Institute for Catastrophic Loss Reduction
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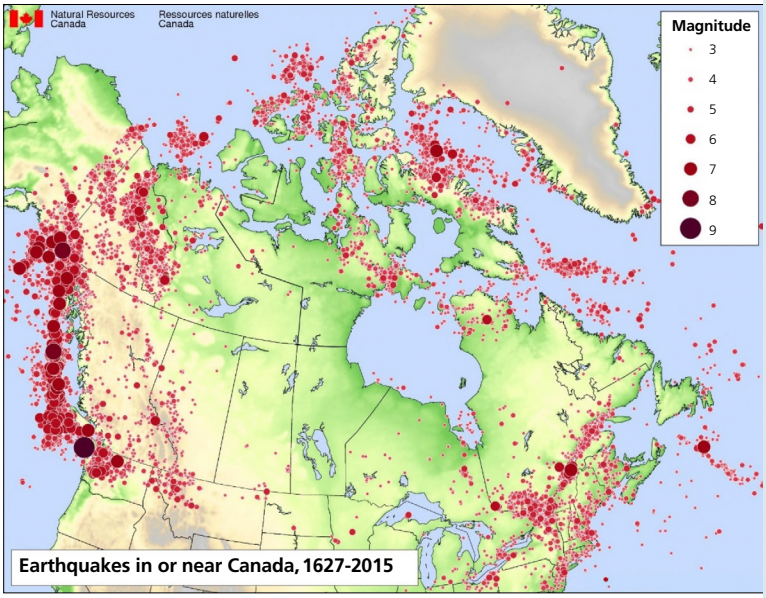
SPA Risk LLC

Fire following earthquake in the Vancouver region

Executive summary

With a population of about 2.5 million, the Vancouver region is the most populous metropolitan area in western Canada, and the third most in the country, comprising more than 7% of the nation's population. About a quarter of the study area's population is within the City of Vancouver itself, which is the eighth largest city in Canada, a major cultural centre with leading universities, major rail hub and port.



Historical seismicity of Canada (Source: Geological Survey of Canada).

The region is exposed to significant earthquake hazard with shaking that could cause significant damage to ordinary buildings and infrastructure. Indeed, in January 1700, the region suffered a magnitude 9 (approximate) subduction earthquake which generated a tsunamis that reached Japan. In December 1949, a magnitude 8.1 event off the Queen Charlotte Islands was widely felt throughout the Pacific Northwest and caused property damage across the region. In June 1886, The Great Vancouver Fire, a non-earthquake related conflagration, took 21 lives and destroyed 600 to 1,000 structures.

Fire services in the Lower Mainland are modern, advanced, well-equipped and of a high caliber in their organization, methods and tactics. The earthquake risk is understood and appears to be a focus for fire departments in the study area. However, damage from fire following an earthquake can greatly exceed the damage caused by shaking alone. This, despite the best efforts of the fire service.

To assess the risk of fire following earthquake and identify opportunities to reduce the risk, five scenario events are examined for the number of fires and amount of firespread they would cause: two distant events: a Mw 9.0 Cascadia Subduction Zone (CSZ) event and a relatively distant Mw 7.3 event on Vancouver Island, and three relatively nearby events: a deep in-slab event on the subducting Juan de Fuca Plate, a Mw 7.3 event in the Georgia Strait just to the west of the city of Vancouver, and a Mw 6.5 shallow crustal event centred under the city of New Westminster.

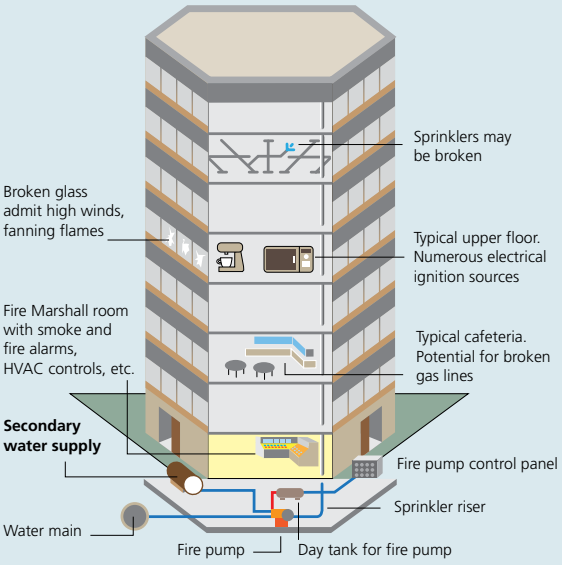
Specific initial steps

to reduce the risk of fire following earthquake would include:

1 **Enhanced post-earthquake firefighting water supply:** Much has been done in the Lower Mainland to improve the ability to fight fires after earthquakes, but more can be done. The fire service in the Lower Mainland is modern, advanced, well-equipped and of a high caliber in its organization, methods and tactics. Earthquake risk in the region is understood and appears to be a focus for fire departments. The city of Vancouver is bordered on many sides by water, as was San Francisco in 1906 – indeed, San Francisco had direct access to the largest body of water on earth yet burned for three days due to lack of firefighting water. As a result, San Francisco and Vancouver have both built specialized high-pressure dedicated fire protection systems (DFPS), for which they are to be commended. In addition to the DFPS, Vancouver has built a defence in depth, with fireboats, hose tenders and hose reels, as well as training citizen volunteer Neighbourhood Emergency Assistance Teams (N.E.A.T.s). However, departments in the region need to improve their access to firefighting water following an earthquake, when water mains are likely to fail. **Recommendation:** We recommend development of an integrated regional Portable Water Supply System (PWSS) of hose tenders/hose reels, with compatible fittings, that can be used to access alternative water supply sources (bays, lakes, rivers etc) and relay water to the fireground. Such a regional system would also benefit from a number of specialized pumps, like Vancouver's HydroSubs®, distributed among the various larger departments in the Lower Mainland. Note that a PWSS has wider applicability than just earthquake – it can be used for wildfires, dewatering flooded areas and other emergency needs.

2 **Secondary water supply for high-rise buildings:** High-rise buildings are particularly vulnerable to fires at all times and fire departments depend to a great extent on sprinkler systems. However, sprinklers depend on the underground water distribution system for supply and, if that system fails in an earthquake, sprinklers may be left without water and fires can grow unimpeded. Building codes in the United States have required high-rise buildings in high seismic zones to have a secondary water supply, typically a 60,000-litre tank located in the basement or mechanical room near the backup fire pump. **Recommendation:** Both the Vancouver Building Code and the Provincial Building Code should include a provision for high-rise building secondary water supply in high seismicity areas.

High-rise building and post-earthquake fire aspects. Secondary water supply is required in seismic zones in U.S. because it is anticipated water mains may fail. If mains fail, sprinklers have no supply (Scawthorn 1989).



3 **Seismic natural gas shutoff valves:** This report has not assessed the seismic vulnerability of gas distribution in general or major energy facilities in the Vancouver area, some of which are in the highly liquefiable Fraser River Delta. **Recommendation:** Several actions have been de rigueur in other earthquake-threatened regions and should be considered in the Lower Mainland: (a) a review of the overall seismic vulnerability and reliability of major energy facilities; (b) a review of the gas distribution operator's ability to control and isolate its transmission and distribution networks in the event of a major earthquake, and (c) consideration by the gas distribution operator of incorporating an automatic gas shutoff device in gas meters. Following the 1995 Kobe earthquake, Japan replaced every gas meter in the country with meters incorporating an automatic gas shutoff device, so the technology is well-established and the cost quite nominal if meters are being replaced for other reasons. The opportunity afforded by the B.C. operator's current plan to replace these meters for more efficient operation permits inclusion of the seismic shutoff device at a very modest marginal cost.

Fire following earthquake in the Vancouver region can be downloaded at **www.iclr.org**

Median number of fires, large fires and losses (in billions $).

Scenario	EQ1 Mw 9.0 CSZ	EQ2 Mw 6.8 JDF	EQ3 Mw 7.3 LRDM	EQ4 Mw 7.3 GS	EQ5 Mw 6.5 NWM
Median ignitions	16	106	4	216	93
Median no. large fires	0.6	31	0.02	47	29
Median losses in billions $	$0.16	$7.4	$0.01	$10.7	$7.2

VFR fireboat 1

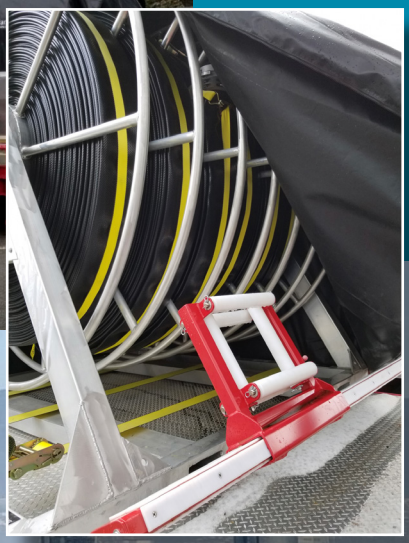
Accounting for fire department response, water system damage, weather and other conditions, the growth and ultimate final burnt area of fires are estimated to result in losses from nil to almost $10 billion. These are median estimates – there are significant probabilities of greater or less damage and the range is a function of the specific earthquake scenario (i.e., location and magnitude), time of day, weather and other factors.

This loss would be almost entirely insured and would have a very significant impact on the Canadian insurance industry. Fire losses would come on top of shaking and other losses which would be insured to a lesser extent. A leading global reinsurer has stated that losses of this magnitude would likely result in failure of some insurers, would entail secondary and contingent losses, and could conceivably lead to financial contagion.

This risk need not be tolerated and indeed the Province of British Columbia, City of Vancouver, and regional agencies such as Metro Vancouver and BC Hydro have implemented excellent programs to reduce this risk. Further actions, however, can still be taken to reduce the risk of fire damage and include creation of a regional portable water supply system, providing secondary water supplies for high-rise buildings, and consideration by the operator of incorporating an automatic gas shutoff device in gas meters.

A small investment now can greatly reduce the risk of loss.

VFR HydroSub®



Vancouver Fire and Rescue Services new Large Diameter Hose reel system – each trailer-mounted motorized reel carries 6000 ft. of 6" hose.
Photo: Scawthorn, 2019

Cover image: Lee Robinson – Own work, unsplash.com

Institute for Catastrophic Loss Reduction
Institut de prévention des sinistres catastrophiques

Toronto Office
20 Richmond Street East
Suite 210
Toronto, Ontario, Canada
M5C 2R9
416-364-8677
416-364-5889

London Office
Western University
Amit Chakma Building, Suite 4405
1151 Richmond Street
London, Ontario, Canada
N6A 5B9
519-661-3234
519-661-4273

info@iclr.org
www.iclr.org
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