

# Lower Churchill Project

NORTH SPUR INFORMATION SESSION

January 2017



SNC • LAVALIN

LOWER CHURCHILL PROJECT

# Session Agenda

- Safety Moment, Kevin Burt
- Introduction of session presenters, Kevin Burt
- Session overview, Corina Walsh
- Presentation by SNC-Lavalin
  - Muskrat Falls dams
  - Dam safety
  - North Spur geology, dam design and construction
  - Expert reviews
- Question and Answers

## Role of SNC-Lavalin (SNC)

- SNC has been involved on the Muskrat Falls Project since the 1970s.
- SNC is responsible for the engineering and design for the Muskrat Falls Project including the hydroelectric and transmission projects.
- SNC designed the Muskrat Falls hydroelectric facilities including the North Spur dam.
- SNC is one of the leading engineering and construction groups in the world and a major player in the ownership of infrastructure.

# SNC's Dam Safety Project Experience

- Chute-à-Caron and Isle Maligne
- Ottawa River System
  - Hydroelectric studies of sites
- Mersey River System Dam Safety Evaluation
  - 6 generating stations
- Madawaska River System Evaluation
  - 5 generating stations and 2 water control dams
- Shipshaw River Dam Safety Evaluation and Rehabilitation of Onatchiway Dam
  - 4 generating stations and 3 water control dams



# Muskrat Falls Dams

- The hydro project includes three dams on the Churchill River:
  - North dam will be constructed of concrete
  - South dam will be earth and rock filled dam
  - North Spur is a natural dam and as a critical piece of infrastructure was strengthened and protected
- All design and construction work is reviewed by external and internal experts



# Muskrat Falls Hydro Facilities

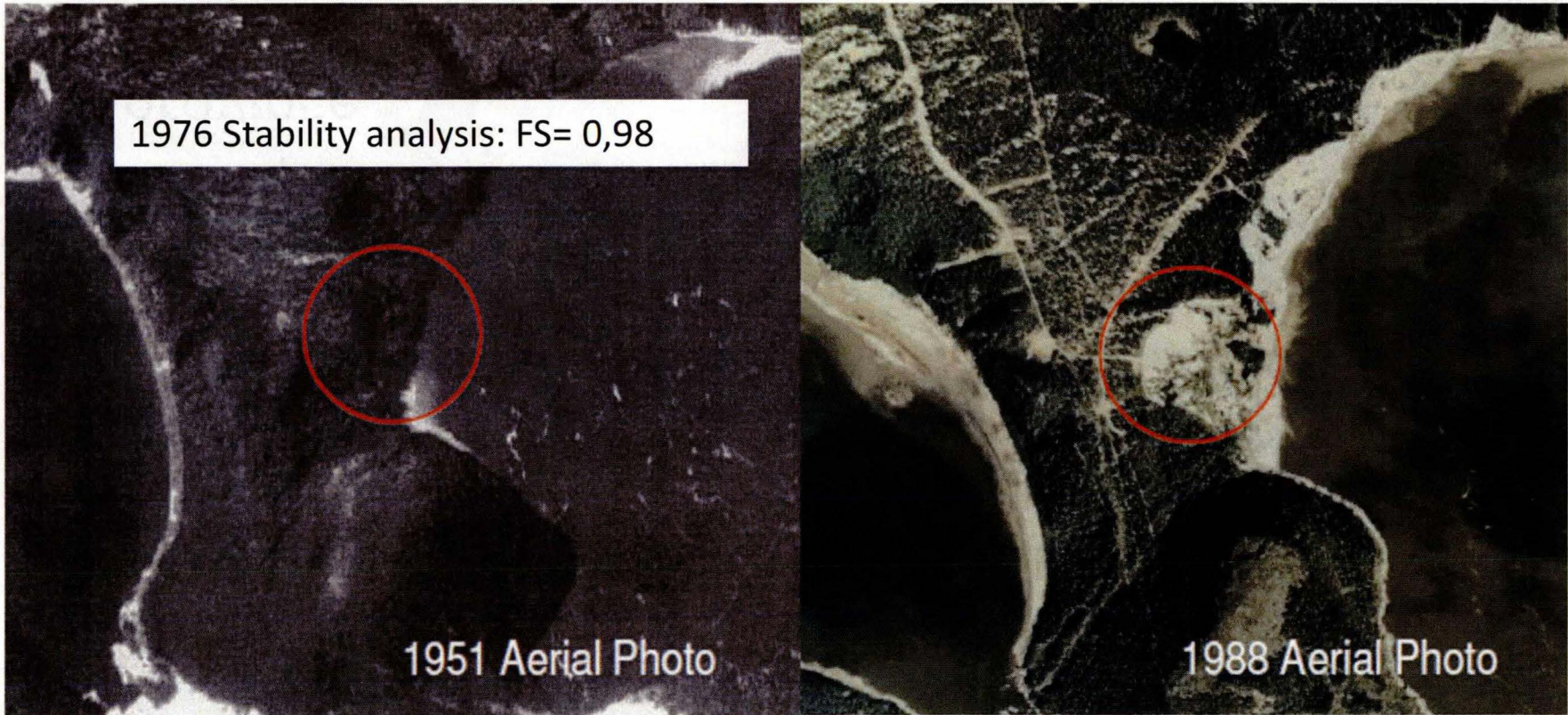


# Ensuring Dam and Public Safety

- The Muskrat Falls facility is being built to the highest standards of dam safety and construction
- The facility is monitored and constructed to meet Canadian Dam Association Dam Safety Guidelines
- Nalcor (NL Hydro and Churchill Falls) maintain and operate more than 25 hydro dams across the province



# 1978 Landslide



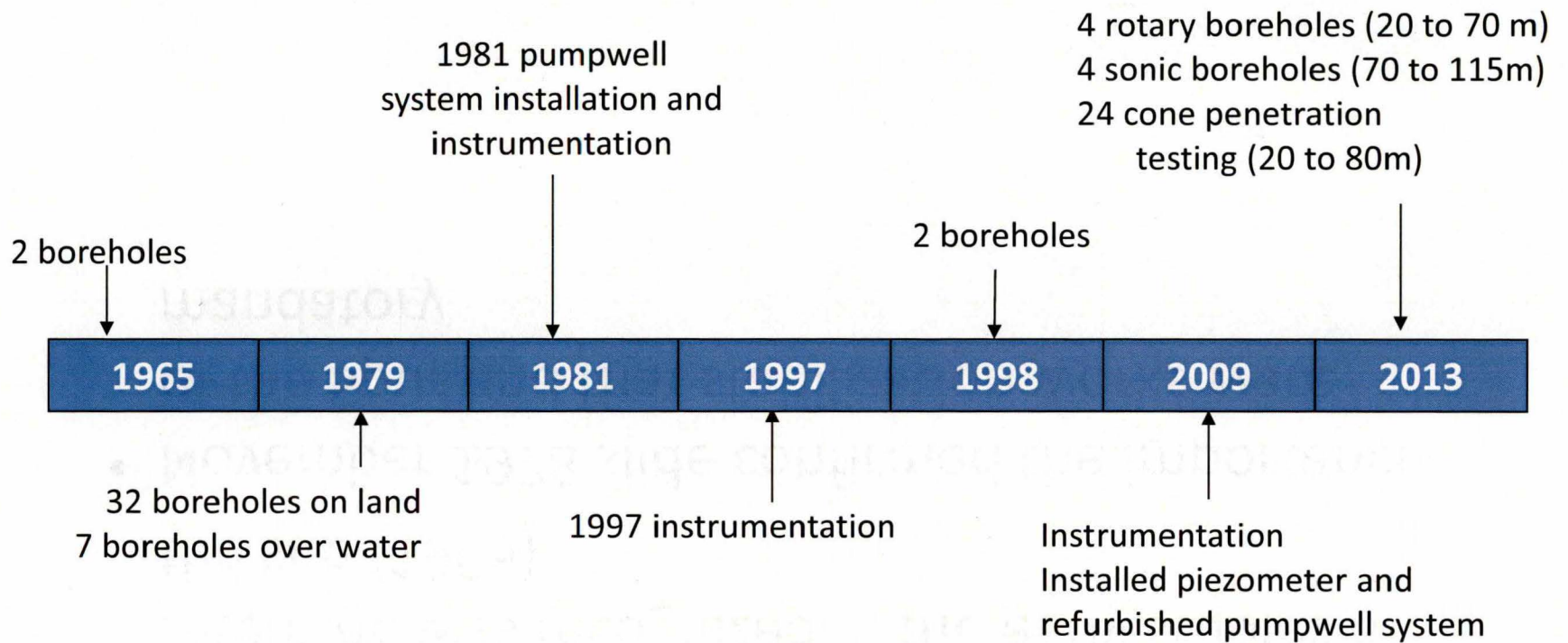


# Consequences of 1978 Landslide

- Importance of the spur as part of the reservoir retention was recognized in the early studies of the site (1965)
- November 1978 slide confirmed the importance of the Spur and that stabilization works were mandatory



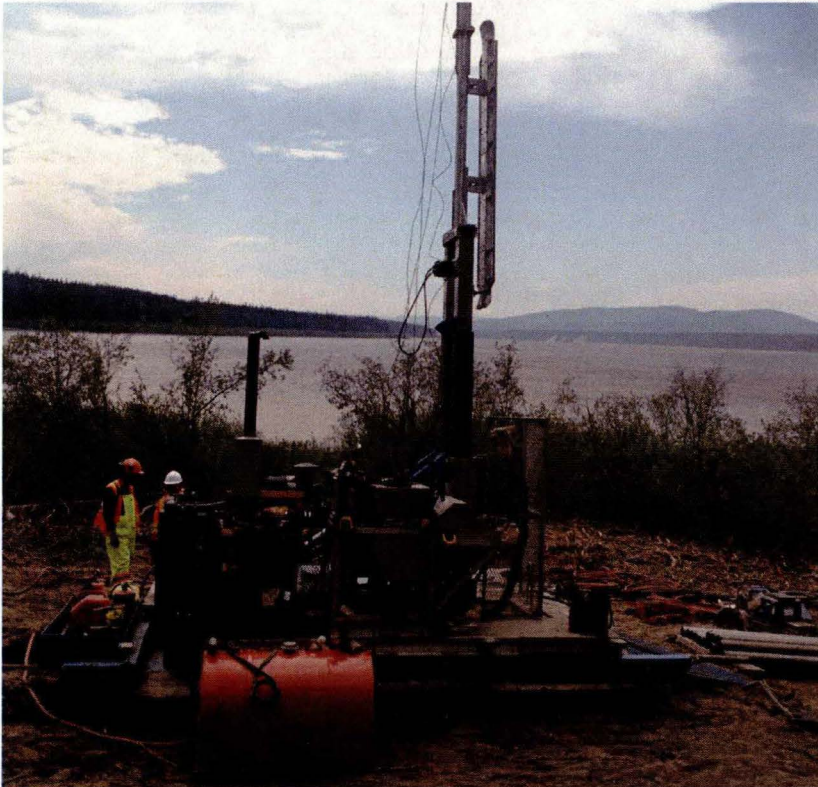
# North Spur Field Programs (1965-2013)



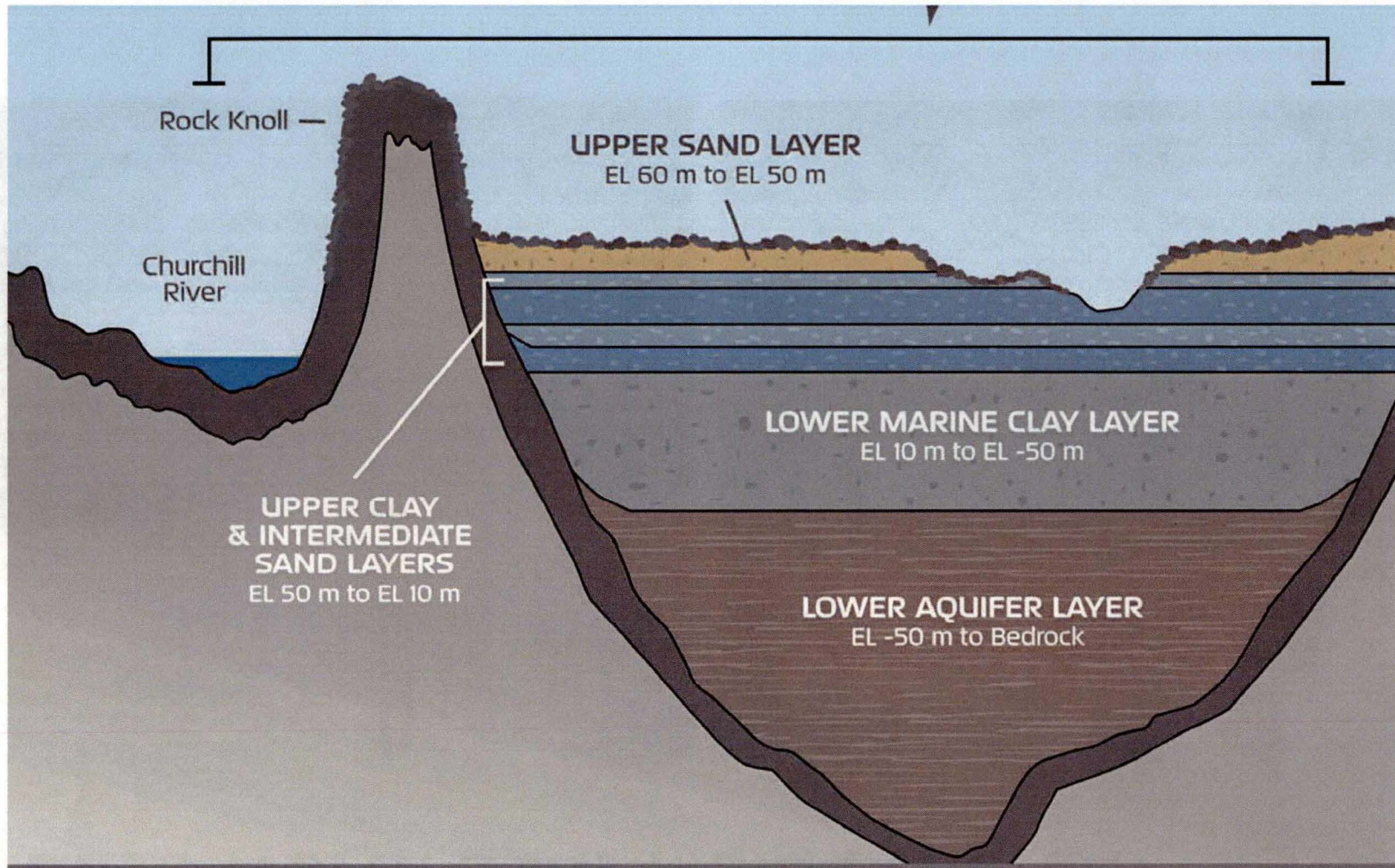
Additional field work included:

- Seismic refraction
- Test pitting
- Mapping

# 2013 North Spur Field Program



# Geology of the North Spur



# North Spur Design and Construction

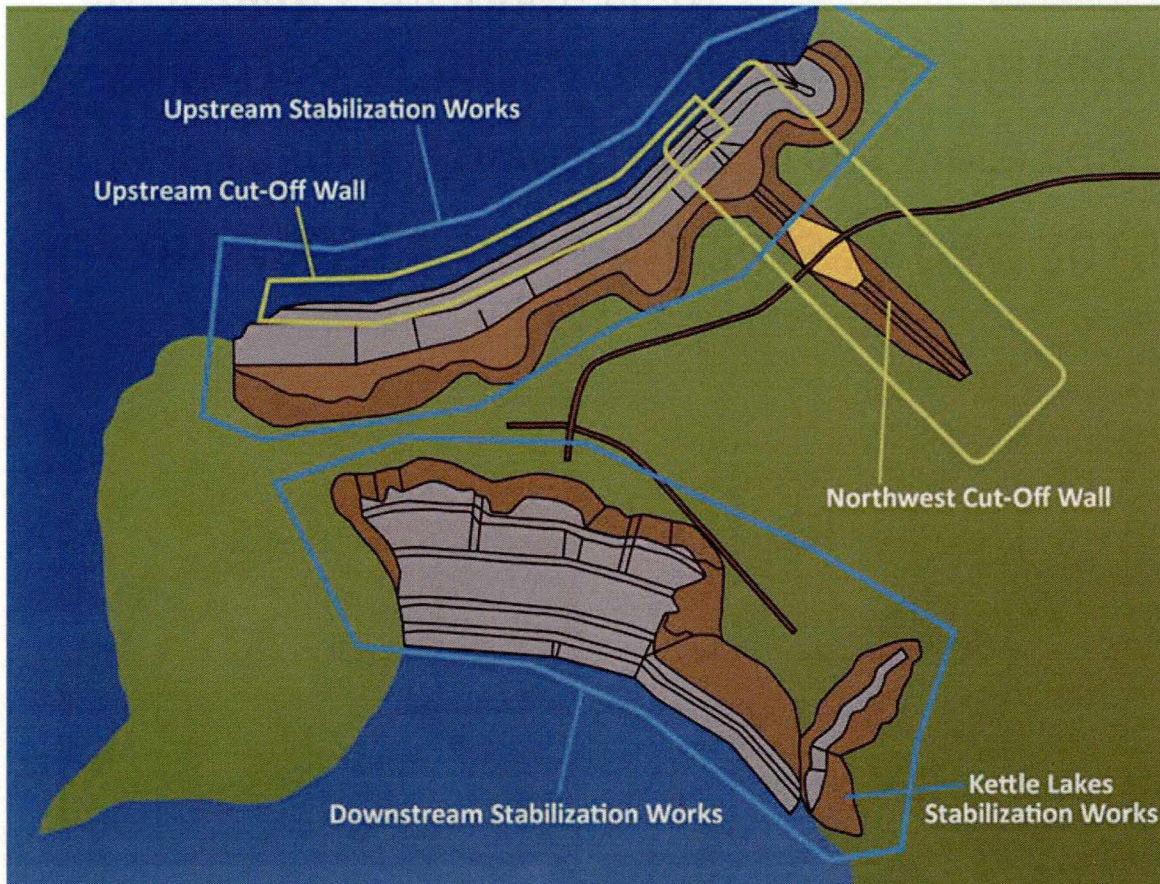
- As a critical piece of infrastructure, the overall goal was to strengthen and protect the North Spur dam.
- Engineering objectives:
  1. Water drainage controls
    - Water resistant walls (barriers) to stop seepage
    - Drainage systems to remove water from the dam area
  2. Stability enhancements
    - Reducing slopes on the upstream and downstream sides
  3. Erosion prevention
    - Rock berms to protect the upstream and downstream shorelines



# North Spur Design and Construction

- Various studies completed during design
  - Progressive Failure Study
  - Dynamic Analysis (Earthquake Triggering)
  - Hydrogeology 3D model (before and after works)
  - Slope stability analysis (before, during and after works)
  - North Spur Dam Breach Analysis
- Construction monitoring
  - Foundation approval and quality
  - Surveillance Plan (Instrumentation and Inspection)
  - Work plan (Execution Method)
  - Design Engineers on site.

# North Spur Dam



Natural dam that has been strengthened & protected using proven engineering techniques



# North Spur Dam Construction



- Construction from April 2015 to Dec. 2016
- Upstream & downstream areas were reinforced
- Removed >1 million cubic metres of material (80 cubic metres was high sensitivity clay)



# Upstream Construction



# Upstream Construction Activities

- Regraded slopes for stabilization
- Excavated and removed high sensitivity clay and the sandy, silty and clayey soils
- Installed cement-bentonite cut-off walls down to the lower clay layer
- Built protective rock berms along the shoreline

# Downstream Construction



## Downstream Construction Activities

- Regraded slopes for stabilization
- Excavated and removed high sensitivity clay
- Built protective rock berms along the shoreline
- Installed drainage and relief wells
- Installed monitoring equipment

# Expert Review and Validation

- Engineering design was undertaken by qualified geotechnical engineers and verified by 3<sup>rd</sup>-party experts.
- Experts in the field of sensitive clays were involved in the research, analysis and review work:
  - SNC-Lavalin (Regis Bouchard Anthony Rattue); Hatch (Richard Donnely, Robert Ilett); Geologist Expert for earthquake science (Gail Atkinson); Dynamic Soil Expert (Professor Idriss); and Dr. Serge Leroueil



## Expert Review and Validation

- Advisory review panel was established for the Muskrat Falls facility.
- The design was further validated through independent reviews by MWH Canada (the project's independent engineer) and Hatch Ltd.

# Reference of Reports

- Numerous studies and reports were completed on the North Spur to inform the design and review:
  - SNC-Lavalin, Acres, Atkinson, Norwegian Technical Institute, SNC-AGRA, Hatch, Amec, Idris



# Ensuring Dam and Public Safety

- The Muskrat Falls facility is being built to the highest standards of dam safety and construction
- The facility will be monitored to meet Canadian Dam Association Dam Safety Guidelines
- There's an established Dam Safety Program for the project developed by the SNC Engineering team
- The Dam Safety Program is active today

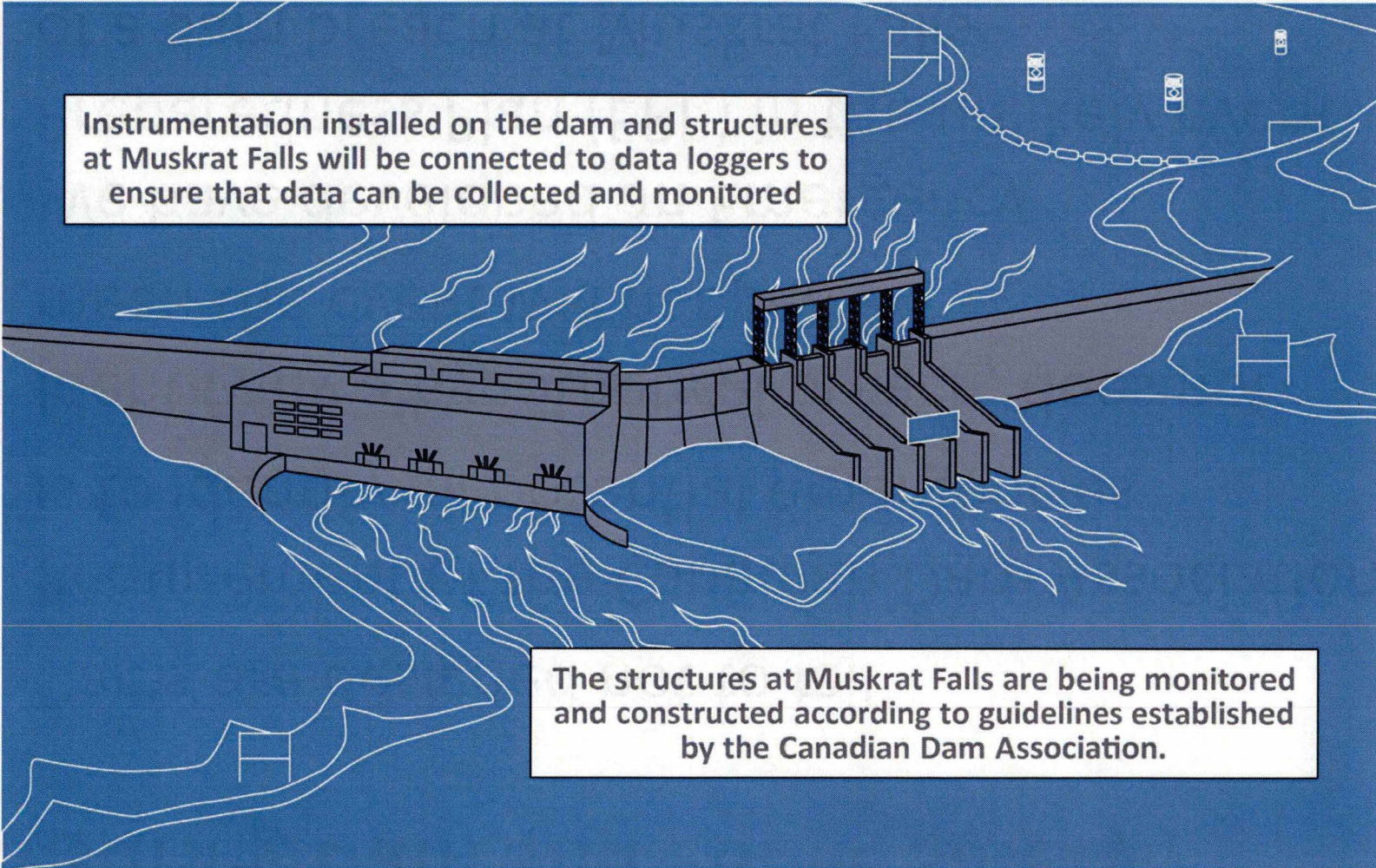


# Ensuring Dam and Public Safety


- Dams are designed not to fail
- Requirement of the Canadian Dam Association is to identify all potential emergencies
- Identifying a hypothetical breach, does not mean the event will happen
- We have developed an Emergency Preparedness Plan (EPP) in the unlikely event of a dam breach at Muskrat Falls




# Ensuring Dam and Public Safety




# Dam Safety Program for Muskrat Falls

-  Close to 30 **survey monuments** to measure structure movement.


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-  65 **piezometers** which measure water pressure changes within structures and confirm water tightness and effectiveness of drainage systems installed.


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-  **Flow weirs** which measure and monitor seepage through the dams and other infrastructure installed.


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-  **Inclinometers** to measure any movement or displacement on the slopes of the North Spur.


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-  An **extensometer** to measure foundation movement on the South Transition Dam.


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-  **Thermistors** to measure concrete temperature during the curing process, which indicates the maturity or strength of the concrete.

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-  An **accelerometer** to measure any occurrence of seismic acceleration on the North Dam.

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-  Trained, **professional inspectors** to conduct extensive inspections of the facilities at Muskrat Falls on a regular basis.

- **Monitoring for:**
  - Structure movement
  - Water pressure
  - Water flow & seepage
  - Slope, foundation & joint movement
  - Temperature
  - Seismic acceleration



# North Spur Dam Surveillance



- 40 piezometers
  - 3 in lower aquifer
  - 7 upstream
  - 6 northwest cut-off wall
  - 24 downstream
- 6 inclinometers
  - 5 downstream
  - 1 upstream
- 1 flow meter
  - Kettle lake outlet

# Muskrat Falls Dam Safety Program

- Dam Safety Program includes on the ground daily, weekly and monthly inspections
- On-going monitoring and analysis of instrumentation
- Hatch undertaking a third-party review and audit of the Nalcor's Dam Safety Program
- Ongoing monitoring will continue during operations



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**THANK YOU**

**QUESTIONS AND ANSWERS**

