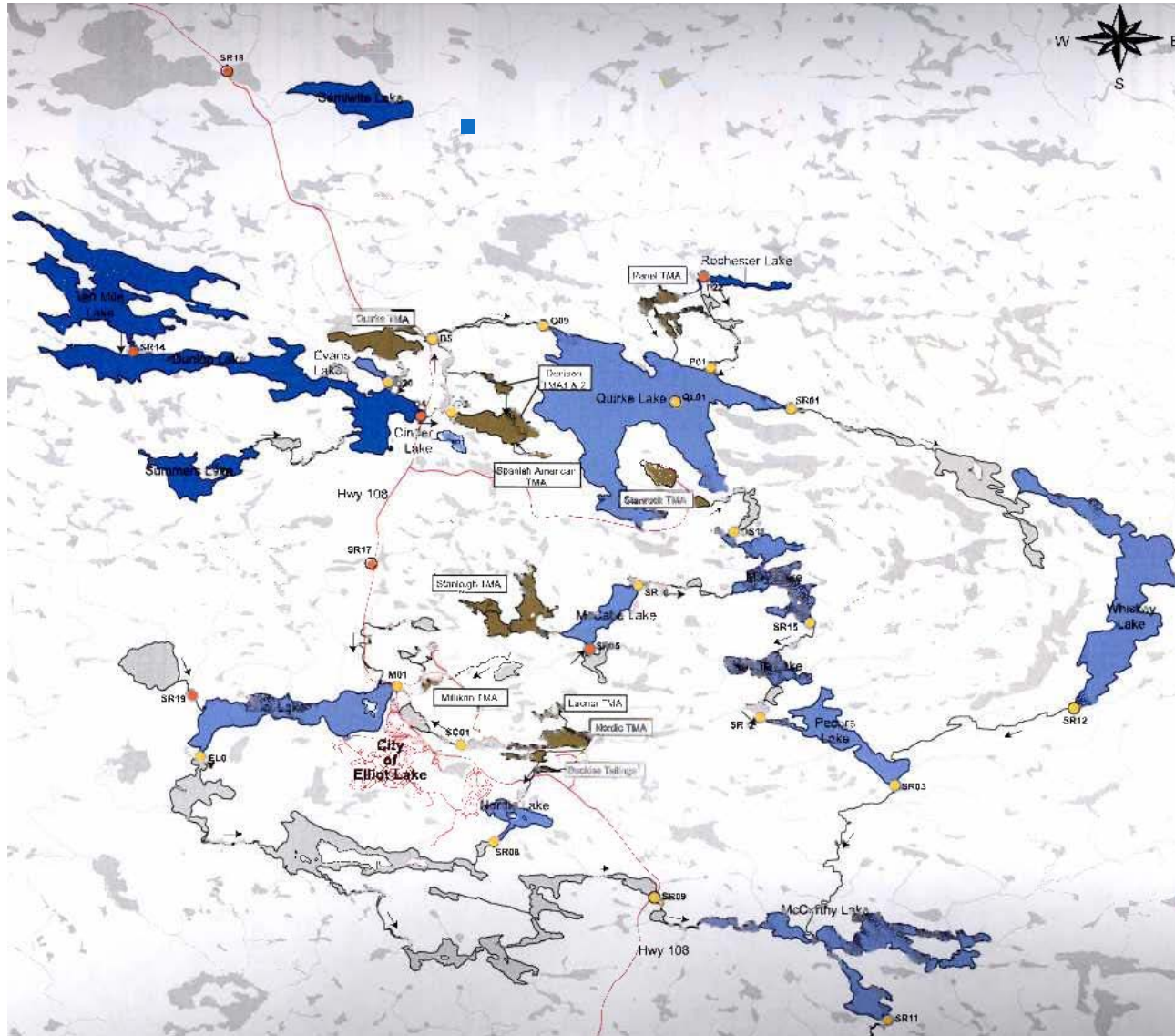


# Aquatic impact of tailings and waste rock management facilities

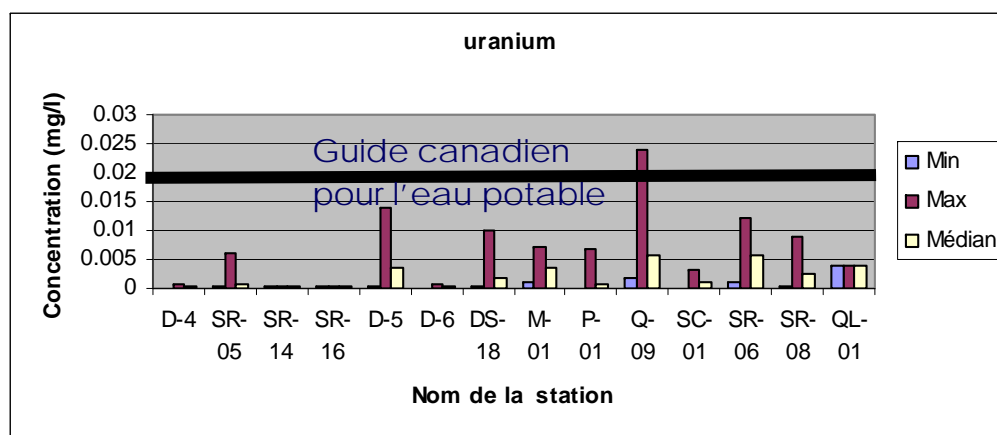
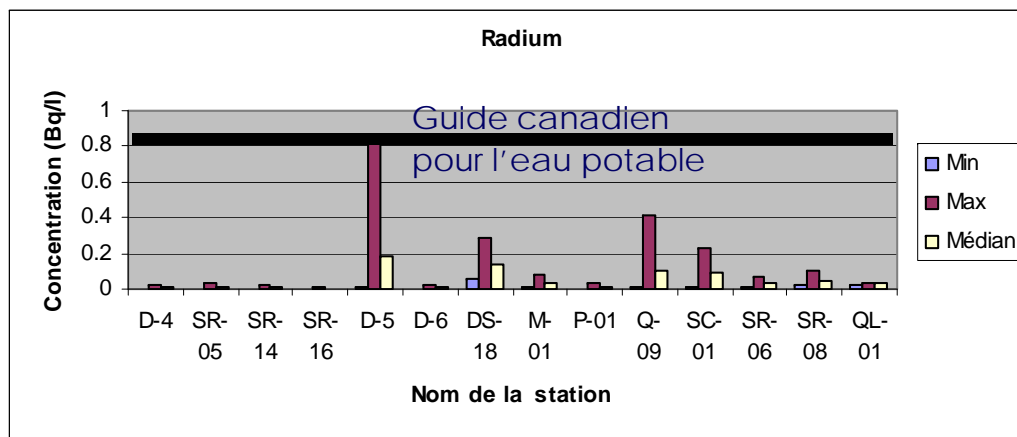
- Tailings and waste rock management facilities regulated by CNSC: no unacceptable risk to public health or the environment.
- In particular, surface and groundwater around facilities is protected
- Examples: Elliot Lake (Ontario) and McClean Lake (Saskatchewan)



# Aquatic impact: example of Elliot Lake



# Example of Elliot Lake: radionuclide concentrations in surface water (2000-2006)



# Example: McClean Lake tailings pit



The dozens of piezometers around the tailings management facility indicate that water quality has not been affected

# Sources of uncertainty associated with tailings and waste rock management

Sources of uncertainty associated with long-term management, such as:

- human intrusion
- long-term stability of containment structures
- long-term reliability of forecasts

The sources of uncertainty are taken into account in the environmental assessment and in the safety analyses. The safety analyses are updated every 10 years taking into account monitoring data, climate change, scientific advances, etc.



# Human intrusion

- Future human actions that can result in an unacceptable impact: excavation of tailings or waste rock and use as construction materials; residential construction on the site.
- Preventive measures:
  - Part or all of the site is indefinitely maintained under institutional control
  - In-pit management substantially reduces the risk of intrusion



# Long-term stability of containment structures

- Containment structures potentially subject to bad weather, erosion, seismic activity, etc.
- Mitigation:
  - Containment structures are designed and built to very high standards (e.g., dams can withstand 1 in 10,000-year earthquakes, in accordance with the standards of the Canadian Dam Association)
  - Annual inspection by consulting engineers (licence condition)
  - Annual maintenance for an indefinite period (licence condition)
  - Environmental monitoring (licence condition)
  - Detailed safety analysis conducted every 10 years
  - Inspection program by CNSC staff
  - Licence conditions and financial guarantee cover the entire operating, decommissioning and post-decommissioning period
  - Preference for in-pit management method



# Examples of financial guarantees for decommissioned sites

- Example of financial guarantee for Elliot Lake

Activities covered by the guarantee:

- Site security
- Reclamation
- Monitoring

\$49.3 million financial guarantee

- Example of financial guarantee for Cluff Lake

Activities covered by the guarantee:

- Site security
- Maintenance
- Monitoring

\$33.6 million financial guarantee





# Uranium tailings management: provincial framework – Quebec

The regulatory framework for uranium tailings management would be the same as that for other mining operations in Quebec in addition to:

- radioactive emissions control measures
- radiation protection measures for workers

Regulations respecting the extraction and processing of nuclear fuel fall under federal jurisdiction. CNSC is the federal body responsible for application of the regulations

# Conclusions

- Mining activity falls under provincial jurisdiction and tailings management is regulated under Quebec legislation
- The regulation and authorization of all uranium mining and milling activities falls under federal jurisdiction (CNSC)
- All present or future uranium mining activity therefore requires provincial authorization (MERN and MDDELCC) and a CNSC licence
- A licence is issued only if the CNSC is assured that the activity involves an acceptable level of risk to public health and the environment



# Conclusions (2)

- In particular, the CNSC must be assured that the methods proposed for the management of uranium mine tailings and waste do not pose an unreasonable risk to health, safety, security or the environment
- The CNSC has the expertise to verify (design, construction, operation, decommissioning, etc.) that protection requirements are met

