COMMUNITY RISK ASSESSMENT

Squamish-Lillooet Regional District

Abstract

This Community Risk Assessment is a component of the SLRD Comprehensive Emergency Management Plan. A Community Risk Assessment is the foundation for any local authority emergency management program. It informs risk reduction strategies, emergency response and recovery plans, and other elements of the SLRD emergency program.

Evaluating risks is a requirement mandated by the Local Authority Emergency Management Regulation. Section 2(1) of this regulation requires local authorities to prepare emergency plans that reflects their assessment of the relative risk of occurrence, and the potential impact, of emergencies or disasters on people and property.

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Executive Summary

This Community Risk Assessment (CRA) is a component of the Squamish-Lillooet Regional District (SLRD) Comprehensive Emergency Management Plan and presents a survey and analysis of known hazards, risks and related community vulnerabilities in the SLRD. The purpose of a CRA is to:

- Consider all known hazards that may trigger a risk event and impact communities of the SLRD;
- Identify what would trigger a risk event to occur; and
- Determine what the potential impact would be if the risk event did occur.

The results of the CRA inform risk reduction strategies, emergency response and recovery plans, and other elements of the SLRD emergency program.

Evaluating risks is a requirement mandated by the Local Authority Emergency Management Regulation. Section 2(1) of this regulation requires local authorities to prepare emergency plans that reflect their assessment of the relative risk of occurrence, and the potential impact, of emergencies or disasters on people and property.

This CRA focuses on the risks associated with the highest frequency and consequence hazards present in the SLRD, namely:

- Wildland interface fire;
- Flooding (riverine, overland, freshet, dam failure and storm surge);
- Geotechnical (debris flow, debris flood and landslide);
- Severe storm and subsequent utility failure;
- Earthquake;
- Hazardous material release (including incidents arising from transportation accidents); and
- Climate change effects.

These are not the only hazards present in the SLRD and the full range of hazards is considered in this CRA. Further, hazards can be interconnected and have cascading effects that increase the overall severity of a risk event. For example, a wildfire on a steep slope can decrease slope stability, leading to erosion that contributes to debris flows and flooding.

Climate change is both a separate hazard and one that interacts with many other hazards, increasing both the frequency and severity of risk events. Changing weather patterns are already contributing to increased effects from flood, wildfire, and landslide events in Canada and these changes are predicted to continue. The cumulative effect of changing and interrelated hazards presents a challenge for community risk assessment, and for this reason a CRA is considered a “snapshot in time” and should be updated periodically. Population growth in the SLRD will also affect the risk profile of some communities.

In Electoral Area A, wildfire and geotechnical hazards present the highest risks, along with a degree of geographic isolation from larger population centers. Communities are vulnerable to being cut off from main evacuation routes if these become compromised by wildfire or geotechnical events such as debris flows. However, this relative isolation can also a protective factor, contributing to resilience with independent drinking water, wastewater and other systems, along with a strong sense of community. Climate change effects may lead to increased risk of drought conditions and water security concerns.

Electoral Area B has a similar hazard profile to Area A but with generally less geographic isolation (excepting the Yalakom Valley). The flood and geotechnical risks in Seton Portage are of particular note. Landslides

from the Whitecap, Pete's, Bear, and Spider Creeks all have potential to impact that community with damage from debris or by diversion of creeks and rivers into inhabited areas. Wildfire is an additional hazard in the hot, dry summers and fire starts ignited by dry lightning are not uncommon.

Electoral Area C is at risk of flood, interface fire, and geotechnical hazard events. Volcanic hazard is also present, with Area C located in the Garibaldi Volcanic belt and proximal to the Mount Meager volcanic complex, north of Pemberton. The Pemberton Valley has flood risk from the Lillooet, Birkenhead and Green rivers. This flood risk was increased by the 2010 Capricorn Creek landslide on Mount Meager, the largest landslide in recorded Canadian history. Sediment from this event is currently moving downstream, causing the river channel to become shallower, reducing its flow capacity and rendering current flood protection infrastructure less effective than originally designed. Further, landslides from Mt Meager that are orders of magnitude larger than the 2010 event are possible. An additional landslide risk is presented by Mount Currie, where a number of areas of slope instability have been identified.

The hazards in Electoral Area D that present the highest risk are flood and interface fire, with debris flows also being a notable risk. Updated floodplain mapping in 2019 for the Upper Squamish Valley found that inundation of most of the valley floor can be expected in a 50-year return period flood event. Wildfires present an existing hazard that is increasing over time with climate change. Hotter, drier and longer summer weather is drying the traditionally lower risk rainforest environment of the coastal mountains. Most Area D communities are situated in or below forested areas, and some communities could experience substantial population growth due to the proximity to Vancouver.

The SLRD has a diverse natural hazard profile, and the risks they present to communities can be compounded by interconnected and cascading effects, including climate change effects. The SLRD will continue to develop and update emergency management plans and policies consistent with the most current community risk information.

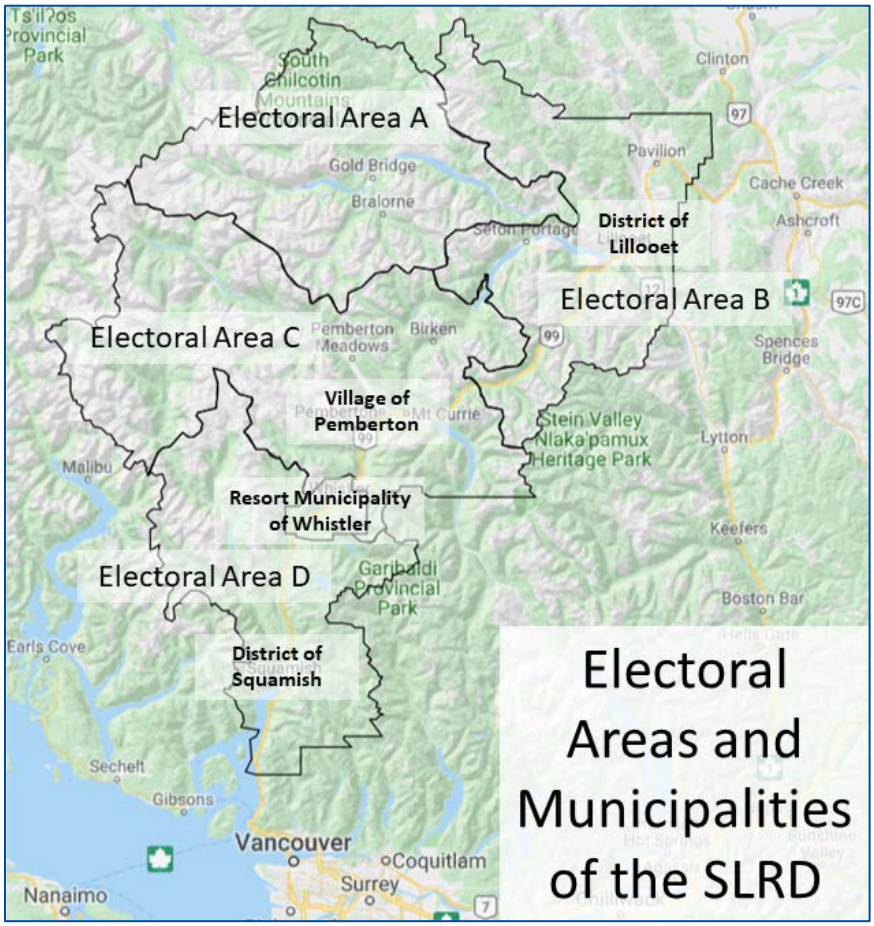
Contents

Introduction

The Emergency Program Act (1996) provides the legislative framework for emergency management in British Columbia. The development of community emergency plans is further mandated by the British Columbia Local Authority Emergency Management Regulation (1995), 2(2) whereby:

> *Each municipal council and each board of a regional district that qualifies as a local authority under section 2 (1) of the Act must reflect in its local emergency plan, unless it is documented elsewhere,*
>
> > *(a) the commitment of the local authority to provide policy guidance and direction to the emergency management organization established by that local authority under section 6 of the Act, and*
> >
> > *(b) the procedures by which that guidance and direction is to be provided.*

The purpose of a Community Risk Assessment (CRA) is to consider all known hazards that may trigger a risk event and impact communities of the SLRD, identify what would trigger a risk event to occur, and determine what the potential impact would be if the risk event did occur. The results of the CRA inform risk reduction strategies, emergency response and recovery plans, and other elements of the SLRD emergency program.



This CRA is organized by each electoral area (A, B, C and D), recognizing the distinct demographic nature, inherent strengths, and potential vulnerabilities in each of those. It focuses on the six hazards that either by frequency or magnitude, pose the highest risk to the safety of people who live, work and recreate in the SLRD. These hazards are wildland interface fire, flood, landslide/debris flow/debris flood, severe storm/utility failure, earthquake, and hazardous material release. Additionally, the forecast effects of climate change on existing hazards are reviewed.

Figure 1 – Electoral Areas and Municipalities of the SLRD

Key Definitions and Common Abbreviations

Emergency	A present or imminent event that requires prompt coordination of actions concerning persons or property to protect the health, safety or welfare of people, or to limit damage to property or the environment.
Hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.
Resilience	A measure of how well prepared and equipped a community is physically, socially, economically and environmentally to minimize the impact of or cope with hazards. Resilient capacity is built through a process of empowering citizens, responders, organizations, communities, governments, systems and society to share the responsibility to keep hazards from becoming disasters.
Risk	Risk in the context of emergency management is the likelihood or probability that there will be loss of life or property or damage to the environment and the likely size or severity of the impact or loss.
Risk Event	A risk event is a hazard actualized: a wildfire, flood, landslide, other geophysical phenomena, or human-induced accident that manifests with negative impact to people, the environment or the economy.
Vulnerability	The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.

Table 1 – CRA Key Definitions

ALARP	As Low As Reasonably Practicable
CEP	Community Emergency Plan
CRA	Community Risk Assessment
CWPP	Community Wildfire Protection Plan
DNV	District of North Vancouver
EMBC	Emergency Management BC
FSR	Forest Service Road
HazMat	Hazardous Materials
IPCC	International Panel on Climate Change
MFLNRORD	Ministry of Forests Lands and Natural Resource Operations and Rural Development
NRCAN	Natural Resources Canada
NSEM	North Shore Emergency Management
OCP	Official Community Plan
SAR	Search and Rescue

Table 2 – CRA Common Abbreviations

PART ONE: HAZARDS IN THE SLRD

Public Safety Canada maintains the Canadian Disaster Database, which references 60 different hazards across three main hazard groups (natural, technological and conflict related) and 13 sub-groups, excluding war. Although all the hazards listed have at least a theoretical possibility of occurring in the SLRD, this community risk assessment has focused on those where there is evidence of greater exposure to the hazard type. The complete reference table of all hazards recognized by Public Safety Canada can be found here: https://www.publicsafety.gc.ca/cnt/rsrcs/cndn-dsstr-dtbs/rfrnc-tbl-smbls-dfntns-en.aspx

1. Index of Hazards Affecting the SLRD

Hazard	Risk*
Climate Change	High
Dam Failure	Low
Drought	Moderate
Earthquake – moderate to severe	Low-Moderate
Epidemic	Low-Moderate
Flood: Freshet	Low-Moderate
Flood: Riverine	Moderate-High
Flood: Outburst	Low
Flood: Storm Surge	Low*
Geotechnical: Debris Flow, Debris Flood – moderate to severe	Moderate
Geotechnical: Rock Avalanche – moderate to severe	Low*
Hazardous Material Release / Transportation	Low
Storm / Utility Outage – moderate to severe	Low-Moderate
Tsunami	Low-moderate
Volcanic	Low
Wildland Interface Fire	Moderate-Severe
*Note that risk may vary considerably from one electoral area and community to another, and that a low risk event may still occur and with severe impacts. Refer to Part Two of this document for more area specific risk assessment.	

Table 3 – Index of Hazards Affecting the SLRD

1.1. Climate Change

Climate change has the potential to affect the risk posed by hazards, including those described above, and set the conditions for more severe events and cascading events where hazard effects interact. For example, increases in the frequency and severity of atmospheric rivers (intense rainfall events) high above the earth's surface increase the chances of storm flooding (NHC, 2019, p. iii), high levels of precipitation also affect slope stability (BGC, 2018a, p. iii) increasing risk from debris flow and flood hazards. Further, unusually hot and dry conditions increase wildfire risk (Abbot & Chapman, 2018). Globally, climate change is expected to have wide ranging effects on ecosystems across the world. The Technical Summary of the International Panel on Climate Change's *Special Report on Climate Change and Land* describes the potential for desertification, drought, changing precipitation patterns and other forms of extreme weather that are assessed as likely to be felt across communities worldwide (IPCC, 2019, p. 88).

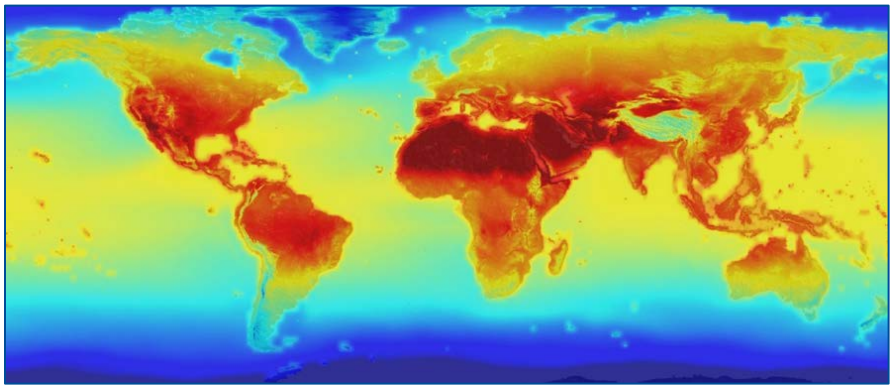


Figure 2 – Changes in global climate lead to local conditions of extreme weather (Source: Government of Canada)

1.2. Dam Failure

BC Hydro operates a number of hydro-electric power generating stations in the SLRD, which are fed by water reservoirs created by dams. There is a low risk, high consequence assessed dam failure hazard that would affect communities downstream due to the resulting high-volume of water suddenly released through water channels. Dams are located at Daisy Lake in Electoral Area D and in Electoral Areas A and B the Bridge River Power System utilizes the LaJoie Dam, upstream of Gold Bridge, and the Terzaghi Dam, upstream of Moha. BC Hydro maintains detailed emergency response plans and conducts regular emergency response exercises with emergency management stakeholders including the SLRD, and maintains dams to the standards set out in the Dam Safety Regulation (2016).

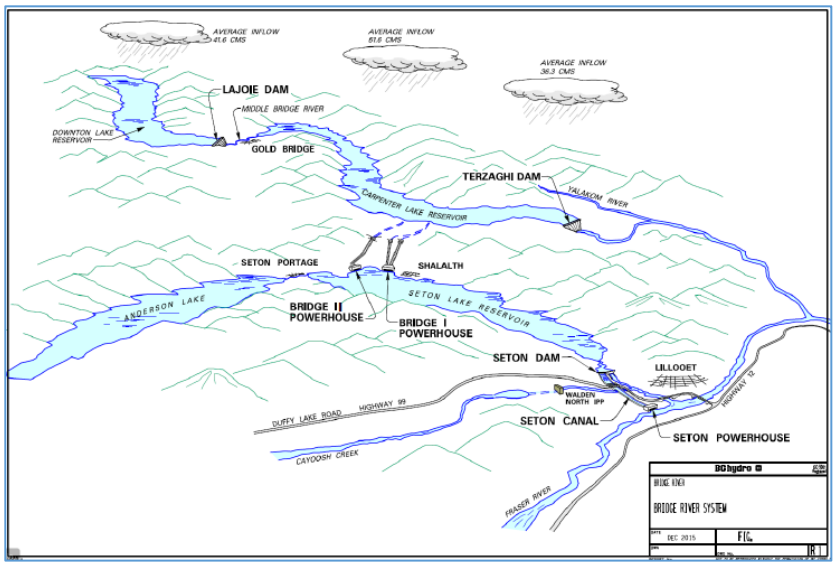


Figure 3 – BC Hydro Bridge River Power System (Source: BC Hydro, 2019)

1.3. Drought

A drought is a prolonged shortage of water in the environment. Meteorological drought is caused by a lack of precipitation. Hydrological drought is brought on by the depletion of aquifers, lakes and reservoirs for reasons other than lack of precipitation. Agricultural drought is caused by soil erosion or poorly planned irrigation that results in a shortfall of water available to crops.

In all cases, drought has the potential for significant economic, social and environmental impact throughout the SLRD. Drought harms agriculture and tourism businesses, and reduces opportunity for water-based recreational activities. Drought also exacerbates wildfire risk because it dries and increases the flammability of potential fire fuel sources. Drought can be made worse by the changing weather patterns brought on by the El Niño Southern Oscillation phase and by climate change.

Drought is a recurrent event in western Canada, sometimes lasting multiple years. The most significant drought in recent years lasted from 1999 to 2005, with most significant impact in Alberta and Saskatchewan. BC experiences drought in various regions on an almost annual basis. All of the SLRD has the potential to be affected by drought, but the drier climate of Electoral Areas B is particularly susceptible. With climate change, areas that have not historically felt the effects of drought may find themselves more affected by this hazard.

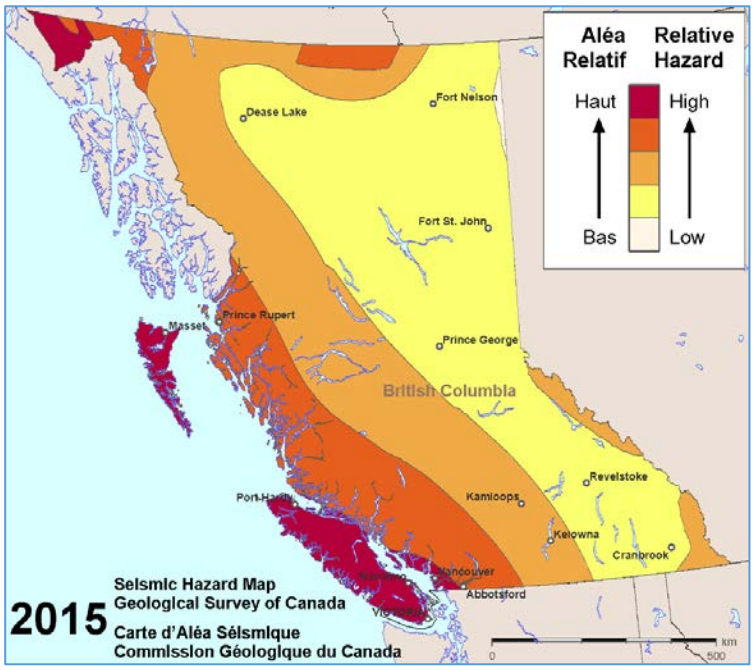
The Ministry of the Environment and Climate Change Strategy is the lead provincial organization for managing drought in BC, and works closely with local governments, first nations, and other provincial agencies in planning and response. The BC Ministry of Agriculture provides advice and drought management tools to farmers and ranchers affected by drought or loss of water.

1.4. Earthquake

The SLRD is exposed to a wide range of seismic hazard threats related to active tectonics along the North American Plate Margin. “Source zones for earthquake events include the interface between oceanic crust of the Juan De Fuca Plate (Cascadia subduction zone), the down-going slab of oceanic crust as it sinks beneath western North America (Benioff zone), and interlocking networks of faults in the overriding North American Plate that accommodate incremental strain and displacement along the Canada subduction zone boundary (Crustal Faults)” (Journey et. al, 2015, p.197). Ground shaking, liquefaction, and earthquake triggered landslides represent the most significant direct hazard threats and the extent of damage will depend on the magnitude, depth and type of seismic event. Earthquakes can result in a number of cascading effects including fires started by downed electrical lines, damaged drinking and waste water infrastructure and damage to communication infrastructure.

Small earthquakes are common in Southwest BC and some are not even felt. However, severe earthquakes are possible and in the Cascadia subduction zone, and geological evidence suggests that large subduction ‘megathrust’ earthquakes have struck the BC coast every 300-800 years (Natural Resources Canada, 2019). As the fault ruptures, tsunami, severe ground shaking and landslides are expected, with many aftershocks possible and widespread damage predicted. Shallow crustal fault earthquakes in the North American Plate also have potential to cause significant damage to communities because these earthquakes occur close to the earth’s surface (Natural Resources Canada, 2011). Liquefaction is an effect of crustal earthquakes and only occurs in saturated soil. The seismic event creates shaking that causes the subsequent failure of water saturated sediment. Effects are most commonly observed in low-lying floodplain areas near bodies of water such as rivers, lakes bays and

oceans. Historically, liquefaction has caused extensive amounts of damage around the world and is a major contributor to urban seismic risk. Deep intraslab earthquakes in the Benioff zone also occur, but are less likely to cause damage to communities because of their depth (City of Vancouver, 2020). The highest earthquake risk areas are closest to the Pacific Ocean coast in Electoral Areas C and D, with the risk tending to reduce further inland (Natural Resources Canada, 2015).



A severe earthquake has the potential to cause sudden and catastrophic damage, destroying structures, disrupting utilities, severing transportation lines, and death and injury from falling debris. Severe earthquakes are a low probability, high consequence event, which means that it is prudent to effectively plan for and mitigate this risk wherever possible, including adherence to building codes relating to seismic standards, household emergency plans, and business continuity plans.

Figure 4 – Simplified seismic hazard map of British Columbia (Source: Natural Resources Canada, 2015)

1.5. Epidemic / Pandemic

An epidemic is the rapid spread of infectious disease to a large number of people within a population in a short period of time. Aside from the obvious direct impact to people's health, epidemics can also have significant economic and social impacts. A pandemic is an infectious disease that has spread around the world. Infectious diseases often disproportionately affect young children, seniors, or people at increased risk due to other medical conditions. This, however, is not always the case. In 2009, the H1N1 "Swine Flu" spread to an estimated 10-20 million people worldwide and is notable in that it posed significant risk for people in otherwise good health.

Vancouver Coastal Health, Interior Health and the BC Centre for Disease Control are responsible for monitoring disease threats to SLRD constituents.

Epidemics and infestations can also involve plants and non-human animals. These can have significant negative impact on agricultural businesses, and food security where such events become widespread, reducing supply and increasing prices. Plant and animal epidemics in wildlands can have cascading effects throughout ecosystems, which in turn can impact human communities. Even small outbreaks of high-risk diseases in agriculture can have significant economic impact because farmers may be required to quarantine and potentially destroy a large number of livestock in an effort to contain the disease. In 2003, the Canadian Food Inspection Agency identified a cow in Northern Alberta with bovine spongiform

encephalopathy, a.k.a., “Mad Cow Disease”. Precautionary measures designed to prevent the spread cost over $1 billion in income support for farmers. Plant and animal epidemics in the wild can have a cascading effect throughout the ecosystem, and potentially exacerbate other hazards. For example, a plant disease can kill forests and provide dry fuel for wildfire.

The Canadian Food Inspection Agency is responsible for monitoring livestock. Other provincial and federal agencies monitor disease threats within their area of expertise.

1.6. Flooding

Overland flooding is the most expensive disaster in Canada (Public Safety Canada, 2019). It occurs when rivers and other bodies of water overflow onto dry land. Traditionally, overland flood insurance has not been available to Canadians for their private residencies. This, however, is changing over time and overland flood insurance is becoming more readily available (Insurance Bureau of Canada, 2017). These new insurance offerings will have implications for the way British Columbians would receive Disaster Financial Assistance (DFA) from the provincial government. “If a flooding disaster occurs and DFA is authorized for a disaster event, an applicant who could reasonably and readily have purchased overland flood insurance would NOT be eligible for DFA” (EMBC, 2016).

1.6.1. Riverine

Many communities within the SLRD, as with other parts of Canada, have developed in the flat and fertile lands of river valley floodplains. These water channels can pose flood hazard to nearby communities, particularly during high-water events. Heavy rains can cause storm flooding as the watershed becomes saturated and precipitation accumulates in low-laying areas, especially during rain on snow events.

Channel aggradation is a hydrological phenomenon that occurs when sediment from debris flows accumulates in water channels, reducing their capacity to contain high water levels. Over time, this reduces the effectiveness of flood protection infrastructure as the sediment raises water levels above current embankments. This sedimentation and the associated increased flood risk has potential to occur in rivers throughout the SLRD’s mountainous environment, but has been particularly problematic in the Lillooet River following the 2010 Mount Meager landslide. A full analysis of this event and its implications for nearby communities is found in the NHC report titled *Lillooet River Floodplain Mapping* (2018).

Climate change is correlated with future flood risk globally (International Panel on Climate Change, 2020) and has the potential to increase flow rates in SLRD water channels such as the Lillooet River (NHC, 2018, p. 48). Torrential downpours and unseasonal or extreme events may become more common in the SLRD, increasing flood risk to communities. During the autumn months typically associated with heavy rainfall events, the BC River Forecast Centre’s Coastal Fall Flood Ensemble Estimation (COFFEE) Model provides regular flood forecasts. This is supplemented with weather bulletins issued by Environment and Climate Change Canada and inter-agency coordination teleconferences hosted by Emergency Management British Columbia (EMBC).

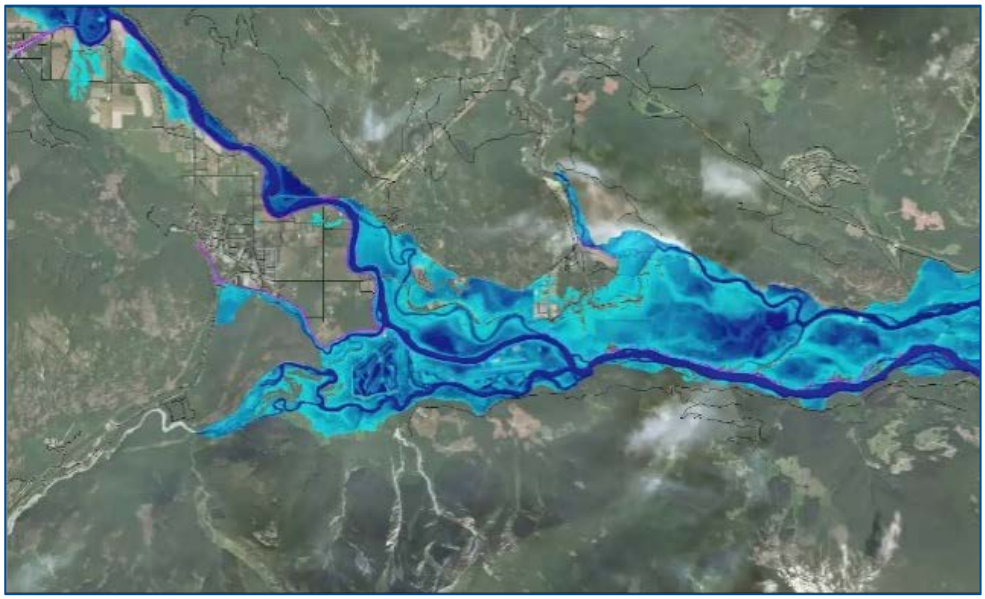


Figure 5 – Projected inundation from a 200-Year Flood event on the Lillooet River Lower Reach, depicting the Village of Pemberton, Pemberton Meadows, Mount Currie and the Pemberton Fringe in Electoral Area C (Source: NHC, 2019)

1.6.2. Freshet

Freshet flood is caused when a sudden occurrence of warm temperatures rapidly melts snow and ice, turning it to liquid water at a faster rate that can be absorbed within the confines of existing water channels (MFLNRORD, 2019, p. 10). In British Columbia, freshet floods have typically occurred during the main spring thaw of mountain snow in the months of April to July (TranBC, 2011). The SLRD and EMBC generally refer to the BC River Forecast Centre's Channel Links Evolution Efficient Routing (CLEVER) Model to monitor freshet hazards during this time of year. In times of higher freshet risk, EMBC hosts inter-agency teleconferences with presentations by subject matter experts to assist with freshet event preparation and response.

Figure 6 – Freshet flooding onto a highway in BC. (Source: Tranbc, 2011)

1.6.3. Storm Surge

Storm surge is caused when large bodies of water flood onto coastal areas due to high winds and low air pressure brought on by severe storms. While storm surge causes damage in conjunction with violent winds and surface waves, it is distinct from them in that the combined effects of low air pressure and strong wind will actually raise the water level of the ocean to make flooding more severe. The communities of Britannia Beach and Furry Creek are more vulnerable to storm surge flooding due to their coastal location in Howe Sound, but an especially severe storm over a lake or other large body of inland water could cause a storm surge as well.

Year	Rank (out of last 56 years)	Surge (m)	ENSO Phase (red El Nino, blue La Nina)
1998	1	1.03	moderate-strong
2015	3	0.95	very strong
2006	5	0.91	weak
2002	8	0.89	moderate
2016	9	0.85	moderate
2011	11	0.84	weak
2005	14	0.82	weak
2018	16	0.81	moderate
2007	20	0.79	weak-moderate
2014	24	0.77	moderate

Figure 7 – 10 most severe storm surge events since 1997 and how they rank among all others recorded, measured in sea level surge at Point Atkinson, West Vancouver. (Source: Tinis, 2019)

1.6.4. Outburst Flood

Outburst flood is the consequence of a river or stream suddenly becoming partially or fully blocked by a land movement event such as landslide and debris flows, and may also occur as the result of an earthquake. These temporary land dams may give way gradually, but may also release suddenly, triggering a wave of flooding downstream of the dammed location. The Lillooet, Squamish and Cheakamus Rivers have all been assessed as having a risk of outburst flooding resulting from land movement events originating from Mt Meager, Mt Currie, Mt Cayley and at the Garibaldi Lake Barrier (NHC, 2018, 2019; BGC, 2018; KWL, 2017).

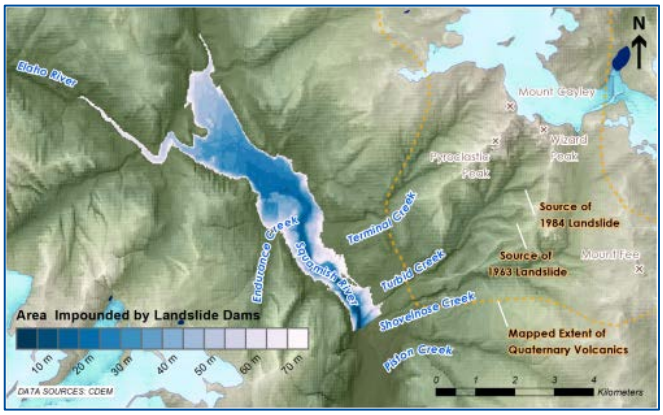


Figure 8 – Potential size of impoundment if a landslide were to block the Squamish River in the vicinity of Turbid Creek. If this landslide dam were to suddenly fail, an explosive outburst flood would could cause significant harm in the Upper Squamish Valley. (Source: NHC, 2019)

1.7. Geotechnical Hazards

The SLRD is located in a mountainous environment and as such it is exposed to landslide hazards, including debris flows and rock avalanches. Landslides are defined a "any type of slope failure or downward movement of rock and/or sediment" (NRCAN, 2017) and may be further classified by the type of material, i.e., rock, earth or debris, and type of movement, i.e., fall, topple, slide, spread, or flow (US

Geological Survey, 2008, p.5). Landslides present the added challenge in that they tend to be sudden-onset hazards. A sudden failure of slope stability leaves communities little time to react (BGC, 2018a, p. 54; US Geological Survey, 2008, p. 16). Structural risk mitigation measures include debris flow berms and rock catchment basins, and non-structural measures include monitoring potential precursor factors such as increased small rock falls, intense rainfall and prolonged periods of unusually hot weather.

Volcanic processes can also create landslide hazards. The SLRD includes the Mt Meager volcanic complex in Area C, where corrosive substances from volcanic activity have created a mountain of 'rotten rock' (Roberti et. al, 2018) that is more easily destabilized by intense rainfall and extreme heat events (Friele et. al, 2008).

Related hazards include landslide damming and outburst floods (see Outburst Flood, p.14).

Geotechnical hazard reports commissioned for Catiline Creek, Seton Portage and Mt Currie assessed group and individual landslide risk in the study area according to criteria adopted by the District of North Vancouver (DNV), Canmore, Alberta and Hong Kong. (BGC, 2015, 2018a, 2018b).

Climate change is expected to increase the frequency and severity of weather events that trigger landslides. Heavy rain events add weight and lubrication to unstable slopes and periods of extreme heat can melt ice beneath the structure of certain mountain formations (Clautier et. al, 2016).

Figure 9 – A structure damaged from a 2010 landslide near Catiline Creek, in Electoral Area C (Source: SLRD, 2010)

1.7.1 Debris flow

Debris flows are a type of landslide that can be suddenly triggered by heavy rainfall, sometimes in addition to rapid snowmelt. Debris flows are "a rapid mass movement in which loose soil, rock, and sometimes organic matter combine with water to form a slurry that flows downslope… [They] can be intensified when occurring on slopes or in gullies that have been denuded of vegetation due to wildfires… [and] are commonly caused by intense surface water flow due to heavy precipitation and snowmelt" (US Geological Survey, 2008, p. 16). Debris flows are often associated with creeks on steep slopes, where debris may build up near the top of a slope and then be channeled into creeks by intense rainfall, flushing the water and debris downhill. Steep slopes previously burned by wildfires can be more prone to debris flows as dead trees and hydrophobic soil compromise slope stability. Evidence of this can be seen in the Thompson Nicola Regional District where the 2017 Elephant Hill fire has resulted in increased debris flow risk, particularly where slopes were severely burned (SNT Geotechnical Ltd., 2017, p.2-8).

1.7.2 Rock Avalanches

Rock avalanches involve an especially large and extremely rapid flow of fragmented rock down a slope (BGC, 2018a, p. 15). The trigger for rock avalanche can be seismic, but generally the processes that degrade slope stability are weather related and occur over time. Wind and rain create erosion and freeze/thaw cycles expand cracks in the rock. As the climate changes, hotter temperatures, lower snowpacks and more intense rainfall events can also potentially increase risk by degrading permafrost that occurs beneath the surface structure of certain rock formations (Clautier et. al, 2016).

1.8. Hazardous Material Release / Transportation

The SLRD is intersected by major road and rail corridors, and natural resource pipelines that connect the BC coast to the interior. These essential transport lines for people and resources also pose a risk to communities from the potential for industrial and transportation accidents involving hazardous materials. Hazardous material exposure, either through liquid spill or gaseous release, can quickly spread through the air and waterways harming people and the environment. In 2005, the derailment of a CN Rail train into the Cheakamus River spilled over 40,000 litres of sodium hydroxide into the environment of Electoral Area D, killing 90% of aquatic life downstream of the derailment (Pique News Magazine, 2009). In the summer of 2018, a small charter aircraft crashed in Tyaughton Lake, spilling aircraft fuel into the water. This resulted in the Interior Health Authority issuing a temporary “do not use” order for all water use in that community.

Figure 10 – CN Rail accident resulting in the hazardous spill of sodium hydroxide into the Cheakamus River in 2005 (Source: Pique News Magazine, 2009)

1.9. Storm / Utility Outage

Perhaps the most commonly experienced hazard, communities of the SLRD are exposed to severe winter snowstorms and other seasonal storms with high winds that may down trees and cause extended power outages. Winter heating is a concern, especially for vulnerable residents. Extended power outages present health and safety risks including food spoilage, shortage and inability to store medications requiring refrigeration (e.g. insulin). Blocked roads and winter conditions on forest service roads compromise community access to emergency health services. Landline telephone infrastructure may be damaged, resulting in disrupted 9-1-1 service.

Figure 11 – Severe weather on Highway 99 causes vehicle accidents in December, 2019. (Source: CBC News, 2019)

The mountainous terrain restricts electrical transmission and telecommunications lines along narrow transportation corridors, challenging efforts to create redundancy in these systems. Severe storm weather often brings high winds and occasionally freezing rain, with the potential for widespread damage and power failure. BC Hydro is the lead organization responsible for restoring power, and the SLRD coordinates with BC Hydro and other agencies around issues of public safety, including working with member municipalities to open warming centers if required.

1.10. Tsunamis and Displacement Waves

A tsunami is a natural hazard consisting of a series of long, surge-like waves generated when a large volume of ocean water is rapidly displaced. Tsunami are known for their capacity to violently flood coastlines, causing devastating property damage, injuries and loss of life. Most tsunami are caused by major subduction zone earthquakes, where there is significant displacement of the ocean floor. Such tsunami produce the most extensive inundation area, i.e., the area subjected to flooding. Coastal and underwater landslides, and volcanic eruptions, can occasionally cause tsunami too. As some landslides and eruptions are not associated with shaking, evacuation should be carried out if the ocean suddenly recedes or if there is roaring like a jet engine from the ocean.

A displacement wave is caused when a sudden, large volume rock or ice avalanche falls into a body of water. This may or may not be connected to an earthquake event, and can occur in river and lake locations in mountainous areas. A risk assessment completed for rockfall hazard from Mt Currie in Electoral Area C identified the potential for an event large enough to suddenly displace a large volume of water from the Green River (BGC, 2018), with severe effects in the area of impact.

Being prepared for a tsunami event includes understanding the risk where you live, and how to quickly get to high ground in the event of a strong earthquake. Risk management for displacement waves includes geotechnical slope stability studies and land use planning. More information about coastal tsunami and emergency notifications can be found at Emergency Info BC:
https://www.emergencyinfobc.gov.bc.ca/resources/

1.11. Volcanic

A number of volcanoes are located in the SLRD including Mount Garibaldi, Mount Caley, Mount Meager and the Bridge River Cones. While the assessed risk of volcanic eruption is low, studies on Mt Meager in recent years have noted the presence of fumeroles, which are openings through which hot sulfurous gases emerge. As glacier melt occurs on Mt Meager, the visible signs of activity from deeper in this volcano may be become more visible. Study of Mt Meager is ongoing, both from a volcanic perspective and for the potential for a severe landslide event as the loose volcanic rock is susceptible to movement. The largest landslide in Canadian recorded history occurred at Mt Meager in 2010 (see also debris flow).

1.12. Wildland Interface Fire

The rural and forested nature of many communities in the SLRD increases the risk of wildland interface fire. Electoral Areas A and B are at higher risk due to an overall drier climate than Areas C and D, which reside on the ocean side of the coast mountains. Wildfires may start naturally with lightning strikes and may also be human caused hazard by sparks from machinery or infrastructure, for example. Interface fire occurs when wildland fires come in contact with human communities. The BC Wildfire Service is the lead agency for responding to wildfire. Responding to interface fire generally requires a joint effort among

many different government agencies and organizations. Volunteer fire services in the SLRD may work with the BC Wildfire Service consistent with their declared firefighting service level and level of wildland interface fire training.

The primary interface fire risk assessment and risk reduction plans in the SLRD are the Community Wildfire Protection Plans (CWPPs) for each electoral area. These plans offer an assessment of areas deemed high risk due to terrain type and fuel availability, and offer recommendations for prescribed burns that can reduce fuel availability under controlled conditions.

It is expected that the changing climate will contribute to an increase of wildfire due to hotter, drier conditions and for extended periods (IPCC, 2019, p. 45). In the SLRD this increases risk in areas traditionally more prone to fires, and in traditionally lower risk areas of rain forest and deciduous forest as they become drier.

Figure 12 – July 2015 Elaho Wildfire in Electoral Area D (Source: Global News, 2015)

PART TWO: ELECTORAL AREA RISK ASSESSMENT

2. Electoral Area A

Figure 13 – Communities of the Bridge River Valley – Electoral Area A

2.1. Overview – People, Environment and Geography

Electoral Area A falls within the traditional territory of the Upper St'át'imc Nation. Both the Nxwisten community, located at the confluence of the Bridge and Fraser Rivers, and the Shalalth community, located on Seton Lake, frequently use this area, which has supported the hunting, gathering and cultural activities of aboriginal communities for thousands of years. These groups continue to fish for salmon and freshwater species in the rivers, creeks, and lakes, and hunt for game. In the 1850s, Europeans and others from outside the area arrived in the region in search of gold. Today, the area is home to just over two hundred full time residents with a growing seasonal population and recreational visitors, particularly to the South Chilcotin area (OCP, 2018, p. 16).

Electoral Area A continues to provide important wildlife habitat for a variety of species. Much of the land within the electoral area is Crown land and provides prime summer and winter range for moose, mountain goat habitat, and important mule deer winter range, along with providing habitat for many other species, including potential habitat for endangered and threatened species, such as the northern spotted owl, is also found in the region (OCP, 2018, p. 22).There are a number of small recreation-oriented parks within Electoral Area A, but no lands have been designated as Ecological Reserves.

The two major reservoirs in the area are Carpenter and Downton Reservoirs, which were created in the 1940s and '50s as hydroelectric power projects on the Bridge River. Fish populations declined in the

Bridge River system as a result of the hydroelectric development and placer mining. In particular, populations of Pacific salmon in the Bridge River were diverted to Seton Lake in the 1950s. Currently, the reservoirs support populations of rainbow trout, bull trout, Dolly Varden, mountain whitefish, and kokanee (OCP, 2018, p. 22).

2.2. Electoral Area Demographics

Population and Housing	Total Number of people	185
	Population percentage change between 2011 to 2016	16.5% decrease
	Number of people younger than 14 years old	10
	Number of people between 15-64 years old	130
	Number of people older than 65 years old	45
	Number of occupied private dwellings	115
Employment and Income	Median household income before tax in 2015	$47 232
	Employment Rate	52.6%
	Unemployment Rate	9.1%
Highest Level of Education	No certificate, diploma or degree	10.5%
	Secondary school diploma or equivalency	28.9%
	Postsecondary certificate, diploma or degree	63.2%

Table 4 – Electoral Area A Demographics (Source: Statistics Canada – All figures from the 2016 census unless otherwise indicated.)

2.3. Community Profiles

2.3.1. Gold Bridge & Bralorne

The typical lot size within the central neighbourhood of Gold Bridge is small, ranging from under 200 m^2 to 450 m^2. There is potential to increase the available number of homes in Gold Bridge through subdivision of lots on the periphery of the neighbourhood; however, expansion of Gold Bridge is somewhat constrained by steep slopes and adjacent waterbodies. The typical lot size within the neighbourhood of Bralorne is also small, ranging from just over 500 m^2 to 750 m^2. The outlying lots, which are not serviced by the neighbourhood water and sewer system, range from 0.4 hectares to 20 hectares. There is considerable potential in Bralorne to increase the number of homes through subdivision of outlying lots, however, the availability of water, the limited capacity to expand community water and sewer systems, and the presence of geotechnical hazards are significant constraints. Should further subdivisions occur, the community has expressed a desire to ensure that the existing character and scale of the neighbourhood is maintained (OCP, 2018, p. 31).

2.3.2. Gun Lake

Over two hundred lots are located on Gun Lake. While a few of these are not developed, most have buildings which serve as summer accommodation and a few are full time residences. In the early 2000s, Gun Lake saw some new residential development and renovation of existing buildings. Many of the lake front lots are in the one-hectare range. There is little potential remaining to subdivide on Gun Lake. Current zoning requires a minimum 0.8-hectare lot size for residential use; however, some subdivisions formed prior to the bylaw being in place are less than 0.2 hectares with limited lake frontage. Some sectors of the community oppose any future

provisions for allowing further density or significant new residential development adjacent to the lake or on the surrounding Crown lands (OCP, 2018, p. 31).

2.3.3. Tyaughton Lake

Other residential developments in the Upper Bridge River Valley are found on Tyaughton Lake, which has approximately sixty parcels on or adjacent to the lake shore, and Gun Creek Road, which has sixteen acreages. Tyaughton Lake has a variety of lot sizes, with some of the smaller lots being 0.4 to 0.8 hectares. A provision for a master planned residential development on approximately 100 hectares at the north end of the Tyaughton Lake has existed since 1996. Tyaughton Lake is the home of Tyax Lodge, a resort offering heli-skiing excursions in the winter as well as various summer recreational opportunities (OCP, 2018, p. 31). In 2018, a small charter plane crashed in Tyaughton Lake causing a spill of avgas that resulted in a temporary 'do not use' water order being issued while assessment and testing was conducted.

2.3.4. Marshall Lake Area

The Marshall Lake area includes Brett Creek Meadows and Liza Lake, an area some 35 kilometers from Tyaughton. Marshall Lake, approximately 2.5 kilometers long, and the similarly named community are located 13 kilometers above and north of Road 40 at the 1,158m summit/terminus (KM85) of Marshall Lake Rd. In recent years, a small community has developed at Brett Creek Meadows approximately 5 kilometers below and south of Marshall Lake (KM80). There is a recreational use home at Liza Lake at approximately KM96 on the Mud Creek Main FSR, 10 kilometers north of Marshall Lake. The community of Marshall Lake consists of 30 recreational lakefront cabins. One cabin, only, is home to two full time residents. Most cabins are "rustic" and are typically used on spring and summer long weekends at which time the temporary population may range between 25 and 50 people. A resident organised fireworks display is now drawing owners and their families to the lake for New Year celebrations. There are approximately 13 recreational lots at Brett Creek Meadows. About half of those include some type of dwelling structure (CEP - Bralorne and Gold Bridge, 2017a, p. 5).

2.4. Critical Infrastructure

2.4.1. Electrical Power Systems

BC Hydro services the communities of Bralorne, Gold Bridge, Gun Lakes, and some lots in Tyaughton Lake. Other lots on Tyaughton Lake and the community of Marshall Lake are on independent solar and wind electrical power systems.

2.4.2. Water and Wastewater Systems

Most individual structures in Electoral Area A are serviced by their own water and septic systems, unconnected from a larger municipal utility service. However, some structures in Electoral Area A are serviced with drinking water by the Gold Bridge Water Treatment Plant/Pumphouse and the Bralorne Pumphouse. Bralorne is also serviced by a centralized wastewater treatment system that is operated by the SLRD.

2.4.3. Major Roads and Access Routes

Electoral Area A is serviced by the following major roads and access routes:

- Hurley River FSR: Access route for Electoral Area A toward Pemberton
- Carpenter Lake Road: Access route for Electoral Area A toward Lillooet
- Marshall Creek Road: Access route for Marshall Lake toward Tyaughton
- Tyaughton Lake Road: Access route for Tyaughton toward Gold Bridge
- Bralorne Road: Access route for Bralorne toward Gold Bridge

2.4.4. Air Transportation

The Gun Lake Heliport is managed by the Gun Lake Airport Society. It is the only designated public air transportation node in Electoral Area A. Tyax Lodge, a resort located near Tyaughton Lake, operates a helipad for guest use on guided heli-skiing trips. Tyax Lodge and other adventure tourism businesses also fly float planes from Tyaughton Lake.

2.4.5. Schools

The Gold Bridge Community School is a one-room school with a small number of students and the only school in Electoral Area A. The school provides access to a variety of resource people including: Public Health Nurse, Speech-Language Pathologist, District Learner Support staff, Dental Health Workers, and Infant Development staff (Gold Bridge Community School, 2020).

2.5. Response Capabilities

2.5.1. Ambulance Services

BCAS Station 313 is located in Gold Bridge at the Gold Bridge Community Complex.

2.5.2. Fire Services

Fire services in Electoral Area A include the Bralorne Fire Protection Society and the Gun Lake Fire Protection Society. These volunteer public safety lifeline groups offer limited fire suppression services for the communities of Bralorne and Gun Lake, respectively. Electoral Area A is located within the Kamloops Fire Centre of the BC Wildfire Service and the Lillooet Fire Zone.

2.6. Emergency Response Partners

2.6.1. First Nations

Electoral Area A falls within the traditional territory of the N’quatqua, Lil’wat, and the Northern St'át'imc Tribal group, including T’it’q’et Nation. There are no designated reserve lands in Electoral Area A, however these groups have used the Bridge River Valley for hunting, fishing, and harvesting of other resources for generations. The Northern St’át’imc Nations have representation on the Lillooet Area Emergency Preparedness Committee in Electoral Area B.

2.7. Economy

The local economy in Electoral Area A is slowly changing as a balance is found between resource and non-resource based economic development. Reflecting this shift, the major industry within the community is tourism. Forestry, mining, agriculture, construction, and other services provide the remainder of the jobs in the community. Mining provides a few local jobs, but it is no longer a major employer. No large scale mining has taken place since the closure of the Bralorne Mine in 1971. However, the draft Lillooet Land and Resource Management Plan has designated several regions near Electoral Area A as having a mining emphasis, indicating that mining could once again become a major employer in the future. Forestry activity employs a number of people from the local area on a seasonal basis (OCP, 2018, p. 20).

2.8. Hazard, Risk and Vulnerability Analysis

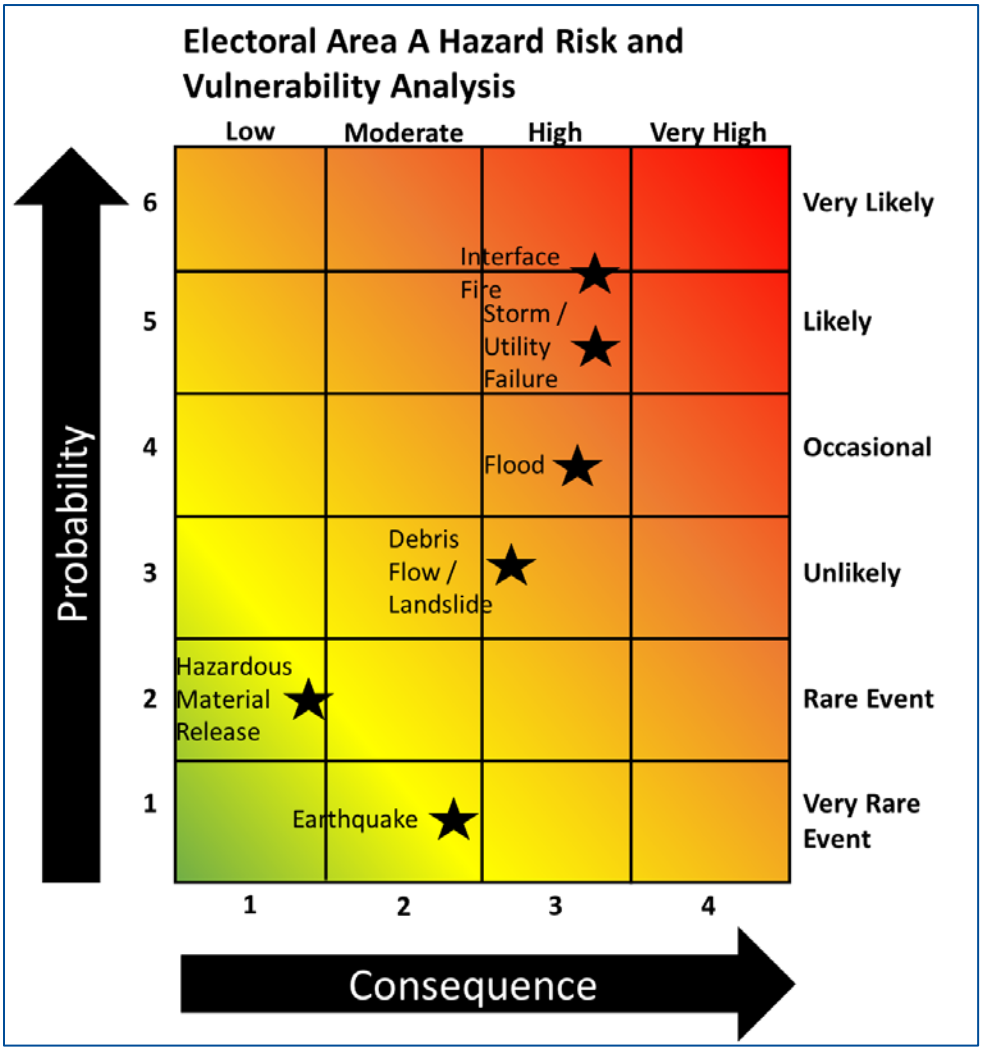


Figure 14 – Hazard, Risk, and Vulnerability Analysis of Electoral Area A. This chart reflects the highest assessed probability and highest assessed consequence for each hazard within the entire electoral area.

Specific communities within the electoral area may experience hazard risk events with more frequency and less consequence due to local geography and weather conditions.

2.9. Hazards

2.9.1. Flood – Moderate to Major

Flood hazards are assessed as moderate risk in Gold Bridge, Bralorne and in Gun Lake, and assessed as low risk in the Marshall Lake and Tyaughton Lake areas. A breach of the La Joie Dam, which impounds the Downton Lake, would impact the community of Gold Bridge and cut off access to the Hurley Forest Service Road and the Lillooet Pioneer Road access routes into the area. BC Hydro maintains emergency response plans for this infrastructure.

2.9.2. Geotechnical Hazard - Debris Flow / Landslide

In Electoral Area A there are steep slopes prone to land movement events as a result of factors such as natural erosion processes and sudden heavy downpours. In February 2020, an atmospheric river weather event brought heavy downpours that triggered rock slides, debris flows and washouts closing roads and affecting communities in Electoral Areas A and B (SLRD, 2020). Development in Area A includes consideration of these geotechnical hazards and may involve considerable expense for hazard mitigation or contain hazards that cannot be mitigated by engineering (OCP, 2018, p. 27).

2.9.3. Interface Fire

In general, residents and property owners in the Upper Bridge River Valley are very aware of the wildfire risk that comes with the beautiful forested landscape. To assist communities in wildfire prone areas such as the Upper Bridge River Valley the Regional District commissioned a Community Wildfire Protection Plan (CWPP). The purpose of the CWPP is to identify the wildfire risks within the Electoral Area in order to describe the potential threat to human life, property, and critical infrastructure, and recommend treatment options to reduce wildfire risk (Area A CWPP, Bruce Morrow Forest Consulting Ltd, 2018, p. 10).

Electoral Area A was heavily impacted by wildfires in 2009. The Tyaughton fire was a stand initiating fire that burned over the entire area between Tyaughton Lake and Marshall Lake valley. Timber harvesting, extreme terrain and large water bodies all limit the potential impacts from another landscape level wildfire, especially south of Carpenter Lake. The five communities do face significant wildfire challenges, especially on the north side of Carpenter Lake. All communities are surrounded by forest ecosystems. Pine beetle and Douglas Fir Beetle are impacting the local forest health, increasing surface fuel loads and reducing site access for wildfire suppression (p. 7).

Fire protection capability varies from location to location within the community. Bralorne has a fire truck and fire hall operated by their fire protection society, which serves the upper and lower town sites. Gun Lake has three fire trailers operated by a fire protection society. Tyaughton Lake has access to a fire trailer during fire season. Gold Bridge and Gun Creek Road have no provision for fire protection (OCP, 2018, p. 28).

2.9.4. Storm / Utility Failure

A community in Electoral Area A may become temporarily isolated by a severe winter snowstorm or summer storm with high winds that down trees and potentially knock out power. Winter heating is a concern, especially for vulnerable residents. Extended power outages present health and safety risks including food spoilage, shortages and inability to store medications requiring refrigeration (e.g. insulin). Blocked roads and winter conditions of forest service roads can compromise community access to emergency health services. Landline infrastructure may be damaged, resulting in no 9-1-1 service, although at least some phone access via internet (e.g., Skype) should remain available due to robust backup systems for local internet provision at Gold Bridge (CEP – Bralorne and Gold Bridge, 2018, p. 10).

2.9.5. Earthquake

Though lower risk than communities closer to the BC coast, Electoral Area A is still exposed to earthquake risk in the event of a megathrust earthquake in the Cascadia subduction zone.

2.9.6. Hazardous Material Release / Transportation

It is unlikely that an industrial hazardous material release will affect Electoral Area A due to its isolation from major industry using such substances and distance from main road and rail corridors. However, there is still potential for hazardous material release, such as the 2018 charter plane crash in Tyaughton Lake that resulted in aircraft fuel spilling into the water and the Interior Health Authority issuing a “do not use” order for all water in that community. Interface fires are another potential source of hazardous material such as fuel storage, and building materials from burned structures are increasingly recognized as an environmental contaminant, also with potential health effects from smoke generated from these compounds (Government of NWT, 2016, p. 5).

3. Electoral Area B

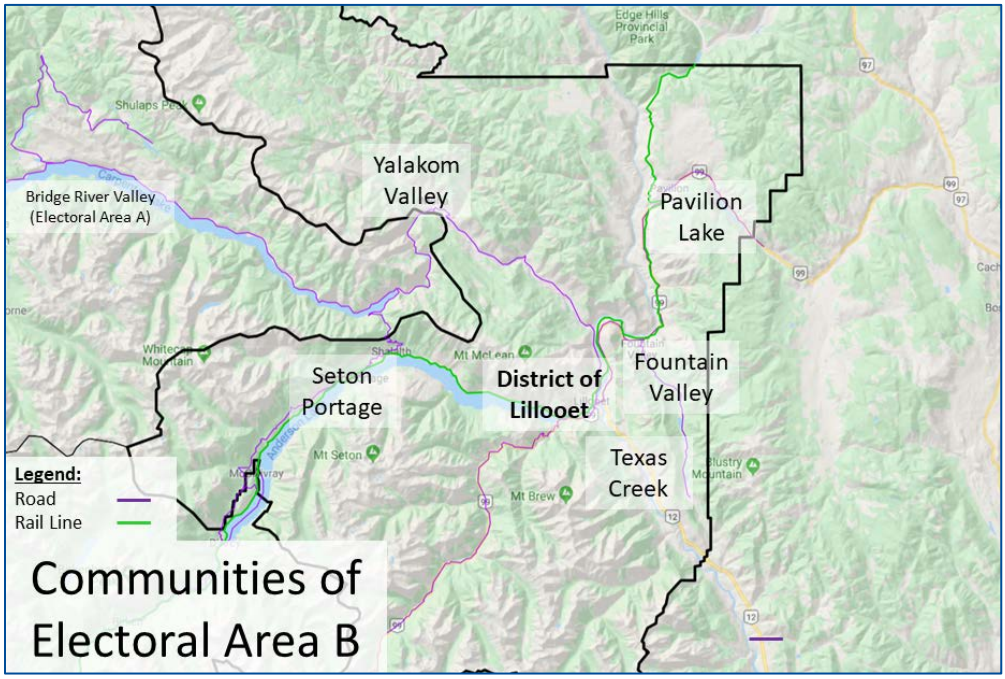


Figure 15 – Communities of Electoral Area B

3.1. Overview – People, Environment and Geography

Electoral Area B is the traditional territory of the St'át'imc and Lil'wat Nations. Large hunter-gatherer winter villages of 500 to 1000 people historically existed alongside the region's lakes and rivers. Rich salmon stocks supported the aboriginal economy. Data from the Ministry of Tourism, Culture, and the Arts' Archaeology Branch indicates that within Electoral Area B there are a large number of St'át'imc and Lil'wat historical sites and artefacts dating from the pre-European contact era. Europeans first came to the area in 1808, which was the year of Simon Fraser's journey through the region as he sought a passage to the Pacific Ocean. Hudson Bay Company employees began to arrive in the 1820s and 1840s. This was followed by the gold rush of 1858. Settlers began farming along the fertile river bottoms and benches in the mid-1850s. Lillooet was the terminus of the Douglas/Harrison trail and Mile 0 of the Cariboo Road. At the peak of the gold rush, Lillooet had a population of 16,000 people. The railway arrived in 1912 (OCP, 2015a, p. 11).

Electoral Area B is located within the Fraser River watershed. Smaller tributaries to the Fraser River found within Electoral Area B include the Bridge, Seton, and Yalakom Rivers, as well as Cayoosh Creek. Local fish species include four species of pacific salmon (chinook, coho, pink, and sockeye), steelhead, bull trout, white sturgeon, rainbow trout, kokanee, white fish, sucker, Dolly Varden, brown trout, and brook trout. The Duffey Lake Corridor and Seton Lake area are recognized as regionally significant bull trout habitat (OCP, 2015a, p. 20).

Electoral Area B provides important wildlife habitat for a variety of species. Wildlife reported to live within Electoral Area B include cougar, bobcat, lynx, wolf, coyote, grizzly bear, black bear, beaver, moose,

mountain goat, mule deer, sheep, and other small mammals, birds, and amphibians. Potential habitat for endangered and threatened species, such as the northern spotted owl, tailed frogs, fisher, bighorn sheep, and grizzly bear, is also found in the region. Most of Electoral Area B west of the Fraser River is designated as a grizzly bear recovery area (OCP, 2015a, p. 20).

3.2. Electoral Area Demographics

Population and Housing	Total Number of people	365
	Population percentage change between 2011 to 2016	19.5% decrease
	Number of people younger than 14 years old	30
	Number of people between 15-64 years old	235
	Number of people older than 65 years old	100
	Number of occupied private dwellings	180
Employment and Income	Median household income before tax in 2015	$50 816
	Employment Rate	43.1%
	Unemployment Rate	0%
Highest Level of Education	No certificate, diploma or degree	20.8%
	Secondary school diploma or equivalency	23.7%
	Postsecondary certificate, diploma or degree	55.3%

Table 5 – Electoral Area B Demographics (Source: Statistics Canada – All figures from the 2016 census unless otherwise indicated.)

3.3. Community Profiles

3.3.1. Seton Portage

Seton Portage is a small community of approximately 46 residents located between Anderson and Seton Lakes with a sizeable seasonal population. Adjacent to Seton Portage and situated on the northwestern shore of Seton Lake is Tsal'alh, home to approximately 500 members of the Seton Lake Band. The IRs in this community include Slosh, Seton Lake, Whitecap, Mission and Necait (OCP, 2015a, p. 8). Seton Portage has significant flood and geotechnical hazards. The community of Seton Portage is established on the site of an ancient historical landslide that divided Anderson and Seton Lakes into two distinct bodies of water. This area is still subject to debris flow from Pete's and Bear Creeks, and debris flood from Whitecap Creek. Landslides from Bear and Pete's Creeks have runout zones that extend well into the community of Seton Portage, and debris flood from Whitecap Creek has the potential to divert the regular flow of water from the Portage River and cause flooding in unexpected parts of the community. In their 2018 report, BGC Engineering assessed that 59 buildings in the vicinity of Bear and Pete's Creeks currently exceed the "Tolerable Individual Safety Risk" and that "Group Risk" in this area is "Unacceptable" when measured by established local and international risk tolerance standards (BGC, 2018b, p. iii).

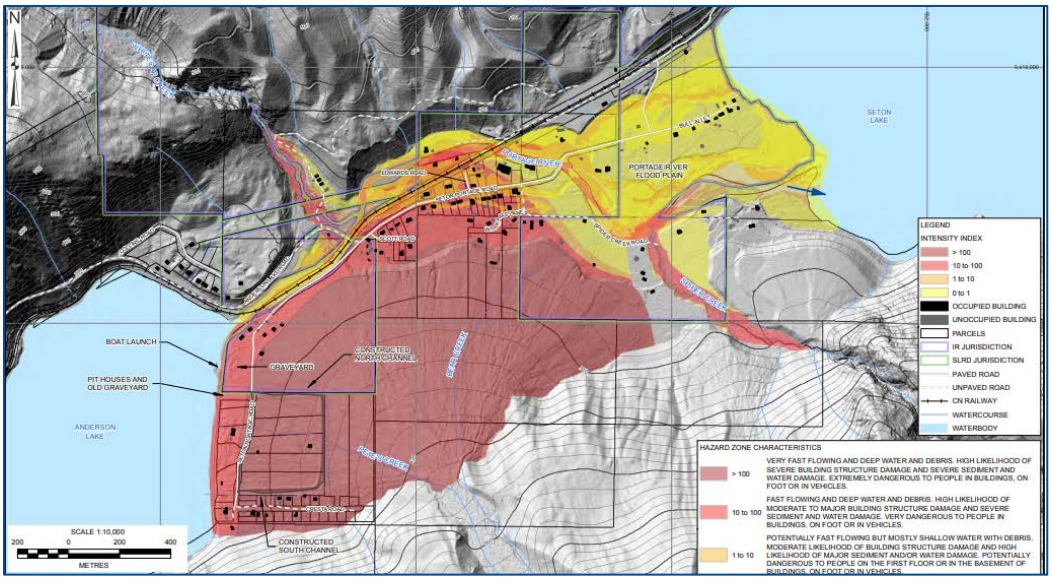


Figure 16 – Composite Landslide Hazard Map of Seton Portage (Source: BGC, 2018b)

3.3.2. Yalakom Valley

The Yalakom Valley is home to a small rural community. There are approximately thirty large parcels of land in the valley with an average size of fifty hectares. Moha is the name given to the lands located at the confluence of the Yalakom and Bridge Rivers. There are no IRs in the Yalakom Valley (OCP, 2015a, p. 8).

3.3.3. Texas Creek

Texas Creek, located on the western shore of the Fraser River where it runs between Lillooet and Lytton, has approximately sixty-five parcels of land and a number of IRs (Pashilqua, Kilchult, Riley Creek, Towinock, and Nesikep) (OCP, 2015a, p. 9).

3.3.4. Fountain Valley

There are approximately forty parcels of land in the Fountain Valley area, as well as several IRs (Fountain, Quatlenemo, Chilhil, Fish Lake, and Nesikep). The parcels range in size from 0.2 hectare lots lining Fountain Lake to sixty-hectare parcels (OCP, 2015a, p. 9).

3.3.5. Pavilion Lake

There are approximately fifty small parcels of land surrounding Pavilion Lake. On neighboring lands west of Highway 99 but east of the Fraser River, including the Pear Lake area and the Pavilion-Clinton Road, there are approximately forty parcels. Many of these parcels are consolidated into a single large ranch. The Ts'kw'aylaxw Nation's traditional territory is centered on the Pavilion IR, located near the western end of Pavilion Lake (OCP, 2015a, p. 9).

3.4. Critical Infrastructure

3.4.1. Electrical Power Systems

Most communities within Electoral Area B are supplied with electricity from BC Hydro, although certain residences throughout the electoral area operate off-grid (OCP, 2015a, p. 28). The only community that operates wholly independently from BC Hydro is the Yalakom Valley, who's residents supply their own power through a combination of micro-hydro and solar generation (OCP, 2017c, p. 5).

3.4.2. Water and Wastewater Systems

Throughout Electoral Area B, wastewater is disposed of by individual property septic systems. Drinking water is also provided through private systems. There are no community water or sewer systems funded or administered by the SLRD within Electoral Area B. Rather, septic systems and potable water supply is privately owned and generally at the individual property level.

3.4.3. Major Roads and Access Routes

Electoral Area B is serviced by the following major roads and access routes:

- Highway 99: Access route out of the SLRD north toward Ashcroft
- Highway 12: Access route out of the SLRD south toward Lytton
- Texas Creek Road: Access route for Texas Creek north toward Lillooet or south toward Lytton
- Highline Forest Service Road (Note: Seasonal use, 4 Wheel Drive recommended): Access route for Seton Portage south toward Birken
- Yalakom Road: Access route for Yalakom Valley toward the Bridge River Road and Lillooet
- Bridge River Road: Access route for Yalakom Valley and secondary route for Electoral Area A toward Lillooet
- Fountain Valley Road: Access route north toward Highway 99, Lillooet and Ashcroft

3.4.4. Air Transportation

The Lillooet Airport and Lillooet Heliport are the two air transportation nodes located in Electoral Area B. The Lillooet Airport runway is 3,990 feet long and 70 feet wide with a clearing of 50 feet and will land a 40,000-pound plane (District of Lillooet).

3.4.5. Schools

The following schools are located within the geographical boundaries of Electoral Area B in School District 74:

- Fountainview Academy
- Sk'il Mountain Community School
- Cayoosh Elementary School
- Lillooet Secondary School

- George M Murray Elementary
- Kids First Pre School

3.4.6. Health Care Facilities

Lillooet Hospital and Health Centre is the sole publicly-funded health care facility in Electoral Area B. Its services include a 24-hour emergency department, six in-patient beds, medical imaging, laboratory, and other out-patient services. Lillooet Hospital is operated by the Interior Health Authority.

3.4.7. Seniors

Almost one third of full-time residents in Electoral Area B are over the age of 65 and many live in areas of the SLRD that can be cut off from evacuation by impacts to roads from severe weather, flood, landslide or wildfire.

3.5. Response Capabilities

3.5.1. Police

The Lillooet Detachment of the RCMP is the sole RCMP station in Electoral Area B. The Stl'atl'imx Tribal Police Service also have a detachment in Lillooet, and they work with the RCMP in major emergency response.

3.5.2. Ambulance Services

Electoral Area B has two BC Ambulance Services Stations: Station 304 is in Seton Portage and Station 318 is located in Lillooet.

3.5.3. Fire Services

The Lillooet Volunteer Fire Department operates out of Lillooet for and as of 2020, the Seton Lake Volunteer Fire Department provides fire services to the Seton-Shalalth Fire Protection Area.

Electoral Area B is located within the Kamloops Fire Centre of the BC Wildfire Service, and the Lillooet Fire Zone.

3.6. Volunteer Response Capabilities

3.6.1. Search and Rescue

The Lillooet and District Search and Rescue Society provides highway rescue, rope rescue, swift water rescue, and can assist other emergency services.

3.6.2. Emergency Social Services / Red Cross

The District of Lillooet maintains a team of Emergency Social Service volunteers and has the capability to establish reception centers and temporary lodging. The SLRD has a service

agreement with the District of Lillooet to provide these resources to evacuees from SLRD communities if required.

3.6.3. Victim Services

The Lillooet RCMP Station offers victim services for Electoral Area B residents.

3.7. Emergency Response Partners

3.7.1. First Nations

The Lillooet Tribal Council has emergency programs with representation at the Lillooet Area Emergency Program Committees.

3.7.2. Municipalities

The District of Lillooet Fire Chief/ Protective Services Director chairs the Lillooet Area Emergency Planning Committee. This committee meets as required and conducts regional exercises.

3.8. Economy

Statistics Canada reports that within Electoral Area B, an equal share of jobs is provided by the following five sectors: agriculture and resource-based industries, manufacturing and construction, health and education, business services, including tourism, and 'other services', which includes wholesale and retail trade. This employment mix reflects the current shift away from a resource-based economy, and also, that the service centre of Lillooet provides much of the employment to Electoral Area B residents (OCP, 2015a, p. 13).

A number of economic development plans and studies have been carried out for the District of Lillooet and the surrounding areas, including Electoral Area B. Many of these studies emphasize building on the existing tourism industry to bolster the local economy. Existing tourism operations within Electoral Area B include rafting tours, heli-skiing, snowmobiling, guest ranches, and golf. New tourism operations developed in a locally responsive manner are reported to have support from the community (OCP, 2015a, p. 13).

3.9. Hazard, Risk and Vulnerability Analysis

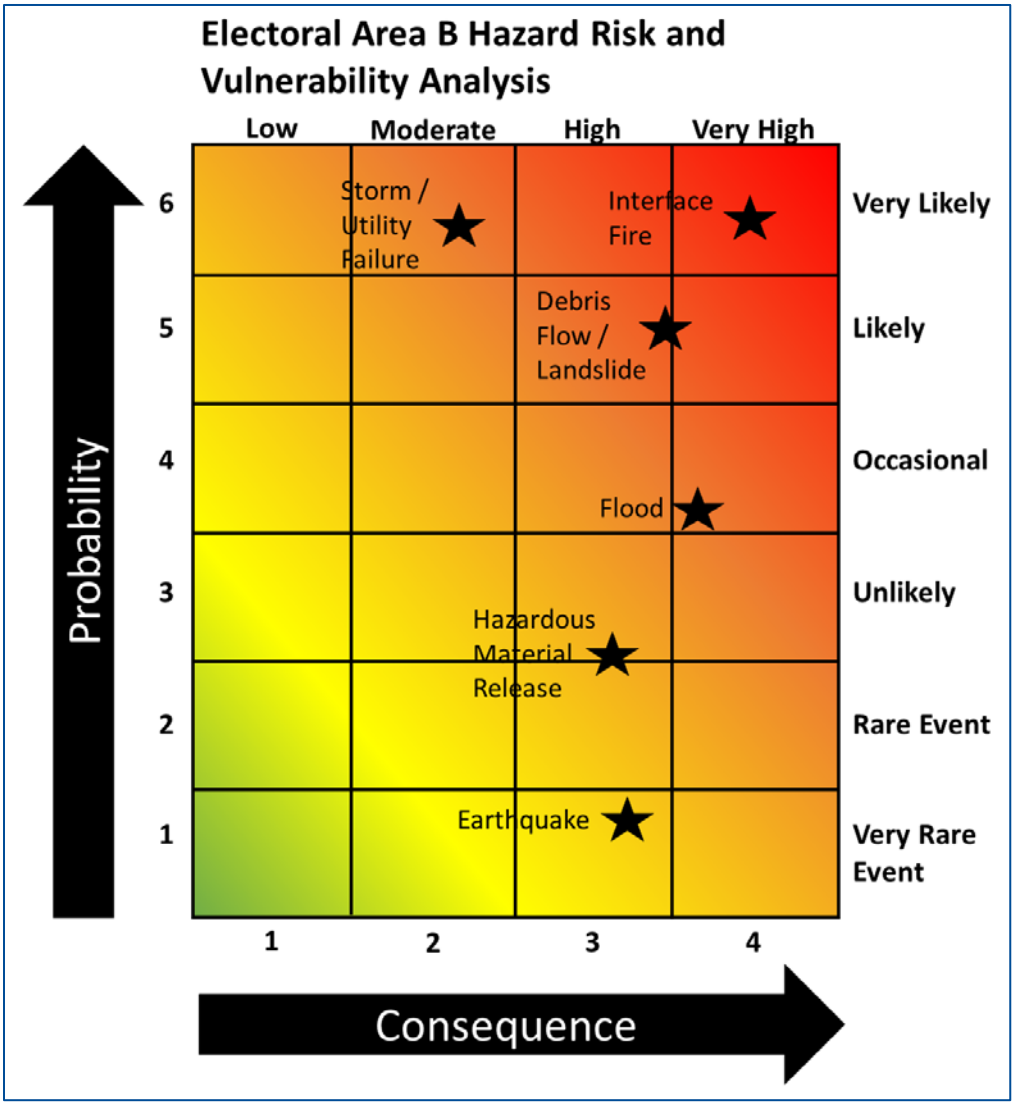


Figure 17 – Hazard, Risk, and Vulnerability Analysis of Electoral Area B. This chart reflects the highest assessed probability and highest assessed consequence for each hazard within the entire electoral area. Specific communities within the electoral area may experience hazard risk events with more frequency and less consequence due to local geography and weather conditions.

3.10. Hazards

3.10.1. Flood

There is flood hazard associated with many creeks and rivers throughout Electoral Area B, but particularly from the Seton River in the Seton Portage area. Debris floods from Whitecap Creek are typically associated with the spring snowmelt, which peaks between May and mid-July:

> "Whitecap Creek, north of Seton Portage, is subject to debris floods which result in fan inundation, bank erosion and channel aggradation both in the creek and Portage River... High magnitude debris floods on Whitecap Creek could also potentially divert Portage River into the presently developed areas along Seton Portage Road… Climate change will likely result in a higher frequency of debris floods on Whitecap Creek combined with a moderate increase in debris flood magnitude. In absence of mitigation, this will result in more frequent road closures and potential damming events for Portage River." (BGC, 2018b, p. 102)

Dam failure is a low probability/high consequence hazard consideration in Electoral Area B due to the location of the BC Hydro-operated Terzaghi and Seton Dams. While the Terzaghi Dam is located in Electoral Area A, its purpose is to impound the Carpenter Lake Reservoir to divert waters into the Bridge River 1 and 2 Generating Stations located in Shalalth. If the Terzaghi Dam were to fail, it would have downstream flood effects in the Yalakom Valley. The Seton Dam is located below the Seton Lake Reservoir, upstream of the Seton Generating Station. If this were to fail, the flood waters could impact the District of Lillooet where many regional services are based, as well as Highway 99. BC Hydro maintains emergency plans for its infrastructure.

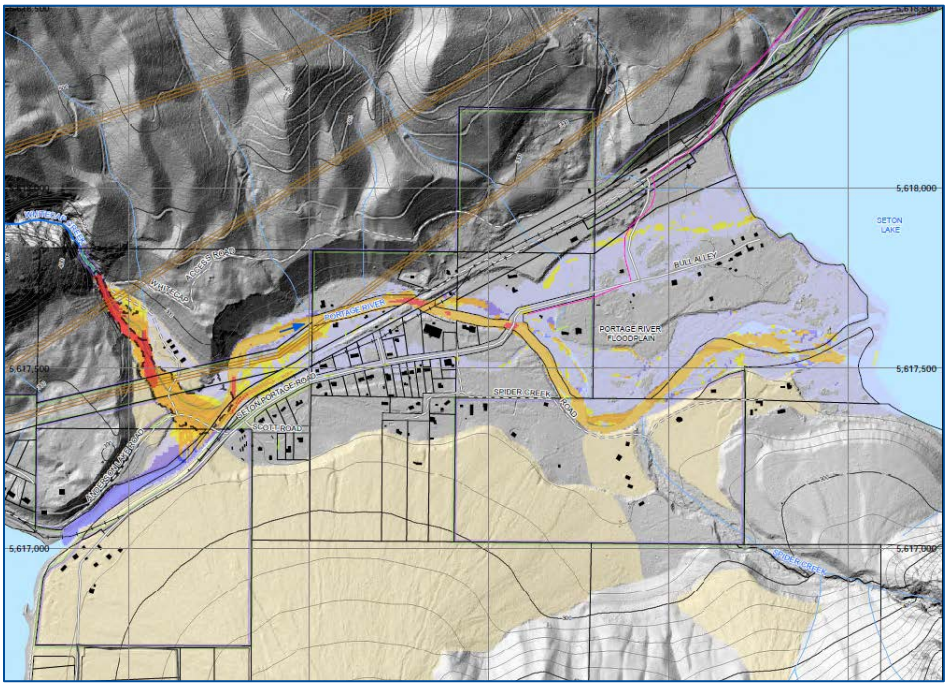


Figure 18 – 100-300 Year debris flood Scenario from Whitecap Creek above Seton Portage (Source: BGC, 2018b)

3.10.2. Geotechnical Hazard - Debris Flow / Landslide

Electoral Area B has areas of high geotechnical activity resulting from unstable ground and rock fall. The landslide that formed Seton Portage, which split the early Seton Lake in two, occurred sometime between 8,000 and 20,000 years ago. Historical records show that along the Fraser River aboriginal communities peaked and declined approximately 1,000 years ago, likely due to

seasonal failure of the salmon runs caused by catastrophic landslides that dammed the Fraser River (OCP, 2015a, p. 24).

East of Fountain Valley, the 10 Mile Slide area is the site of ongoing structural mitigation efforts by the BC Ministry of Transportation and Infrastructure to protect from landslide risk that threatens Highway 99 (Province of BC, 2019). In February 2020, an atmospheric river weather event brought heavy downpours that triggered rock slides, debris flows and washouts closing roads and affecting communities in Electoral Areas A and B (SLRD, 2020).

A debris flow from Bear and Pete's Creeks is also likely to impact roads in the area and the CN Rail line, which could impede response and disrupt business and industry (BGC, 2018b, p. 73).

In Seton Portage, one residence is assessed as being at risk from severe debris floods from Whitecap Creek. This type of event could also run into the Portage River, potentially diverting its flow into developed areas along Seton Portage Road (p. 102). Additionally, Bear Creek and its tributary watershed Pete's Creek are subject to debris flows that can affect homes, roads and the CN Rail Line. The *Seton Portage Area Integrated Hydrogeomorphic Risk Assessment* describes the risk as follows:

> "Debris flows [from Bear and Pete's Creek] with return periods between 10 and 30 years can reach the Whitecap development and development along Cresta Road. Debris flows with higher return periods are very likely to travel beyond to and beyond the sharply defined fan edge where they can lead to damage and potentially loss of life. The risk assessment indicates that up to 30 persons could lose their lives in a single debris flow (the 1000 to 3000-year event). The risk assessment for individuals suggests that 59 structures exceed risk tolerance criteria developed and applied elsewhere. For group risk which describes the total risk to all people affected for all debris-flow scenarios, we conclude that it well exceeds commonly accepted risk thresholds." (BGC, 2018b)

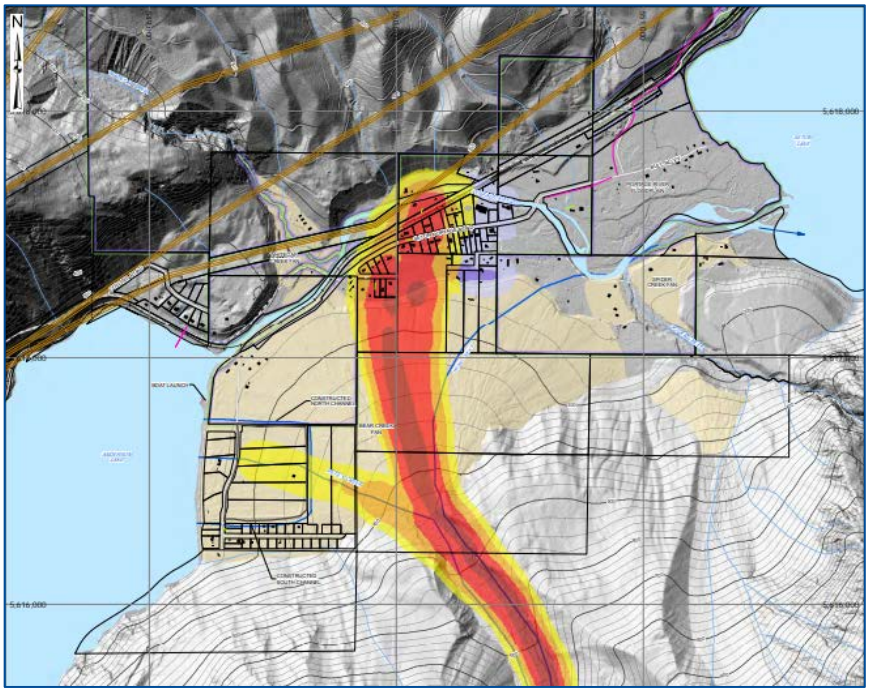


Figure 19 - Potential landslide runout from Bear Creek above Seton Portage (Source: BGC, 2018b)

3.10.3. Interface Fire

Electoral Area B is located in the hot, dry transitional coast-to-interior and rain shadow region of the Coast Mountains, an area where wildfires are a natural part of the landscape. Wildfires occur frequently, generally every 4 to 50 years in any given location. The 2009 Mt. McLean fire and 2009 Seton Portage fire burned 3,696 hectares and 1,381 hectares respectively, resulting in the evacuation of the entire communities of Lillooet, Seton Portage, Sekw'el'was, Xwisten, and T'ít'q'et, and Tsal'alh. Climate change is expected to increase wildfire risk in the future (Landscope Consulting Corporation, 2016, p. 1).

The current mountain pine beetle outbreak in the interior of British Columbia has extended through Electoral Area B and south to the Whistler area. In areas supporting pine trees, this has increased fuel load of dead standing and fallen trees. The resulting fuel accumulations will pose a significant wildfire threat to existing developments, pointing to a need to find a balance between fire suppression, community safety, and ecosystem integrity (Landscope Consulting Corporation, 2016; OCP, 2015a).

Fire protection capability varies from location to location within Electoral Area B and include volunteer fire services for exterior attack only, community groups with basic fire suppression equipment, and some First Nations also have their own fire protection services.

3.10.4. Storm / Utility Failure

Electoral Area B obtains electricity through a mix of BC Hydro supply and independent power generation. With some exceptions, the majority of Texas Creek, Fountain Valley, Pavilion and Seton Portage are serviced by BC Hydro. Residences in the Yalakom Valley generate power independently through solar energy and micro-hydro installations. Many households/residences in Electoral Area B have independent drinking and waste water infrastructure. Independent services can increase resiliency to severe weather because homes that operate their own electricity and water systems are not vulnerable to system outages on the main grid. Severe storms are more likely to cause isolation issues when transportation routes are compromised by falling debris. Earthquake

Electoral Area B is at lower risk of earthquake than other areas of the SLRD because it is farther from active fault lines along the BC coast. Earthquake is still, however, a higher risk in Area B than it is in BC's interior or northern regions.

3.10.5. Hazardous Material Release / Transportation

Electoral Area B is at risk of hazardous material release from transportation accidents along Highway 99 or the CN Rail Line (if there is hazardous cargo in a shipment). Communities at risk include Seton Portage due to its location along the CN Rail Line, as well as Pavilion, Fountain Valley, and Texas Creek where a rail or road accident could impede access to emergency resources along Highway 99.

4. Electoral Area C

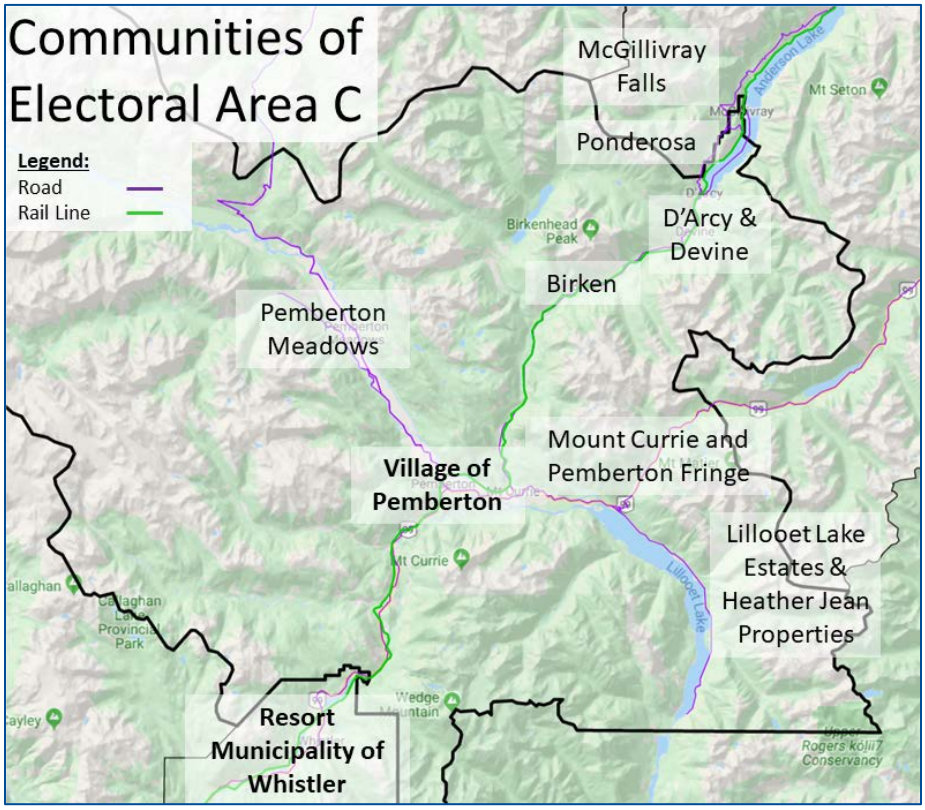


Figure 20 – Communities of Electoral Area C

4.1. The History

Electoral Area C falls within the traditional territories of the Lil'wat, N'Quat'qua, In-SHUCK-ch and Squamish Nations. The land within Area C has supported the hunting, gathering and cultural activities of aboriginal people for thousands of years (OCP, 2015b).

Pemberton has experienced tremendous growth over the last two decades. Electoral Area C has not experienced these same levels of growth but in general the population has seen small increases over time and is currently experiencing strong growth and an active real estate market. Between the 1996 and 2001 census periods Whistler grew by 24% and the Village of Pemberton grew by 91%. Within this same period, the population of Electoral Area C dropped by almost 3%. By the 2016 census however, the population of Electoral Area C was recorded as 1660, showing overall an 11% increase over the 2001 population of 1499 (OCP, 2015b). This increase in population between 2001 and 2016 may be attributed, at least in part, to infrastructure improvements brought on by the 2010 Olympic Games in Whistler. After another period of modest decline in population, the wider area is experiencing strong growth, potentially driven by the increasing availability of telecommuting and families seeking a more rural lifestyle

4.2. Natural Environment and Geographical Setting

Area C has a great diversity of wildlife, including species that are considered rare or at the limit of their range in either the province or North America. Wildlife species in Area C that are actively managed for by Provincial agencies include deer, grizzly bear, moose, mountain goat and spotted owl. Other species within the electoral that are known to be sensitive to human disturbance and require consideration in future developments include the rubber boa, great blue heron, coastal tailed frog, Townsend's big-eared bat, peregrine falcon, wolverine, fisher, bull and cutthroat trout, and trumpeter swans. These species have specific habitat requirements that can be used to inform appropriate development in Electoral Area C (OCP, 2015b). Electoral Area C also provides significant fish habitat. The two largest river systems include the Lillooet River and the Birkenhead River. Other rivers in the area include the Green, Ryan, and Soo. Lakes in Area C include Birkenhead, One Mile, Mosquito, Ivey, Lillooet, Anderson, and Gates, as well as dozens of small wilderness lakes. Gates, Anderson and Lillooet Lakes have some lakeshore development. Wetlands with significant wildlife habitat value are associated with most of these waterbodies. The Soo and Lillooet River valleys, in particular, support large wetlands. Important salmon and kokanee spawning channels include Fee Creek, Gates Creek, and Phelix Creek, and the Gates, Lillooet and Birkenhead Rivers (OCP, 2015b).

One of the primary environmental challenges in Area C is maintaining wildlife populations that are sensitive to land use practices and human disturbances in an area subject to recreation and development pressure (OCP, 2015b).

4.3. Electoral Area Demographics

Population and Housing	Total number of people	1660
	Population percentage change between 2011 to 2016	4.4% decrease
	Number of people younger than 14 years old	305
	Number of people between 15-64 years old	1175
	Number of people older than 65 years old	180
	Number of occupied private dwellings	655
Employment and Income	Median household income before tax in 2015	$70 912
	Employment Rate	74.6%
	Unemployment Rate	6.1%
Highest Level of Education	No certificate, diploma or degree	12.7%
	Secondary school diploma or equivalency	29.9%
	Postsecondary certificate, diploma or degree	57.8%

Table 6 – Electoral Area C Demographics (Source: Statistics Canada – All figures from the 2016 census unless otherwise indicated.)

4.4. Community Profiles

4.4.1. McGillivray

McGillivray (formerly McGillivray Falls) is an unincorporated recreational retreat on the west shore of Anderson Lake, just east of midway between the towns of Pemberton and Lillooet, and around 8 kilometers from D'Arcy. McGillivray Falls Recreation Retreat Ltd. (MFRR) holds title to the property, and is a company controlled by 40 shareholders with a Board of Directors. The

SLRD Land Use Contract for the area included provisions for a recreational area by the lake including small summer cabins for the shareholders of MFRR. McGillivray is a water access only community, with property owners and visitors generally travelling to the community by boat from the SLRD-owned dock at D'Arcy. The area is beautiful but easily isolated with no cell phone reception in the community (CEP – McGillivray, 2018).

4.4.2. Ponderosa

Ponderosa is a 26-lot subdivision of recreational property owners on the west side of Anderson Lake, with the chair of the strata community in full time residence. Anderson Lake is located 45 kilometers north of Pemberton, drained by the Seton River which feeds Seton Lake. It is fed by the Gates, McGillivray and Lost Valley Creeks, which drain from the Pemberton Pass divide with the Birkenhead River Valley towards Pemberton-Mount Currie. Access to the Ponderosa Community is via the Highline Road, which runs between D'Arcy to the south and Seton Portage to the north and by water access from the SLRD-owned dock at D'Arcy. 'The Highline' as it is known, is a 4WD vehicle access only road, which becomes largely inaccessible in the winter months due to snow and ice and hazardous in the spring due to rock falls and muddy conditions during the snowmelt period. The area is beautiful but easily isolated, with no cell phone reception in the community, plus landline phone and power lines are exposed to outages at several points. Power, water and waste water systems are entirely 'off-grid' with electricity supplied by a combination of micro-hydro, solar panels, and generators (OCP, 2015b; CEP – Ponderosa, 2018).

4.4.3. D'Arcy & Devine

The D'Arcy area includes the communities of D'Arcy and Devine, located at the southern end of Anderson Lake, and some water access only recreational properties on the north-eastern side of the lake. Communities are a mix of small, historic properties and more recently built homes. The area is exposed to a range of hazards, including interface fire from surrounding woodlands and hazardous material accidents from transport through the road and rail corridor. Low-lying areas of D'Arcy are subject to surface flooding from time to time. The area has spotty or no cellphone reception and landline service is vulnerable to storm damage, leaving the community with no 9-1-1 service. Severe storms may also result in extended utility outages and blocked roads, leaving the community isolated.

4.4.4. Mount Currie & Pemberton Fringe

The Mt Currie community is mainly the home of Lil'wat First Nation residents, with properties in the SLRD concentrated in the Pemberton Fringe areas to the north and east of the Village of Pemberton. Originally founded on agriculture and forestry, the area is now shifting to include growing agri-tourism, service-based industries and recreation tourism along with a new demographic that includes other business startups and professionals who telecommute.

The community of ~800 fulltime residents is spread out along the Pemberton Portage Road alongside the Birkenhead River and Reid Road to the North. Pemberton Portage Road is regularly inundated at points and has been washed out by historical flood events. Flood is the most present hazard in the area with debris flows, severe storms and interface fire also a concern (CEP – Mount Currie and Pemberton Fringe, 2018).

4.4.5. Birkenhead Lake Estates

Birkenhead Lake Estates is a small strata recreational community on the south shore of Birkenhead Lake and accessed from Birkenhead Lake Forest Service Road via the Pemberton Portage Road. It currently has no full-time residents.

4.4.6. Pemberton Meadows

Pemberton Meadows is a rural residential farming and equestrian area some 17 kilometers north of the Village of Pemberton and adjacent to the Lillooet and Ryan rivers, with the Pemberton Meadows Road being the main access road through the community. Originally founded on agriculture, forestry and mining it's now shifting to include growing agri-tourism, service-based Industries and recreation tourism along with a new demographic that includes other business startups and professionals who telecommute. The community of ~900 fulltime residents is spread out along the Pemberton Meadows Road and Ryan River Road with most development on low lying floodplain land. Pemberton Meadows Road is regularly inundated at points and has been washed out by historical flood events. Flood is the most present hazard in the area with debris flows, severe storms and interface fire also a concern. The community has the potential to become isolated due to the effects of any of these hazards.

4.4.7. Birken

Birken is located at Gates Lake, near Pemberton and has a population of ~250 residents. Birken is comprised of mainly detached single family homes, and some mobile home dwellings. The Community is situated in a semi-forested area at the base of steep slopes including nearby Mt Birken and alongside Gates Lake, Pemberton Portage Road and the CN Rail Corridor. The community is exposed to a range of hazards, most notably flood and landslide events, but also interface fire from surrounding woodlands and hazardous material accidents from transport through the road and rail corridor. Birken has no cellphone reception and landline service has been repeatedly cut after storms, leaving the community with no 9-1-1 service. Severe storms may also result in extended utility outages and blocked roads, leaving the community isolated.

4.4.8. Lillooet Lake Estates & Heather Jean Properties

The Lillooet Lake Estates (LLE) is a 152-lot subdivision on the northeast side of Lillooet Lake in the Pemberton Valley of British Columbia. Heather Jean Properties (HJP) is an 18-site development that shares District Lot 4901 with LLE. Each group operates as a separate entity. The communities are about seven kilometers south of Highway 99 on the In-SHUCK-ch Forest Service Road. There is extremely limited cell phone reception in the community; landline phone and power lines are exposed to outages at several points. Power supply is entirely ‘off-grid’ with electricity supplied by solar panels and diesel generators.

A debris flow from Catiline Creek, located above the Lillooet Lake Estates and Heather Jean Properties, poses significant risk to the community below. In their 2015 report, BGC found that a “best-estimate of individual risk exceeded 1:10,000 risk of fatality per year for 76 of the 114 occupied, residential-classed lots within the study area. Of these, 18 lots exceeded 1:1,000 annual risk of fatality, more than one order of magnitude above the DNV individual risk tolerance

threshold. Estimated group safety risk also fell entirely into the 'Unacceptable' range when compared to the [District of North Vancouver] risk tolerance standards" (BGC, 2015, p. i).

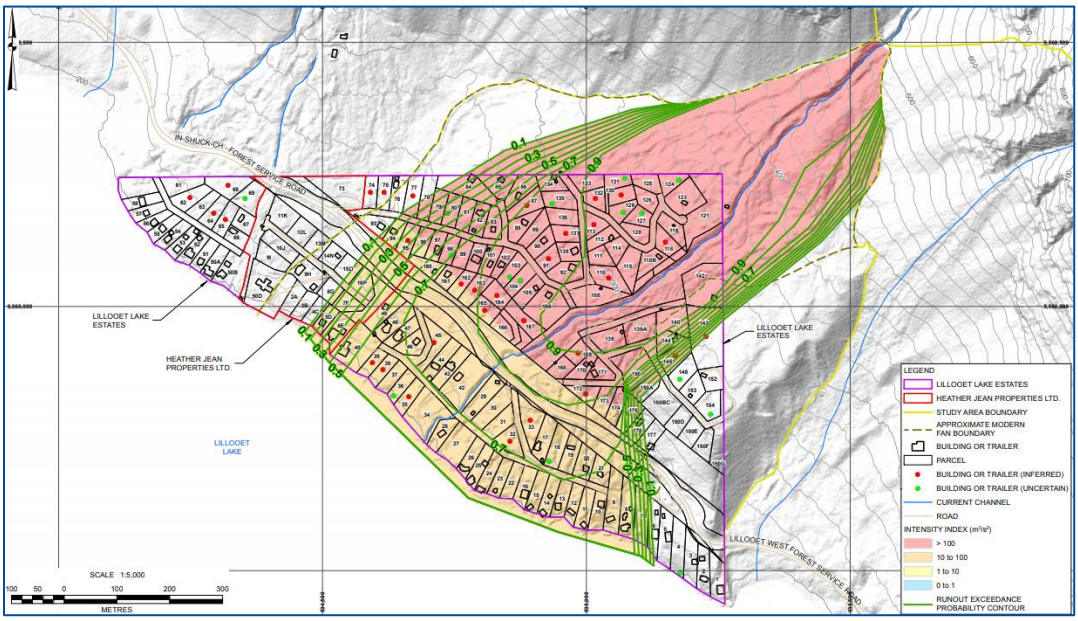


Figure 21 – Catiline Creek Landslide Risk over Lillooet Lake Estates and Heather Jean Properties (Source: BGC 2015).

4.4.9. WedgeWoods

Located 1.2 kilometers from the north boundary of the Resort Municipality of Whistler, WedgeWoods is a master planned property development encompassing 600 acres, 350 acres of which are protected wilderness. It is a four-phase development of large residential lots situated in a forested area alongside Highway 99. Currently the community is in an active buildout phase with many new homes under construction and the population increasing from an initial ~6 full time residents. The community is most obviously exposed to interface fire risk due to the surrounding forest, and the proximity of a main highway increases the potential for a hazardous material incident or an interface fire starting from a vehicle accident. Severe storms may result in extended utility outages.

4.5. Critical Infrastructure

4.5.1. Electrical Power Systems

Communities in Electoral Area C are serviced by a mix of BC Hydro infrastructure and independent power generation. The communities of WedgeWoods, Birken, D'Arcy, Mount Currie and Pemberton Meadows receive electrical service from BC Hydro. The communities of Ponderosa, McGillivray, and Lillooet Lake Estates & Heather Jean properties are serviced by a mix of independent solar, diesel, and micro-hydro power generation and benefit from local knowledge and expertise in running these systems. Areas serviced by BC Hydro are vulnerable to system outages, but benefit from that agency's response resources in the event of a service

disruption. Areas that generate power independently are isolated from wider system outages, but in some cases require a supply of diesel fuel, and supply could be interrupted if roads were to become impassible due to severe weather or other risk events.

4.5.2. Water and Waste Water Systems

Water and sanitation systems in Electoral Area C are a combination of local government owned and operated systems provided by the SLRD and the Village of Pemberton, and independent systems operated by local communities or individual households. Ponderosa, McGillivray, and Pemberton Meadows residents are typically on household septic tanks and water supplies fed by wells or streams. The communities of Birken, D'Arcy and Devine receive water service from the Devine Pumphouse. WedgeWoods, Lillooet Lakes Estates and the Heather Jean Properties are on community-managed water and septic systems. Pemberton Fringe households receive water and septic service from the Village of Pemberton municipal infrastructure.

4.5.3. Major Roads and Access Routes

Electoral Area C is serviced by the following major roads and access routes:

- Pemberton Portage Road: Access for Birken, Devine, D'Arcy, Ponderosa, and McGillivray Falls (via water) toward Pemberton.
- Lillooet River Forest Service Road: Access for Pemberton Meadows and the Bridge River Valley toward Pemberton.
- In-SHUCK-ch Forest Service Road: Access for Lillooet Lake Estates and Heather Jean Properties towards Pemberton.
- Highway 99: Access for Electoral Area A towards Electoral Areas B and D.

4.5.4. Flood Protection Assets

There is a significant amount of flood protection infrastructure in Electoral Area C, particularly in the Pemberton Valley area. There are 44 km of dykes, 25 km of drainage ditches, 30+ culverts and flap gates and 16 km of bank armoring in the valley that are maintained by the Pemberton Valley Dyking District (PVDD, 2020). The SLRD, Lil'wat Nation, Village of Pemberton and the PVDD work together through the Pemberton Valley Emergency Planning Committee on coordinated flood protection strategies for all communities of the area.

Following the 2010 Mount Meager / Capricorn Creek landslide, a significant amount of sedimentation has accumulated in the Lillooet River throughout the Pemberton Meadows area. This sedimentation has reduced the capacity of the Lillooet River to absorb precipitation from storm and freshet events throughout the watershed, and this sedimentation is expected to continue to worsen over time. This reduced capacity of the Lillooet River has rendered current dyke infrastructure insufficient for 50-year floods (NHC, 2018, p. 90). Potential interventions to mitigate this hazard include sediment removal and the upgrading of dyke infrastructure.

4.5.5. Water Transportation

The main water transport infrastructure in Electoral Area C is the SLRD-owned Anderson Lake dock in D'Arcy. This dock serves as a launch point for recreational vessels and those used to access properties on Anderson Lake, including the communities of Ponderosa and McGillivray.

This dock is important from an emergency planning perspective because it is the evacuation route from McGillivray and properties on the north-east side of Anderson Lake to the closest road infrastructure in D'Arcy, with access to Pemberton via Pemberton Portage Road. It is also a means of evacuating people from other properties if road access is cut off.

4.5.6. Air Transportation

Electoral Area C is served by two airports and two heliports. The Pemberton Regional Airport has over 400 fixed wing and helicopter landings a year with most of the volume occurring in August. Airport users include emergency vehicles, commercial companies such as heli-ski operators, gliders, and local aircraft. There are no lights, towers or navigational assistance, however, expansion to the runway and facilities has been discussed by the Village of Pemberton.

The Whistler Hospital Heliport provides medical transportation services for the Whistler Health Care Centre. The Whistler Municipal Heliport provides service for other public and private rotary wing operations, including Blackcomb Helicopters. The Whistler / Green Lake Aerodrome operates a water runway for Harbour Air Seaplanes on Green Lake, with service from Vancouver and Victoria.

4.5.7. Mental Health

Both the Whistler Health Care Centre and the Pemberton Health Centre offer outpatient individual and group mental health and substance use services. Additionally, the Whistler Health Care Centre offers an Adult Mental Health and Substance Use Program to assist community members who are diagnosed with major mental illness and are experiencing significant problems that interfere with their functioning in the community. There are no mental health long term care facilities in Electoral Area C.

4.5.8. Schools

The following schools are located within the geographical boundaries of Electoral Area C as part of School District 48:

- Blackwater Creek Elementary
- Xeɬólacw Community School
- T'zil Learning Centre
- Head of Lake School
- Pemberton Secondary School
- Signal Hill Elementary School
- L' 'École La Vallee De Pemberton
- Whistler is the Whistler Secondary School
- Whistler Waldorf School
- Myrtle Philip Community School
- Alta Lake School
- Tamwood International College Ltd.
- Advantage English School

4.5.9. Health Care Facilities

The two main health care facilities in Electoral Area C are the Whistler Health Care Centre and the Pemberton Health Care Centre. The Whistler Health Care Centre has an emergency department that has 15 stretches for emergency are and is staffed 24/7. The Pemberton Health Centre has 4 stretchers for emergency care an on-call nurse that stays in the facility during non-business hours.

4.5.10. Seniors

There are no elder care facilities in Electoral Area C, however roughly 10% of the permanent population is over the age of 65. This number does not account for seasonal residents.

4.6. Response Capabilities

4.6.1. Police

The RCMP operates detachments in Pemberton and Whistler. The Stl'atl'imx Tribal Police serves local First Nations and operates out of Mount Currie.

4.6.2. Ambulance Services

BCAS operates two ambulance stations in Electoral Area C. Station 224 is located in Whistler and Station 219 is located in Pemberton.

4.6.3. Fire Services

Pemberton Fire Rescue Service (PFRS) provides fire services to the Pemberton Meadows, Pemberton Fringe and Pemberton Heights communities under a service agreement with the SLRD. The Pemberton Meadows Fire Association volunteers also support fire suppression in their area, working in cooperation with the PFRS. PFRS also provides service to the Lil'wat community at Mt Currie and N'Quat'qua operate a volunteer fire department for their community, and work in cooperation with the BCWFS on wildfire response when required.

The Birken Volunteer Fire Department is an independent Society operated service which serves an area that includes Birken, Gramsons and Gates, in the vicinity of Gates Lake and Gates Creek.

The BC Wildfire Service Coastal Fire Centre operates a base adjacent to Pemberton Regional Airport. Electoral Area C falls within the Pemberton Fire Zone of the Coastal Fire Centre, with the exception of McGillivray and Ponderosa that fall within the Lillooet Fire Zone and Kamloops Fire Centre.

4.7. Volunteer Response Capabilities

4.7.1. Search and Rescue

Pemberton Search and Rescue and the Whistler Search and Rescue Society are the two main volunteer search and rescue organizations in Electoral Area C. Both of these organizations are capable of conducting remote backcountry, swift water and mountain rescue operations.

4.7.2. Emergency Social Services / Red Cross

The Resort Municipality of Whistler and the Village of Pemberton maintain a team of Emergency Social Service volunteers and has the capability to establish reception centers and temporary lodging.

4.8. Emergency Response Partners

4.8.1. First Nations

Lil'wat and Squamish Nations have emergency programs with representation on the Sea-to-Sky Regional Emergency Coordination Committee and Lil'wat is a member jurisdiction of the Pemberton Valley Emergency Management Committee.

4.8.2. Municipalities

The Village of Pemberton and the Resort Municipality of Whistler both maintain an active emergency management program.

4.8.3. Pemberton Valley Dyking District

The Pemberton Valley Dyking District (PVDD) was created to manage diking infrastructure in the Pemberton Valley on behalf of local governments. In addition to maintaining local dikes, the PVDD facilitates flood hazard mitigation planning between the SLRD, Lil'wat Nation, the Village of Pemberton, and provincial stakeholders for the Pemberton Valley area.

4.9. Economy

The key industries in Electoral Area C include tourism, agriculture, and forestry. There are a significant number of home-based businesses, including telecommuters, consultants, and crafters. Factors limiting economic development include competition from Squamish in the housing market, the high price of land, and distance from the population center of Vancouver (OCP, 2015b, p. 9).

The Pemberton Valley continues to be an important seed potato producer, however, the agricultural industry in Area C has seen continued diversification. Brewing operations, extensive equestrian facilities, food and accommodation, agricultural festivals and events, and other agritourism operations are being developed (OCP, 2015b, p. 9).

4.10. Hazard, Risk and Vulnerability Analysis

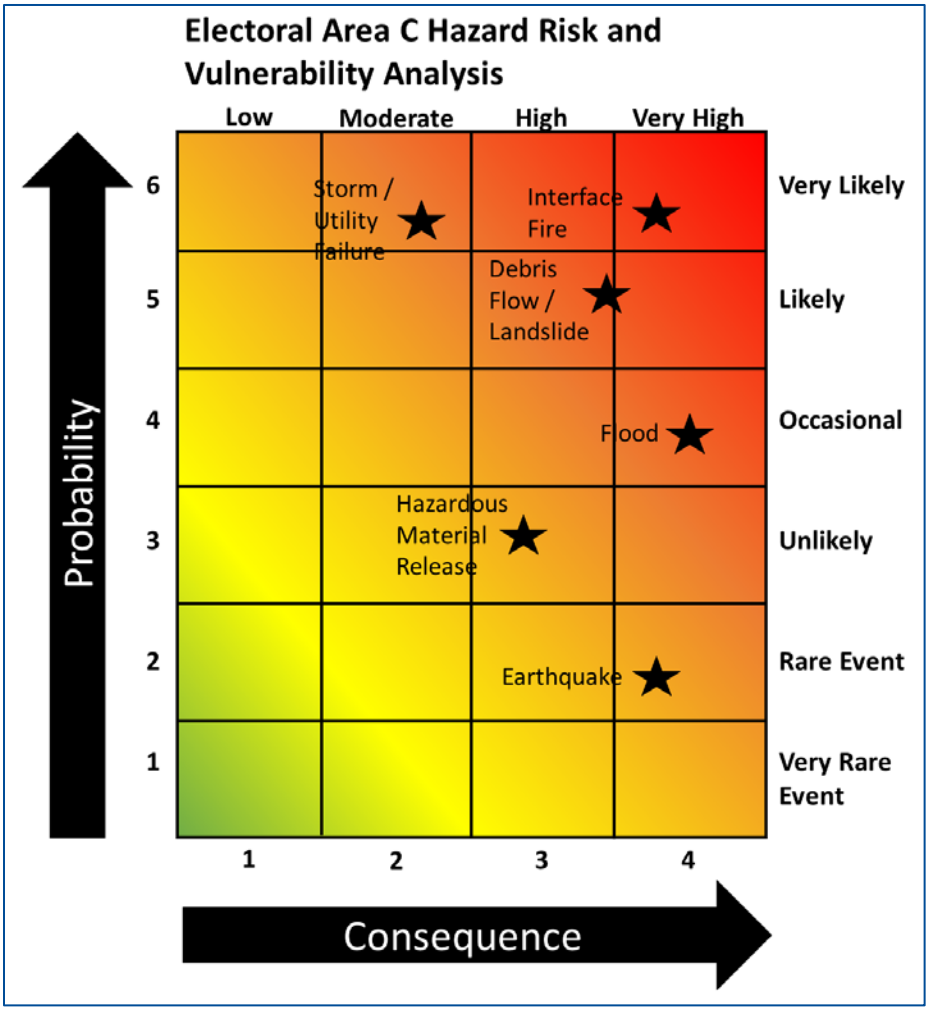


Figure 22 – Hazard, Risk, and Vulnerability Analysis of Electoral Area C. This chart reflects the highest assessed probability and highest assessed consequence for each hazard within the entire electoral area. Specific communities within the electoral area may experience hazard risk events with more frequency and less consequence due to local geography and weather conditions.

4.11. Hazards

4.11.1. Flood

The Pemberton Valley is located on a floodplain, which means that it is prone to periodic flooding from nearby rivers, lakes and streams. NHC's 2018 report on Pemberton Valley Floodplain Hazards indicates that "some overtopping is likely at the 50-year flood and the present diking will not adequately protect against the 200-year flood" (NHC, 2018, pp. vi). Hydraulic models show that "by the 50-year flood level, the diking is extensively compromised… Corresponding flow velocities would be very high and flood hazard ratings are categorized as significant or extreme in

many locations." (NHC, 2018, p. 90). Sedimentation from the 2010 Mount Meager landslide and changes in the timing of flood events (floods are more likely to occur after rain-on-snow events in the fall, rather than at spring freshet) all contribute to the increased flood risk in the Pemberton Valley. Climate change is also expected to increase the peak flow rate over the next 80 years as more precipitation falls as rain rather than snow.

Figure 23 – Sedimentation from Mount Meager flows down Capricorn Creek toward the Lillooet River (Photo: Michael Zima, Vancouver Outdoor Club)

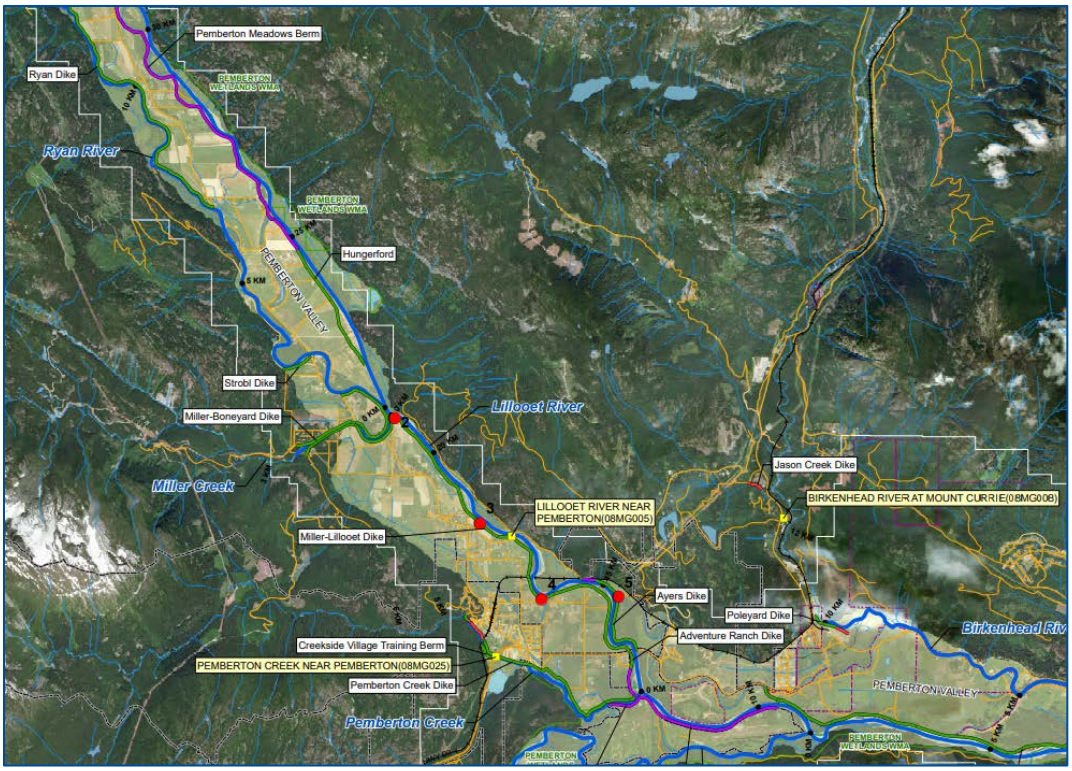


Figure 24 – Flood Zones and Dike Infrastructure in the Lillooet River Lower Reach (Source: NHC 2018)

4.11.2. Geotechnical Hazard - Landslide / Debris Flow

There are a number of notable landslide and debris flow risks in Electoral Area C, including landslide risk from steep slopes on the Mount Meager massif and Mount Currie, debris flows at Catiline Creek, and the slopes adjacent to the Pemberton Portage Road between Pemberton Fringe and Birken.

The *Catiline Creek Debris-Flow Hazard and Risk Assessment* (BGC, 2015) found that debris flow potential above the Lillooet Lake Estates and Heather Jean Properties exceeds DNV criteria for individual risk for 76 of the 114 occupied residential lots in that area. "BGC's best-estimate of individual risk exceeded 1:10,000 risk of fatality per year for 76 of the 114 occupied, residential-classed lots within the study area. Of these, 18 lots exceeded 1:1,000 annual risk of fatality, more than one order of magnitude above the DNV individual risk tolerance threshold. Estimated group safety risk also fell entirely into the "Unacceptable" range when compared to the above risk tolerance standards (BGC, 2015, p. i).

The *Mount Currie Landslide Risk Assessment* found that rock avalanches from Mount Currie could travel north of the Green River and impact communities in the Pemberton Valley, both from direct impact and from the risk of subsequent river damming and outburst flood risk (2018a, pp. 14-15). It states that "Up to 15 parcels [in the Mount Currie rock avalanche runout zone] could be exposed to risks that exceed individual risk tolerance criteria. For the group risk, depending on the rock avalanche scenario and the climate sensitivity analysis, the results indicated the risk could range from tolerable to unacceptable." (BGC, 2018a, p. iii). Rock slope stability is believed

to be influenced, in part, by the assumed existence of permafrost (BGC, 2018a, p.66). Permafrost can be degraded over time by prolonged spells of unusually hot weather, lower snowpack levels and increased intense rainfall events, all of which are projected to occur in Area C with the changing climate.

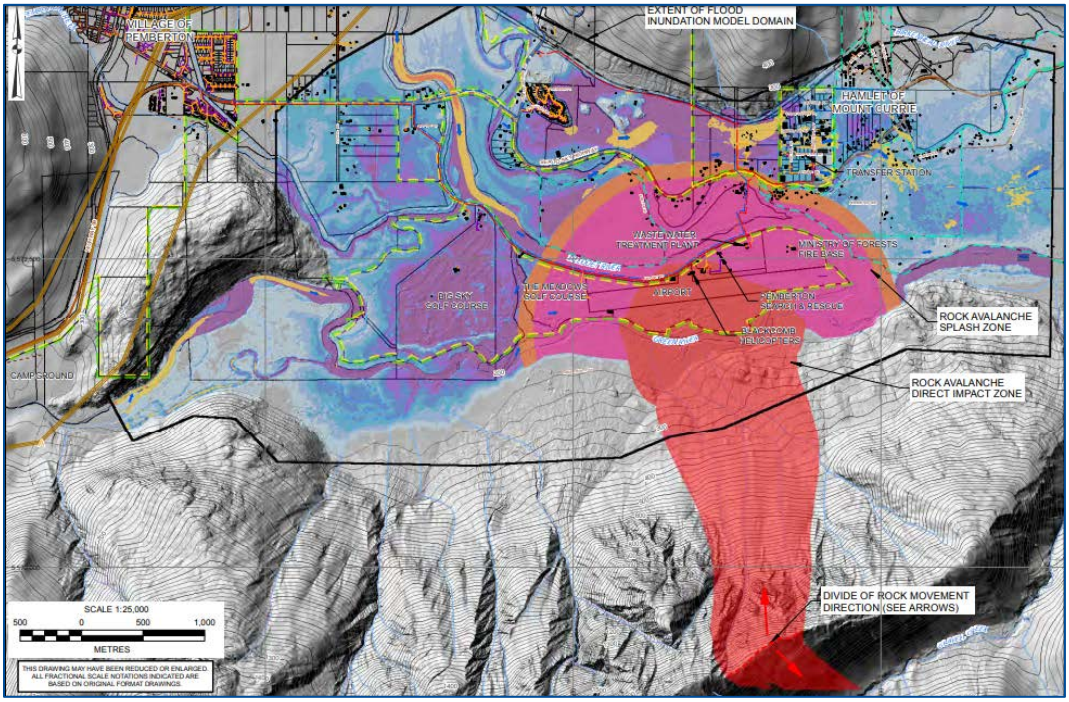


Figure 25 – Mount Currie landslide runout model and flood projections that include Pemberton Airport, the BCWFS Base, and Pemberton Water Treatment Plant (Source: BGC, 2018)

4.11.3. Interface Fire

Electoral Area C is vulnerable to interface fire, particularly the areas of Birkenhead Lake, Lillooet Lake Estates & Heather Jean Properties, Ponderosa, and McGillivray Falls Recreation Retreat. Most of these areas have taken notable FireSmart action to mitigate wildfire risk to their homes and properties. Interest in wildfire mitigation measures is variable across other areas of Electoral Area C (B.A. Blackwell & Associates Ltd., 2016, p. 10). Wildfires are increasingly common in Area C, and since 2015 smoke from fires in other areas and direct wildfire impacts have occurred almost annually. In 2018, fires above Anderson Lake resulted in the communities of Ponderosa and McGillivray being under evacuation order and the community of D'Arcy was under evacuation alert for weeks.

4.11.4. Storm / Utility Failure

Severe storms can disrupt BC Hydro power in many areas of Electoral Area C. That said, the communities of McGillivray, Ponderosa, Lillooet Lake Estates and Heather Jean Properties generate power independently of the BC Hydro system and are therefore not impacted by disruption in the main grid.

4.11.5. Earthquake

The earthquake hazard in southwestern British Columbia lowers as one moves inland and north from Vancouver, however, a number of small (magnitude 1 to 2) earthquakes occur in Electoral Area C every year.

4.11.6. Hazardous Material Release / Transportation

Hazardous Material Release is possible in the form of transportation accident, particularly along the CN Rail line or along Highway 99. Train derailments at Gates Lake in 2017 and 2018 have thankfully not contained hazardous materials but highlight the risk (Global News, 2018).

5. Electoral Area D

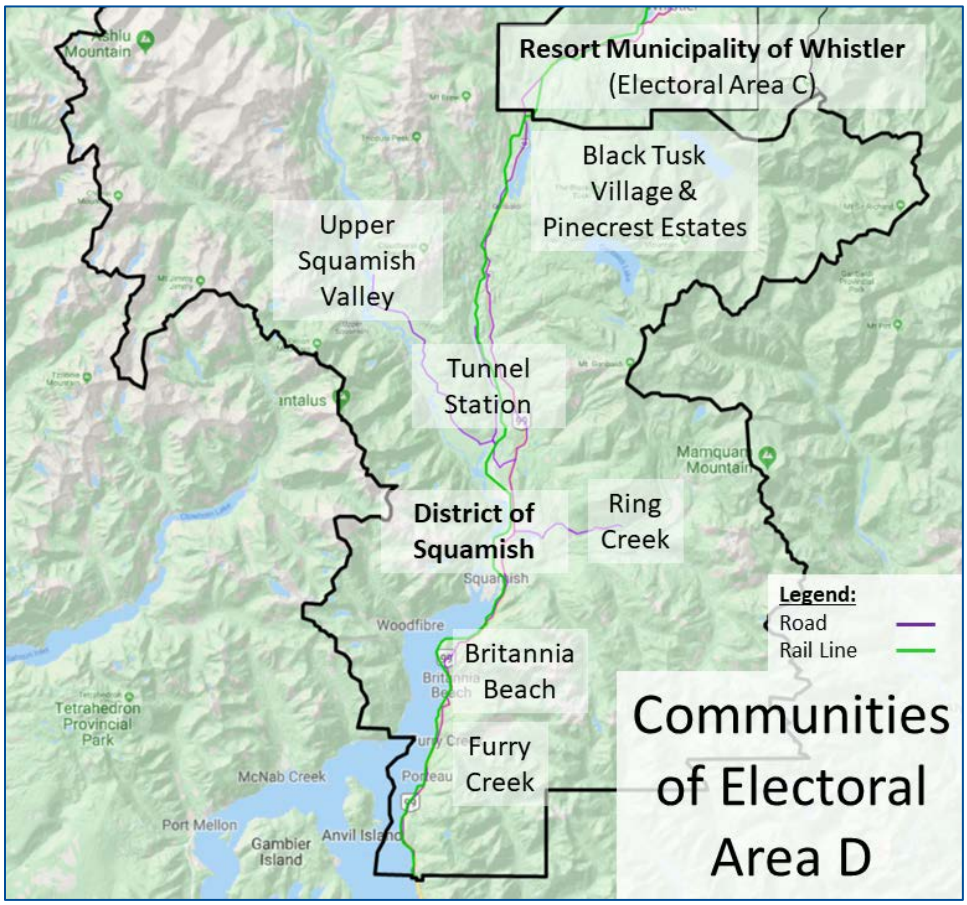


Figure 26 – Communities of Electoral Area D

5.1. The History

Electoral Area D is located within the over-lapping traditional territories of the Squamish and Lil'wat Nations. The Squamish Nation traditional territory includes the entire Squamish Valley and Howe Sound drainages; then north to the confluence of the Soo and Green Rivers north of Whistler. The traditional

territory of the Lil'wat extends south to include the Callaghan Valley in Area D. Both the Squamish & Lil'wat Nations have created land use plans to guide human activities occurring within their traditional territories. Data from the Ministry of Tourism, Culture, and the Arts' Archaeology Branch indicates that within Electoral Area D there are a large number of Squamish and Lil'wat historical sites and artifacts dating from the pre-European contact era. The Britannia Mine Museum is a BC Historic Landmark, and the concentrator, which is the large multi- story building built into the hillside beside Highway 99 was designated a National Historic Site in 1988. Other archaeological resources within Electoral Area D also include several old mining cabins and remains of early non-native settlements and mining operations (OCP, 2013, p. 6).

5.2. Natural Environment and Geographical Setting

Electoral Area D is located in Howe Sound and the surrounding mountainous area. It is home to diverse array of plant and wildlife. There are local efforts to have Howe Sound designated as a UNESCO Biosphere. A number of rivers drain into Howe Sound, including the Squamish, Cheakamus, Cheekye, and Stawamus Rivers.

5.3. Electoral Area Demographics

Population and Housing	Total Number of people	1055
	Population percentage change between 2011 to 2016	26.4% increase
	Number of people younger than 14 years old	150
	Number of people between 15-64 years old	720
	Number of people older than 65 years old	185
	Number of occupied private dwellings	440
Employment and Income	Median household income before tax in 2015	$95 872
	Employment Rate	58.8%
	Unemployment Rate	6.5%
Highest Level of Education	No certificate, diploma or degree	10.7%
	Secondary school diploma or equivalency	23.3%
	Postsecondary certificate, diploma or degree	66.3%

Table 7 – Electoral Area D Demographics (Source: Statistics Canada – All figures from the 2016 census unless otherwise indicated.)

5.4. Community Profiles

5.4.1. Black Tusk Village & Pine Crest Estates

Black Tusk Village and Pine Crest Estates are strata communities located off Highway 99, south of Whistler. Their only road access and egress is along the Highway 99 corridor, constraining evacuation options. A rail line exists behind the communities but there is no passenger transport option from the communities. Power services are provided by BC Hydro for both communities. The SLRD owns and operates the Pine Crest Estates water and wastewater systems, and the Black Tusk Village strata operates their water and wastewater systems. The Garibaldi Volunteer Fire Department provides structural fire suppression, vehicle fire response and interface fire assistance to a service area which includes Black Tusk Village and Pine Crest Estates, and extends

from the southern boundary of the RMOW southwards to the Ministry of Transportation salt sheds on Highway 99.

5.4.2. Britannia Beach & Furry Creek

The majority of Area D residents live in the Howe Sound East communities of Britannia Beach and Furry Creek. Highway 99 is the main access route to and from the communities, which are otherwise geographically constrained by ocean and mountains. The Britannia Beach Volunteer Fire Department is active and to an increasing number of calls, including motor vehicle incidents on Highway 99.

5.4.3. Upper Squamish Valley

The Upper Squamish Valley community is located along the Squamish River. It is located in a known flood risk area, and detailed mapping is available in the 2019 Flood Hazard Mapping and Risk Assessment report conducted by Northwest Hydraulic Consultants. This report found that "at the 50-year flood event and above, most of the valley floor is flooded, with typical depths of 1 to 2 m within the inundated area" and that "when areas are inundated, much of inundated areas have a high hazard rating and classified as dangerous for most to all people" (NHC, 2019, p. iv). Power is supplied by BC Hydro.

5.4.4. Tunnel Station

Tunnel Station is a small rural community located just north of the District of Squamish in the Paradise Valley. Flooding from the Cheakamus River is a key risk for the community. The District of Squamish's Interim Flood Hazard Management Plan shows that "most of Paradise Valley could be flooded during a major flood event… including key access routes like Fergie's Bridge, Paradise Valley Road, and the Bailey Bridge" (KWL, 2017, p. 3-6). Climate change may be increasing the risk of flooding and debris flood/flow events. Tunnel Station is located downstream of Daisy Lake Dam, which would require the immediate evacuation of some homes if a "free spill" is required to alleviate dam pressure when the reservoir reaches capacity. Additionally, Tunnel Station is located along the CN Rail Line, which makes it vulnerable to transportation accidents.

5.4.5. Ring Creek

Ring Creek is located on the southern flank of Round Mountain, bordering Garibaldi Provincial Park. The risk of wildfire in the area of the community of Ring Creek is notably high due to the community's location in a heavily forested area and alongside a main vehicular access route to popular Garibaldi Provincial Park recreational areas, bringing thousands of vehicles through the area in summer during the highest risk times. The Electoral Area D Community Wildfire Protection Plan notes that in addition to Ring Creek's proximity to dense forest fuels, many homes in this community are recommended to undertake FireSmart work to reduce the risk directly on their properties. (B.A. Blackwell & Associates Ltd, 2017, p. 57) Ring Creek residents utilize independent electricity, water and wastewater systems.

5.4.6. Porteau Cove

Porteau Cove is a proposed community planned for construction above and east of Highway 99, south of Furry Creek. The developer, Concord Pacific, is planning for a community of over 1,400

homes, including condominiums, townhomes and single-family lots, but there is currently no active development proposal before the SLRD

5.5. Critical Infrastructure

5.5.1. Electrical Power Systems

BC Hydro supplies power to almost all Electoral Area D residences with the exception of Ring Creek, where properties have off-grid power generation systems. In addition, BC Hydro maintains critical infrastructure within the SLRD including the Cheakamus Generating Station, the Daisy Lake Dam, and the Britannia Beach and Furry Creek substations.

5.5.2. Water & Wastewater Systems

The communities in Electoral Area D have a variety of water and wastewater systems. The communities of Tunnel Station, Upper Squamish Valley and Ring Creek operate off-grid drinking water and septic systems at the individual property level. Britannia Beach and Furry Creek have SLRD operated water and waste water systems. Black Tusk Village and Pine Crest Estates draw their drinking water from Brew Creek Drainage system and Retta Lake, respectively. The SLRD owns and operates the Pine Crest Estates water and wastewater systems, and the Black Tusk Village strata operates the water and wastewater systems for that community.

5.5.3. Major Roads and Access Routes

Electoral Area D is serviced by the following major roads and access routes:

- Highway 99: Access route for Electoral Area D north into Electoral Area C and south into the Greater Vancouver Regional District
- Garibaldi Park Road: Access route for Ring Creek toward Highway 99
- Squamish Valley Road: Access route for the Upper Squamish Valley toward Highway 99
- Paradise Valley Road: Access route for Paradise Valley toward Highway 99

5.5.4. Water Transportation

Squamish Terminals is a deep-water, break-bulk terminal at the north end of Howe Sound. It features an intermodal transportation infrastructure that provides access to transported goods via road, rail and ocean. It has two berths, three warehouses and specialized cargo handling equipment. In the event of a major disaster, Squamish Terminals could be used as a regional supply line. It is also a component of the District of Squamish and Resort Municipality of Whistler's *Sea to Sky Multi-Modal Evacuation Plan* (2019) and could be used for mass evacuation during a major emergency. It notes that a cruise ship could be docked at Squamish Terminals and used for evacuation due to the deep-water nature of the berths (p. 37). In Furry Creek, Oliver's Landing provides water access for small boats and may be to facilitate an alternate evacuation route.

5.5.5. Air Transportation

Squamish Airport is located in the District of Squamish's Brackendale neighborhood. It is typically used by charter services, private aircraft, flying clubs, or other commercial activities. Squamish Airport is a component of the District of Squamish and Resort Municipality of Whistler's *Sea to Sky Multi-Modal Evacuation Plan* (2019). The potential for using float planes on the water in Howe Sound is also presented as an option for evacuation (p. 38). In addition to evacuation, aircraft can also bring emergency supplies into the area during a risk event.

5.5.6. Mental Health

Squamish Mental Health and Substance Use Service is an outpatient clinic operated by Vancouver Coastal Health and located in downtown Squamish. The Squamish General Hospital Emergency Department can receive patients in immediate mental health distress. There are no mental health long term care facilities located in Electoral Area D.

5.5.7. Schools

The following schools are located within the geographical boundaries of Electoral Area D and School District 48:

- Don Ross Middle School
- Valleycliffe Elementary
- School Les Aiglons
- Ecole Squamish Elementary
- Howe Sound Secondary School
- Stawamus Elementary
- Mamquam Elementary
- Garibaldi Highlands Elementary
- Brackendale Elementary School
- Squamish Montessori Elementary School
- Hollands school
- Quest University Canada
- Squamish Waldorf School

5.5.8. Health Care Facilities

Publicly funded health care facilities in Electoral Area D are focused within the District of Squamish. Squamish General Hospital is a 25-bed acute care facility. It offers a 24-hour emergency room and a helipad that can transport patients to Vancouver General Hospital or other locations in the BC Lower Mainland.

The Squamish Community Health Centre and Squamish Mental Health and Substance Use Services are the two public health programs located in Squamish.

5.5.9. Seniors

Hilltop House is an 85-bed long term care facility for seniors. It is located on the campus of Squamish General Hospital is operated by Vancouver Coastal Health. Shannon Falls Retirement

Residence is a privately run, 30 bed, assisted living and long-term care facility for seniors. The Squamish Senior Citizens Society is an 88-bed independent living facility for seniors. Both Shannon Falls Retirement Residence and the Squamish Senior Citizens Society are located in downtown Squamish.

5.6. Response Capabilities

5.6.1. Police

The Squamish Detachment of the RCMP provides law enforcement services for Area D. The Squamish Nation Peacekeepers provide law enforcement services for Squamish Nation and work with the RCMP in major emergency response such as evacuation notification.

5.6.2. Ambulance Services

BCAS Station 22 is located in the Squamish neighborhood of Dentville. It is the sole BCAS station in Electoral Area D.

5.6.3. Fire Services

The SLRD manages two volunteer fire services in Electoral Area D. The Britannia Beach Volunteer Fire Department provides structural fire suppression, vehicle fire response and interface fire assistance for a service area that extends from the southern boundary of the District of Squamish southwards to the northern boundary of the Village of Lions Bay. The Garibaldi Volunteer Fire Department provides structural fire suppression, vehicle fire response and interface fire assistance to a service area which extends from the southern boundary of the RMOW southwards along Highway 99 to the Ministry of Transportation Salt sheds.

Electoral Area D is located within the Pemberton Fire Zone and the Coastal Fire Centre of the BC Wildfire Service.

5.7. Volunteer Response Capabilities

5.7.1. Search and Rescue

Squamish Search and Rescue is a volunteer, community-based organization that provides 24/7 search and rescue services in and around Squamish. Its capabilities include ground search and rescue, rope and mountain rescue, the Helicopter External Transportation System (H.E.T.S.), swift water rescue, and tracking.

The Whistler Search and Rescue Society would operate in northern areas of Electoral Area D. Its volunteer personnel are certified in crevasse and avalanche rescue, long line and helicopter medevacs, and swift water rescue.

5.7.2. Royal Canadian Marine Search and Rescue

Royal Canadian Marine Search and Rescue is a volunteer-based organization that operates 33 marine rescue stations in British Columbia. Rescue Station 4 is located in Squamish and serves the Howe Sound area.

5.7.3. Emergency Social Services / Red Cross

The District of Squamish maintains a team of Emergency Social Service volunteers and has the capability to establish reception centers and temporary lodging.

The Canadian Red Cross has an office in Squamish. This office offers a Basic Health Equipment Short Term Loan Program, as well as access to information about other Canadian Red Cross services.

5.7.4. Victim Services

Squamish RCMP offer victim services in Electoral Area D. Sea to Sky Community Services in Squamish offers a range of social programs, including victim services.

5.8. Emergency Response Partners

5.8.1. First Nations

Squamish Nation and Lil'wat Nation both have emergency programs that work regularly with the SLRD, the District of Squamish, the Resort Municipality of Whistler, and other regional partners in disaster preparedness for Electoral Area D. Squamish Nation and Lil'wat Nation are members of the Sea to Sky Regional Emergency Preparedness Committee.

5.8.2. Municipalities

The District of Squamish is the largest community in Electoral Area D and serves as the economic center for most of Electoral Area D's rural constituents.

The SLRD Emergency Program regularly communicates and cooperates with the emergency program staff of the Village of Lions Bay and Bowen Island Municipality on matters of shared interest and through the Sea to Sky Regional Emergency Preparedness Committee, along with the District of Squamish and other governmental, non-governmental and first nations partners.

North Shore Emergency Management is an inter-municipal agency that provides emergency management services to the District of West Vancouver, City of North Vancouver and District of North Vancouver, which would be potential host communities in the event of a larger scale evacuation operation from the Sea-to-Sky area of the SLRD.

5.9. Economy

Core economic sectors in Area D include tourism, agriculture, education and resource industries, with emergency sectors in the green economy and outdoor recreation. The mountainous area along the Highway 99 corridor is popular with backcountry recreationalists, providing easy access to rock climbing, skiing, mountain biking, fishing, hiking and camping and this is one aspect that is driving a steady demand for residential property and business growth. The Sea-to-Sky Gondola is the single largest summer employer in the Howe Sound area. The Furry Creek Golf and Country Club is also a popular attraction in the area.

5.10. Hazard, Risk and Vulnerability Analysis

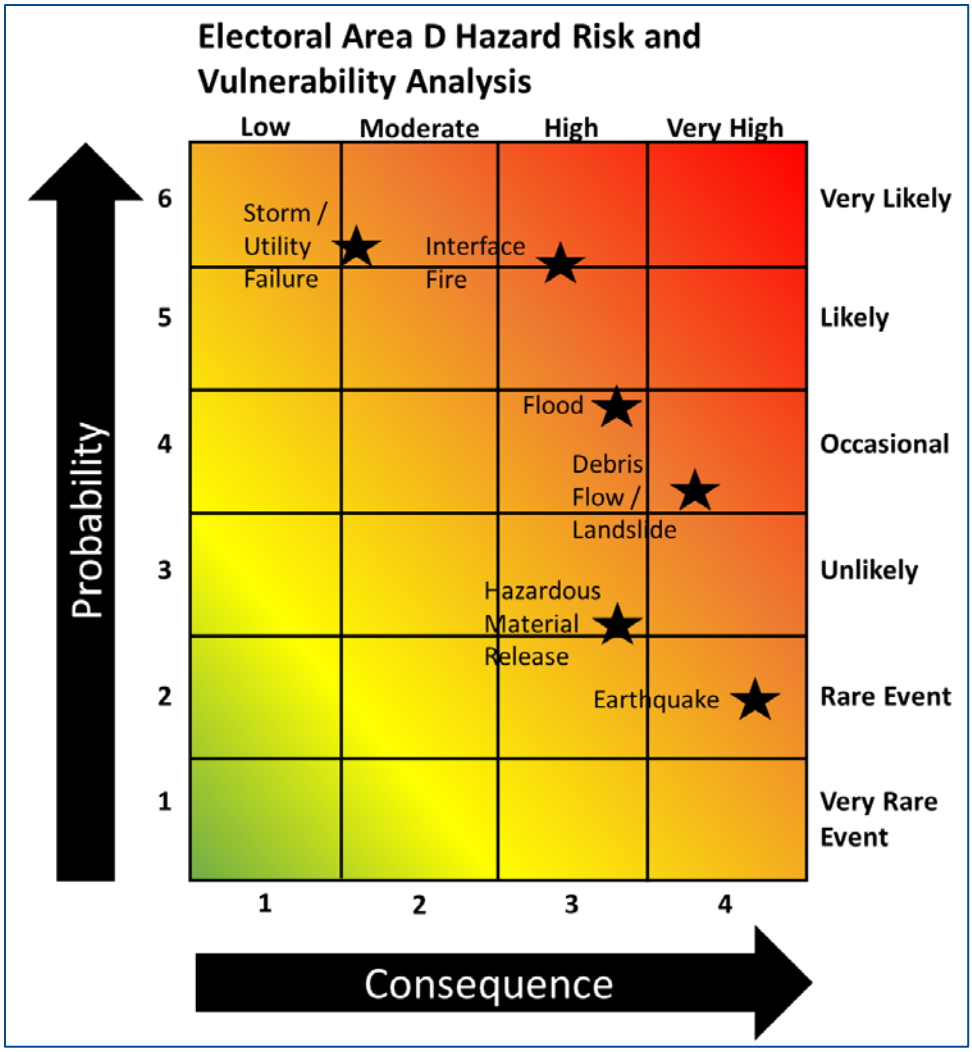


Figure 27 – Hazard, Risk, and Vulnerability Analysis of Electoral Area D. This chart reflects the highest assessed probability and highest assessed consequence for each hazard within the entire electoral area. Specific communities within the electoral area may experience hazard risk events with more frequency and less consequence due to local geography and weather conditions.

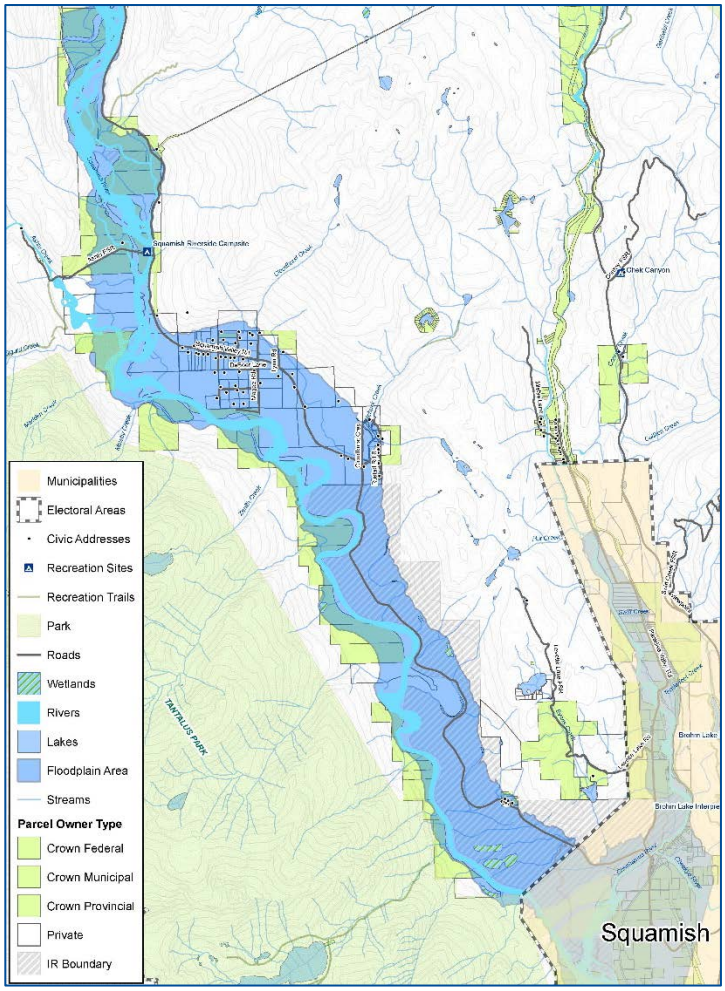
5.11. Hazards

5.11.1. Flood

There is flood hazard associated with many creeks and rivers throughout Electoral Area D including the Squamish River, Cheakamus River, Brandywine Creek, and Furry Creek. General floodplain mapping is available from the Ministry of Environment (Water Stewardship Division) for some rivers in Electoral Area D, and updated floodplain mapping has been completed for the

Squamish River, with updated floodplain mapping for the Cheakamus River due for completion by 2022.

In 2019, the NHC conducted a study on behalf of the SLRD to map flood hazard in the Upper Squamish Valley. The results of that study are posted on the SLRD website in the report titled: *Upper Squamish Flood Hazard Mapping and Risk Assessment.* Among other findings, the study shows that in the 50-year flood event and above, most of the Upper Squamish valley floor would be inundated with 1-2m of water. It also found that an outburst flood caused by an upsteam landslide could raise the water level by several meters and reach populated areas within a few hours (2019b, p. iv).



In addition to riverine flooding, shoreline areas of Britannia Beach and Furry Creek are vulnerable to storm surge flooding (CEP – Britannia Beach & Furry Creek, 2017b).

Lastly, a rapid release of water at the Daisy Lake Dam, which impounds Daisy Lake, could impact the community of Tunnel Station and cut off access to the Paradise Valley Road access routes into the area. BC Hydro maintains emergency response plans for this infrastructure. In 2003, as many as 150 people living along the Cheakamus River had to evacuate their homes after heavy rains forced BC Hydro to open the flood gates of the dam (CBC News, 2003).

Figure 28 – Upper Squamish Valley Historical Floodplain Area (Source: NHC, 2018)

5.11.2. Geotechnical Hazard - Debris Flow / Landslide

A natural hazard within Electoral Area D is the Rubble Creek Landslide Area (previously called the Garibaldi Civil Defense Zone). The area below and adjacent to 'the Barrier', a geological feature upholding Garibaldi Lake, is considered hazardous. Although imminent danger is unlikely, geotechnical studies have determined that areas downstream could be inundated if there was

ever a failure in the barrier wall. The Cheekye Alluvial Fan is another known hazard area with potential for debris flows large enough to impact Highway 99 and the northern Squamish area extending into the SLRD.

In the Upper Squamish area, debris flows from Mount Cayley large enough to partially or fully impound the Squamish River are possible, creating outburst flood hazard for the communities downstream (NHC, 2019).

5.11.3. Interface Fire

Climate change is drying and warming an area of the SLRD that has generally been assessed as lower risk than other areas of the SLRD, due to greater rainfall and milder temperatures overall. Volunteer fire departments and community fire suppression groups may be the first response to a wildfire start in their community, while the BC Wildfire Service is the lead agency for wildfire response throughout the SLRD. The community of Ring Creek, while not remote, is is surrounded by coniferous forest, a significant amount of potential wildfire fuel. Wildfires have occurred in the Upper Squamish Valley in 2019 and 2020, requiring evacuation alerts and orders. Response to the 2020 was further complicated by the concurrent COVID-19 pandemic, and infectious disease protective measures were required for evacuees and response personnel. The July 2015 Boulder Complex fire also resulted in some properties in the Upper Squamish Valley being placed on evacuation alert, and spread smoke throughout BC's Lower Mainland.

Figure 29 – Boulder Complex Wildfire in July, 2015 (Source: Government of BC, 2015)

5.11.4. Earthquake

Electoral Area D is the area at highest risk of earthquake impacts in the SLRD. It is the closest to the shifting tectonic plates in the Pacific Ocean.

Figure 30 – Damage to California State University, Northridge from a 6.7 magnitude earthquake in 1994 (Source: FEMA, 1994)

5.11.5. Storm / Utility Failure

Wind storm and severe weather notifications from Environment Canada are common in Area D. BC Hydro's works yard in the District of Squamish would be the first responders for restoring electricity in Electoral Area D after a severe storm. Sea level rise is predicted with climate change, potentially increasing risks related to storm surges for coastal communities in Area D.

5.11.6. Hazardous Material Release / Transportation

Squamish Terminal is an intermodal transportation hub with access to ocean, road and rail lines. Hazardous materials are transported and while safety plans and processes are mandated, accidents can occur. Communities in Area D are situated alongside main road, rail and marine transportation lines.

Figure 31 – Toxic smoke from a fire at Squamish Terminals in April, 2015 (Source: Vancouver Sun, 2015)

6. Figures and Tables

Figures

Tables

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