Newfoundland Labrador

Water Resources Management Division

Dam Safety in Newfoundland & Labrador

Dam Safety 101 Workshop, Gander
Paula Dawe, P.Eng
pauladawe@gov.nl.ca
Nov 10, 2017

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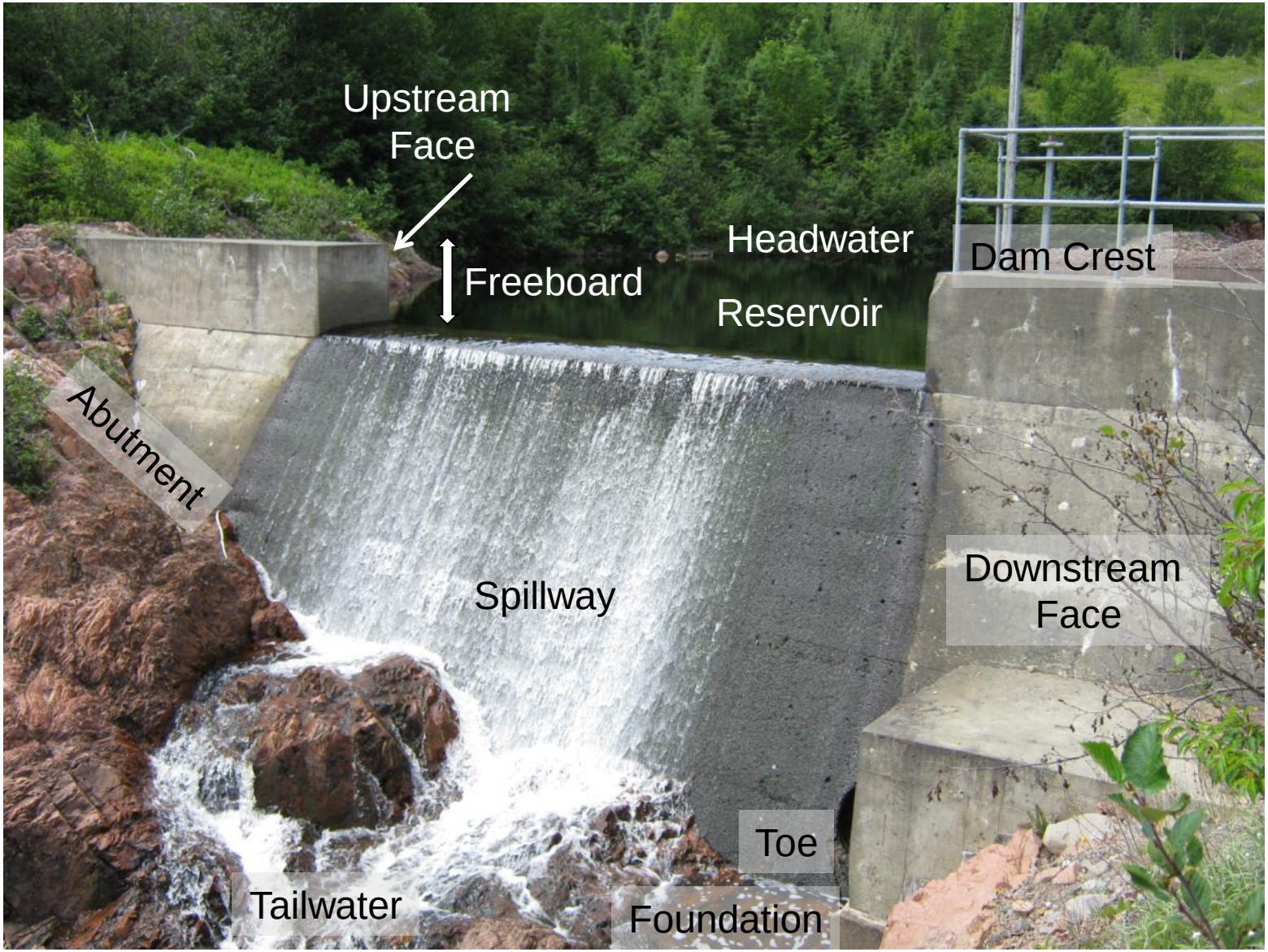
Components of a Dam



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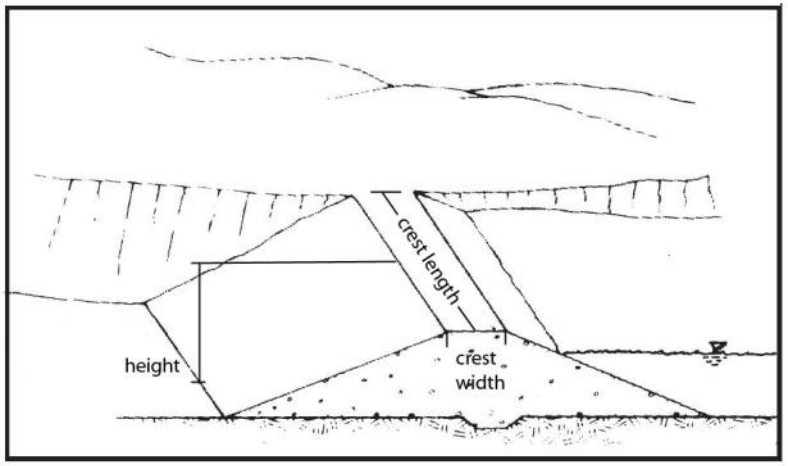
What is considered a dam in NL?

- Canadian Dam Association based definition
  - A barrier constructed for the retention of water (and water containing other substances- i.e., tailings)
    - Impounds at least 30,000 m^3, or
    - 2.5 m in height measured vertically from the crest to the downstream toe
  - Includes all appurtenances and systems associated with the barrier (eg. intakes, gates, stoplogs, valves, fishways, etc.)
  - Consequences of dam operation or failure are likely to be unacceptable to the public



- Very Small Dam
  - a barrier constructed for the retention of water, including water containing other substances, that is greater than 1.0 meter and less than 2.5 meters in height, and that is not otherwise defined as a dam

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Who is considered a dam owner in NL?

- The person or legal entity that is responsible for the safety of the dam
- The person or entity who had the dam constructed
- The owner of the land or holder of crown title on which the dam is located
- The person or entity who was issued a permit by government for construction of the dam
- A successor, assignee, purchaser, executor, administrator, receiver, liquidator or trustee of a previous dam owner

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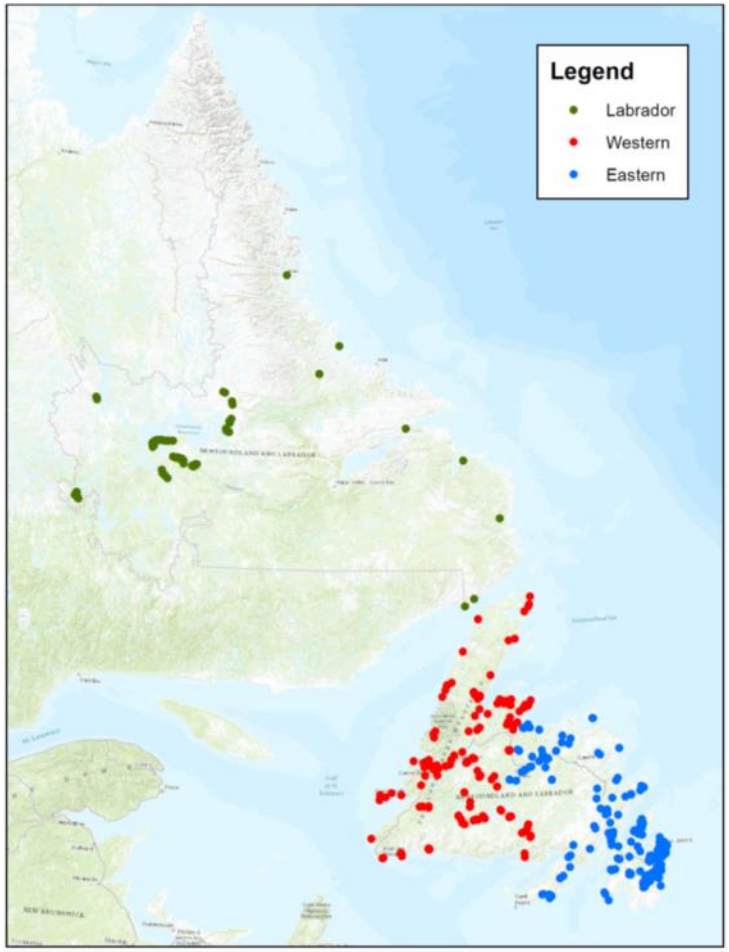
Dams in NL



- Approximately 700 dams in NL
- NL has 90 dams over 15 m in height or that otherwise meet the ICOLD definition of a "Large Dam"
- Most common dam materials:
  - Earthfill/rockfill
  - Concrete
  - Timber

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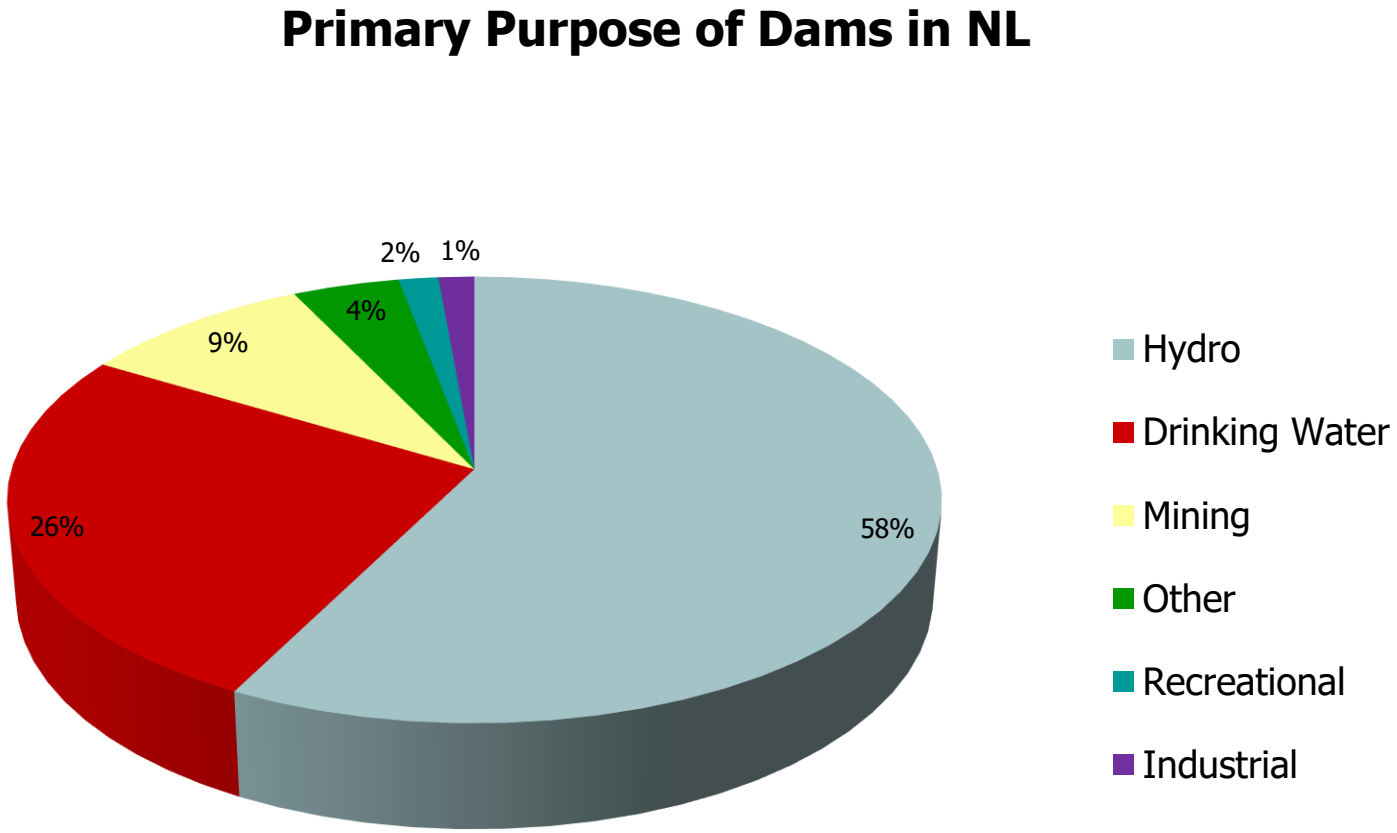
Primary Purposes of Dams in NL



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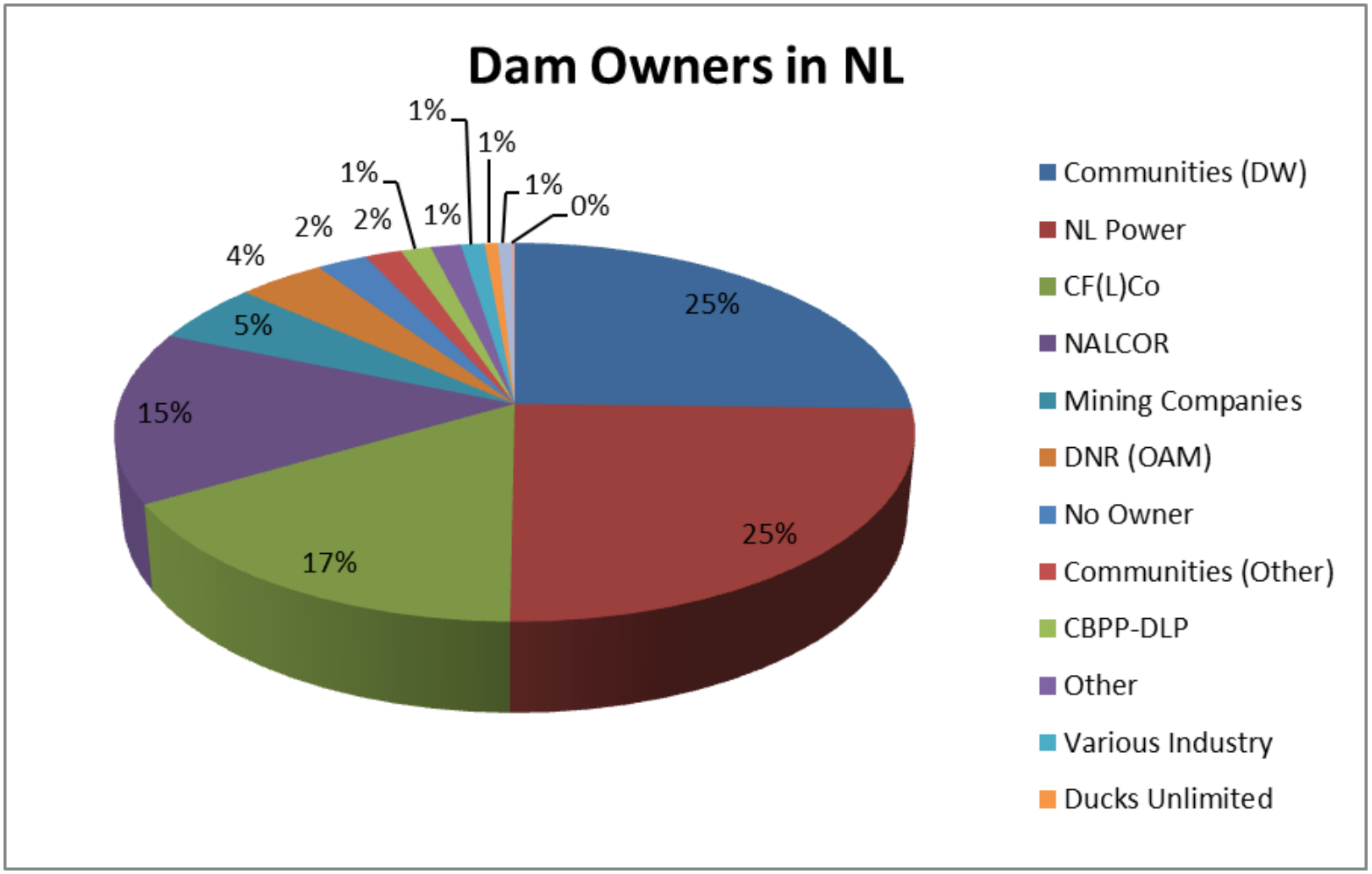
Dam Owners in NL



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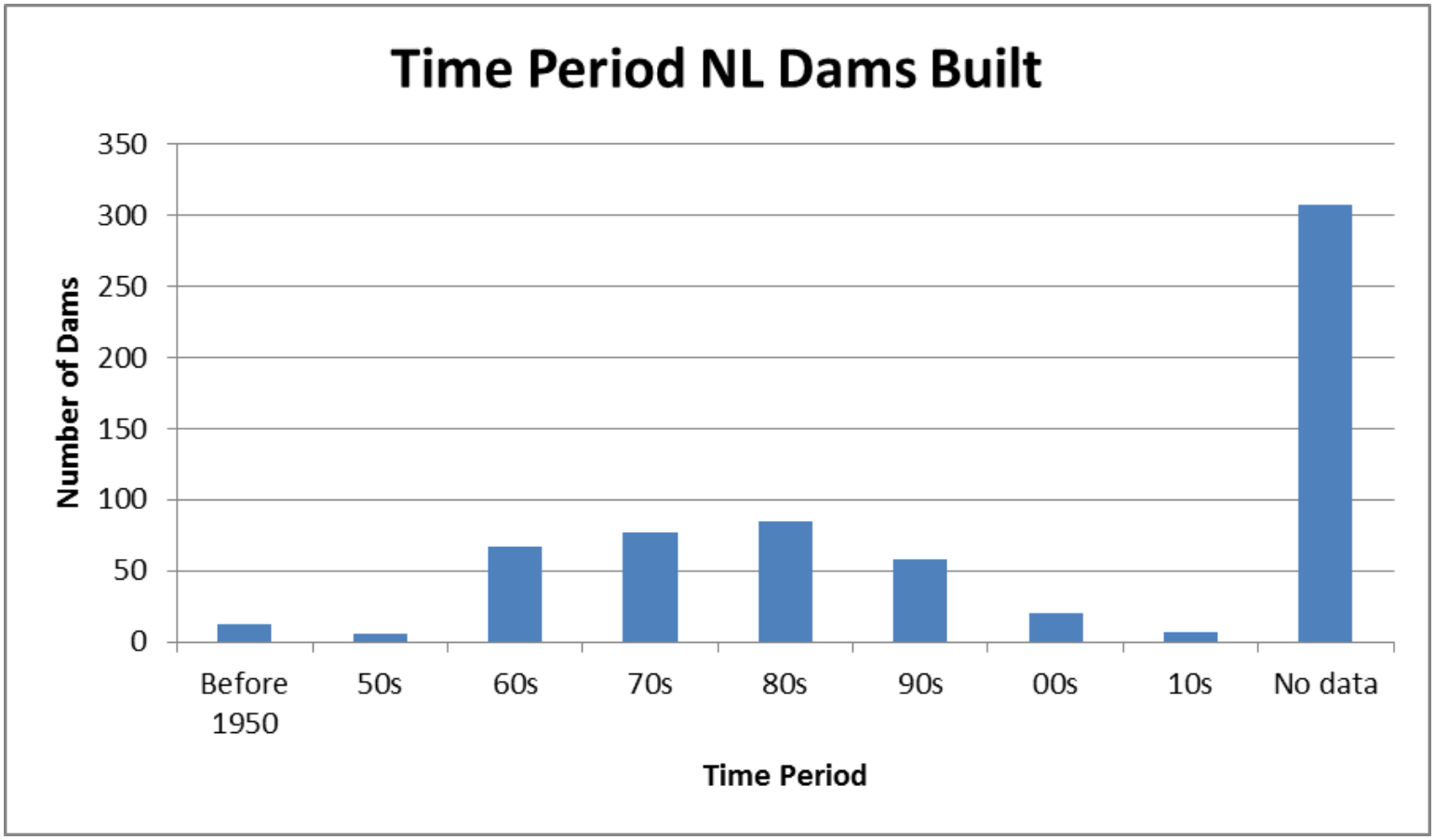
Age of Dams in NL



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Canadian Dam Association (CDA)

CDA ACB

- CDA is a group of dam owners, operators, regulators, engineers and others who share the goal of advancing knowledge and practices related to dams
- Publications:
  - Dam Safety Guidelines 2007
  - Technical Bulletins

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Responsibilities of a Dam Owner- Water Resources Act

- Apply for a permit under Section 48 of the WRA for the building of a new dam or any upgrades to an existing dam
  - Not required for routine O&M work
- WRA, Section 43
  - Owner must maintain the dam in good repair
  - Owner must conduct periodic inspection and submit results of inspection to Minister
- WRA, Section 44
  - Notify the Minister of hazardous condition and take actions to minimize or eliminate those hazardous conditions
  - Direct dam owner to undertake a dam safety review and submit report
  - Direct dam owner to submit information on dam to the Minister
  - Direct dam owner to take an action for the safety of the dam or for public safety

Responsibilities of a Dam Owner- Section 48 Permit

- CDA Dam
  - Determine consequence classification
    - Considered conditional unless confirmed by dam break flood inundation mapping and a failure consequence assessment
  - Designed according to CDA Dam Safety Guidelines and associated Bulletins
  - Dam Safety Review
  - Annual Dam Safety Inspection
  - OMS Manual
  - Emergency Preparedness and Response Plan
  - Consequences of failure of the dam should be reviewed periodically
- Very Small Dam
  - Designed according to best practice
  - Consequences of failure of the dam should be reviewed periodically

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Section 48 Application

Schedule C - Dam
(Please complete one Schedule for each dam)

Dam Name: _____ **Waterbody Name:** _____

Project Name: _____ **Year Built:** _____

Location
Please mark location of dam on a copy of a topographic map (preferably at 1:50,000 scale) or Google Earth Image and include as a separate attachment with the application. Please provide coordinates (UTM or Lat/Long):

N _____ E _____ NAD _____ ZONE _____

Dam Material:

☐Concrete ☐Earthfill ☐Rockfill ☐Timber ☐Sandbag ☐Other_____

Dam Details:

Dam Height:	_____ m	Minimum Freeboard:	_____ m
Storage Capacity:	_____ m^3	Normal Freeboard:	_____ m
Crest Elevation:	_____ m	Spillway Elevation:	_____ m
Crest Length:	_____ m	Spillway Width:	_____ m
Crest Width:	_____ m	Core Elevation:	_____ m
Normal Operation Elev:	_____ m		
Max Water Elevation:	_____ m	Min Water Elevation:	_____ m
Spillway Capacity:	_____ m^3/s	Gate Capacity:	_____ m^3/s

Construction of Dams & Related Works	(j)	• Dam failure consequence classification of Extreme	$50,000
		• Dam failure consequence classification of Very High	$25,000
		• Dam failure consequence classification of High	$10,000
		• Dam failure consequence classification of Low and Significant	$4,000
		• Very small Dam	$1,000
		• Upgrades to an existing dam (Extreme to Low classification)	$1,000
		• Upgrades to a very small dam	$500

Main Channel Length: _____ km Barren: _____ %

Slope of Drainage Area: _____ % Wetland: _____ %

Urban: _____ %

Inflow Design Flood (IDF):

Return Period: 1: _____ years IDF: _____ m^3/s

Probable Max Flood (PMF): _____ m^3/s EDF: _____ m^3/s (for tailings dams only)

Dam Design Brief and Drawings:

Please provide specifications and drawings of proposed works signed and stamped by a professional engineer. Please provide a dam design brief outlining hydrotechnical, seismic, geotechnical and structural design considerations, as appropriate. Attached documents:

Revised: August 18, 2016 Page 1 of 2

Proposed dewatering method(s): _____

Briefly describe how erosion control and stabilization will be carried out:

Briefly describe how site restoration will be carried out:

Submit to: **Department of Environment and Climate Change**
Water Resources Management Division
PO Box 8700, St. John's NL A1B 4J6
Attention: Paula Dawe, Manager

Email: pauladawe@gov.nl.ca
Phone: 709-729-4048
Fax: 709-729-0320

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http://www.mae.gov.nl.ca/waterres/regulations/appforms/Schedule_C_2016.pdf

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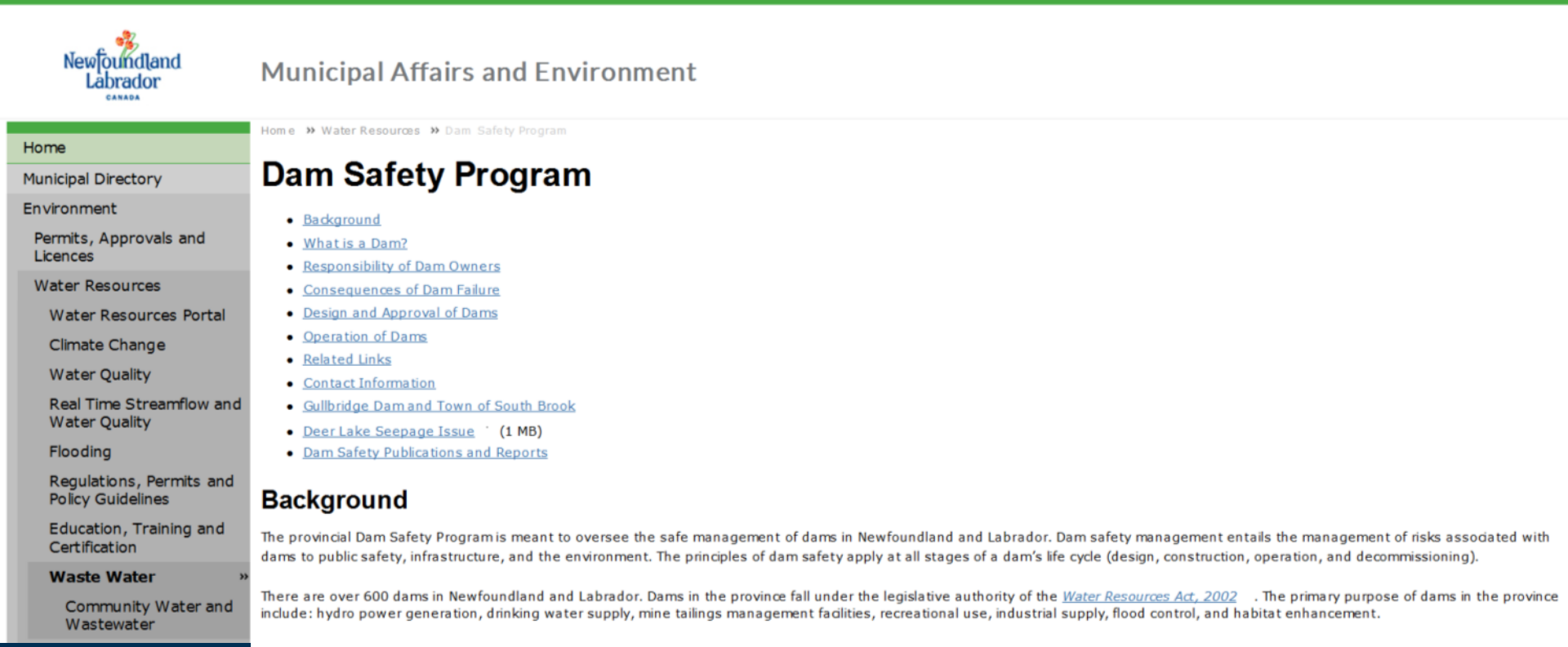
Dam Safety Program Website



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http://www.mae.gov.nl.ca/waterres/damsafety/index.html

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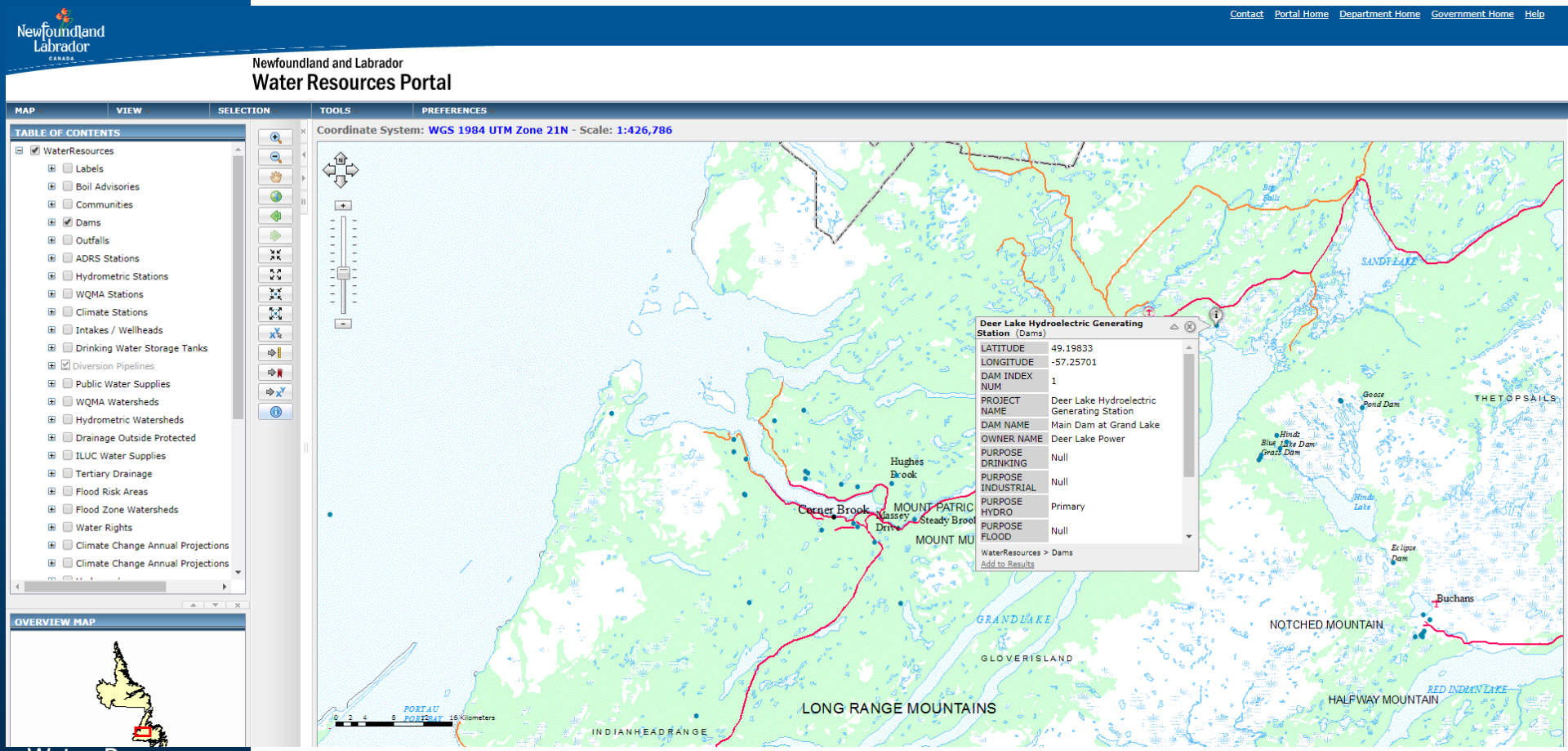
Water Resources Portal



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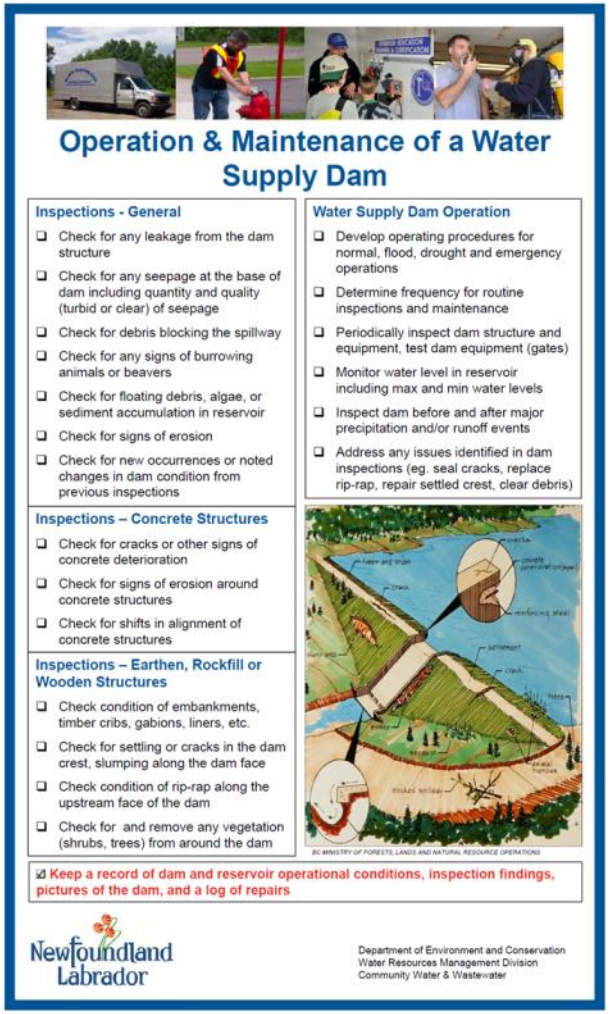
Portal: https://maps.gov.nl.ca/water/mapbrowser/Default.aspx

Map Service: http://maps.gov.nl.ca/water/mapservices.htm

Other Tools for Dam Owners



Operation & Maintenance of a Water Supply Dam

Inspections - General

- ❑ Check for any leakage from the dam structure
- ❑ Check for any seepage at the base of dam including quantity and quality (turbid or clear) of seepage
- ❑ Check for debris blocking the spillway
- ❑ Check for any signs of burrowing animals or beavers
- ❑ Check for floating debris, algae, or sediment accumulation in reservoir
- ❑ Check for signs of erosion
- ❑ Check for new occurrences or noted changes in dam condition from previous inspections

Water Supply Dam Operation

- ❑ Develop operating procedures for normal, flood, drought and emergency operations
- ❑ Determine frequency for routine inspections and maintenance
- ❑ Periodically inspect dam structure and equipment, test dam equipment (gates)
- ❑ Monitor water level in reservoir including max and min water levels
- ❑ Inspect dam before and after major precipitation and/or runoff events
- ❑ Address any issues identified in dam inspections (eg. seal cracks, replace rip-rap, repair settled crest, clear debris)

Inspections – Concrete Structures

- ❑ Check for cracks or other signs of concrete deterioration
- ❑ Check for signs of erosion around concrete structures
- ❑ Check for shifts in alignment of concrete structures

Inspections – Earthen, Rockfill or Wooden Structures

- ❑ Check condition of embankments, timber cribs, gabions, liners, etc.
- ❑ Check for settling or cracks in the dam crest, slumping along the dam face
- ❑ Check condition of rip-rap along the upstream face of the dam
- ❑ Check for and remove any vegetation (shrubs, trees) from around the dam

☑ Keep a record of dam and reservoir operational conditions, inspection findings, pictures of the dam, and a log of repairs

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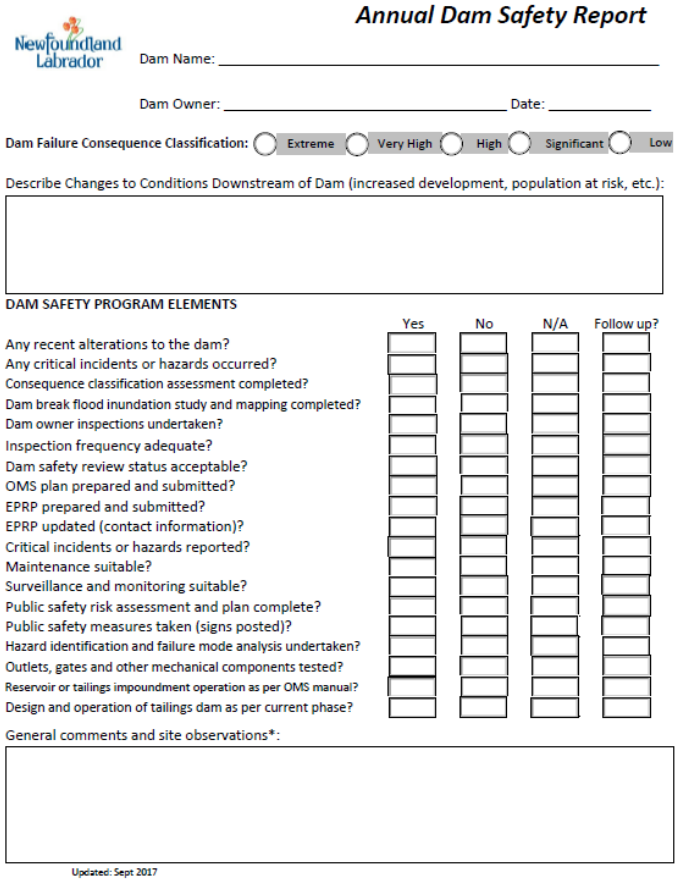
Water Resources Management Division
Community Water & Wastewater

http://www.env.gov.nl.ca/env/waterres/training/operator_onsite_training/index.html



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Annual Dam Safety Report

Dam Name: _____

Dam Owner: _____ Date: _____

Dam Failure Consequence Classification: ◯ Extreme ◯ Very High ◯ High ◯ Significant ◯ Low

Describe Changes to Conditions Downstream of Dam (increased development, population at risk, etc.):

DAM SAFETY PROGRAM ELEMENTS

	Yes	No	N/A	Follow up?
Any recent alterations to the dam?				
Any critical incidents or hazards occurred?				
Consequence classification assessment completed?				
Dam break flood inundation study and mapping completed?				
Dam owner inspections undertaken?				
Inspection frequency adequate?				
Dam safety review status acceptable?				
OMS plan prepared and submitted?				
EPRP prepared and submitted?				
EPRP updated (contact information)?				
Critical incidents or hazards reported?				
Maintenance suitable?				
Surveillance and monitoring suitable?				
Public safety risk assessment and plan complete?				
Public safety measures taken (signs posted)?				
Hazard identification and failure mode analysis undertaken?				
Outlets, gates and other mechanical components tested?				
Reservoir or tailings impoundment operation as per OMS manual?				
Design and operation of tailings dam as per current phase?				

General comments and site observations*:

Updated: Sept 2017

http://www.mae.gov.nl.ca/waterres/damsafety/Dam_Owner_Annual_Dam_Safety_Report.pdf

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CBC News Posted: May 23, 2015 1:36 PM NT | Last Updated: May 24, 2015 1:54 PM NT

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Work continues at Gullbridge mine dam

Ashley Fitzpatrick afitzpatrick@thetelegram.com
Published: Sept. 29, 2017, 6:35 p.m.

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Ten months ago, the dam holding back tailings at the former Gullbridge copper mine in central Newfoundland failed.


Gullbridge mine breach in December 2012.

Now, the provincial government is preparing to put a permanent fix in place. According to a spokeswoman for the Department of Natural Resources, it will be the first step in a long-term solution for the dangers still held at the abandoned mine site.

The tender for tailings dam rehabilitation work was issued Oct. 3 and will close Monday, Oct. 21.

On Dec. 17, 2012, a 25-metre wide breach — originally estimated at 50 metres — released waste from behind the mine dam out into the adjacent area, with some finding its way beyond the bog and trees to the waters of South Brook.

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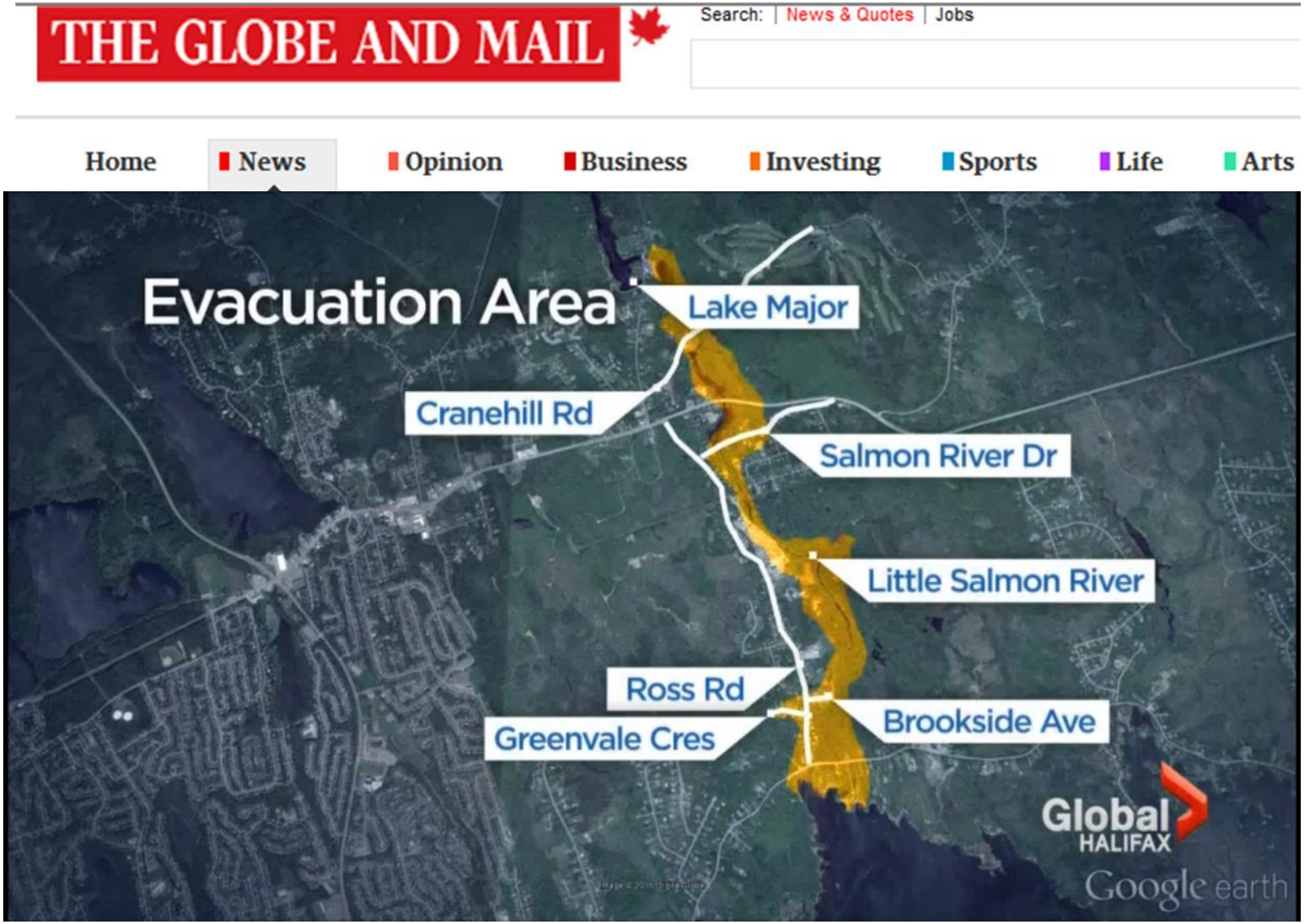

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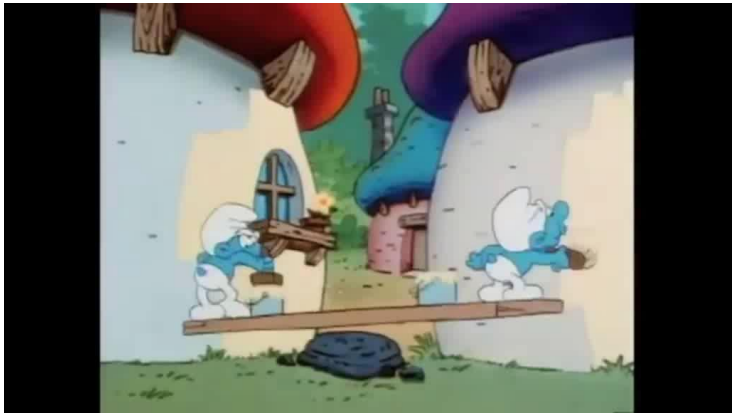
Consequences of a Dam Failure



- Impacts downstream or upstream of dam
  - Population at risk
  - Potential loss of life
  - Environmental losses
  - Cultural losses
  - Infrastructure losses
  - Economic losses

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Why Dam Break Flood Inundation Mapping is Needed

- To determine consequence classification
- To reassess consequence classification
  - Hazard creep
- Emergency response

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Consequence Assessment

Consequence Assessment					
	Number Affected	Unit	Cost Per Unit	Total Cost	Reference
Small Commercial Buildings	1	building	$ 40,000.00	$ 40,000.00	RE/MAX, 2017
Homes	5	home	$300,000	$1,500,000.00	RE/Max, 2017
Wooden Bridge	50	metre	$ 6,000.00	$ 300,000.00	GPA, 2015a GPA, 2016b
Concrete Bridge	30	metre	$ 98,000.00	$ 2,940,000.00	GPA, 2016a
Culverts	2	culvert	$ 60,000.00	$ 120,000.00	
	Estimated Total Loss ($)				$ 4,900,000.00
	Estimated Order of Magnitude of Losses				Tens of Millions
	Permanent Population at Risk				15

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CDA Dam Classification

Dam Class	Population at Risk	Loss of Life	Infrastructure & Economic Losses
Low	None	0	-Low
Significant	Temporary	Unspecified	-Moderate (eg. recreational facilities)
High	Permanent	10 or fewer	-High (eg. commercial facilities)
Very High	Permanent	100 or fewer	-Very high (eg. highway)
Extreme	Permanent	More than 100	-Extreme (eg. hospital)

- Environmental and cultural value losses not included
- Recommend dam breach and inundation analysis for dams of high or greater consequence

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CDA Dam Safety Guidelines

- Consequence classification determines:
  - Design standards
  - Dam Safety Review frequency
  - Standard of care

Dam Class	Design Standards-Design Flow	Frequency of Dam Safety Reviews
Low	1/100	-
Significant	Between 1/100 and 1/1000	Every 10 years
High	1/3 between 1/1000 and PMF	Every 7 years
Very High	2/3 between 1/1000 and PMF	Every 5 years
Extreme	PMF	Every 5 years

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Hermitage-Sandyville Dam Failure

- Earth dam washed out due to significant rainfall amounts in April 1998
- Town without drinking water
- Access to community cut
- Dispute over dam ownership may have resulted in failure
  - Improper operation and management practices
- Estimated costs failure approximately $3-million

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Little Bay Copper Mine Tailings Dam Failure

- Failed in 1989
- 1.8 million tonnes of tailings placed in an impoundment area behind a dam
- Tailings dam washed out releasing 30-50% of the tailings
- Little Bay marine area has become contaminated with heavy metals (Cu, Ni, Zn, Fe, Mn).
- $0.5-million rehabilitation project includes stabilization of tailings and water diversion
- Studies by DFO show that wild mussels from this site have some of the highest copper concentrations ever reported

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Bishop's Falls Dam Failure

- Dam overtopped in phenomenal flood in Jan 1983
- Earth filled dam at left abutment washed out due to an under designed spillway
  - 1.2-million cubic meters of material eroded
  - Damaged properties and subdivision downstream
  - Caused power transformers containing PCBs to wash into Exploits River
- Estimated cost $34 million

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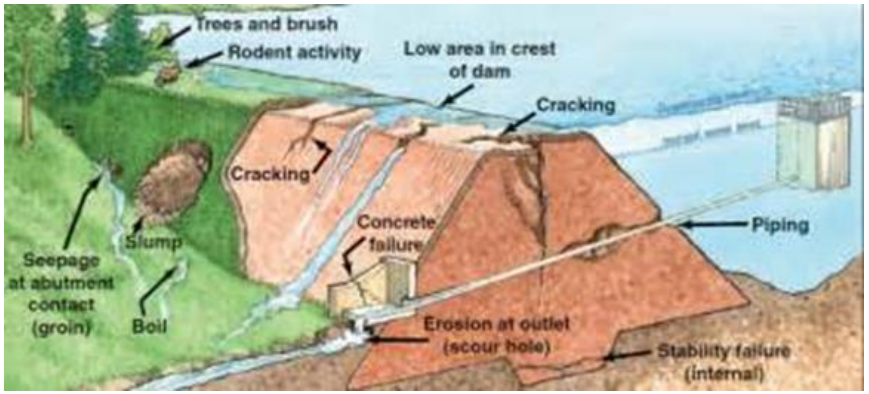
Dam Failure Modes in NL

- Overtopping
  - Spillway capacity insufficient
  - Heavy rainfall/runoff
- Inadequate reservoir operation
- Piping (seepage and erosion)
- Foundation failure
- Poor construction
- Structural weakening (loss of strength over time)



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Path Forward

- Continue issuing Section 48 permits for new dam construction or rehabilitation
- Continued engagement with dam owners
- Risk assessment of dams
- Reducing risk posed by dams in the province
- QA/QC of the provincial dam inventory database
- Guidance for dam decommissioning
- Improved dam classification using dam break flood inundation mapping

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Questions?

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