


1



2

		Consequences of Failure		
Classification	Population at risk	Loss of life	Environmental, cultural	Infrastructure, economics
Low	None	None	Minimal	Minimal, limited
Significant	Temporary	Low potential	No significant loss	Low, limited, temporary
High	Permanent	10 or fewer	Significant loss	High economic, impact to infrastructure, destruction residential buildings
Very High	Permanent	100 or fewer	Significant, compensation impractical	Very high, important infrastructure, destruction of residential, commercial
Extreme	Permanent	More than 100	Major loss, restoration impossible	Extremely high economic loss, critical infrastructure, severe destruction

3



City Owned Dams

Name	Type	Consequence Classification
Jump Creek	Water Supply	Very High
South Fork	Water Supply	Very High
Lower Colliery	Recreation	Very High
Middle Colliery	Recreation	High
Westwood Lake	Recreation	High
Old Harewood	Recreation	Significant
Upper Colliery	Recreation	Significant
McGregor Creek	Recreation	Significant
Old Reservoir No. 1	Partially Decommissioned	Low
Witchcraft Lake	Partially Decommissioned	Significant


- The City owns and maintains two (2) water supply dams and eight (8) recreation dams.
- Water Supply Dams Asset Value = \$180 Million
- Recreation Dams – Asset Value = \$20 Million
- Annual Operation Costs:
 - Water Supply \$292,000
 - Recreation \$49,000

4

CITY OF NANAIMO
THE QUALITY OF LIFE

Jump Creek Dam


- Height: 6.7 m
- Hazard Rating: Very High
- Retained Water: 16.6 Million m³



5

CITY OF NANAIMO
THE QUALITY OF LIFE


South Fork Dam



Height: 30.5m Hazard Rating: Very High
Retained Water: 2 Million m³


6

CITY OF NANAIMO
THE QUALITY OF LIFE



Upper Colliery Dam

Height: 5.5m
Hazard Rating: Significant
Retained Water: 60,000m³




Middle Colliery Dam

Height: 12.5m
Hazard Rating: High
Retained Water: 111,000m³

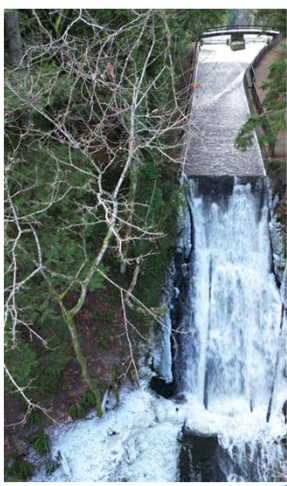
7

CITY OF NANAIMO
THE QUALITY OF LIFE

Lower Colliery Dam



Height: 23.3m
Hazard Rating: Very High
Retained Water: 122,000m³



8

Old No. 1 Dam



Height: 11.5m

Hazard Rating: Low

Retained Water: 64,000m³



9

Harewood Dam



Height: 3.4m Hazard Rating: Significant Retained Water: 32,000m³

10

Westwood Lake Dam



Height: 12.3m

Hazard Rating: High

Retained Water:
2.7 Million m³

11

Linley Valley Dam (McGregor Creek)

Height: 3m

Hazard Rating: Significant

Retained Water: 26,000m³



12

CITY OF NANAIMO
THE QUALITY CONNECTION

Witchcraft Lake Dam

- Height: 1.8m
- Hazard Rating: Significant
- Retained Water: 31,000m³




13

CITY OF NANAIMO
THE QUALITY CONNECTION

Public Safety Around Dams

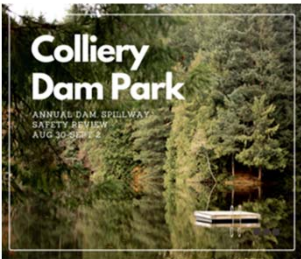
- BC Dam Safety Regulation (2016):
 - The City is obligated to protect public safety around its dams
- Transport Canada:
 - Requires booms in front of all spillways
- CDA Public Safety Around Dams Guidelines (2011)
- Municipal Insurance Association of BC – Safety Audits
- Works to Date (catching up on long term overdue deficiencies):
 - Fencing / Signage
 - Spillway Boom(s) – prevent people from being drawn through spillways
- Challenges:
 - Minimizing impact on safe public usage
 - Very narrow window to complete work due to public usage (often must be done after Labor Day)



City of Nanaimo Local Government
Just now

...

Heads up, Colliery Dam Park users: an annual safety review of the dams and spillways will take place Aug 31 to Sept 2, 2021. Starting today, water levels in the dams will drop by about 30 cm to accommodate the inspection. This shouldn't impact water quality or your enjoyment of the dams. Once inspections are complete, the water levels will return to normal.



👍 Like

💬 Comment

➦ Share

14

Public Safety Around Dams cont'd

- Keep the public from interacting with serious hazards at the dam through reasonable control measures (signs, fencing, booms)
- Compared to dam safety, there are news records of well over 300 fatalities associated with public safety incidents at dams in Canada
- 105 of these between 2000 and 2021
- Incidents are seriously under-reported
- Between June 17 – July 8, 2013 (21 days) there were:
 - 40 reported public safety incidents at dams in North America (4 in Canada)
 - 24 fatalities
 - 16 resulting in a hospital stay due to major injuries/near drownings
 - 11 rescued by EMS

15

What is Dam Safety?

- What is a dam?
 - A man-made barrier intended to retain water.
- Dam Safety:
 - Management of the risks dams pose to:
 - Public
 - Infrastructure
 - Environment



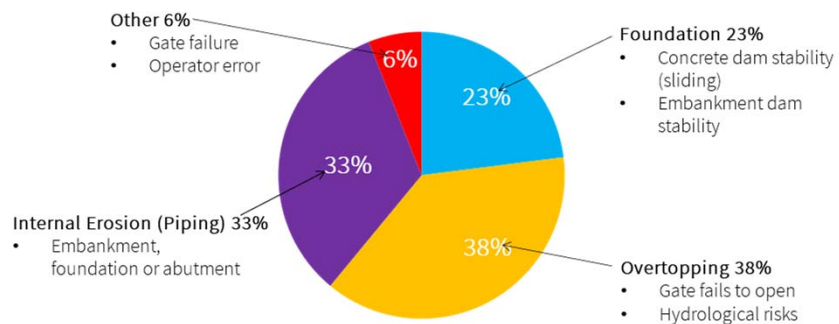
16

Dam Safety Incident/Breach

- The sudden failure of the dam resulting in rapid release of the stored water.
- The consequences of a dam failure can include:
 - loss of Life
 - economic losses
 - infrastructure losses
 - environmental losses
 - cultural losses

17

Why Dams Fail – Principal Failure Modes



18

The Causes of Dam Failure

- Dams fail because of:
 - improper design/poor standards at the time
 - improper construction (materials, processes, etc)
 - unexpected conditions (exceeding design events, changing climate, etc)
 - lack of maintenance/poor inspections/surveillance



19

Record of Dam Safety in Canada

- Exceptional Canadian Record – i.e. very few failures resulting in loss of life
- 5 recorded dam failures resulting in 11 lives lost in Canada (Ref. Bennett, Spektor, 2013)
- BUT... Dam Failures can and do occur:
 - Testalinden, British Columbia, 2010
 - Mount Polley Tailings Dam Breach, 2014



20

Record of Dam Safety in British Columbia

- 1500 active water dams
- 11+ known Dam Failures in BC. Half occurred since 1995
- BC has had Dam Safety Regulation since 2000
- Failure of Testalinden, Mount Polley and several other small dams in BC prompted review and revamp of Dam Safety Regulation in 2016
- MANY small dams in BC are:
 - old, many over 100 years
 - of questionable design, construction and foundation conditions
 - have not received needed regular maintenance
 - originally built in sparsely populated areas that are now densely populated

21

Industry Standards

- CDA Guidelines – first published in 1995, most recent 2007 (2013 Revision)
- BC Dam Safety Regulation 2000, **revised in 2016:**
 - Broadly references CDA and conforms to CDA



22

BC Dam Safety Regulation 2016 Revision

- Dam owners may be held liable for any damage and loss caused by the negligent construction, operation or failure of a dam.
 - If the dam fails in a manner that could have been detected and prevented, the owner is most likely to be held responsible for any and all damages.
 - Following the regulation and guidelines addresses this and provides broad protection against this liability.

23

Dam Classifications

- Based upon what would happen should the dam fail.
- Not a statement about the condition of the dam or probability of failure.

Item	Column 1 Dam failure consequences classification	Column 2 Population at risk	Column 3 Loss of life	Column 4 Consequences of failure Environmental and cultural values	Column 5 Infrastructure and economics
1	low	none ¹	no possibility of loss of life other than through unforeseeable misadventure	minimal short-term loss or deterioration and no long-term loss or deterioration of: (a) fisheries habitat or wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value	minimal economic losses mostly limited to the dam owner's property, with virtually no pre-existing potential for development within the dam foundation zone
2	significant	temporary only	low potential for multiple loss of life	no significant loss or deterioration of: (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is highly possible	low economic losses affecting limited infrastructure and residential buildings, public transportation or services or commercial facilities, or some destruction of or damage to locations used occasionally and irregularly for temporary purposes
3	high	permanent ²	10 or fewer	significant loss or deterioration of: (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is highly possible	high economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings
4	very high	permanent ²	100 or fewer	significant loss or deterioration of: (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is possible but impractical	very high economic losses affecting important infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas
5	extreme	permanent ²	more than 100	major loss or deterioration of: (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is impossible	extremely high economic losses affecting critical infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas

24

BC Dam Safety Regulation (cont'd)

Activity	Consequence Classification/Risk Posed				
	Extreme	Very high	High	Significant	Low
Re-evaluate classification	annually	annually	annually	annually	annually
Conduct site surveillance	weekly	weekly	weekly	monthly	quarterly
Conduct formal inspection	semi-annually	annually	annually	annually	annually
Test operation and communication equipment	annually	annually	annually	annually	annually
Collect instrumentation readings	annually	annually	annually	annually	if and when required
Review DEP Contacts	annually	annually	annually	annually	not applicable
Review OMS manual and DEP	every 7 yrs	every 7 yrs	every 10 yrs	every 10 years	not applicable
Formal Dam Safety Review	every 7 yrs	every 10 yrs	every 10 yrs	not applicable	not applicable

- Owners of dams have obligations under the Regulation
- Directly related to the dam's failure consequence classification
- City of Nanaimo currently following this requirement

25

3 Year Plan and Future

Name	2024	2025	2026	2027-2029	2030-2032
Jump Creek	DSR Formal Annual Dam Inspection (FADI)	FADI	Dam and Spillway Stability Analysis FADI	FADI	FADI
South Fork	Seismic Analysis FADI	DSR FADI	Prelim Intake Design and Seismic Upgrade FADI	FADI	Seismic Upgrade and new Intake Construction
Lower Colliery	DSR	Concrete Assessment (CA) FADI	FADI	FADI	FADI
Middle Colliery	Hydrology Analysis DSR Seismic Analysis	CA FADI	FADI	FADI	FADI
Westwood Lake	DSR	CA FADI	FADI	FADI	FADI
Old Harewood	FADI	CA FADI	FADI	FADI	FADI
Upper Colliery	FADI	CA FADI	FADI	FADI	FADI
McGregor Creek	FADI	CA FADI	FADI	FADI	FADI
Old Reservoir No. 1	FADI	CA FADI	FADI	FADI	FADI
Witchcraft Lake	FADI	FADI	FADI	FADI	FADI
Water Supply Dam Maintenance	\$177,000				
Recreational Dam Maintenance	\$112,000				

26

2024 Work

- Dam Safety Reviews:
 - Middle Colliery Dam – first in 10 year cycle
 - Lower Colliery Dam
 - Jump Creek Dam
 - South Fork Dam
 - Westwood Lake Dam
- Seismic Analysis – outstanding deficiencies:
 - Middle Colliery Dam
 - South Fork Dam

27

Middle Colliery Dam Status

- Importance to the City of Nanaimo:
 - Important recreational, historical space, cultural spaces and natural space
 - Very High consequence classification
 - Challenges
 - perform maintenance to preserve dam
 - respect public users wants and need
 - Strong community desire to preserve spaces
- Requirements:
 - Regulations changed in 2016
 - Seismic has changed
 - Tools have changed/improved
 - May need further investigations
 - Dam in deteriorated state
 - Concrete spillway is in advanced state of deterioration
 - Spillway is undersized



28

Middle Colliery Dam – Steps Forward

- Goal:
 - Address major issues with Middle Colliery Dam per provincial order
 - preserve the dam and space for public
- Completing the following studies as per order:
 - Hydrology Analysis
 - Dam Classification and Inundation Mapping
 - Geotechnical Investigation and Seismic Analysis
 - Full Dam Safety– report to Council – Fall 2024

