

# Hazard Risk Analysis

## *Dam Failure and Structural Collapse*

Dam Failure  
Structural Collapse – Buildings  
Structural Collapse - Transportation

### Dam Failure and Structural Collapse

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This section covers both dam failure and structural collapse for buildings and for transportation bridges or overpasses. As you will see when completing the risk analysis both can be caused by nature and by people (human-caused).

Resources are available to assist you in completing this analysis in the [Risk Analysis Resources](#) section.

#### **Dam Failure** - Natural and Human-caused

##### Definition

A dam breach happens when there is a breach in the dam itself, its foundation, abutments, or spillway. A breach releases large or rapidly increasing, uncontrolled amounts of water from the lake (or 'reservoir) behind the dam. Dams can be made of concrete, earth, steel or timber. Most dams are made by people, to make (hydro-) electricity, but beavers also build dams.

Don't forget that dams can be many kilometres away and still have an impact on your community if they fail. This is because water travels at great speeds.

##### Discussion

A dam breach threatens life and property downstream of the failure. In many locations, roads, railways, bridges and ferry networks could also be at risk. The three most common causes of dam failure are:

- caused by long-term constant processes such as erosion, increased seepage, ice effects,
- earthquakes; and
- floods (fast increases in water levels can damage or breach dams).

Of course, dams can also fail because of a terrorist act. Fortunately, large terrorist attacks on dams have not happened in Canada.

In Canada dam failure is mostly due to ice effects (fluctuations in water levels affecting ice loads) because of its northern orientation. Large dams in Canada have an average age of 40 years. A typical unmaintained dam has a 75-year life span. Dams can also fail when a landslide hits the reservoir or lake. A landslide into a lake will create huge waves. These waves can overtop and damage a dam, and even cause it to fail.

### It Happened Here...

On October 1<sup>st</sup>, 2020 one person died and four others were caught in a torrent of water Thursday after a dam on the Capilano River in North Vancouver opened unexpectedly during maintenance. Work was being done on the Cleveland Dam shortly before 2 p.m. when the spillway gate — which controls the water's flow — opened and released a large volume of water into the river. Human error was later found to be the cause.

On August 4<sup>th</sup>, 2014 a breach in the Mount Polley tailings pond, British Columbia led to one of the worst environmental disasters in Canadian history. The cause of the dam breach is still unclear. The spill that resulted from the breach, reached into Polley Lake, Hazeltine Creek, Quesnel Lake and Cariboo Creek. The dam failure affected many First Nation communities in the area. The toxic slurry of water and mud contained many harmful chemicals, and in some areas residents were warned not to use the water.

On June 13, 2010 a privately-owned earthen dam failed causing a debris and mud torrent that severely impacted homes, roads and agriculture in the area, including Testalinden Creek, British Columbia.

Between July 18-20, 1996 severe flooding in the Saquenay region of Quebec caused multiple dams to fail. Of the 280 municipalities in the region 63 were stuck by the flood and 16,000 people had to be evacuated. Ferland-et-Boilleau, Quebec (population 626) was among the many affected. There were no deaths or injuries linked directly to the dam failures. The estimated damage costs for the region was \$700M.

In 1995 a spillway failure on Cannon Creek, east of Quesnel British Columbia caused the death of 48 cattle and caused \$500,000 in damages to the local road system and nearby agricultural land.

## Dam Failure

Hazard Rating				High Risk	<input type="checkbox"/>	Low Risk	<input type="checkbox"/>	Need More Info	<input type="checkbox"/>	Not Applicable	<input type="checkbox"/>
Yes	No	Need More Info	Not Applicable	FACTORS							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	There is a risk if a dam is located upstream of a community Is there a dam located upstream of your community?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Improper dam maintenance increases risk. Is your community located near a dam that is not regularly checked and does not have safety records?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Dam failure can have a domino effect and cause dams downstream of the first dam to also fail. Are there other dams located upstream from the dam in/near your community?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Unusually high rain and/or flooding can cause a dam to fail. Is your community at risk for floods or extensive rainfall (refer to the section on Floods)? Have Traditional Knowledge holders noticed increased numbers, frequency and intensity of rain storms in the areas upstream of the dam?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Earthquakes can cause dam failure, especially in the case of earth dams. Are there earth dams upstream of your community that have not been improved to withstand earthquakes? And is your community at risk of earthquakes (Refer to the section on Earthquakes)?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Landslides along the reservoir banks can cause dam failure. Are the banks around the dam at prone to landslides, or have landslides happened here before (Refer to the section on Landslides)?							

## Structural Collapse

### Definition

Structural collapse is defined as the collapse or damage of a building, bridge, or other structure. This collapse can result in personal injury, death, or can lead to major economic loss. Structural collapse occurs when a building or structure collapses due to engineering or construction problems. Metal fatigue or added weight to a structure can also lead to structural collapse. For example, a thick snow pack can cause roofs to collapse.

### Discussion

Building collapse is often linked to the occurrence of earthquakes, but have also been linked to heavy snowfall.. When buildings collapse other infrastructures, such as gas lines, electricity, water, sewerage and telephone lines, often break or are damaged. Broken gas mains can lead to fires when buildings or other structures collapse.

Buildings that are old, or that have not been maintained are of most worry when it comes to the possibility of structural collapse. Also buildings that accommodate a large number of people are of concern. Although engineering standards are often high, human error can always occur. Structural collapse of a major structure can happen anywhere. Structural failure can occur in bridges, highway overpasses, silos, reservoirs, tanks and towers. Usually failures in these types of structures are as a result of poor maintenance or engineering error.

### It Happened Here...

On December 11, 2020, two people died and four others were in hospital after a building partially collapsed Friday in London, Ontario. A statement from the City of London says the collapse happened at 555 Teeple Terrace in the city's west end just before noon when the wall of a four-storey building under construction suddenly gave way.

On June 23, 2012 the roof of the Algo Centre Mall collapsed. Two cars fell through the 40-by-80 gap and two people were killed. The mayor declared a state of emergency and the Heavy Search and Rescue Team was deployed to Elliot Lake, Ontario.

On March 1, 2011 in Lebret, Saskatchewan (population 203) part of the roof of the community's arena collapsed during a hockey game and involved an area of the rink that wasn't being used. The weight of snow on the roof is being blamed.

At the end of March 2009, the roof of an ice rink in the remote First Nation community of Fond du Lac collapsed. The collapse was caused by a large amount of snow on the roof. The walls and the roof of the ice rink were made of thin tin, which could not support the added weight. Fortunately, no one was in the rink at the time. Things could have been much worse, as the weekend before a big hockey tournament filled the ice rink with people.

In 2005, the Archie Simpson Arena roof collapsed at about 6 p.m. on a Sunday, closing down the 22-year-old structure indefinitely. Fortunately, no one was injured in Fort Chipewyan about 280 kilometres north of Fort McMurray and is accessible only by boat, air and winter road.

## Structural Collapse – Buildings Natural and Human-caused

The Canadian National Building Code was first adopted in 1941. New buildings have to meet the standards set in the Building Code. Older buildings need to be regularly maintained and checked by a structural engineer. However, buildings and structures on First Nation reserves are not required to follow federal or provincial building codes. First Nation communities are responsible for housing and maintenance on reserves. The Government of Canada, through Aboriginal Affairs and Northern Development Canada, can assist First Nations in building healthy and sustainable housing (see Risk Analysis Resources)

Hazard Rating				High Risk	Low Risk	Need More Info	Not Applicable
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Yes	No	Need More Info	Not Applicable	FACTORS			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Has your community set standards for new constructions? And/ or does your community follow Federal or Provincial building codes?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Building codes help to ensure that structures are well built and safe. Have new and past construction projects been built without being regularly inspected? And/or have building standards not been regularly enforced?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there unreinforced masonry buildings in your community and is your community at risk of earthquakes? (Refer to the section on Earthquakes)			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there unreinforced masonry buildings in your community sitting on liquefiable soils and is your community at risk of earthquakes? (Refer to the section on Earthquakes)			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Buildings and other infrastructure may decay over time. Have buildings been allowed to exist without regular inspections and repairs over time?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there public buildings such as schools, arenas or auditoriums which have been built without following any standard? And have these buildings not been recently inspected by a structural engineer? And are there large numbers of people that may gather here at one time?			

## Structural Collapse – Transportation Natural and Human-caused

Hazard Rating				High Risk	<input type="checkbox"/>	Low Risk	<input type="checkbox"/>	Need More Info	<input type="checkbox"/>	Not Applicable	<input type="checkbox"/>
Yes	No	Need More Info	Not Applicable	FACTORS							
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Has your community set standards for new construction of infrastructure (such as bridges and overpasses)? And/ or does your community follow Federal or Provincial building codes?			
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Engineering standards help to make sure that bridges, overpasses and other transportation infrastructure are well built and safe. Have new and past construction projects been built without being regularly inspected and/or have construction standards not been regularly enforced?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there major older bridges or highway overpasses which have not been recently reviewed by a structural engineer?							
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Are there major older bridges or highway overpasses which have not been well maintained?							

## Risk Analysis Resources

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Indigenous Services Canada has some resources available that can assist First Nation communities to build healthy, [safe and sustainable housing](#).

Keywords: Indigenous Services Canada, building codes, housing, sustainable housing, healthy living environment.

Canada Mortgage and Housing Corporation has current and emerging strategies for [affordable, sustainable housing projects](#).

Keywords: Canada Mortgage and Housing Corporation, housing, sustainable housing.

The [Sustainable Housing Initiative](#) provides a resource for individuals and groups who want to develop, build, and operate affordable rental housing.

Keywords: Sustainable housing, affordable rental housing.

The [First Nations National Building Officers Association](#) (FNNBOA) also has information available to assist in improving housing conditions. You can also find a Certified Building Officer in your area. The website also offers information on education (how to become a Certified Building Officer).

Keywords: First Nations National Building Officers Association, housing conditions, building codes, Certified Building Officer.

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