HRVA Report: District of Summerland HRVA

Community Name: The District of Summerland

Completed By: Odessa Cohen

Date: October 19, 2023 1:24 pm

Introduction

The purpose of a Hazard, Risk and Vulnerability Analysis is to help a community make risk-based choices to address vulnerabilities, mitigate hazards and prepare for responding to and recovering from hazard events. The HRVA process assesses sources of potential harm, their likelihood of occurring, the severity of their possible impacts, and who or what is particularly exposed or vulnerable to these impacts. The results from an HRVA are foundational for any community emergency management program.

This Hazard, Risk and Vulnerability Analysis is based on recommended practices and standards for conducting a local hazard risk assessment. Elements of this report were generated using the Hazard, Risk and Vulnerability Analysis Tool for First Nations & Local Authorities produced by Emergency Management and Climate Readiness (EMCR). The tool was developed with the support of a working group of emergency management practitioners across British Columbia, as well as the Alberta Emergency Management Agency (AEMA), through funding opportunities under the Federal Government's National Disaster Mitigation Program (NDMP). The tool and its supporting documents are provided free of charge to First Nations and Local Authorities in British Columbia.

This HRVA supports the implementation of the Local Authority Emergency Management Regulation 2(1) which requires local authority emergency plans to be reflective of a local risk assessment.

BRITISH COLUMBIA Ministry of Emergency Management and Climate Readiness | Government of Canada Gouvernement du Canada | Alberta Alberta Emergency Management Agency

Methodology

The disaster risk calculations and visualizations used in this assessment are based on common practices for conceptualizing risk. It is important to note that there are many ways of conceptualizing risk; quantitative data is only one aspect of risk analysis, and a number of additional qualitative factors will often influence local decision making. This tool and its outputs should be considered as one element of a comprehensive Disaster Risk Reduction (DRR) program, and can help inform emergency planning and risk reduction strategy development at the community level.

The hazard list referenced within this report is based on the 57 Hazards identified in the Emergency Management Regulation (update) as well as any unique local hazards identified during the HRVA Process. For additional information on hazard identification and the HRVA process, please feel free to visit the Emergency Management and Climate Readiness website.[1]

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[1] https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery

All-Hazards Summary

The following table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood/ High Consequence

Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

Priority	Hazard List	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
1	**Wildfire**	**E**	**25**	High Likelihood/ Med Consequence	**E**
2	**Human Disease (Including Pandemic and Epidemic)**	**D**	**27**	High Likelihood/ Med Consequence	**E**
3	**Public Health Crisis**	**D**	**27**	High Likelihood/ Med Consequence	**E**
4	**Drought**	**D**	**21**	High Likelihood/ Med Consequence	**D**
5	**Landslide/Debris Flow**	**D**	**21**	High Likelihood/ Med Consequence	**D**
6	**Extreme Heat**	**E**	**16**	High Likelihood/ Med Consequence	**E**
7	**Transportation Route Interruption**	**D**	**16**	High Likelihood/ Med Consequence	**E**
8	**Plant Disease and Pest Infestation**	**E**	**15**	High Likelihood/ Med Consequence	**E**
9	**Air Quality**	**C**	**21**	Med Likelihood/ Med Consequence	**D**
10	**Lake, River, and Stream Flooding**	**C**	**28**	Med Likelihood/ Med Consequence	**C**
11	**Storm Water Flooding (urban, local, pluvial)**	**C**	**19**	Med Likelihood/ Med Consequence	**D**
12	**Flash Flooding**	**C**	**20**	Med Likelihood/ Med Consequence	**D**

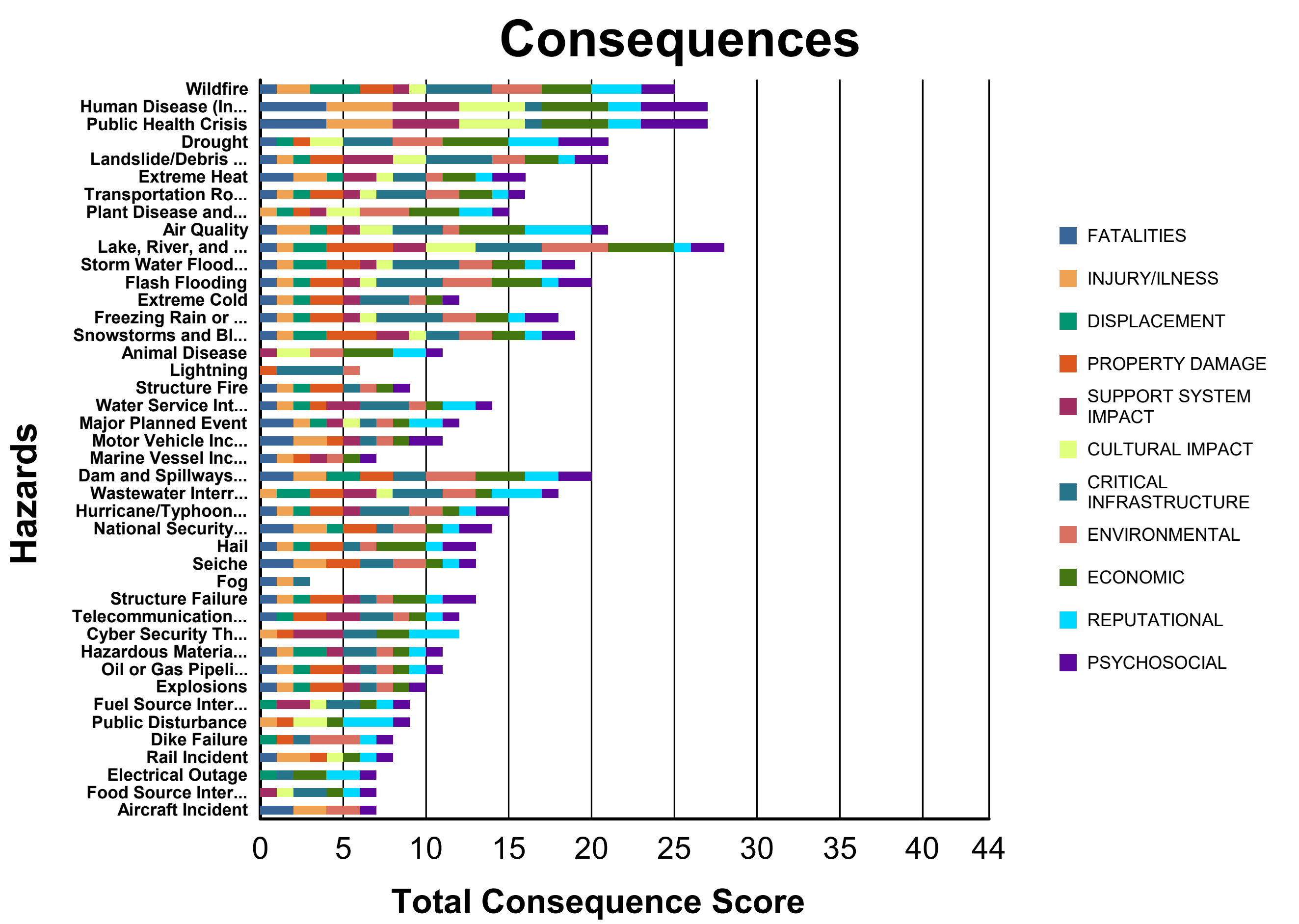
13	**Extreme Cold**	**E**	**12**	High Likelihood/ Low Consequence	**E**
14	**Freezing Rain or Drizzle**	**C**	**18**	Med Likelihood/ Med Consequence	**D**
15	**Snowstorms and Blizzards**	**C**	**19**	Med Likelihood/ Med Consequence	**D**
16	**Animal Disease**	**D**	**11**	High Likelihood/ Low Consequence	**E**
17	**Lightning**	**E**	**6**	High Likelihood/ Low Consequence	**E**
18	**Structure Fire**	**D**	**9**	High Likelihood/ Low Consequence	**D**
19	**Water Service Interruption (Includes shortage and**	**C**	**14**	Med Likelihood/ Med Consequence	**E**
20	**Major Planned Event**	**E**	**12**	High Likelihood/ Low Consequence	**E**
21	**Motor Vehicle Incident**	**E**	**11**	High Likelihood/ Low Consequence	**E**
22	**Marine Vessel Incident**	**E**	**7**	High Likelihood/ Low Consequence	**E**
23	**Dam and Spillways Failure**	**A**	**20**	Low Likelihood/ Med Consequence	**B**
24	**Wastewater Interruption**	**B**	**18**	Low Likelihood/ Med Consequence	**C**
25	**Hurricane/Typhoon/High Wind Event**	**B**	**15**	Low Likelihood/ Med Consequence	**C**
26	**National Security Threat**	**A**	**14**	Low Likelihood/ Med Consequence	**C**
27	**Hail**	**C**	**13**	Med Likelihood/ Low Consequence	**D**
28	**Seiche**	**C**	**13**	Med Likelihood/ Low Consequence	**C**
29	**Fog**	**C**	**3**	Med Likelihood/ Low Consequence	**D**
30	**Structure Failure**	**A**	**13**	Low Likelihood/ Low Consequence	**A**
31	**Telecommunications Interruption**	**B**	**12**	Low Likelihood/ Low Consequence	**C**
32	**Cyber Security Threat**	**A**	**12**	Low Likelihood/ Low Consequence	**C**
33	**Hazardous Materials Spill**	**B**	**11**	Low Likelihood/ Low Consequence	**C**
34	**Oil or Gas Pipeline Spill**	**B**	**11**	Low Likelihood/ Low Consequence	**C**

35	**Explosions**	**B**	**10**	Low Likelihood/ Low Consequence	**C**
36	**Fuel Source Interruption**	**B**	**9**	Low Likelihood/ Low Consequence	**B**
37	**Public Disturbance**	**A**	**9**	Low Likelihood/ Low Consequence	**C**
38	**Dike Failure**	**A**	**8**	Low Likelihood/ Low Consequence	**B**
39	**Rail Incident**	**A**	**8**	Low Likelihood/ Low Consequence	**A**
40	**Electrical Outage**	**B**	**7**	Low Likelihood/ Low Consequence	**C**
41	**Food Source Interruption (supply chain, or community**	**B**	**7**	Low Likelihood/ Low Consequence	**C**
42	**Aircraft Incident**	**A**	**7**	Low Likelihood/ Low Consequence	**A**

All-Hazards Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme



Community Mapping Summary

Community maps have been provided as part of this report and are saved on an internal server [https://ln5.sync.com/dl/caf2e4680/hnqs7h4t-y8nkn24j-gftc6n4q-647ddzr4]. These include maps of water and wastewater systems, transportation infrastructure, critical locations, community land use, electrical infrastructure and other utilities, wildfire boundaries, hazard zones (e.g., landslide areas, floodplains), community socioeconomic profile, and land surface temperature during the 2021 BC Heat Dome. Maps were developed using data provided by the District, as well as open source data from StatsCan and provincial databases.

Critical Assets & Infrastructure Summary

The critical assets, infrastructure, and services identified during the District of Summerland HRVA are listed below:
- Dams
- Reservoirs
- Water Treatment Plant
- Water Supply Distribution Network (Water Mains/Service Pipes)
- Pumphouses and Pressure Reducer Valves
- Wastewater Treatment Plant
- Wastewater Collection Network (Sanitary Mains/Service Pipes)
- Lift Stations
- Stormwater Collection Network (Storm Mains, Catch Basins/Stormwater Ponds, Waterways)
- Parks and Outdoor Recreation (Parklands, Trails, Playgrounds/Sports Fields & Courts/Campgrounds, Beaches)
- Road Network (Roads, Highway)
- Municipal Facilities and Community Buildings (Municipal Hall, Works & Utilities Office, Electrical Warehouse, RCMP Station, Fire Hall, Health Centre, Aquatic Centre, Museum, Heritage Buildings/Cultural Sites)
- Waste Management Facilities (Landfill, Recycling Depot, Organics Facility)
- Utilities (Substations, Natural Gas Pipelines, Solar Facility)

Social & Economic Factor Summary

The District has a population of 12,042 (as of 2021 census), nearly 30% of which is over 65 years of age. The highest percentage of residents 65 years and over currently live in the Downtown and Lower Town areas (38 - 53%). This is consistent with the locations of assisted living facilities and critical services, e.g., Angus Place, Summerland Health Centre.

Healthcare in the District is mainly provided by independent family physicians. Current health care capacity is not sufficient to manage major human disease events or public health crises. There is one main health centre (Summerland Health Centre) and doctors' offices are located around the District. Many residents commute to Penticton Regional Hospital for specific services, e.g., day surgeries, laboratory tests. Planning for a new health centre is underway.

The top economic sectors in Summerland are healthcare and social assistance; retail trade; construction;
public administration; accommodation and food services; and agriculture, forestry, fishing, and hunting. Median income in Summerland is approximately $66,000, which is slightly lower that the BC median of $70,000. Median household income for owner households is much higher than in renter households ($71,000 compared to $38,000 in 2016).

There is a lack of affordable housing in the District. This includes rentals, owned housing, and subsidized and supportive housing. More renters spend over 30% of their income on shelter in Summerland than the national average. The cost of purchasing a house in Summerland has risen three times as much as the provincial average. The average mortgage for a single-detached home as of 2017 was approximately 58% of Summerland's average annual household income and 70% of the median annual household income. Low-income housing supports primarily take the form of social housing units (88) and rental subsidies (94). As of 2016, 4% of households in Summerland were in core housing need (residing in housing that is unsuitable, inadequate or unaffordable). The proportion is higher in renter households, of which 30% are in core housing need and 15% are considered to be in extreme core housing need. The highest prevalence of low-income households occurs along Highway 97 in high hazard areas that are prone to landslides. The District currently has no shelters for persons experiencing homelessness. Population growth in the area may place further strain on housing availability.

Agriculture is a key sector in Summerland and is sensitive to climatic fluctuation. The District currently reserves approximately 35% of its land area for agricultural use as part of the Agricultural Land Reserve established in 1972. Agricultural producers who need water for irrigation are most vulnerable when water supply is low, e.g., during hot summers. During the BC Heat Dome, there was restricted water availability for agricultural producers, many of whom lost crops in the event. While water running through the creeks was not reduced, there was a higher demand on the water treatment plant than it was able to treat. When this occurs, the District typically bypasses the treatment system and issues a boil water notice. There has been separation of irrigation and potable/domestic supply to manage capacity needs, e.g., separation of Garnet Valley Dam. However, when water volume is low or supply in hindered, there can be economic impacts for the community's agricultural sector.

Physical & Environmental Factor Summary

Landslides frequently occur in the District and can impact the road network, water supply, and private properties. Highway 97 has been impacted by more than three landslides since the start of 2023, resulting in transportation delays. The Perpetual Slide along Trout Creek, which has been active since 1914, has the potential to block water flow and cause flooding of surrounding areas. Past landslides have made key water sources muddy and hindered operation at the water treatment plant, thereby restricting the water supply. Private properties located in major landslide hazard zones have been damaged in the past, e.g., Garnet Valley in 2019.

Residences, municipal facilities, and roadways have been constructed in the Trout Creek floodplain and are at risk of creek flooding. These facilities include Summerland Treatment Plant, Trout Creek Elementary, and the Sun-Oka Beach Provincial Park. Eneas Creek is also prone to overflow, largely because the creek has been rerouted numerous times in the District's history to align with property lines.

Limited drainage does not have the capacity needed for short duration high intensity rainfall events. The District has historically relied primarily on natural drainage, but this is no longer sufficient to divert runoff caused by heavy rainfall. Extreme runoff events can create high turbidity in waterways, which the water treatment plant may not have the capacity to treat. Existing drainage can also be blocked by debris and sedimentation that is transported by runoff.

The capacity of the District's water supply is limited by demand and water quality. During periods of high heat, the demand for irrigation supply rises and may exceed the capacity of the supply systems. Water quality may be compromised by algal growth in reservoirs in high temperatures or sedimentation and turbidity of waterways during extreme rainfall events, which the water treatment plant may not be able to adequately clean. Poor water quality in one of the reservoirs or creeks may lead to a need for 'Do Not Drink' or 'Boil Water' notices.

Watersheds and riparian areas in the District are prone to wildfires and creek flooding. Wildfires burn vegetation, cause issues with debris and toxins, and can temporarily lead to faster or greater flow from watersheds into reservoirs that cannot keep up with that flow. There has been potential in some areas for wildfires to destroy watersheds and make them unusable. Wildfire fuel load has the potential to increase in the Trout and Eneas Creek watersheds due to infection of pine stands from Mountain Pine Beetles. Creek flooding uproots vegetation along waterways, particularly along the frequently rerouted Eneas Creek.

Underlying Disaster Risk Driver Summary

Climate change is an underlying risk driver for the District. Climate projections for Summerland indicate that annual temperatures will increase by up to 3 degrees Celsius by mid-century and 5 degrees Celsius by the end of the century. Temperatures are projected to increase in all seasons, with greatest change occurring in summer periods. Seasonal rainfall is projected to increase, except in summer during which conditions are likely to be drier. Greatest increase in rainfall is projected to occur in spring (7.5% increase). Warmer and drier summers have the potential to stress water supplies for agriculture production, human health, and ecosystem health, while increasing the potential for wildfire occurrence. Shifting seasonality may lead to longer growing seasons, which may strain agriculture by altering yield from particular crops. Warmer seasons may also encourage the spread of invasive species, pests, and disease vectors in the community and the region. An increase in rainfall may increase the occurrence of landslides, flooding, and erosion. This report is accompanied by a climate profile of the District of Summerland and a Climate Change Risk Assessment (CCRA), which are saved on an internal server [https://ln5.sync.com/dl/caf2e4680/hnqs7h4t-y8nkn24j-gftc6n4q-647ddzr4]. While the HRVA helps the District to identify high risk hazards and broader social impacts, the CCRA helps to identify assets most at risk within the climate-related hazards.

The population of Summerland is increasing, accompanied by further strain on housing, healthcare, and critical services. The annual growth rate is projected to be 0.5 - 2% up to 2031 and is expected to be highest in the age group 65 - 84, which will raise the average age of the population. The District's Urban Growth Strategy aims to address the need for more development by focusing on growth in the Downtown, Lower Town, and Trout Creek areas and continuing to protect Agricultural Land Reserve areas surrounding Downtown. Planning is also underway for an additional healthcare facility for the community. However, current circumstances may limit the capacity for the community to respond and recover in the event of a disaster.

Hazard Scenario Summary

Hazard scenarios have been provided as part of this report and are saved on an internal server [https://ln5.sync.com/dl/caf2e4680/hnqs7h4t-y8nkn24j-gftc6n4q-647ddzr4]. Hazard scenarios were developed using information on past impacts of the selected hazards obtained from District reports, interviews with knowledge holders, news reports, and workshops. A summary of the discussions with local knowledge holders can also be found on the internal server [https://ln5.sync.com/dl/caf2e4680/hnqs7h4t-y8nkn24j-gftc6n4q-647ddzr4].

Individual Hazard Breakdown

Hazard: WILDFIRE **Priority:** 1

Hazard Score: 25

Individual Hazard Summary Table

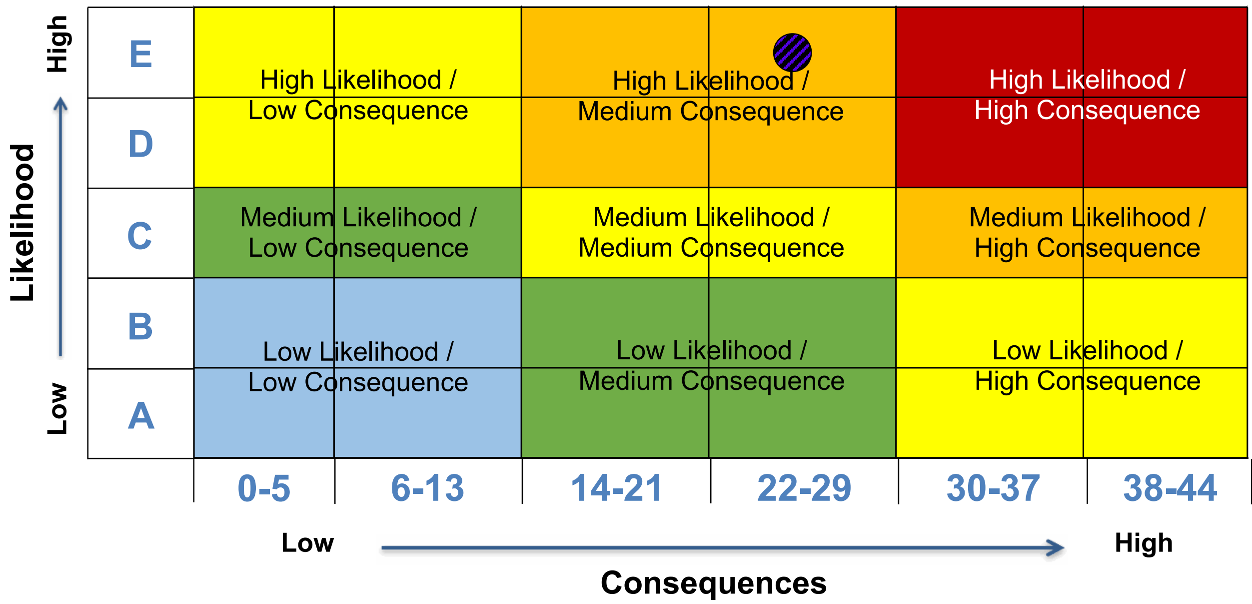
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
WILDFIRE	E	25	High Likelihood/ Med Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Wildfire



Individual Consequence Breakdown

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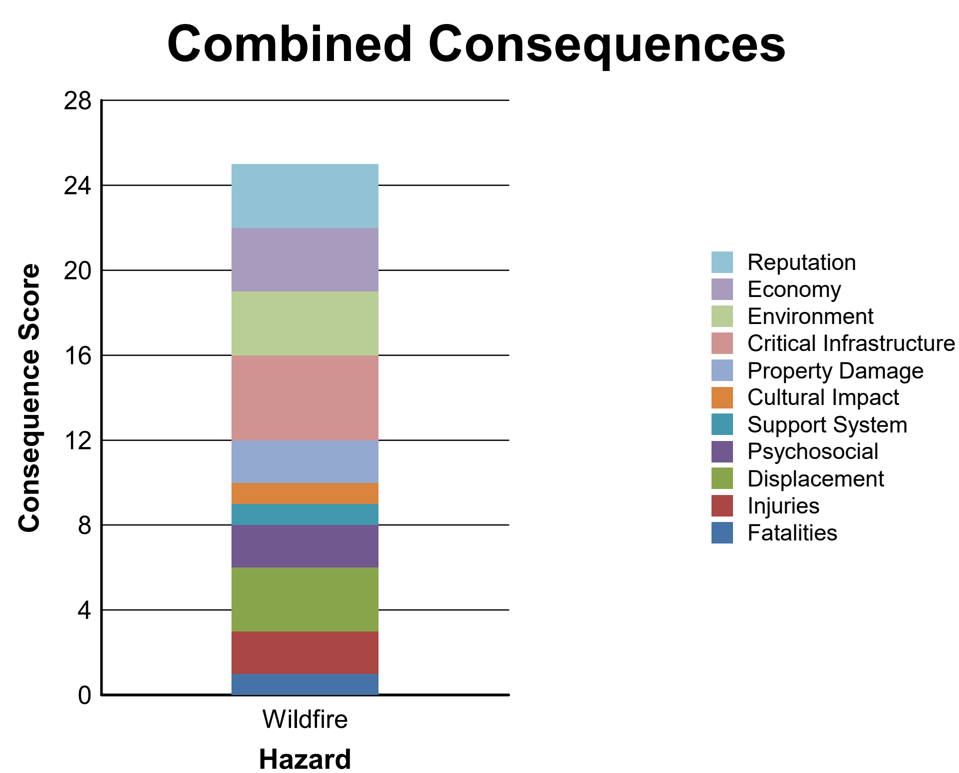
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was fires greater than 200 hpa (within 100km). Historical occurrence was 29 fires per year. Data Source: Canadian Wildfire Database

Changes Observed to Date Summary

Occurrence of wildfires is projected to increase by the 2030s.

Future Changes Expected Summary

Occurrence of wildfires is projected to increase by the 2050s.

Existing Risk Reduction Measures

- Community Wildfire Protection Plan (CWPP)
- Contractual agreement with OASISS to annually control invasive plants that could increase the fire hazard
- BC Wildfire are provided with critical infrastructure to identify where to protect
- MOTI checks storm drains after wildfire
- Mutual Aid agreement with neighbouring Fire Depts.
- Park closures, e.g., Giants Head Mountain
- FireSmart Program

New Risk Reduction Measures

- Increased attention to fuel reduction in high-risk interface areas
- Fire Smart Coordinator needs to act on behalf of the District to advocate for more funding for projects in Summerland
- Knowledge of prospective evacuation routes
- Areas have been identified in and around Summerland, but no funding. District applies for grants.
- Focus invasive plant removal efforts in areas at moderate-high risk for wildfires
- Guidance re: mitigation of wildfire smoke
- Cluster development close to utility services (i.e., avoid sprawl) and avoid (postpone) new development in interface
- Hire fire smart coordinator 2024
- Develop education/training and programs to assist residents in being fire-ready

Individual Hazard Breakdown

Hazard: HUMAN DISEASE (INCLUDING PANDEMIC AND EPIDEMIC) **Priority:** 2

Hazard Score: 27

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
HUMAN DISEASE (INCLUDING PANDEMIC AND	D	27	High Likelihood/ Med Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

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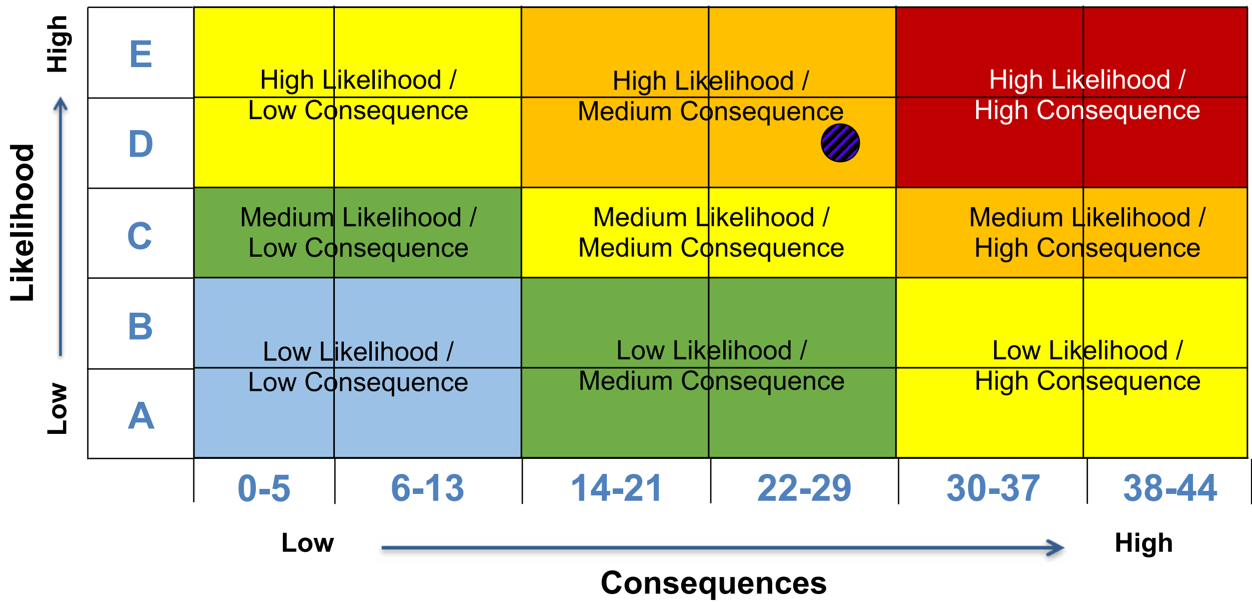
RISK MATRIX TABLE

For Human Disease (Including Pandemic and Epidemic)



Individual Consequence Breakdown

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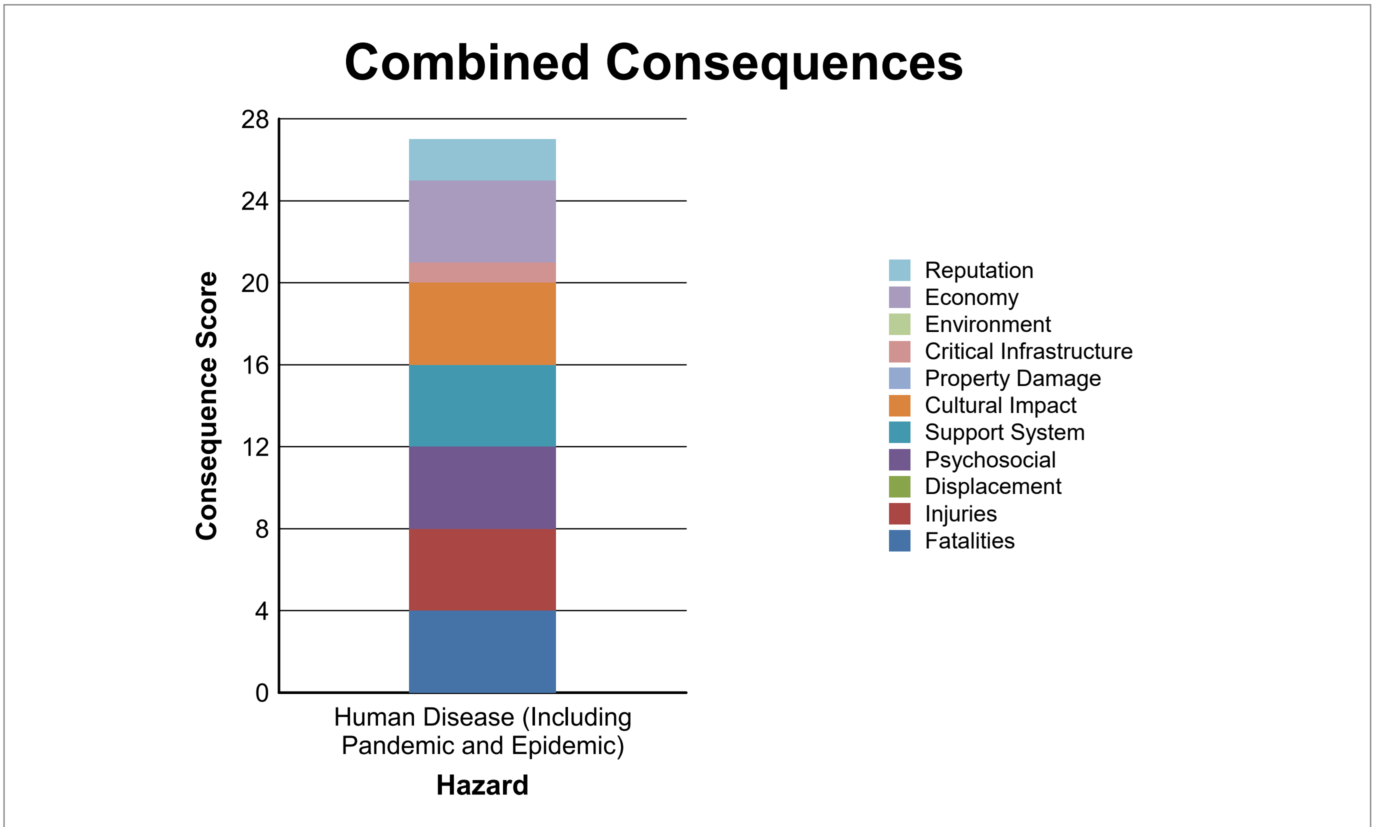
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

The District's ageing population and inadequate healthcare capacity have made it vulnerable to health concerns of varying degrees. The District has not had recent large scale epidemics, but has been impacted by frequently occurring illnesses (e.g., influenza) an the COVID-19 pandemic.

Changes Observed to Date Summary

Human disease occurrence is likely to increase in frequency by the 2030s. Climate change is making conditions more suitable for many invasive species, pests, and disease vectors to increase their range and abundance. West Nile Virus has affected animals and humans in BC at various rates since it was first confirmed and has the potential to occur in Summerland as well. Summerland is located in a high-risk tick zone (mainly the north and west sections of the District), which exposes residents to tick-borne diseases. The District was affected by the COVID-19 pandemic and there is also potential for outbreaks of more frequently occurring illnesses, such as influenza.

Future Changes Expected Summary

Human disease occurrence is likely to increase in frequency by the 2050s. Changes in seasonality and warming temperatures are likely to drive the spread of invasive species, pests, and disease vectors into new areas and increase abundance where they already exist in Summerland and the surrounding Okanagan region. This may lead to an increase in the spread and potency of infectious diseases. Global pandemics are also projected to occur more frequently, spread more easily, and result in greater economic loss and mortality (WHO).

Existing Risk Reduction Measures

- Planning is underway and a feasibility study has been conducted for construction of a new health care facility in Summerland.
- Municipal hall put together new work from home policy to support out of office staff working
- Disease transmission tracing (IH, Province)
- Vaccination awareness campaigns, clinics (IH)
- Animal contact process (rabies)
- Physicians obligated to report to IH certain communicable diseases of concern
- IH monitors for communicable disease & has response process established
- IH Population and Public Health portfolio is focused on identifying, preventing, and protecting against human disease and promoting behaviours which support health, this includes mental health

New Risk Reduction Measures

- Develop a healthy community plan (in collaboration with IH and community partners), which identifies actions related to Determinants of Health
- Collaborate with IH re: education, re: vector-borne disease (e.g., ticks, hantavirus, West Nile virus)
- Consider measures to control vector if needed based on surveillance and changing climate (e.g., mosquito, rat, tick control)
- Continued public education re: vaccination, virus transmission (and combatting mis/disinformation)

Individual Hazard Breakdown

Hazard: PUBLIC HEALTH CRISIS Priority: 3

Hazard Score: 27

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
PUBLIC HEALTH CRISIS	D	27	High Likelihood/ Med Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
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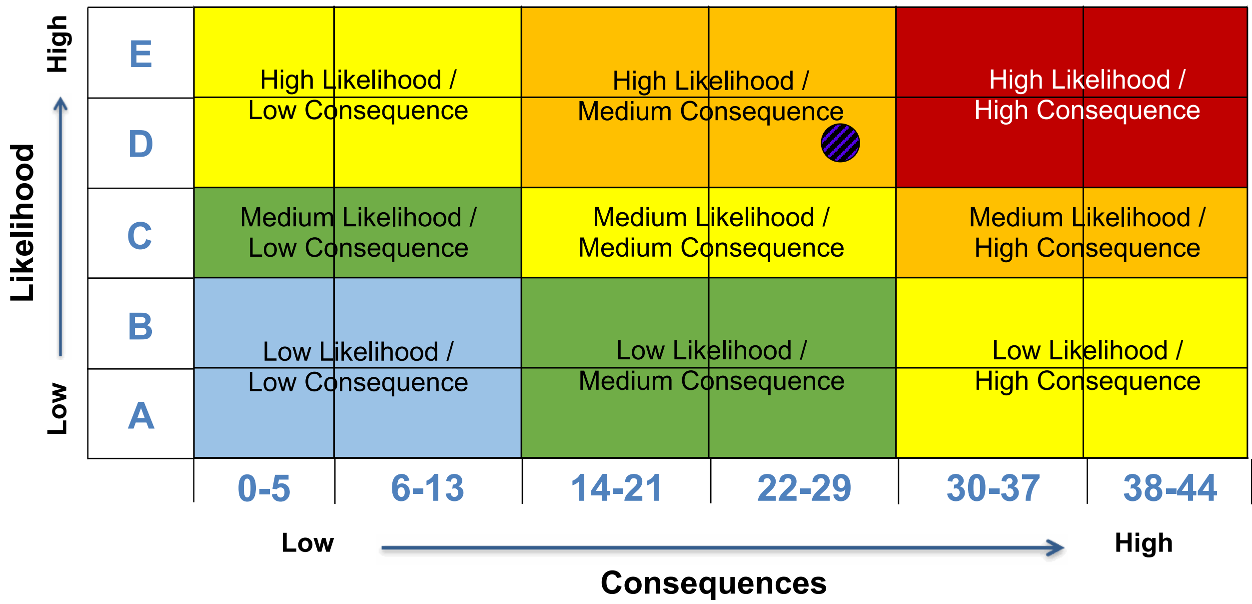
RISK MATRIX TABLE

For Public Health Crisis



Individual Consequence Breakdown

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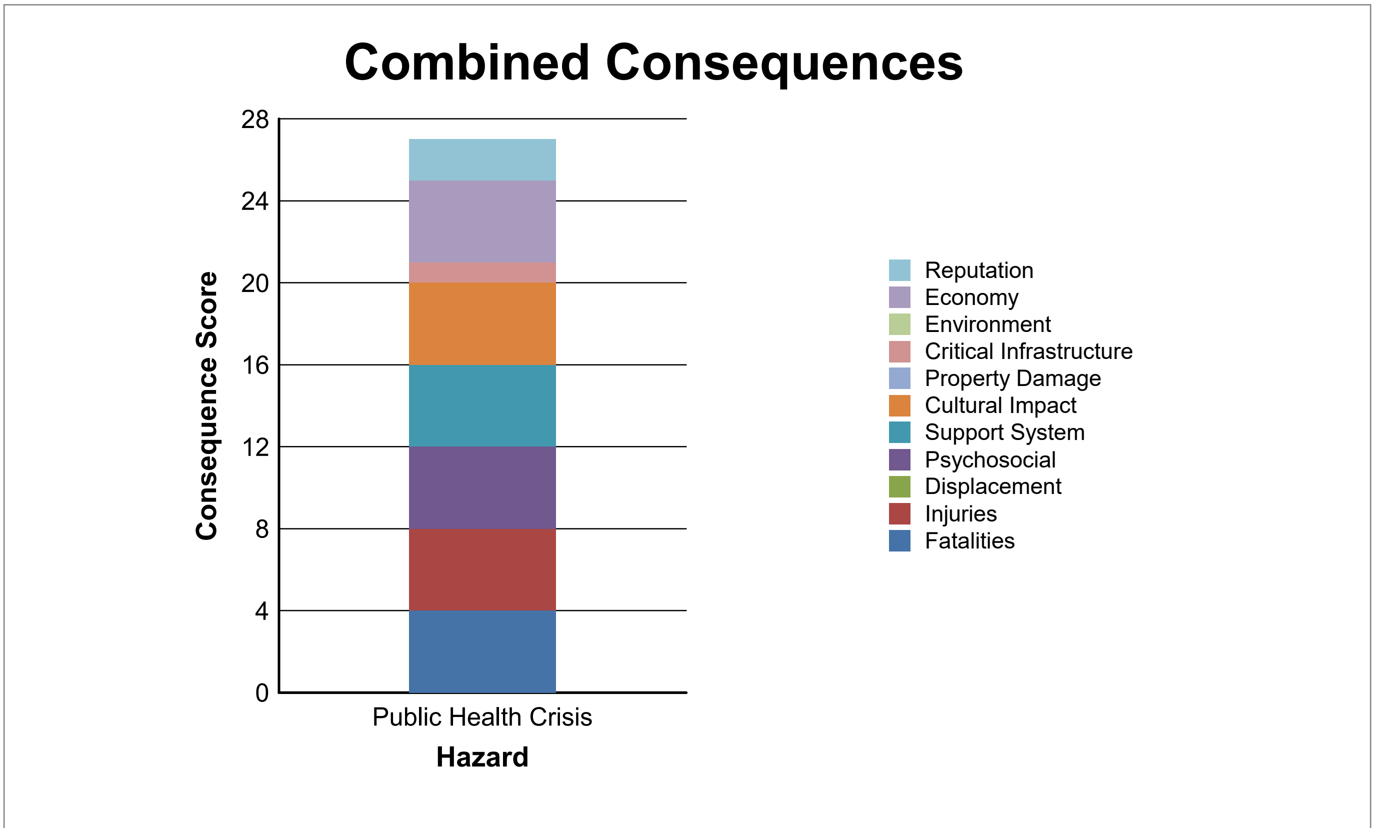
Consequence Stacking Table



Local Knowledge Summary

There have been concerns about potential for contamination of the District's water supply from the Summerland landfill, agricultural runoff, and accidental or intentional contamination of the District's numerous open flumes and reservoirs. Contamination has been found in watersheds in the past (2012 Watershed Master Plan), but not to the extent of being a widespread health concern due to extensive monitoring. Residents have been impacted by respiratory issues related to poor air quality due to wildfires and heat stress due to extreme summer temperatures. The District is highly vulnerable to health and safety threats, given the high number of older individuals living in the community and the gaps in healthcare capacity in the District.

Changes Observed to Date Summary

There is ongoing concern about potential for contamination of the District's water supply from the Summerland landfill, agricultural runoff, and accidental or intentional contamination of the District's numerous open flumes and reservoirs. An increase in flooding and intense rainfall events make contamination more likely, such as along Trout Creek, where runoff from agricultural lands may introduce fecal matter, pesticides, and fertilisers into the creek. There has been an increase in the frequency of wildfires and extreme heat events, which could increase incidents of respiratory illness and heat stress. The District was impacted by the 2021 BC Heat Dome, during which additional cooling amenities had to be established for residents. The frequency of such events is likely to increase in the near future.

Future Changes Expected Summary

It is likely that public health emergencies will increase by the 2050s due to the projected increase in frequency of related climate hazards, such as wildfires, extreme heat events, and flooding. It is also likely that health and emergency services will be strained by the increase in mental and physical health concerns, which may exacerbate existing challenges.

Existing Risk Reduction Measures

- Business continuity measures e.g., remote work
- During COVID District established work from home policy
- Guidance/communication from BC & IH MHOs
- IH implementing and applying resources to address opioid overdose crisis
- IH in collaboration with partners (District, operators etc.) monitor continuously for disease and system malfunctions, which could lead to disease and communicate & collaborate with District to mitigate
- District has been working on housing availability issue

New Risk Reduction Measures

- Establish communication plans, long term work from home, and accommodations in anticipation of future pandemics
- Develop an initiative for the mitigation of communicable disease and poisoning due to drug use in the community, in coordination with Interior Health
- Continue to have good work relationship with IH MHO, Healthy Community Development Team, Health Emergency Management, Drinking Water Officers, etc.

Individual Hazard Breakdown

Hazard: DROUGHT Priority: 4

Hazard Score: 21

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
DROUGHT	D	21	High Likelihood/ Med Consequence	D

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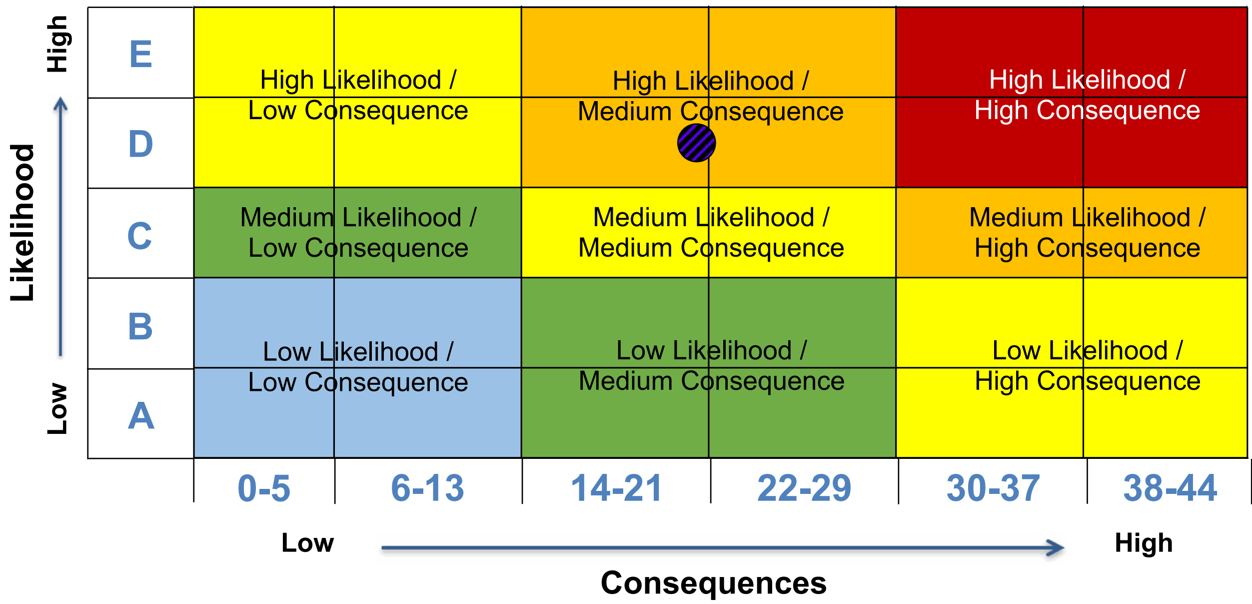
RISK MATRIX TABLE

For Drought

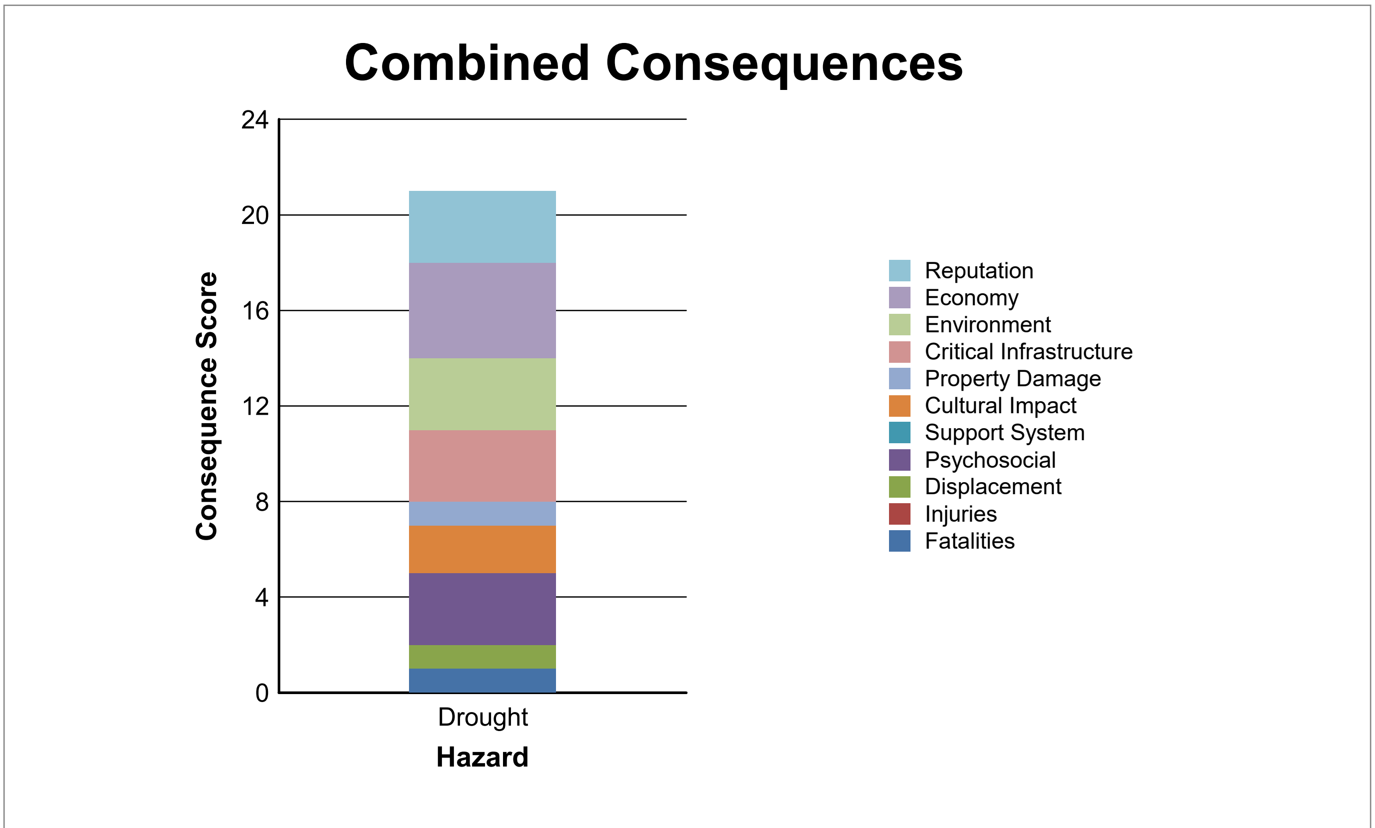


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was Standardized Precipitation Index (SPI or SPEI) of less than -1 (12-month scale). Historical SPI value was -0.07. Data Source: CMIP 5 (RCP8.5) - 1981 to 2010

Changes Observed to Date Summary

Intensity of drought events is projected to increase to SPI -0.27 by the 2030s. Data Source: CMIP 5 (RCP8.5)

Future Changes Expected Summary

Intensity of drought events is projected to increase to SPI -0.31 by the 2050s. Data Source: CMIP 5 (RCP8.5)

Existing Risk Reduction Measures

- Watershed Master Plan guides management and use of the community's water supply system
- District has closed parks - Closes Giants Head Mountain Park every year

New Risk Reduction Measures

- Increase storage
- Majority of water use is agricultural – possible information or support to help them conserve
- Implement drought resistant landscaping requirements for new builds

Individual Hazard Breakdown

Hazard: LANDSLIDE/DEBRIS FLOW Priority: 5

Hazard Score: 21

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
LANDSLIDE/DEBRIS FLOW	D	21	High Likelihood/ Med Consequence	D

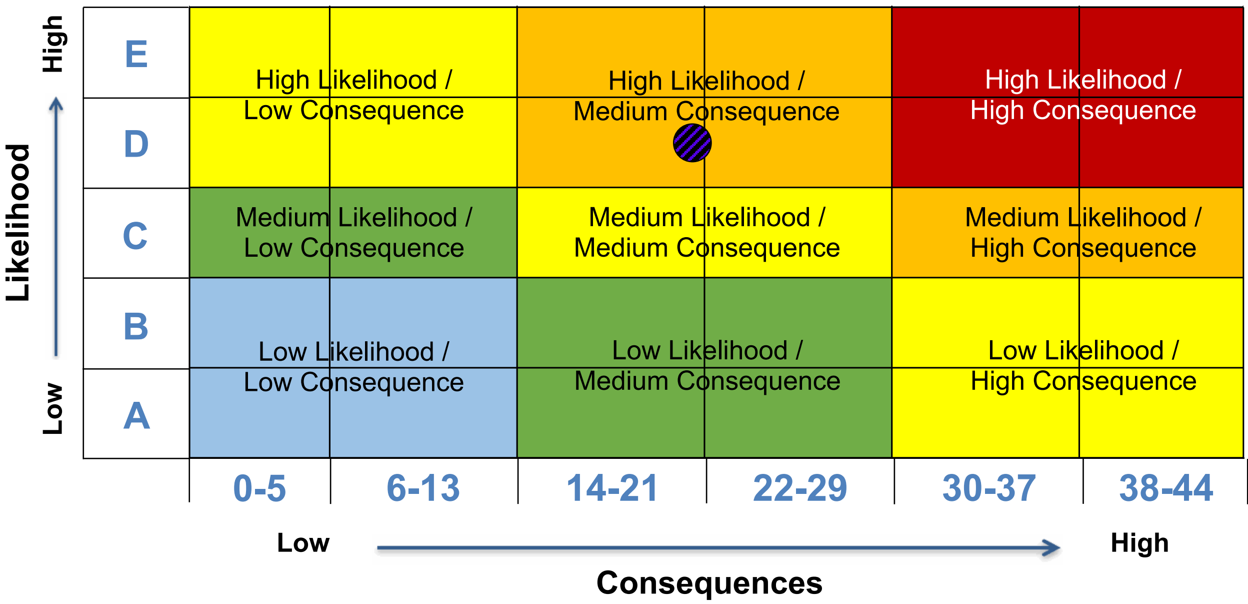
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Landslide/Debris Flow



Individual Consequence Breakdown

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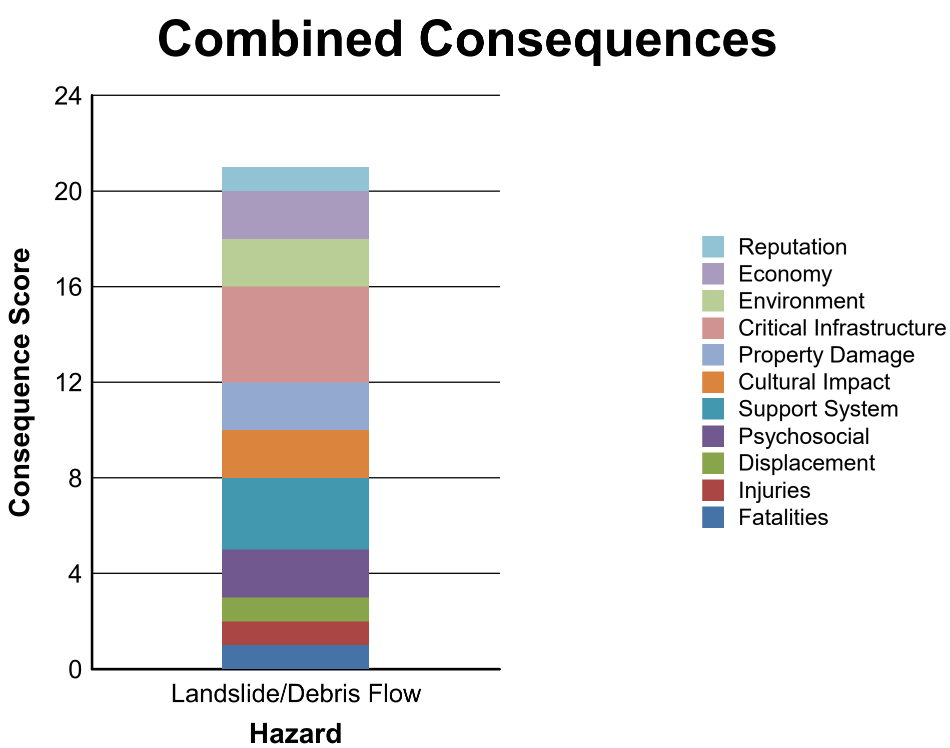
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was occurrence of landslides in the region. Historical occurrence was ~10 slides in area in 80 years. Data Source:
https://www.saobserver.net/news/past-landslides-have-devastated-summerland/#:~:text=The%20slides%2C%20at%20the%20bottom,other%20parts%20of%20the%20community.&text=On%20Sept.,Summerland's%20Lowertown%20destroyed%20three%20homes.

Changes Observed to Date Summary

Occurrence of landslides is projected to remain steady into the 2030s.

Future Changes Expected Summary

Occurrence of landslides is projected to remain steady into the 2050s.

Existing Risk Reduction Measures

- Water Utility Emergency Response Plan (ERP) – includes landslide response for water resources
- Province has mapped some areas, but not all

New Risk Reduction Measures

- More comprehensive mapping of landslide zones
- Improve relationship/communication between province and district to establish detour routes for traffic through town. Coordinate with IH as well for emergency routes.
- Inventorying hazard areas, and working with local property owners to mitigate any identified hazards
- Regional discussions and collaborations to better respond to road and service road disruptions. As well as determining long term solutions to these road disruptions.

Individual Hazard Breakdown

Hazard: EXTREME HEAT **Priority:** 6

Hazard Score: 16

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
EXTREME HEAT	E	16	High Likelihood/ Med Consequence	E

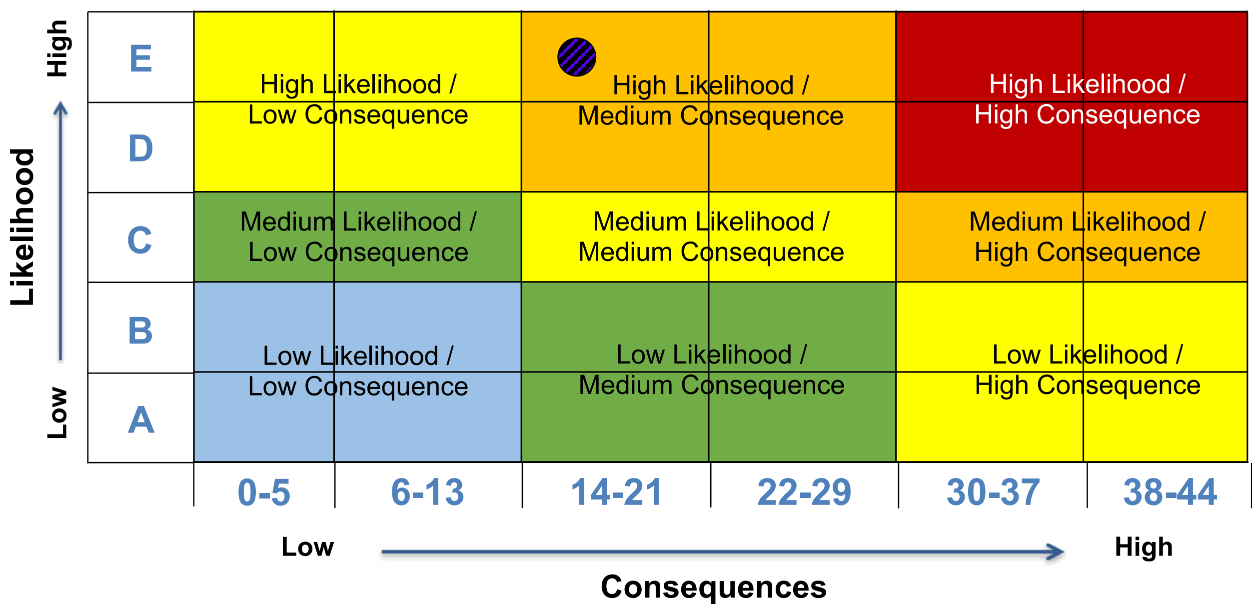
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Extreme Heat

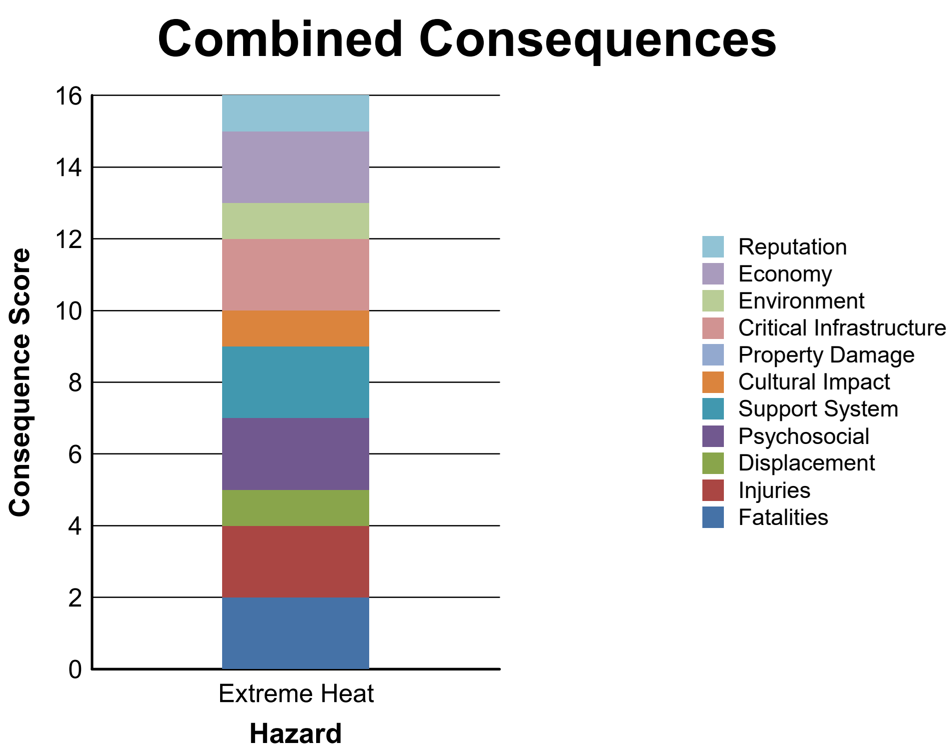


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was days/year with Tmax ≥ 32°C. Historical occurrence was 3 days per year. Data Source: NRCan (1981-2010)

Changes Observed to Date Summary

Occurrence of extreme heat events is projected to increase to 21.55 days per year by the 2030s. Data Source: CMIP 6 (SSP5-8.5)

Future Changes Expected Summary

Occurrence of extreme heat events is projected to increase to 49.9 days per year by the 2050s. Data Source: CMIP 6 (SSP5-8.5)

Existing Risk Reduction Measures

- Established cooling centres, misting stations, water bottle refill stations
- Request for A/C for low-income housing
- Safety officer on District staff
- Interior Health Heat Response Planning for Southern Interior BC Communities – Toolkit
- HVAC upgrades to District buildings
- BC Provincial Heat & Response System
- Food Bank used heavily (as the public in need, are attached to this resource centre) for both heat and cold sheltering with very little space. Hoping to relocate, if possible, in the future. To create a more suitable space to respond, especially as it is staffed Monday to Friday.
- Food Bank – Present cooling centre, well used but is not air conditioned (basement area for people to sit in – space with fans)

New Risk Reduction Measures

- Development of a community heat response (Regional). Sharing of resources.
- Adopt an urban tree policy & support a free plant a tree program (e.g., North Vancouver & Kelowna)
- Transportation options to bring people to cooling centres
- Ensure planted trees are native and drought resistant to sustain themselves in drought and heat to reduce maintenance
- Support households to have cooling (e.g., insulation, heat pump, etc.) Links to CEERP/CEEMP plan
- Support shelter housing with cooling to support those most vulnerable to experiencing heat exposure
- Extended cooling hours for facilities that act as cooling centres during heat events (evening)
- Increased public education on heat-related illness
- Establish registration for isolated residents or people living alone
- Continue to adopt new building code measures that align with provincial targets for emission reduction and increased energy efficiency
- Collaborate with mental health associations to provide support for higher risk community members (higher risk of mortality among seniors and persons suffering from schizophrenia)

Individual Hazard Breakdown

Hazard: TRANSPORTATION ROUTE INTERRUPTION Priority: 7

Hazard Score: 16

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
TRANSPORTATION ROUTE INTERRUPTION	D	16	High Likelihood/ Med Consequence	E

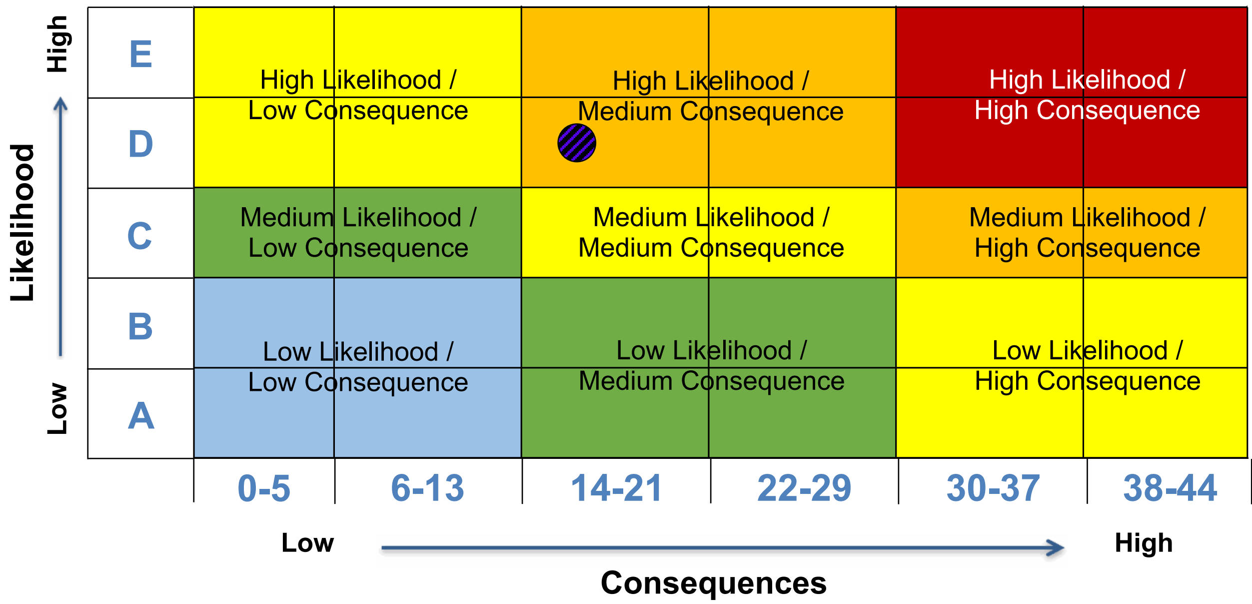
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Transportation Route Interruption

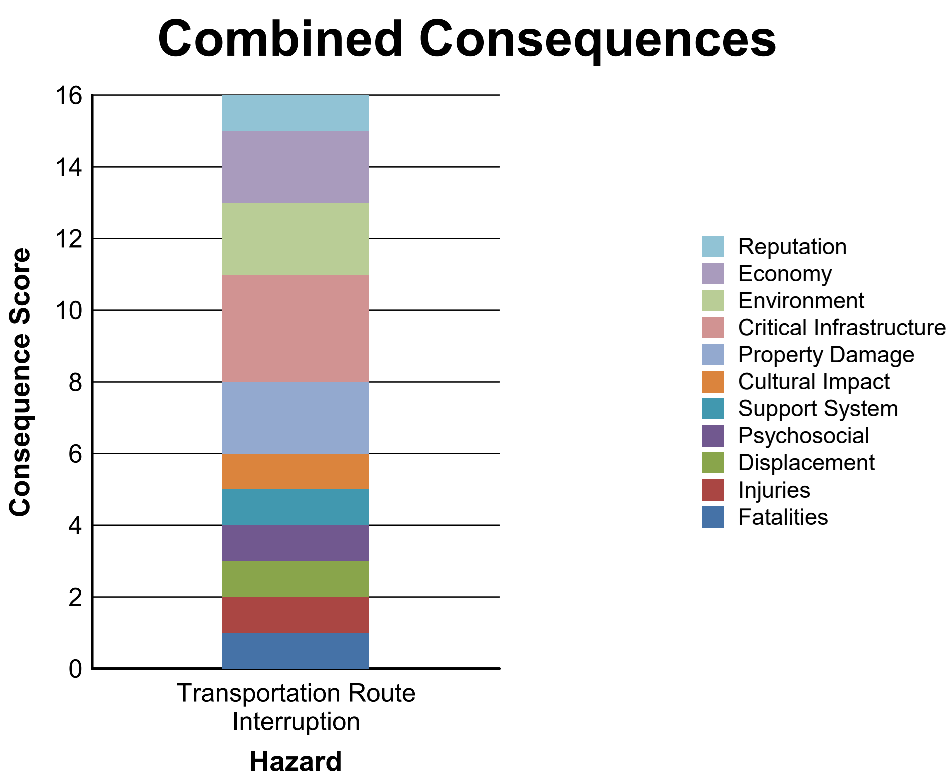


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Transportation interruption has historically occurred due to freezing rain, winter freeze thaw, landslides, and snow. Roads become difficult to traverse, but are not closed during snow or freezing rain events. Freeze-thaw events have caused breaking up of roadways. The District has year to year maintenance in place and a plan to improve maintenance.

Changes Observed to Date Summary

Transportation interruption occurs due to freezing rain, winter freeze thaw, snow, landslides, and wildfire. While road closure does not frequently occur due to these events, roadways do become more difficult to traverse.

Future Changes Expected Summary

Transportation routes are affected by external environmental factors such as wildfires, flooding, intense rainfall, landslides, snowfall, and freezing rain. Given the projected increase in likelihood of these events, it follows that transportation routes will also be interrupted more frequently.

Existing Risk Reduction Measures

- Master Transportation & Trails Plan relatively recently completed
- Mayors in Okanagan are working together to advocate to the Province to find alternative highway routes and or new highway routing in the event of closures

New Risk Reduction Measures

- Need to discuss alternate permanent route for transportation throughout the valley. Economic and health risk
- Private water taxi provided service along Okanagan lake between Peachland and Summerland

Individual Hazard Breakdown

Hazard: PLANT DISEASE AND PEST INFESTATION   Priority: 8

Hazard Score: 15

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
PLANT DISEASE AND PEST INFESTATION	E	15	High Likelihood/ Med Consequence	E

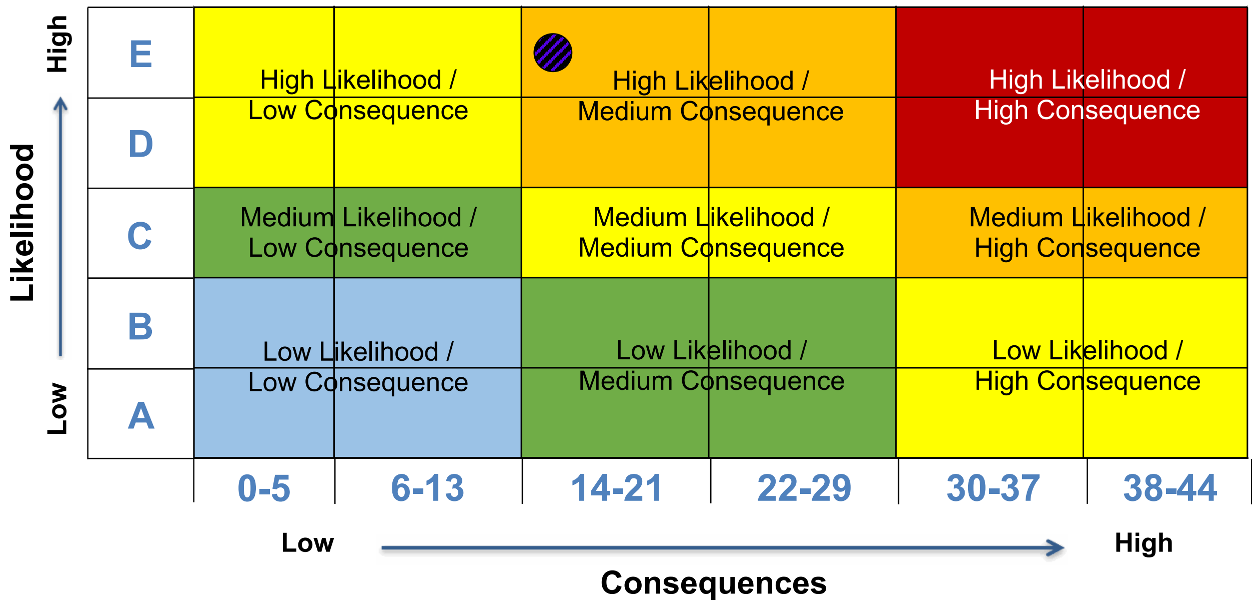
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Plant Disease and Pest Infestation

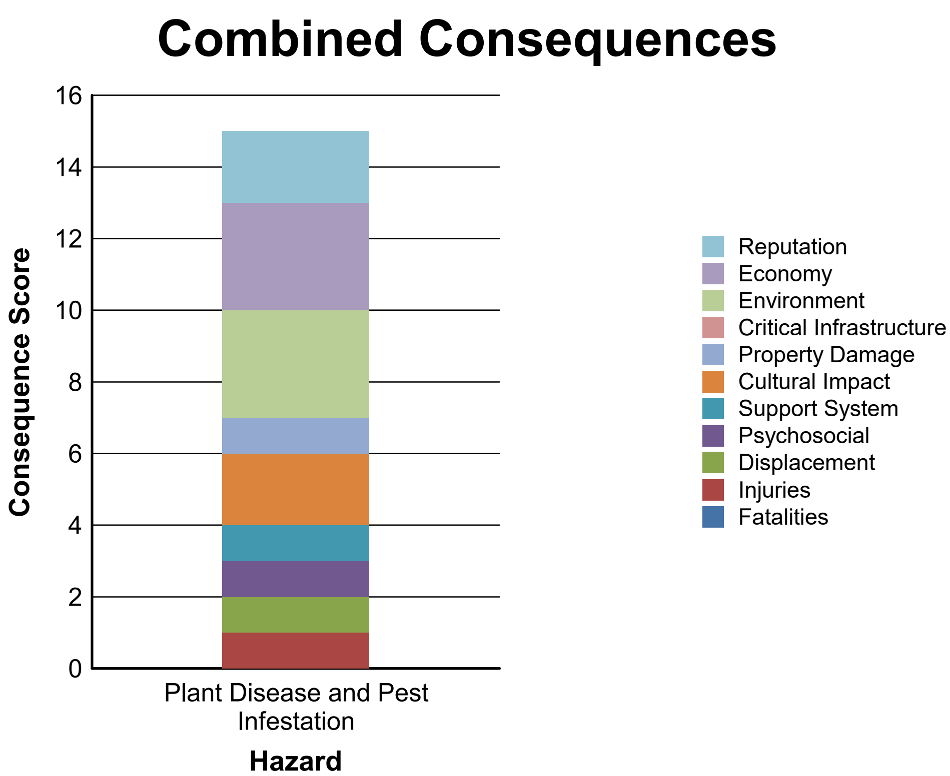


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Numerous pests and plant diseases affect the forests of the Okanagan Shuswap Forest District, e.g., Douglas-fir beetle, root diseases (2019 Okanagan TSA Forest Health Strategy). The District has also been affected by tree fruit diseases and pests, such as Bacterial Canker of Stone Fruits and Tree Fruit Aphids. These occur at high frequency.

Changes Observed to Date Summary

Numerous pests and plant diseases affect the forests of the Okanagan Shuswap Forest District, e.g., Douglas-fir beetle, root diseases (2019 Okanagan TSA Forest Health Strategy). The District has also been affected by tree fruit diseases and pests, such as Bacterial Canker of Stone Fruits and Tree Fruit Aphids. These are likely to continue to occur at high frequency due to warming and changing seasonal patterns, such as extended growing seasons.

Future Changes Expected Summary

Numerous pests and plant diseases affect the forests of the Okanagan Shuswap Forest District, e.g., Douglas-fir beetle, root diseases (2019 Okanagan TSA Forest Health Strategy). The District has also been affected by tree fruit diseases and pests, such as Bacterial Canker of Stone Fruits and Tree Fruit Aphids. These are likely to increase in frequency due to warming and changing seasonal patterns, such as extended growing seasons.

Existing Risk Reduction Measures

- Policies to limit nitrates and phosphates entering waterways via stormwater may reduce proliferation of aquatic invasives
- Research from the Canadian Government
- Summerland Agricultural Research Centre focuses in part on plants, insects, orchards
- Cooperative actions underway to manage and raise awareness of invasive species supported by OASISS and the RDOS
- Vulnerability risk assessment tools for invasive mussels being lead by OBWB
- Invasive plant management plan for Giants Head Mountain Park
- Eurasian milfoil (since the 1970's), addressed through region OBWB
- Toxicity to livestock: OASISS worked with the district for Hoary alyssum, 3 year agreement to manage the plant
- OASSIS is supporting the District through management, public awareness to raise awareness of invasive pests, training of district staff (landscaping crew), and collaboration on treatment of plants (on the ground)

New Risk Reduction Measures

- Need for invasive species management plan for the whole District
- Consider measures to control vector if needed based on surveillance and changing climate (e.g., mosquito, rat, tick control)
- Bylaws or policies for subdivision applications that address a requirement for revegetation and control of invasive plants post-development. Ensuring compliance is critical.
- More money needs to be invested re: mussel transfer. Money was reduced and resources eliminated.

Individual Hazard Breakdown

Hazard: AIR QUALITY Priority: 9

Hazard Score: 21

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
AIR QUALITY	C	21	Medium Likelihood/ Med Consequence	D

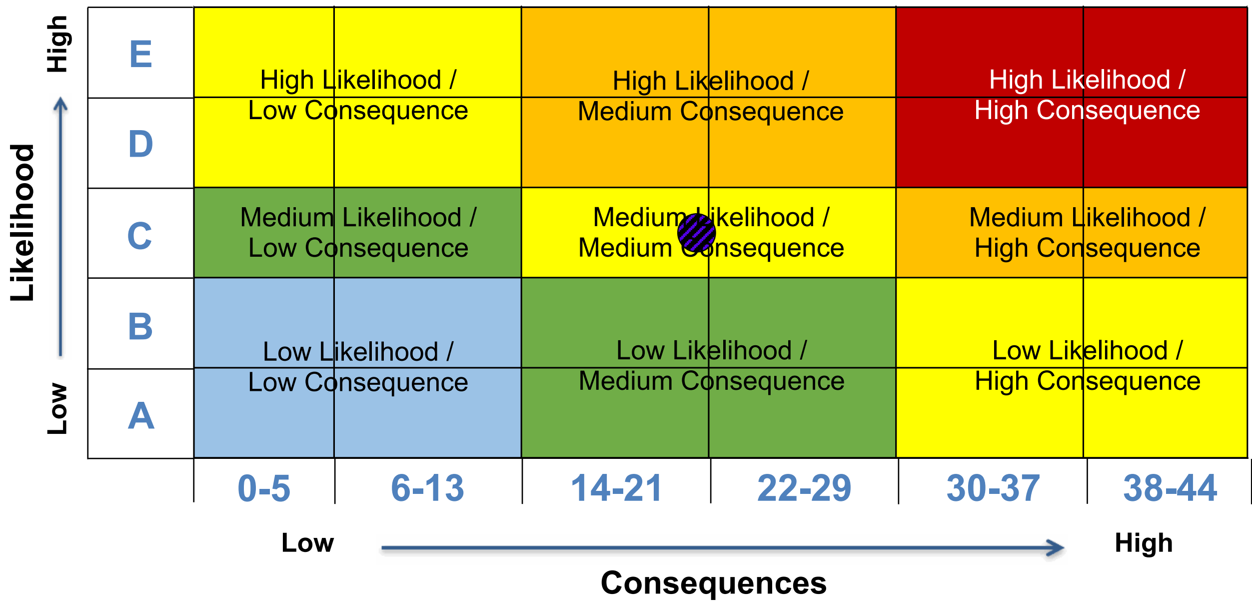
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	
	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Air Quality



Individual Consequence Breakdown

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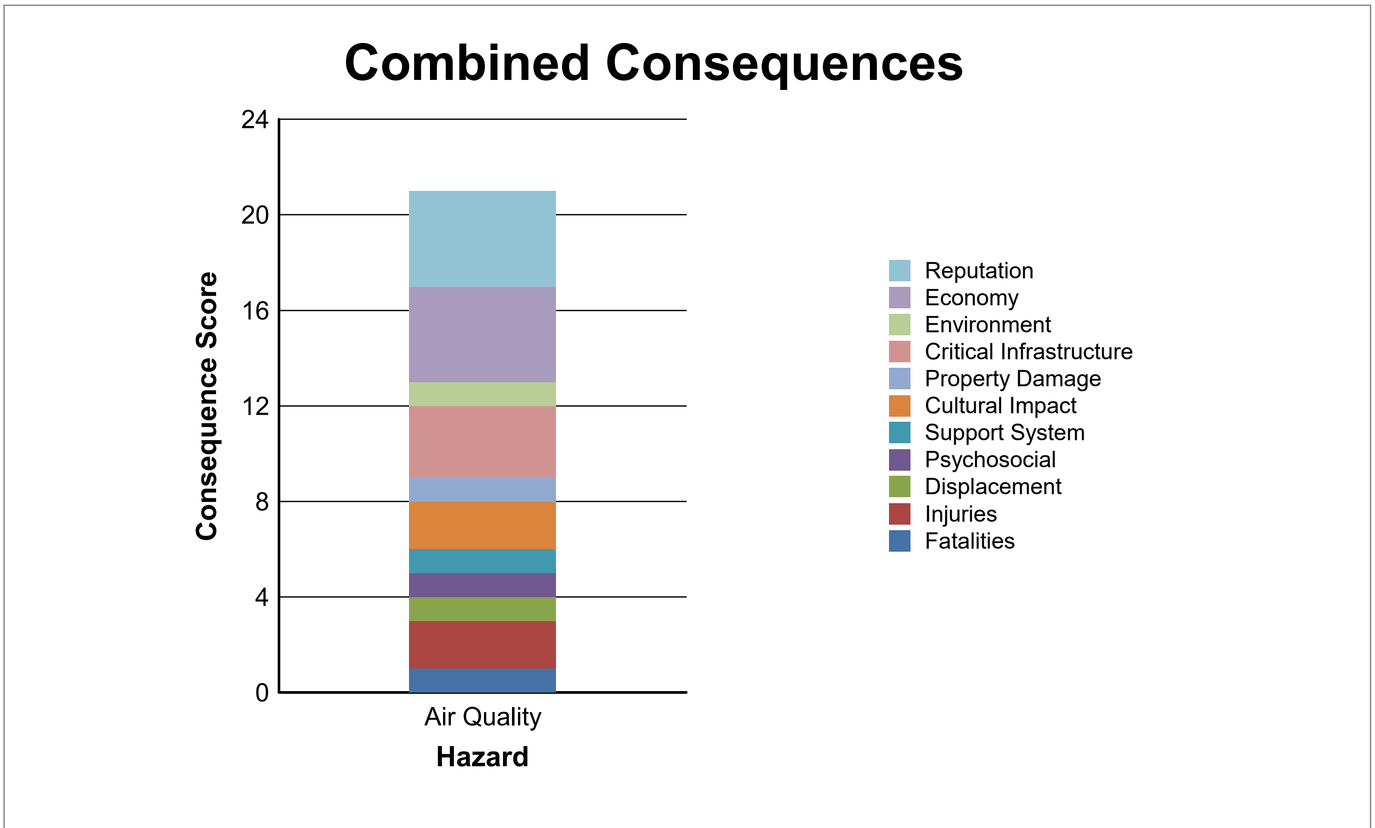
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Wildfire occurrence was used as a proxy. Historical occurrence was 29 fires per year. Data Source: BC Air Data Archive accessed at https://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/current-air-quality-data/bc-air-data-archive

Changes Observed to Date Summary

Wildfires and air quality concerns are projected to increase by the 2030s. Data Source: Flannigan, M. K. (2009). Implications of changing climate for global wildland fire. International Journal of Wildland Fire,18,, 483-507.

Future Changes Expected Summary

Wildfires and air quality concerns are projected to increase by the 2050s. Data Source: Flannigan, M. K. (2009). Implications of changing climate for global wildland fire. International Journal of Wildland Fire,18,, 483-507.

Existing Risk Reduction Measures

- Air Quality Health Index (BC Government)
- Social media posts are made to notify public of the spaces to find relief from smoke or poor air quality
- Promoted indoor events at our recreation centres to provide relief for young children and adults

New Risk Reduction Measures

- Install DDC Systems in facilities managed by District to more efficiently and quickly control air flow during events
- Collaborate with IH & partners to educate residents about radon
- Update air filters in facilities more regularly during bad smoke events
- Support households to have ability to close windows and air filtration (e.g., insulation, heat pumps, etc.) – Links to CEERP/CEEMP plan
- Use (higher) quality road gravel which has minimal dust
- Enhancement of building codes to accommodate filtration (to mitigate wildfire smoke, virus transmission, radon etc.)
- Create/support residents to transition from less efficient wood burning appliances (e.g., RDCO/Kelowna example)
- Update CEERP/CEEMP with considerations for air quality in community and corporate buildings

Individual Hazard Breakdown

Hazard: LAKE, RIVER, AND STREAM FLOODING **Priority:** 10

Hazard Score: 28

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
LAKE, RIVER, AND STREAM FLOODING	C	28	Medium Likelihood/ Med Consequence	C

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

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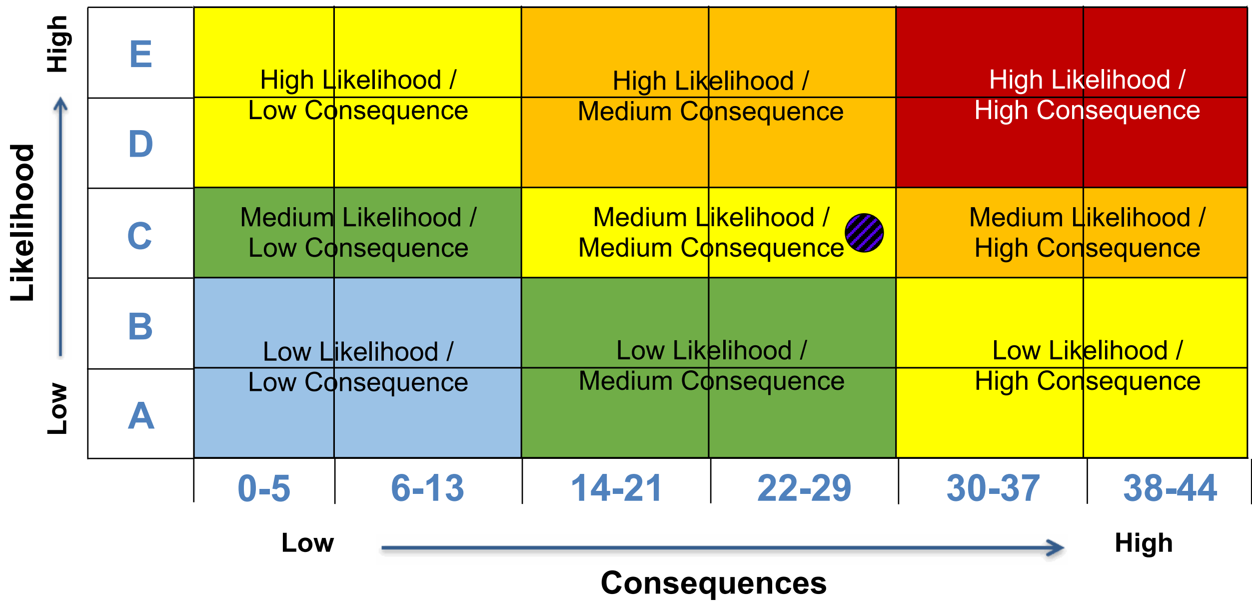
RISK MATRIX TABLE

For Lake, River, and Stream Flooding



Individual Consequence Breakdown

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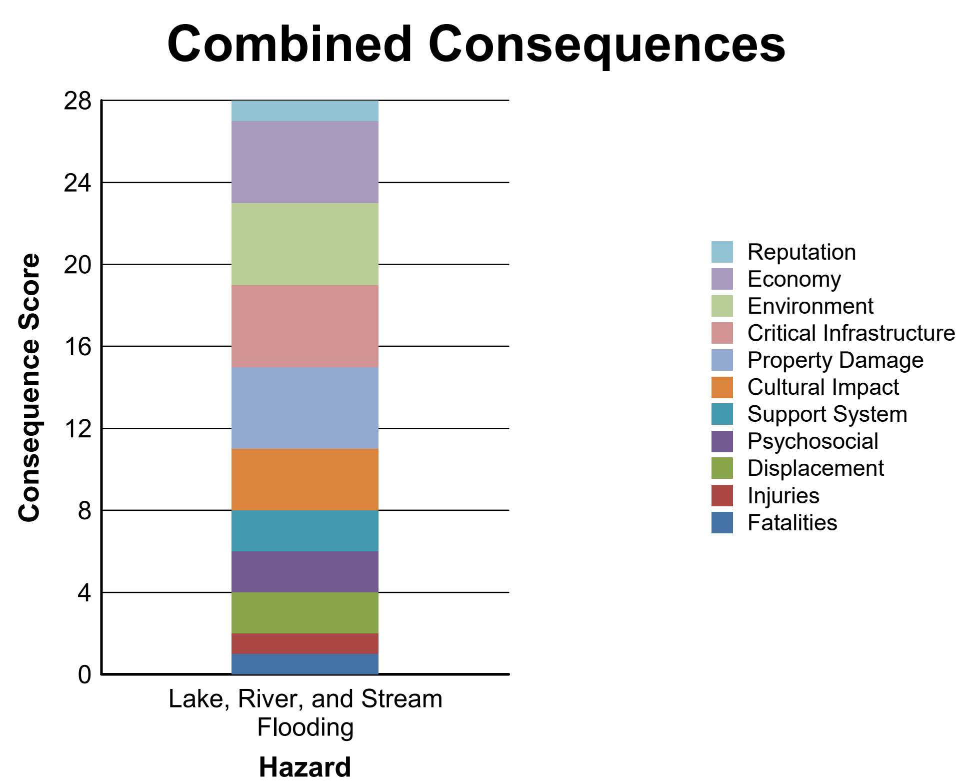
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Maximum 5-day precipitation was used as a proxy. Historical maximum was 37.4 mm. Data Source: NRCan (1981-2010)

Changes Observed to Date Summary

Maximum 5-day precipitation (proxy) is projected to increase to 43.5 mm by the 2030s. Data Source: CMIP 6 (SSP5-8.5); Flood mapping for the Okanagan Valley Watershed

Future Changes Expected Summary

Maximum 5-day precipitation (proxy) is projected to increase to 51.2 mm by the 2050s. Data Source: CMIP 6 (SSP5-8.5); Flood mapping for the Okanagan Valley Watershed

Existing Risk Reduction Measures

- Water Utility Emergency Response Plan (ERP) outlines responses to various emergency scenarios related to water supply and distribution.
- Watershed Master Plan guides management and use of the community's water supply system.
- Turbidity sensor on WTP SCADA system
- Ongoing flood inundation studies for dams
- Widening spillways of dams

New Risk Reduction Measures

- Consider adjusting required setback distances to high water mark (i.e., change high water mark elevation)
- Enhanced protection of existing riparian habitats for natural flood protection – less reliance on riprap and leads to greater benefits environmentally
- Identify opportunities to widen and enhance riparian habitats
- Limit or stop new development in flood zones, riparian areas or high-water risk areas in Summerland
- Establish a riparian areas protection bylaw, or section in the building bylaw to specifically guide development along riparian areas. We currently rely on Provincial regulations, which can't speak to Summerland specifically.
- Remediation of known creeks (Eneas) that cause flooding during seasonal rains or snowmelt

Individual Hazard Breakdown

Hazard: STORM WATER FLOODING (URBAN, LOCAL, PLUVIAL) Priority: 11

Hazard Score: 19

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
STORM WATER FLOODING (URBAN, LOCAL, PLUVIAL)	C	19	Medium Likelihood/ Med Consequence	D

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

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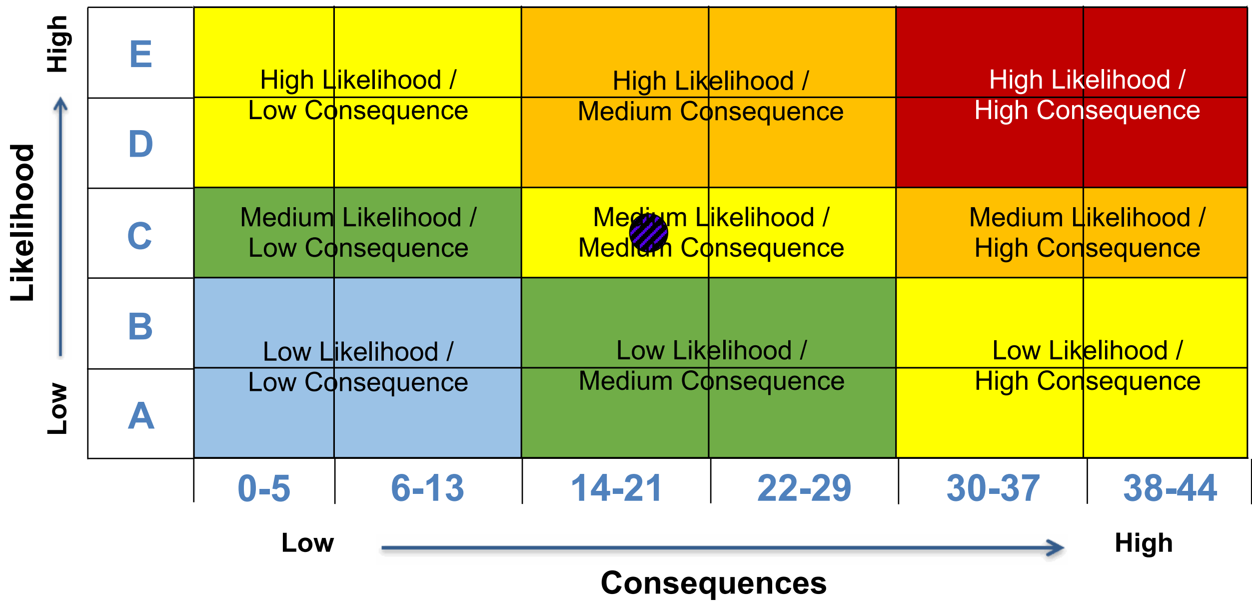
RISK MATRIX TABLE

For Storm Water Flooding (urban, local, pluvial)



Individual Consequence Breakdown

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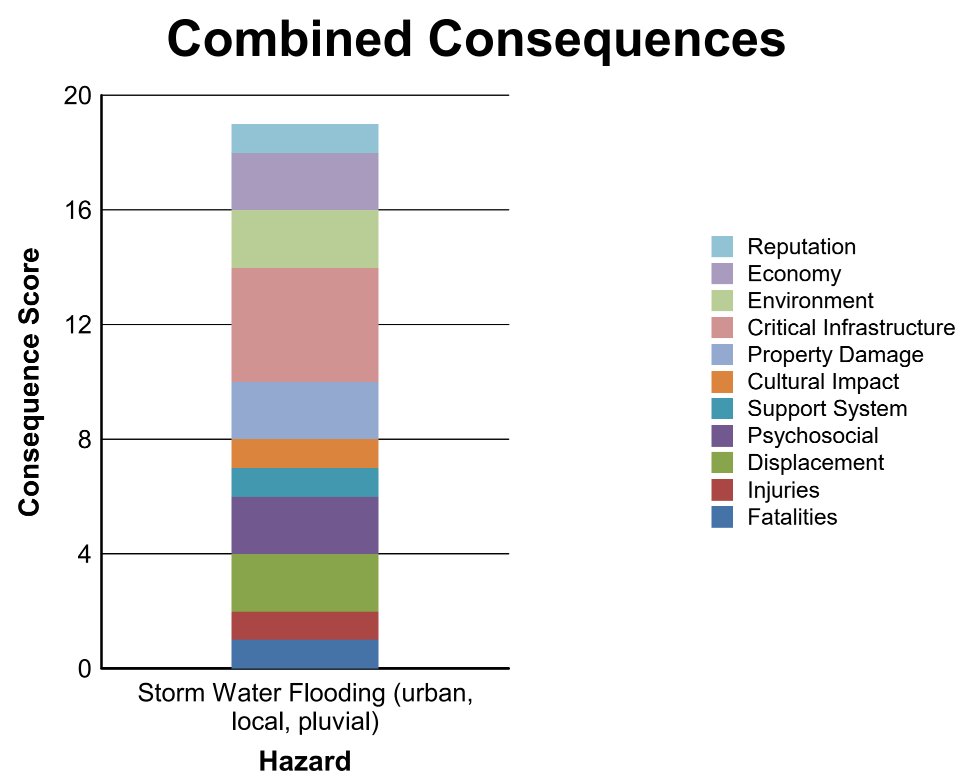
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Short duration high intensity rainfall (15 mm or more rainfall in 1 hour) was used as a proxy. Historical occurrence was 1 in 50 years. Data Source: IDF

Changes Observed to Date Summary

Occurrence of short duration high intensity rainfall events (proxy) is projected to increase to 1 in 25 years by the 2030s. Data Source: IDF; Flood mapping for the Okanagan Valley Watershed

Future Changes Expected Summary

Occurrence of short duration high intensity rainfall events (proxy) is projected to increase to 1 in 10 years by the 2050s. Data Source: IDF; Flood mapping for the Okanagan Valley Watershed

Existing Risk Reduction Measures

- Water Utility Emergency Response Plan (ERP) outlines responses to various emergency scenarios related to water supply and distribution.
- Watershed Master Plan guides management and use of the community's water supply system.
- Victoria Road is upgrading to install stormwater utilities.

New Risk Reduction Measures

- Change Subdivision & Development Servicing Bylaw road cross-section to include drainage swales, if not already included
- Consider natural asset management (i.e., what natural features present that could be used to slow flow of water?)
- Improve and upgrade stormwater systems within Summerland
- Implementation of green infrastructure in new road, building and utility upgrades
- Adjusting maintenance schedule (and budget) in keeping with weather context
- Integrate green infrastructure into building and subdivision bylaws
- Ensure underground stormwater structures are up to capacity/drainage upgrades
- Climate adjusted stormwater system sizing – conveyance and storage (move beyond historic climate design criteria)

Individual Hazard Breakdown

Hazard: FLASH FLOODING Priority: 12

Hazard Score: 20

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
FLASH FLOODING	C	20	Medium Likelihood/ Med Consequence	D

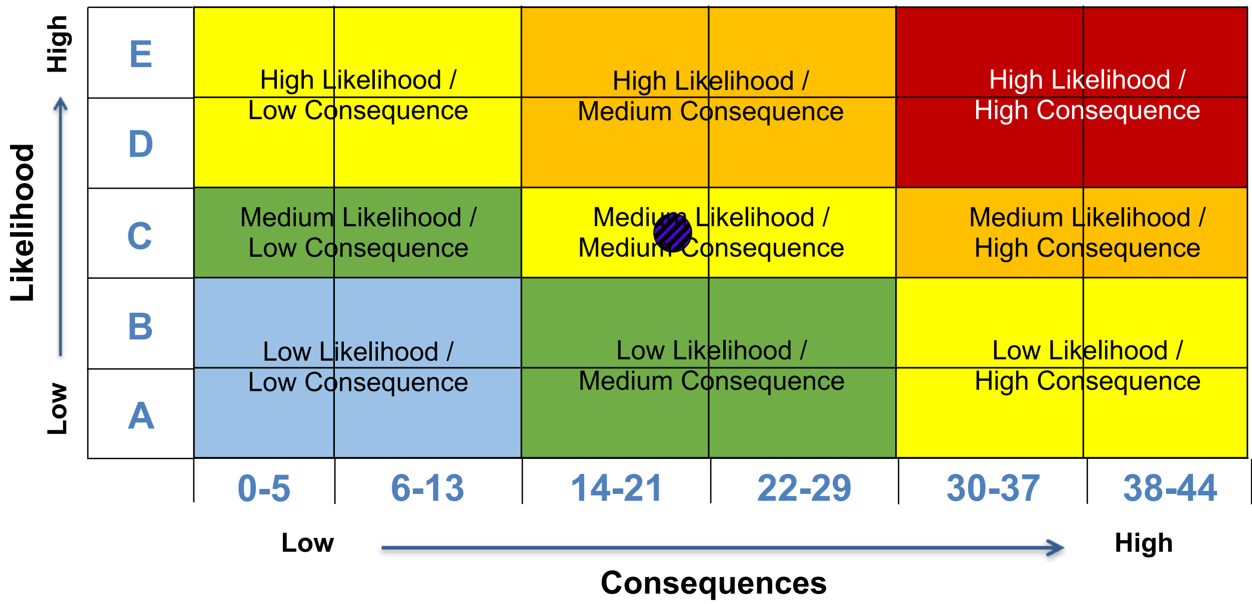
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Flash Flooding

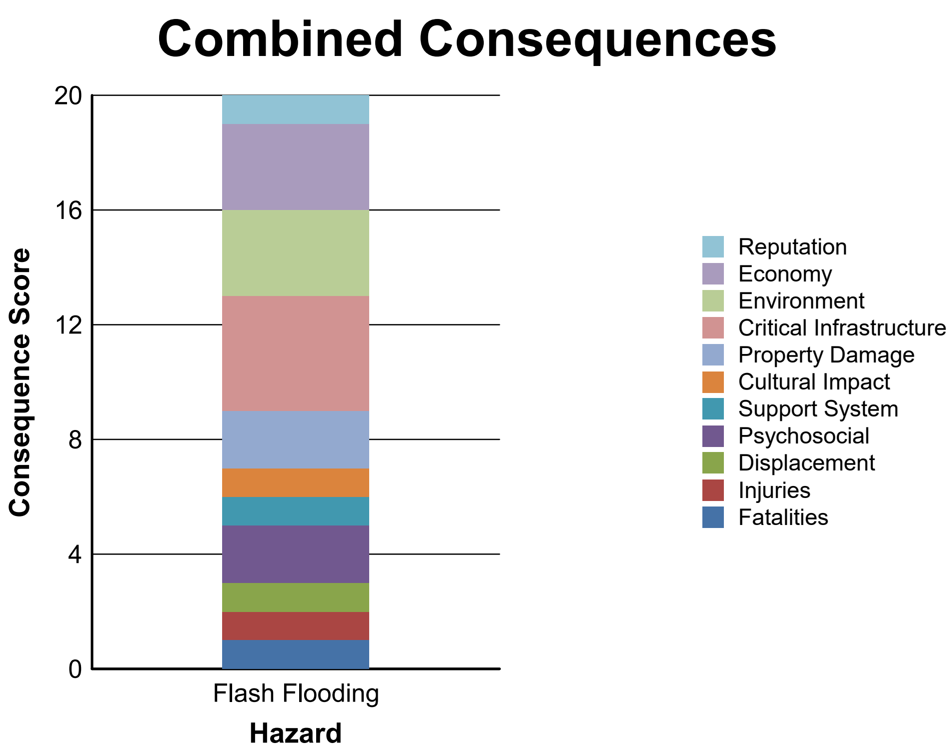


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Short duration high intensity rainfall (15 mm or more rainfall in 1 hour) was used as a proxy. Historical occurrence was 1 in 50 years. Data Source: IDF

Changes Observed to Date Summary

Occurrence of short duration high intensity rainfall events (proxy) is projected to increase to 1 in 25 years by the 2030s. Data Source: IDF; Flood mapping for the Okanagan Valley Watershed

Future Changes Expected Summary

Occurrence of short duration high intensity rainfall events (proxy) is projected to increase to 1 in 10 years by the 2050s. Data Source: IDF; Flood mapping for the Okanagan Valley Watershed

Existing Risk Reduction Measures

- Water Utility Emergency Response Plan (ERP) outlines responses to various emergency scenarios related to water supply and distribution.
- Watershed Master Plan guides management and use of the community's water supply system.
- The Mayor sits on the Okanagan Basin Water Board to stay informed and provide district representation. This provides opportunities to share and learn about water-based issues and regional collaboration.

New Risk Reduction Measures

- Identify likely routes flood water will travel & then mitigation measures, e.g., consider culvert sizes and drainage
- Change Subdivision & Development Servicing Bylaw road cross-section to include drainage swales, if not already included
- Consider natural asset management (i.e., what natural features present that could be used to slow flow of water?)
- Mapping out flash flood prone area in Summerland + implementation of green infrastructure

Individual Hazard Breakdown

Hazard: EXTREME COLD **Priority:** 13

Hazard Score: 12

Individual Hazard Summary Table

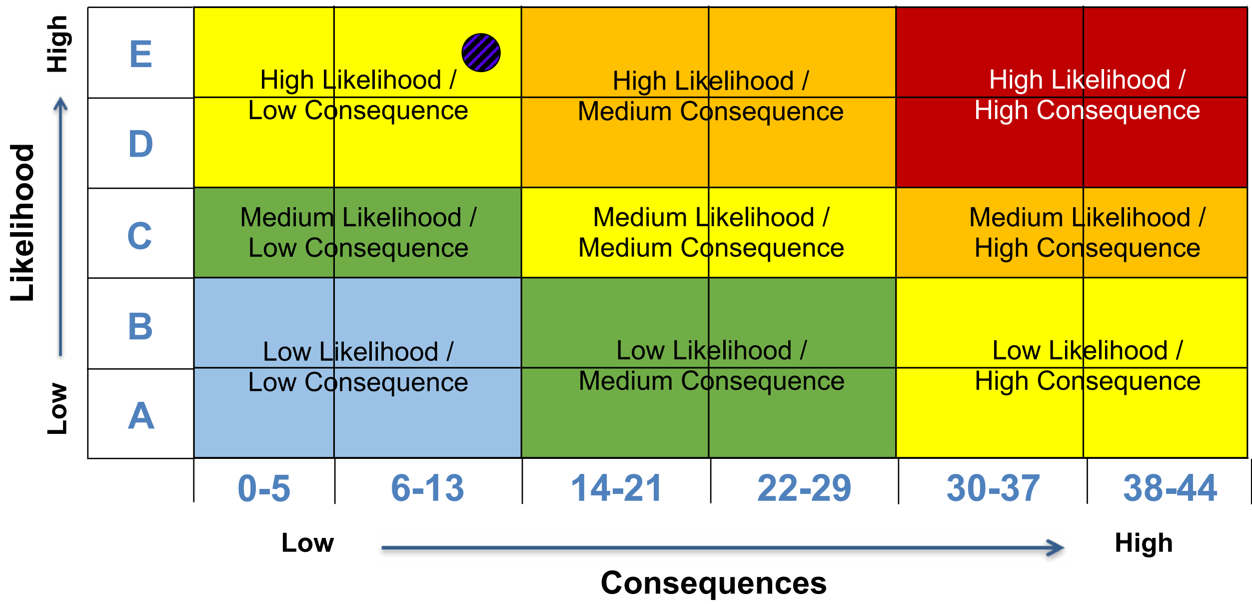
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
EXTREME COLD	E	12	High Likelihood/ Low Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Extreme Cold

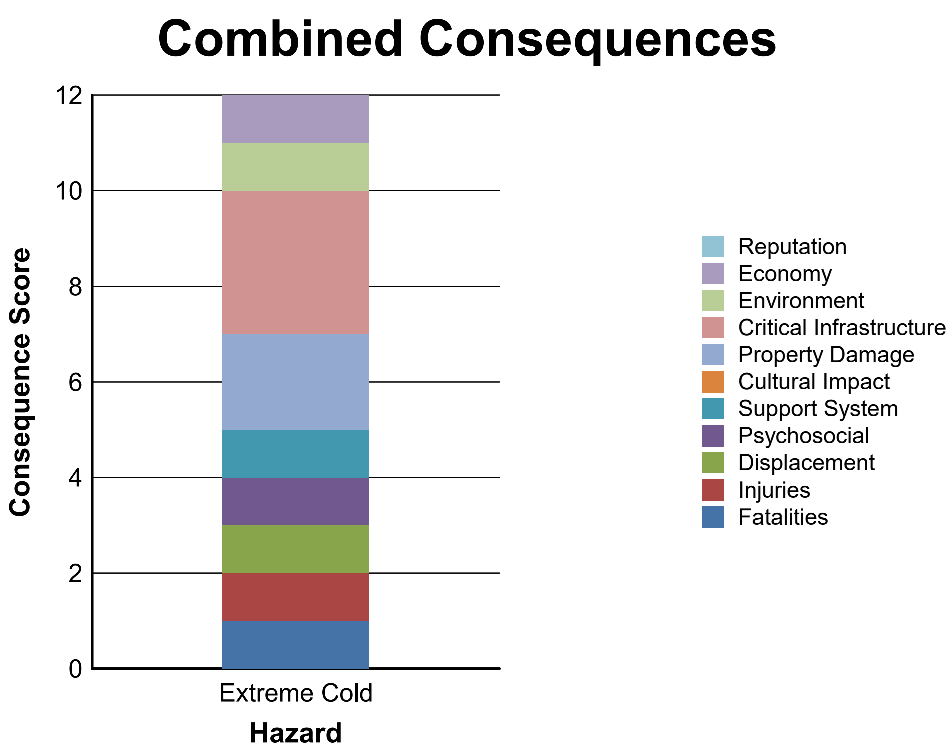


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was days/ year with Tmin ≤-15°C. Historical occurrence was 15.5 days per year. Data Source: NRCan (1981-2010)

Changes Observed to Date Summary

Occurrence of extreme cold events is projected to increase to 4.7 days per year by the 2030s. Data Source: CMIP 6 (SSP5-8.5)

Future Changes Expected Summary

Occurrence of extreme cold events is projected to decrease to 1.9 days per year by the 2050s. Data Source: CMIP 6 (SSP5-8.5)

Existing Risk Reduction Measures

- No emergency plan or space identified for homeless
- Standard operating procedures for sanding and ice cleaning for public safely
- No ID area for those with no ability to supplement heat to gather

New Risk Reduction Measures

- Adjustments to equipment specifications
- Shelters for vulnerable and homeless to keep warm and out of extreme conditions
- Development of extreme weather response plan
- Work with regional partners, such as SD67 to coordinate responses to extreme temperature events (i.e., sharing generators)
- Investigate whether building code sufficiently accounts for extreme temperatures in building requirements
- Work is being done through province – sealed well, contained, heat pumps, zero carbon.; revise at local level; ensure that Summerland is meeting higher Step Codes
- Retrofit older buildings – have in community/corporate emissions plans that retrofitting is encouraged, may be cost prohibitive. Can do better at promoting and encouraging in District.
- Following codes for new buildings, need more done for older buildings, e.g., PACE financing, Summerland Credit Union keen to introduce programme. Waiting for enabling legislation to allow District to do that.
- Property assessed clean energy (PACE) is an innovative tool that provides access to long-term financing for energy efficiency, water conservation, renewable energy, and resiliency measures for owners and developers of residential, commercial, industrial, institutional, and multifamily properties. PACE loans are repaid through an addition to property tax bills and are transferred from one owner to the next when the properties are sold.

Individual Hazard Breakdown

Hazard: FREEZING RAIN OR DRIZZLE Priority: 14

Hazard Score: 18

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
FREEZING RAIN OR DRIZZLE	C	18	Medium Likelihood/ Med Consequence	D

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence

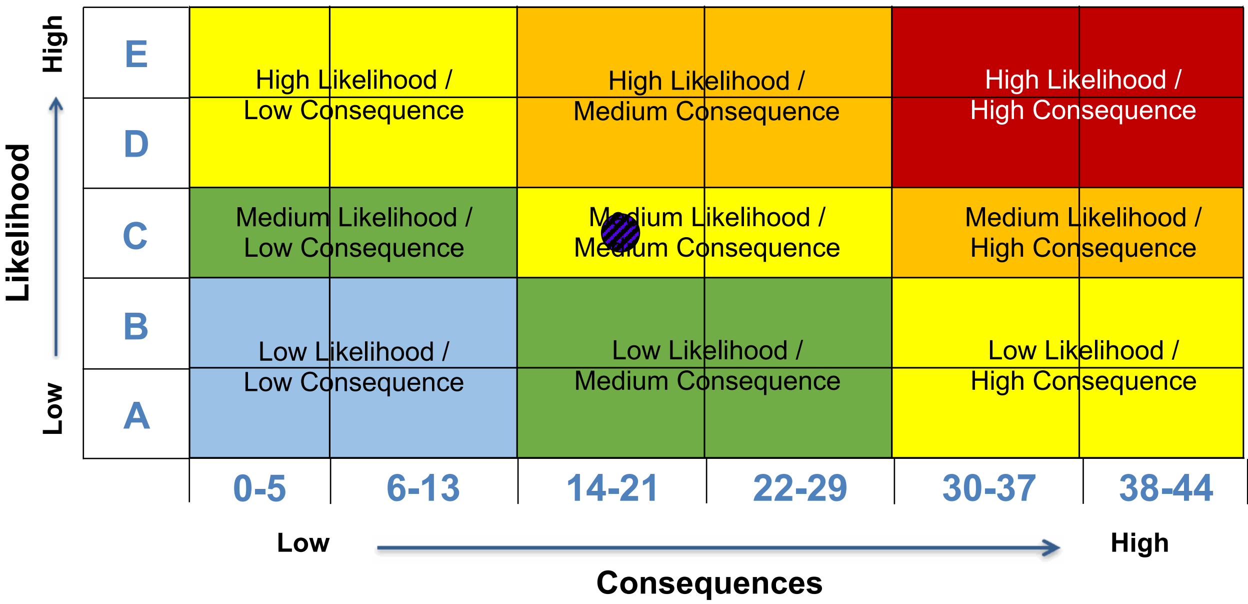
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Freezing Rain or Drizzle



Individual Consequence Breakdown

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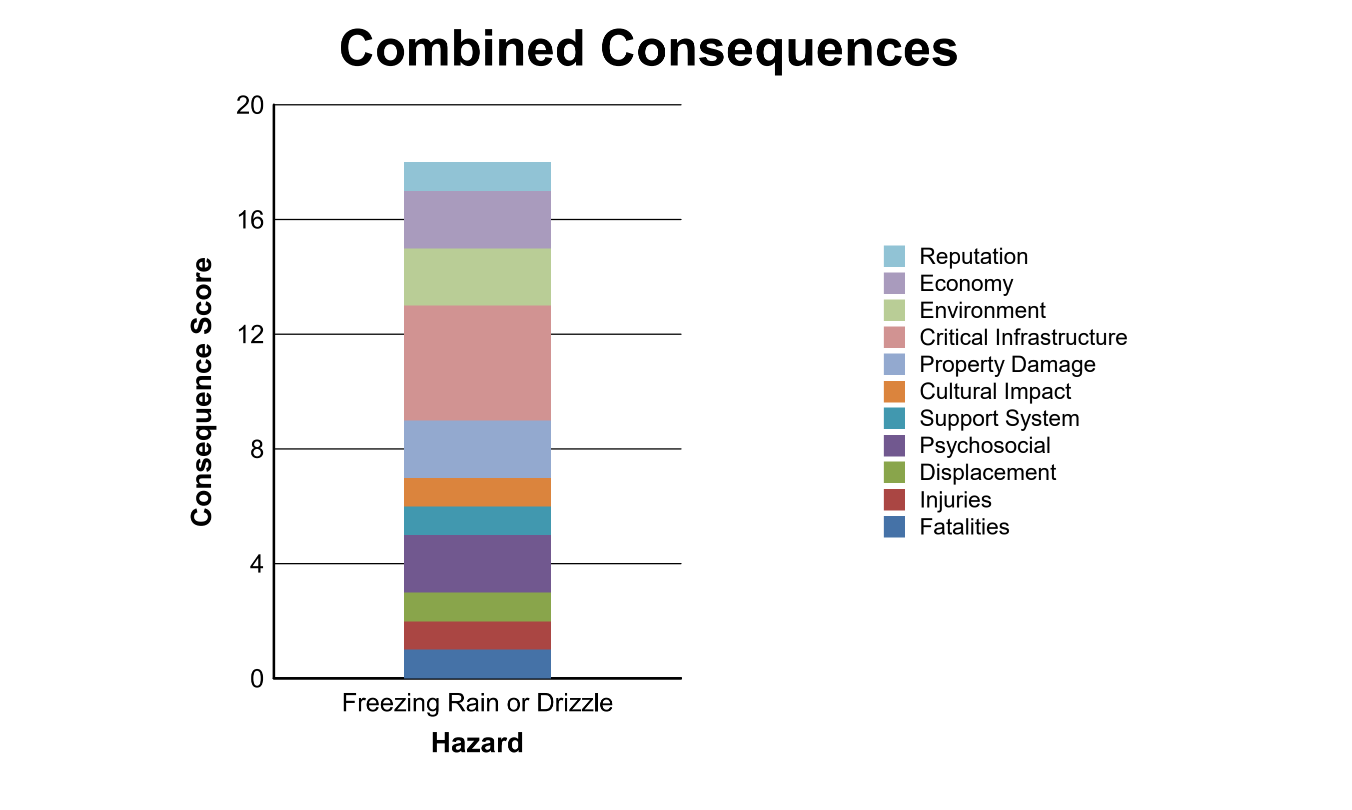
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was median annual hours of freezing rain. Historical occurrence was 5 - 10 hours per year. Data Source: McCray (2019) Fig 1a (1979-2016)

Changes Observed to Date Summary

Occurrence of freezing rain/drizzle events is projected to remain stable at 5 - 10 days per year by the 2030s. Data Source: McCray (2022) Fig 7

Future Changes Expected Summary

Occurrence of freezing rain/drizzle events is projected to increase to 15 - 22.5 days per year by the 2050s. Data Source: McCray (2022) Fig 7

Existing Risk Reduction Measures

- Electrical systems designed to withstand some amount of freezing

New Risk Reduction Measures

- Additional underground electrical systems
- Additional on-site material inventory

Individual Hazard Breakdown

Hazard: SNOWSTORMS AND BLIZZARDS **Priority:** 15

Hazard Score: 19

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
SNOWSTORMS AND BLIZZARDS	C	19	Medium Likelihood/ Med Consequence	D

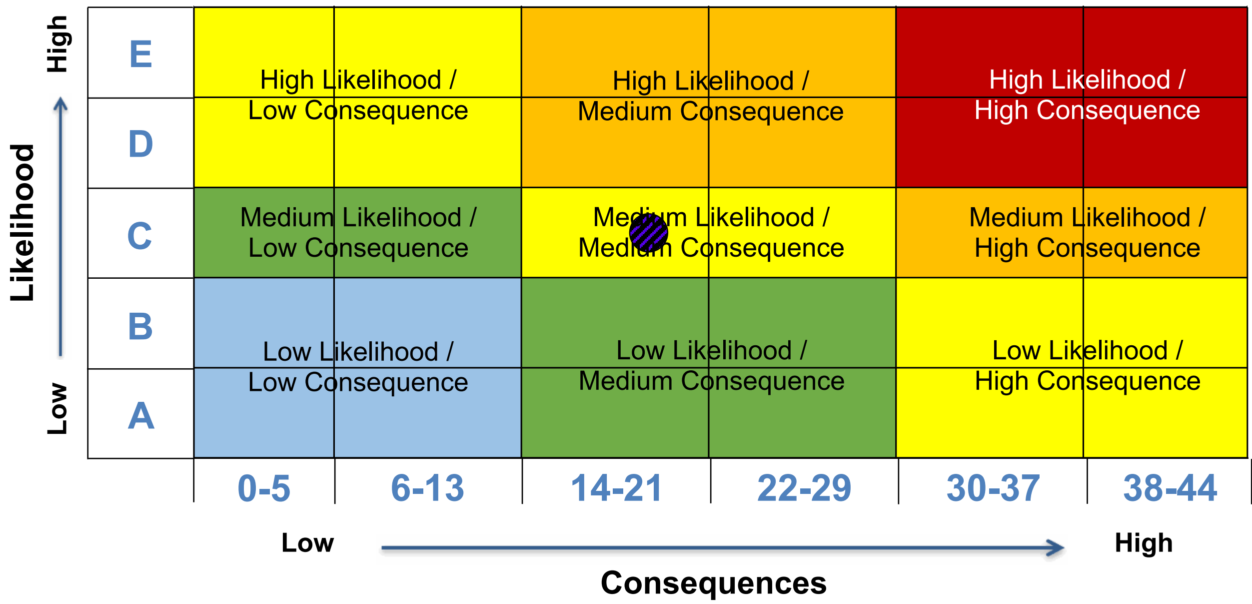
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Snowstorms and Blizzards

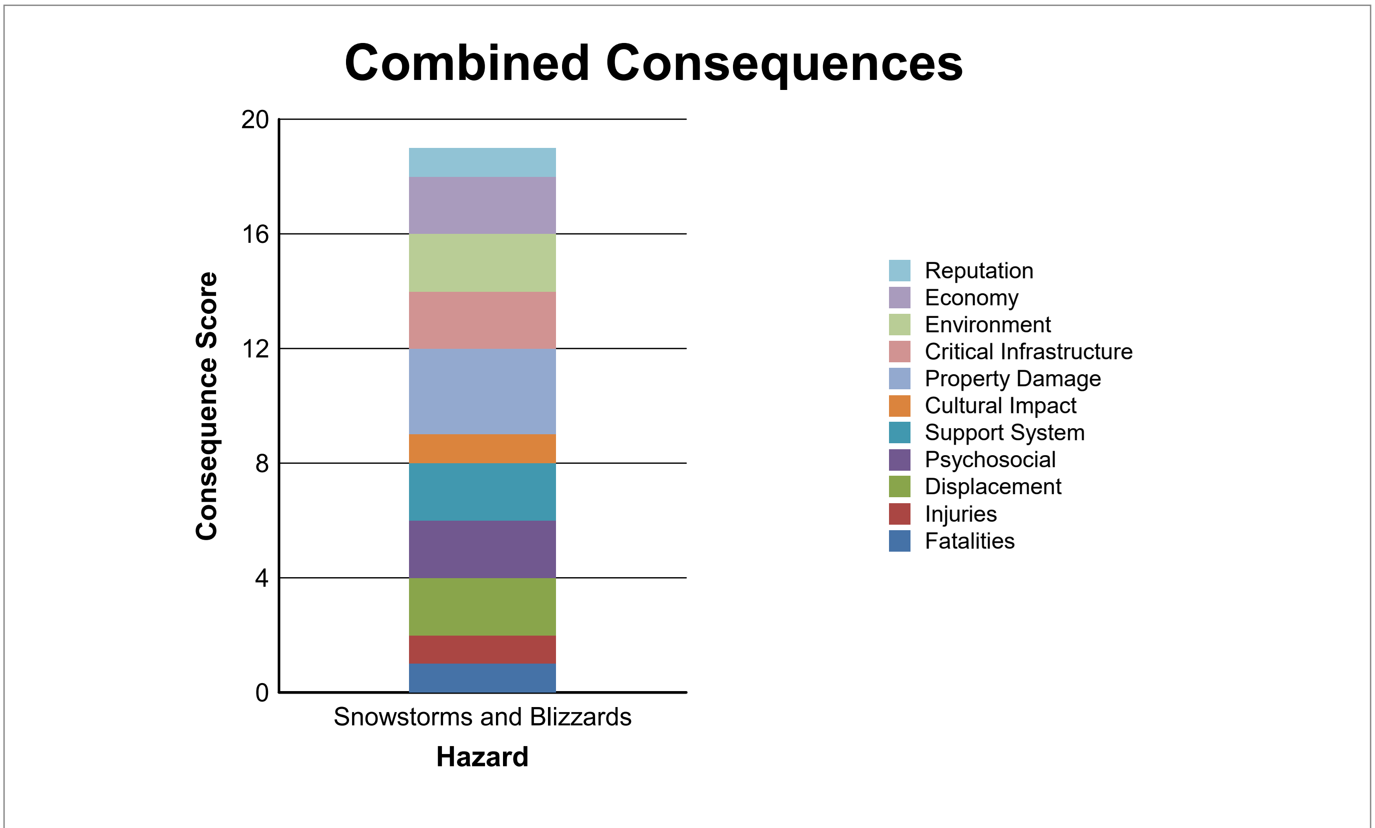


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was heavy snowfall (10 cm or more snowfall in 24 hours). Historical occurrence was 3.3 days per year. Data Source: ECCC Station (ID: 112G8L1)-113 days/34yr based on SNOW data

Changes Observed to Date Summary

Occurrence of heavy snowfall events is projected to increase by the 2030s.

Future Changes Expected Summary

Occurrence of heavy snowfall events is projected to increase by the 2050s.

Existing Risk Reduction Measures

- Standard procedures for snow cleaning and public communications
- Not selling or retiring surplus plow to build redundancy

New Risk Reduction Measures

- Establish emergency shelter if people get stuck in Summerland or cannot get home (back part of Summerland is quite a distance away and on narrow rural roads)
- Equipment sharing between regional partners and local governments if plows go down or more are needed

Individual Hazard Breakdown

Hazard: ANIMAL DISEASE **Priority:** 16

Hazard Score: 11

Individual Hazard Summary Table

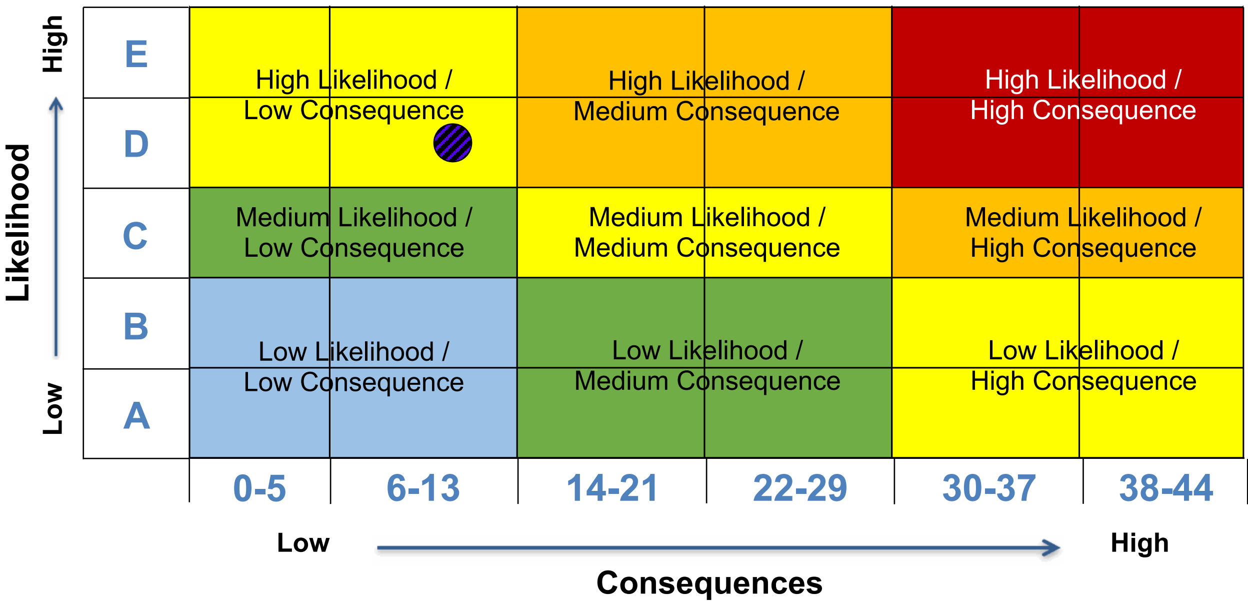
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
ANIMAL DISEASE	D	11	High Likelihood/ Low Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Animal Disease

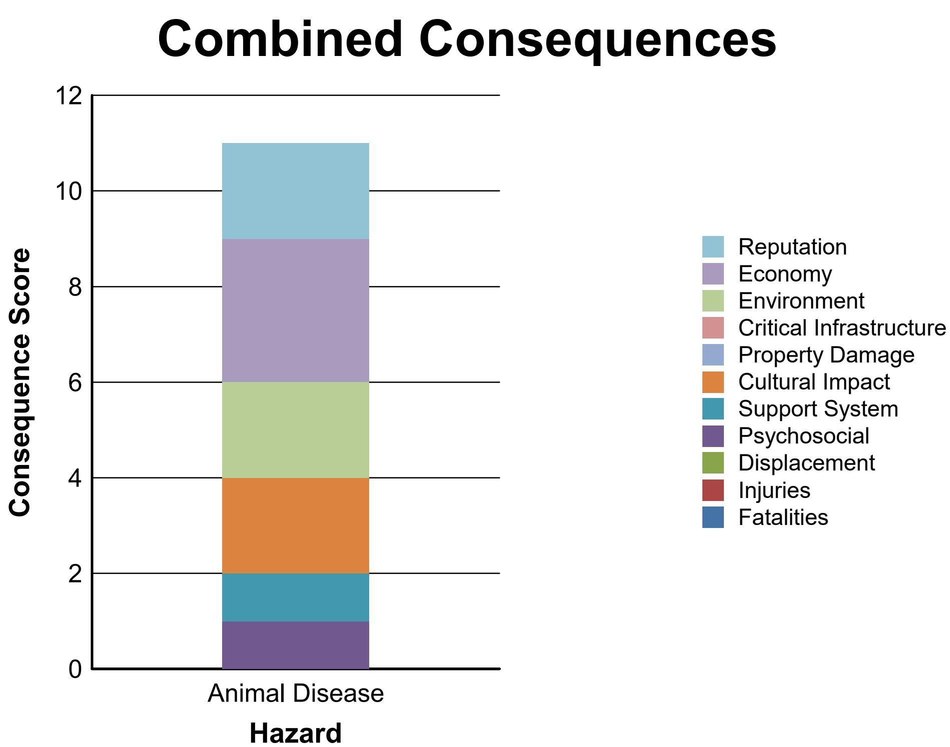


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Historically, frequency of occurrence of animal diseases in Summerland has been low. As of the publication of District's previous HRVA (2006), no cases of West Nile Virus had been reported in BC. However, avian influenza was being transmitted among bird species in the province and occurrence in Summerland was possible.

Changes Observed to Date Summary

Avian influenza cases have been increasing in BC, particularly among wild birds. Two cases were reported in Summerland in 2022. The Okanagan was among the first regions in BC to have confirmed cases of West Nile Virus in 2009. West Nile is thought to be the most widespread vector-borne disease in North America. Warming temperatures and spread of invasive species in the Okanagan and surrounding regions make it likely that animal diseases will increase in frequency in the District.

Future Changes Expected Summary

Warming temperatures and spread of invasive species in the Okanagan and surrounding regions make it likely that animal diseases such as avian influenza and West Nile Virus will increase in frequency in the District.

Existing Risk Reduction Measures

- Quarantine individual farms
- Communicating to all residents to stop bird feeders to reduce interactions with wild birds
- Vaccination awareness and uptake
- Disease transmission tracing
- Provincial monitoring of Corvidae (Crow Family) deaths (related to West Nile)

New Risk Reduction Measures

- Continued public education re: handwashing, animal handling, bites
- Collaborate with IH re: education, re: vector-borne disease (e.g., ticks, hantavirus, West Nile virus)

Individual Hazard Breakdown

Hazard: LIGHTNING Priority: 17

Hazard Score: 6

Individual Hazard Summary Table

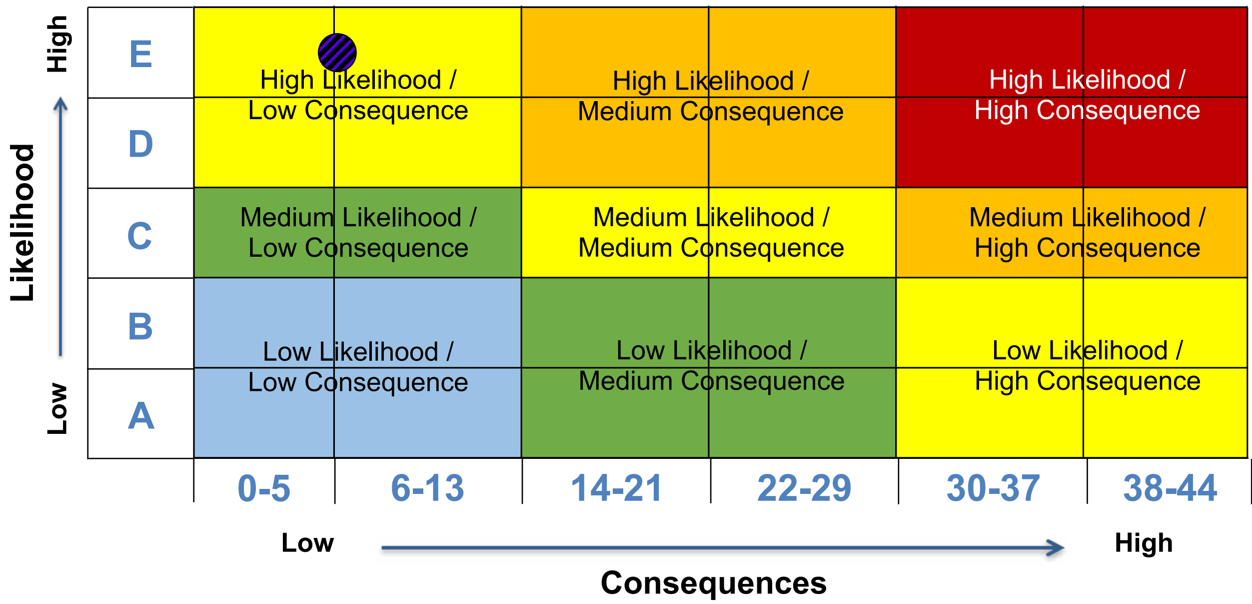
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
LIGHTNING	E	6	High Likelihood/ Low Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Lightning



Individual Consequence Breakdown

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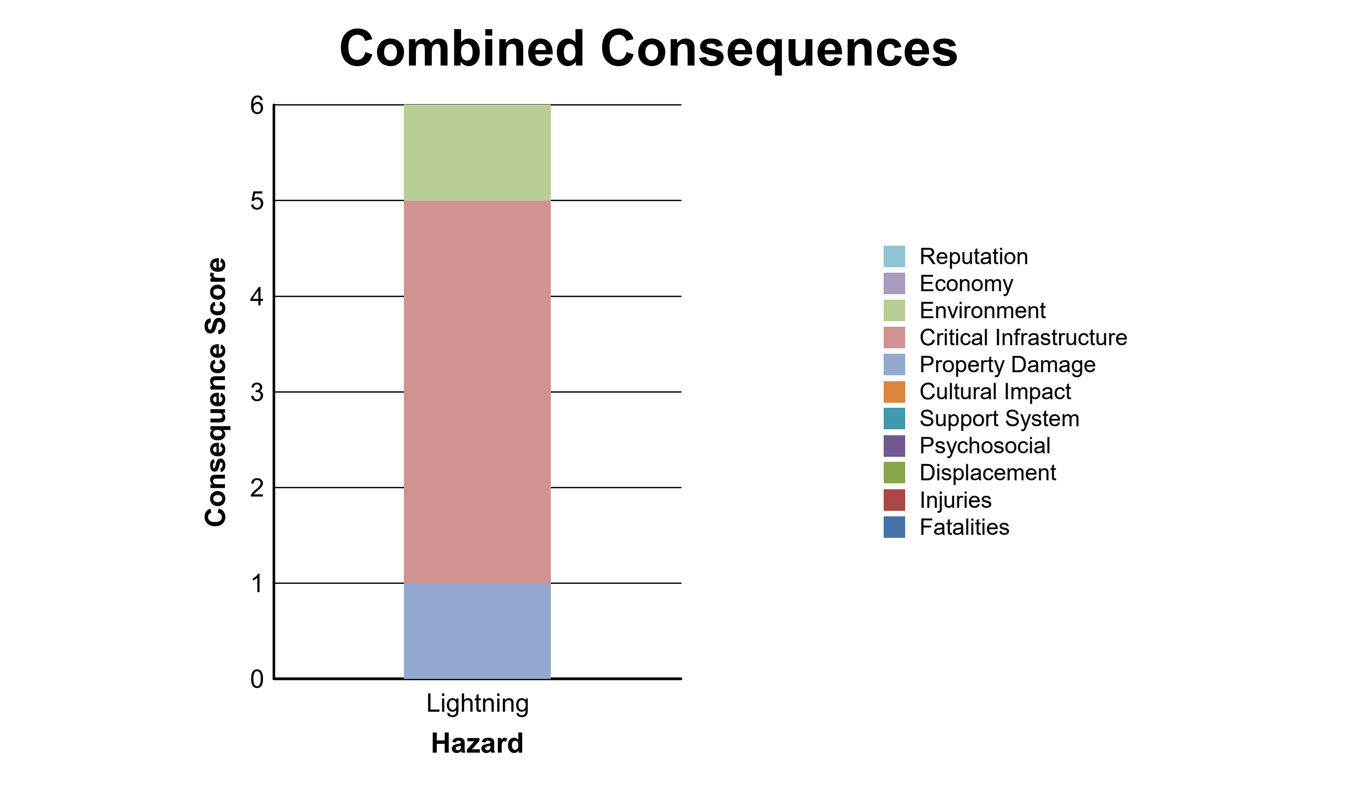
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was average number of days with lightning (within 25km). Historical occurrence was 24.4 days per year. Data Source: ECCC Lightning Activity in Canadian Cities - Penticton

Changes Observed to Date Summary

Occurrence of lightning events is projected to increase by the 2030s.

Future Changes Expected Summary

Occurrence of lightning events is projected to increase by the 2050s.

Existing Risk Reduction Measures

- Installing more lighting arresters (Waste Water Treatment Plant)

New Risk Reduction Measures

- Additional underground electrical systems

Individual Hazard Breakdown

Hazard: STRUCTURE FIRE Priority: 18

Hazard Score: 9

Individual Hazard Summary Table

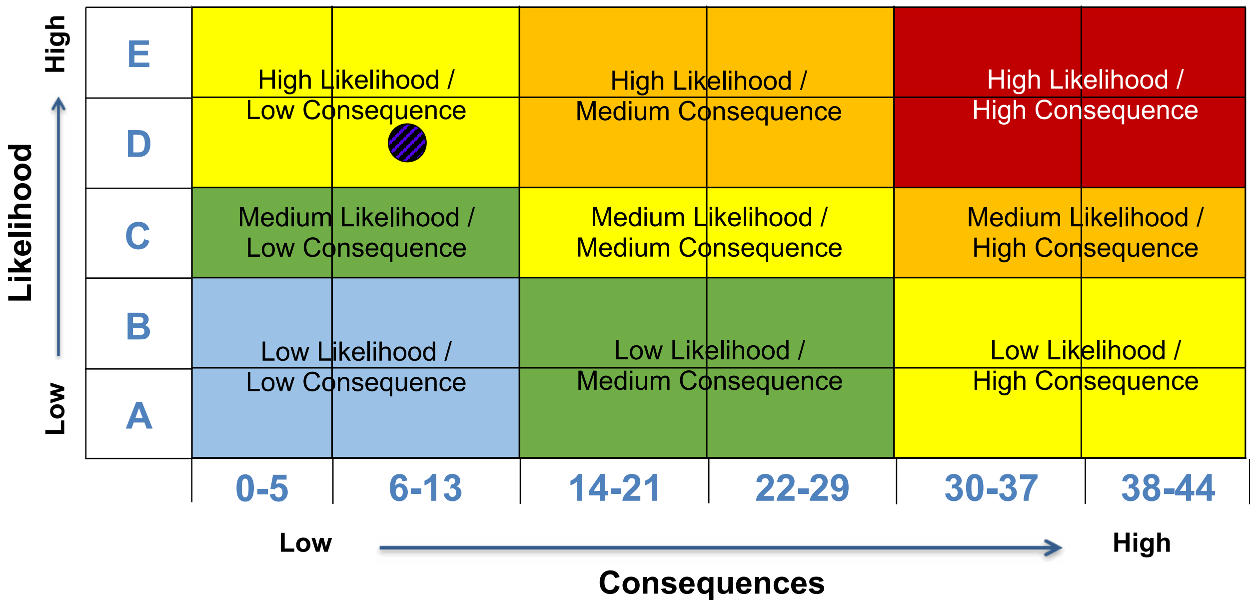
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
STRUCTURE FIRE	D	9	High Likelihood/ Low Consequence	D

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Structure Fire



Individual Consequence Breakdown

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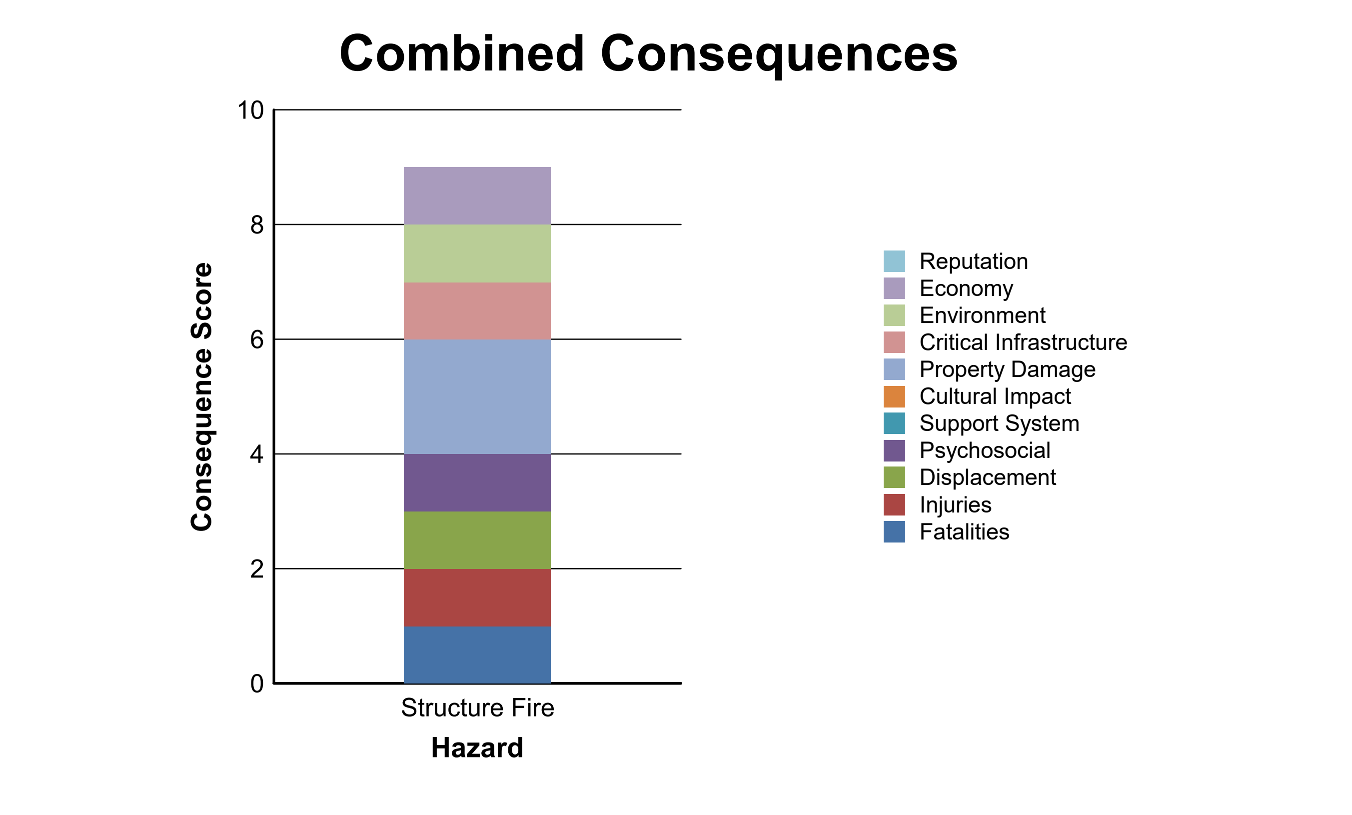
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Rate of occurrence of structure fires varies from year to year. Structure fires are most frequent in residential structures. Some houses may be more difficult to save due to their distance from the fire hall, ignition source or time of day. There may also be fires in non-residential structures (e.g., electrical fire in 2022). While the Summerland Fire Department responds quickly and has mutual aid agreements with neighbouring communities, structure fires are still likely in the District.

Changes Observed to Date Summary

Rate of occurrence of structure fires varies from year to year. While the Summerland Fire Department responds quickly and has mutual aid agreements with neighbouring communities, structure fires will continue to be likely in the District.

Future Changes Expected Summary

Structure fire incidents are likely to continue to occur at a similar rate in the District, given that they are not typically impacted by changing external influences.

Existing Risk Reduction Measures

- Full-service department – On-call person at all times
- Access to external capacity/human resources/regional support
- ESS (Emergency Support Services) e.g., Psychosocial support system
- Backup communications system if one fails
- Pre-fire plans (assess building materials/construction, start-to-finish assessments)

New Risk Reduction Measures

- Continue to implement building bylaws to provide continued protection of firefighters (volunteers) when calls happen

Individual Hazard Breakdown

Hazard: WATER SERVICE INTERRUPTION (INCLUDES SHORTAGE AND **Priority:** 19

Hazard Score: 14

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
WATER SERVICE INTERRUPTION (INCLUDES	C	14	Medium Likelihood/ Med Consequence	E

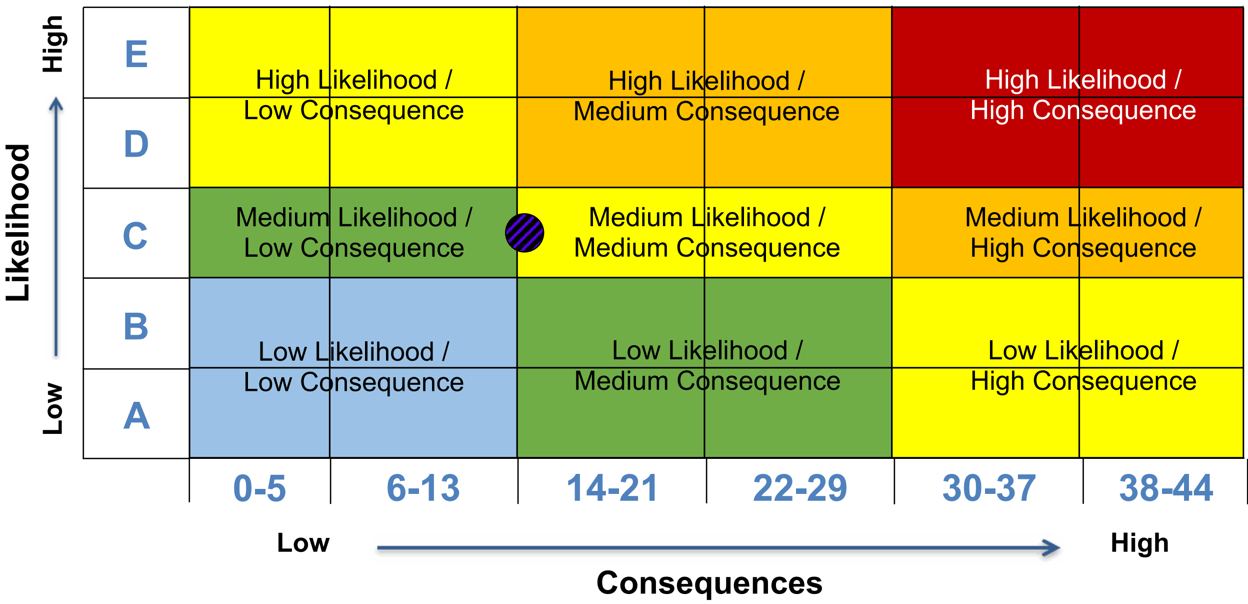
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Water Service Interruption (Includes shortage and contamination)



Individual Consequence Breakdown

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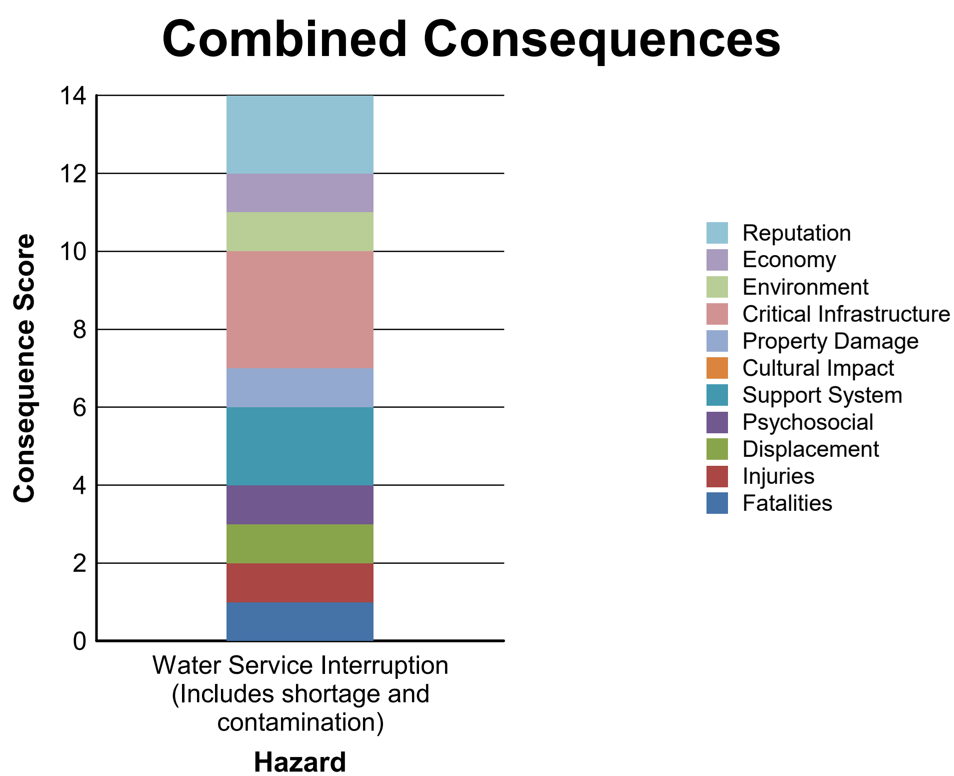
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Water service interruption has historically occurred with moderate frequency due to droughts, low volume due to extreme heat, and high turbidity and sedimentation due to flooding. The capacity of the Water Treatment Plant has been just enough to meet the needs of the community. In the event of demand exceeding supply, the District has bypassed the treatment plant and released 'Do Not Drink' or 'Boil Water' notices.

Changes Observed to Date Summary

Water service interruption is likely to increase in frequency due to warmer temperatures and increasing overland flooding due to short duration high intensity rainfall. The District has expanded its water supply by restructuring supply zones (e.g., separating Prairie Valley and Garnett Valley from main supply), which offsets some of the potential for interruptions.

Future Changes Expected Summary

Changes in climate will impact water availability, e.g., warming may increase algal growth in reservoirs, increase in droughts may reduce creek volume, increase in wildfires may degrade watersheds, As a result, water service interruptions are likely to increase in frequency. Several water service risk mitigation measures are in place in reduce the consequences of such events.

Existing Risk Reduction Measures

- Routes of contamination from Summerland landfill to Summerland Reservoir are monitored via active monitoring wells to prevent contamination.
- Water Utility Emergency Response Plan (ERP) outlines responses to various emergency scenarios related to water supply and distribution, including water interruptions.
- Water Conservation Plan provides guidance for water conservation initiatives in the District to avoid low volume scenarios.
- Watershed Master Plan guides management and use of the community's water supply system.
- Consideration of 2nd water source underway (e.g., OK Lake) recognize would be difficult and costly
- District Water Management Plans
- We have a 2nd water intake license from the lake

New Risk Reduction Measures

- Increased infrastructure capital/operational budgets

Individual Hazard Breakdown

Hazard: MAJOR PLANNED EVENT Priority: 20

Hazard Score: 12

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
MAJOR PLANNED EVENT	E	12	High Likelihood/ Low Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

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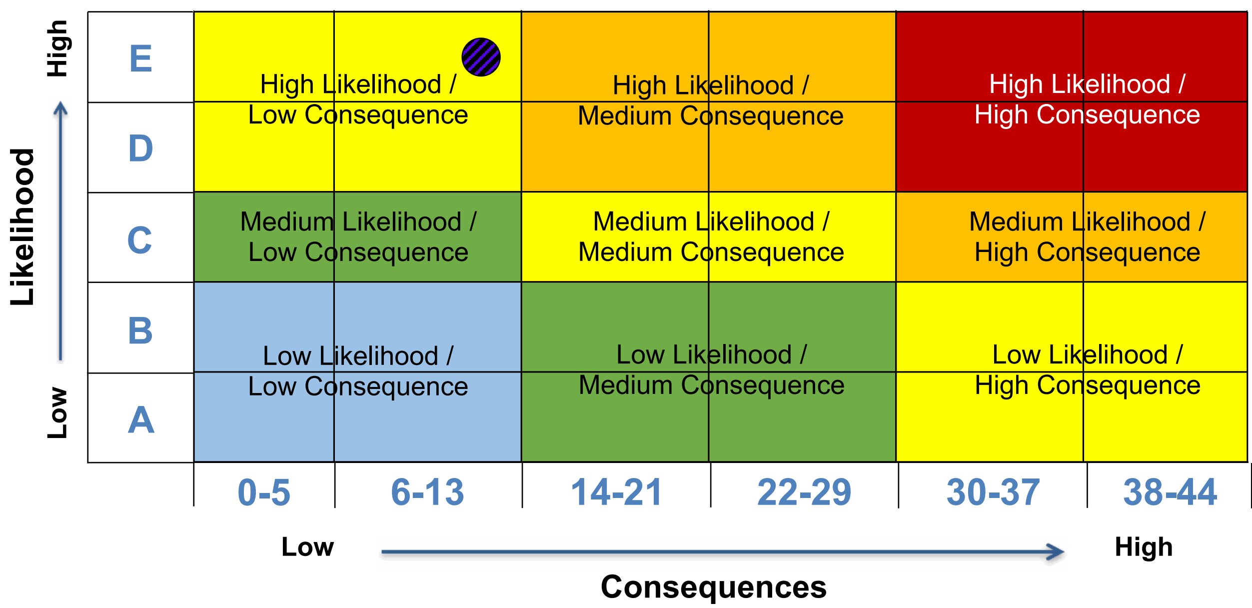
RISK MATRIX TABLE

For Major Planned Event



Individual Consequence Breakdown

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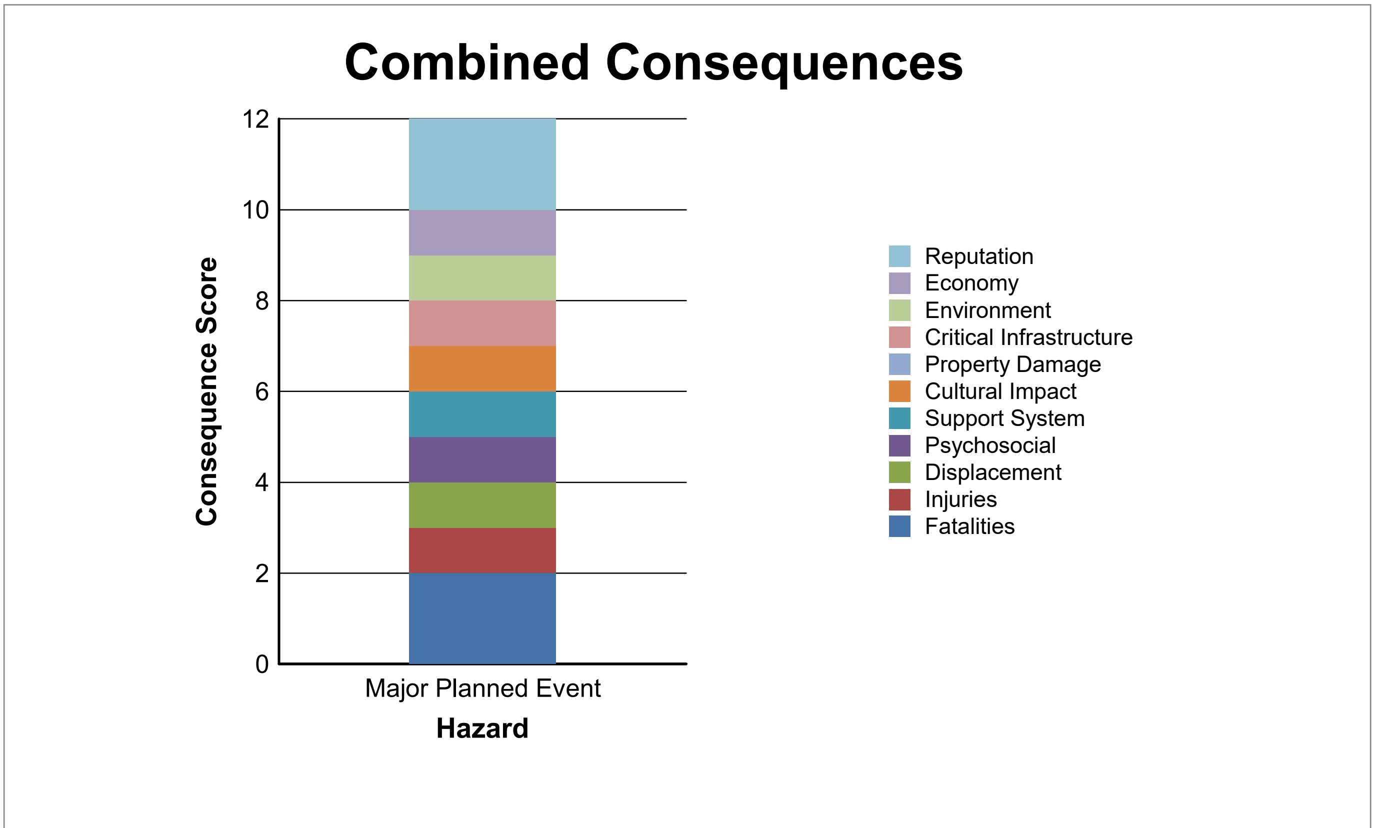
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Major planned events have historically been regular occurrences in Summerland. During the end of year Festival of Lights, more staff has to be brought in to assist, e.g., RCMP. This is arranged by Chamber of Commerce. Some of these events disrupt the Downtown core, e.g., Sunday market may block roads and divert response vehicles. There are also other large scale events that occur in or pass through Summerland that may cause disruption to normal operations, e.g., Gran Fondo.

Changes Observed to Date Summary

Major planned events are regular occurrences in Summerland. During the end of year Festival of Lights, more staff has to be brought in to assist, e.g., RCMP. This is arranged by Chamber of Commerce. Some of these events disrupt the Downtown core, e.g., Sunday market may block roads and divert response vehicles. There are also other large scale events that occur in or pass through Summerland that may cause disruption to normal operations, e.g., Gran Fondo.

Future Changes Expected Summary

Farmers' markets, festivals, and other events occur regularly in Summerland and are likely to continue.

Existing Risk Reduction Measures

- The Water Utility Emergency Response Plan (ERP) outlines responses to various emergency scenarios related to water supply and distribution.
- The Watershed Master Plan guides management and use of the community's water supply system.
- Traffic is diverted
- IH regulators & oversees food vendors, drinking water for mass gatherings, and other public health measures as applicable, e.g., wastewater, harm reduction supplies

New Risk Reduction Measures

- Enforcement sharing programs between communities during major events
- Development of a Major Events Bylaw to provide guidance and direction on management planning, enforcement etc.

Individual Hazard Breakdown

Hazard: MOTOR VEHICLE INCIDENT **Priority:** 21

Hazard Score: 11

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
MOTOR VEHICLE INCIDENT	E	11	High Likelihood/ Low Consequence	E

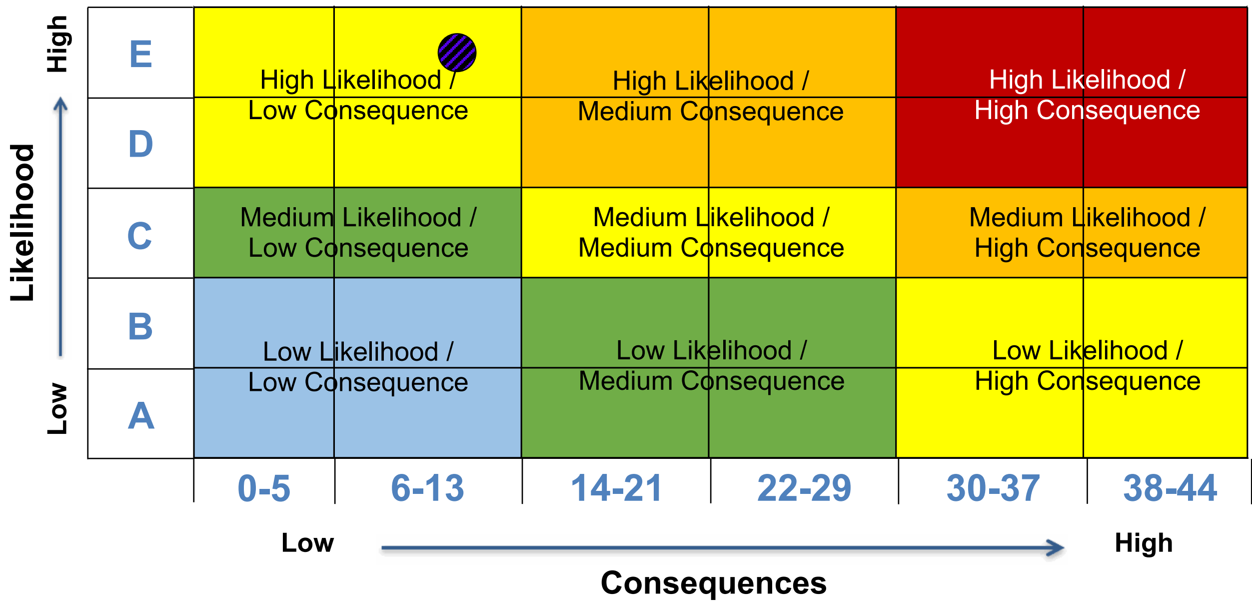
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Motor Vehicle Incident

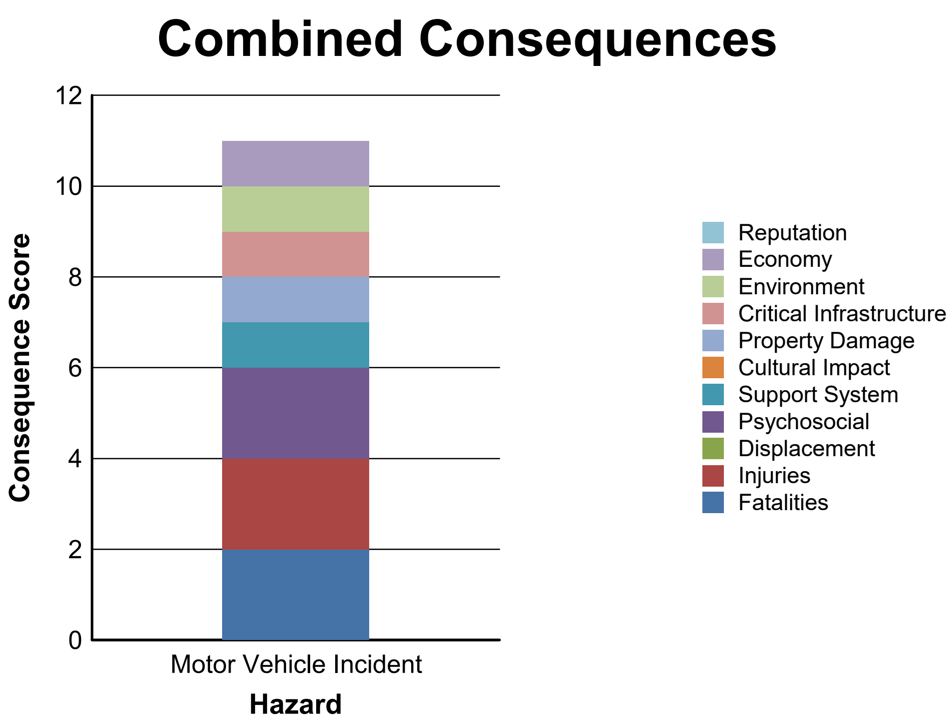


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Motor vehicle incidents vary in annual frequency. They are almost certain to occur in the District, particularly on Highway 97 given that it is a major north-south highway in the region.

Changes Observed to Date Summary

Motor vehicle incidents vary in annual frequency. They are almost certain to occur in the District, particularly on Highway 97 given that it is a major north-south highway in the region. There were 101 motor vehicle crashes in 2021, 32 of which resulted in casualties (Insurance Corporation of British Columbia).

Future Changes Expected Summary

Motor vehicle incidents are likely to continue to occur at a similar rate in the District, given that they are not typically impacted by changing external influences.

Existing Risk Reduction Measures

- Highway 97 and Prairie Valley Rd – changing lighting sequence
- Speed limits have been reviewed by council
- Advocated jerseys barriers on Highway 97 in both directions
- Requested bike path on the bike side of jersey barriers

New Risk Reduction Measures

- Fire Department is looking to expand its jaws of life in case of multiple calls

Individual Hazard Breakdown

Hazard: MARINE VESSEL INCIDENT **Priority:** 22

Hazard Score: 7

Individual Hazard Summary Table

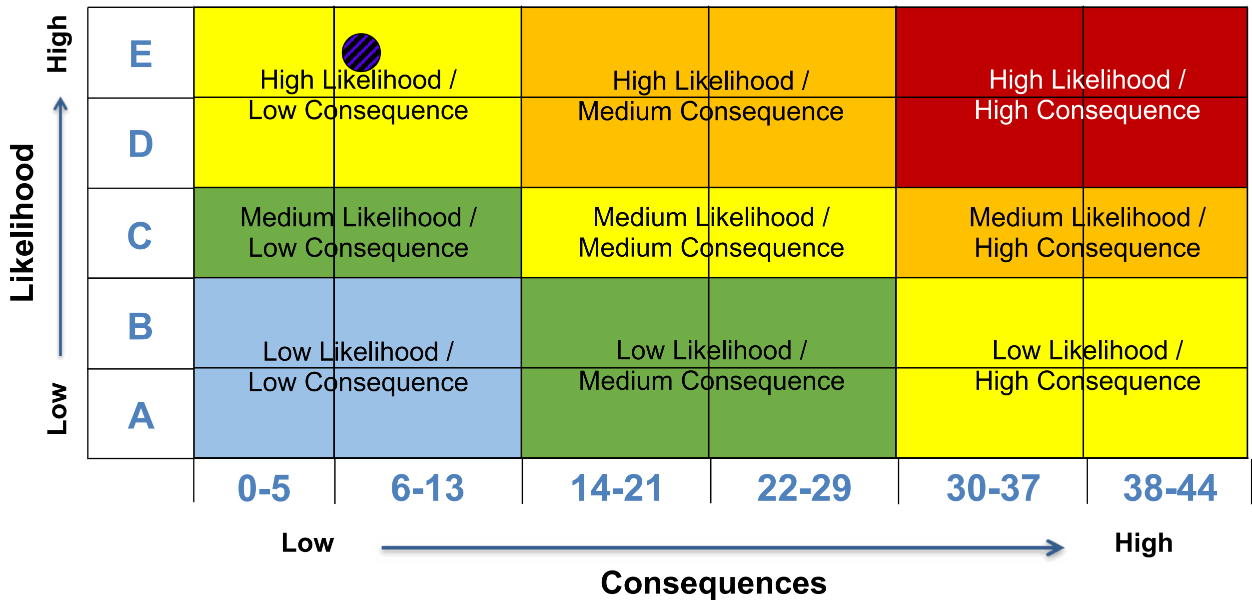
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
MARINE VESSEL INCIDENT	E	7	High Likelihood/ Low Consequence	E

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Marine Vessel Incident

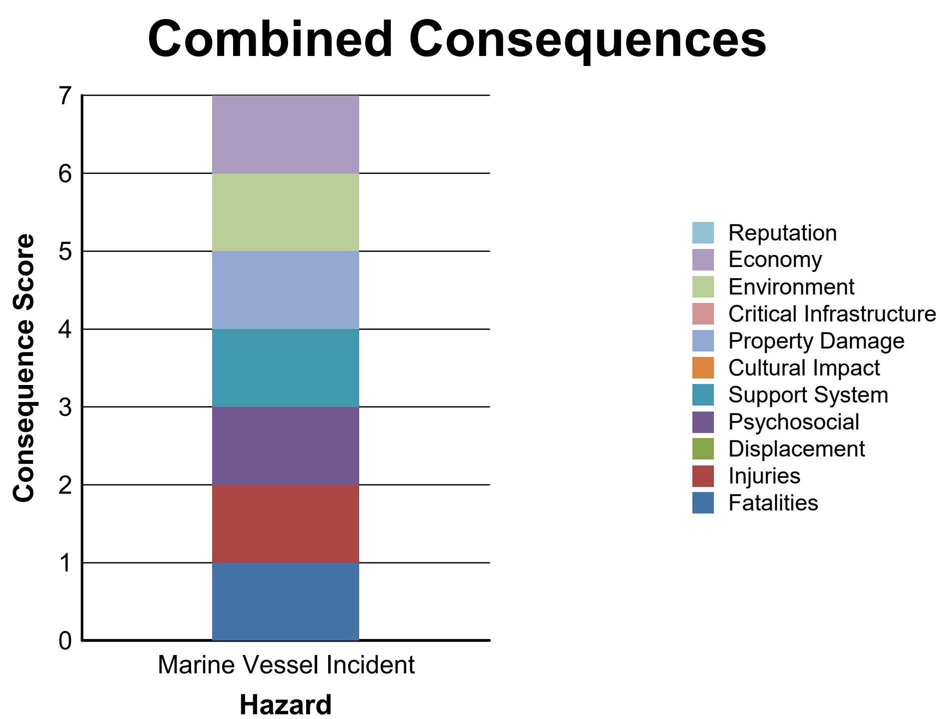


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There is a high level of recreational boating activity on Okanagan Lake by local residents and tourists. While response capacity from the neighbouring City of Penticton is high after incidents occur, marine vehicle incidents are almost certain to occur along the coast of the District.

Changes Observed to Date Summary

There is a high level of recreational boating activity on Lake Okanagan by local residents and tourists. While response capacity from the neighbouring City of Penticton is high after incidents occur, marine vehicle incidents are almost certain to occur along the coast of the District. There is potential for recreational boating collisions, explosions, petroleum spills, human injury/death on Okanagan Lake, e.g., fatal boat accident in 2021 involving an off-duty RCMP officer on Lake Okanagan in the vicinity of Summerland.

Future Changes Expected Summary

Marine vehicle incidents are likely to continue to occur at a similar rate in the District, given that they are not typically impacted by changing external influences.

Existing Risk Reduction Measures

- Naramata and Penticton Fire respond to these types of incidents. Not Summerland.

New Risk Reduction Measures

- Does Summerland have an appetite for a boat that is run by the fire department?

Individual Hazard Breakdown

Hazard: DAM AND SPILLWAYS FAILURE Priority: 23

Hazard Score: 20

Individual Hazard Summary Table

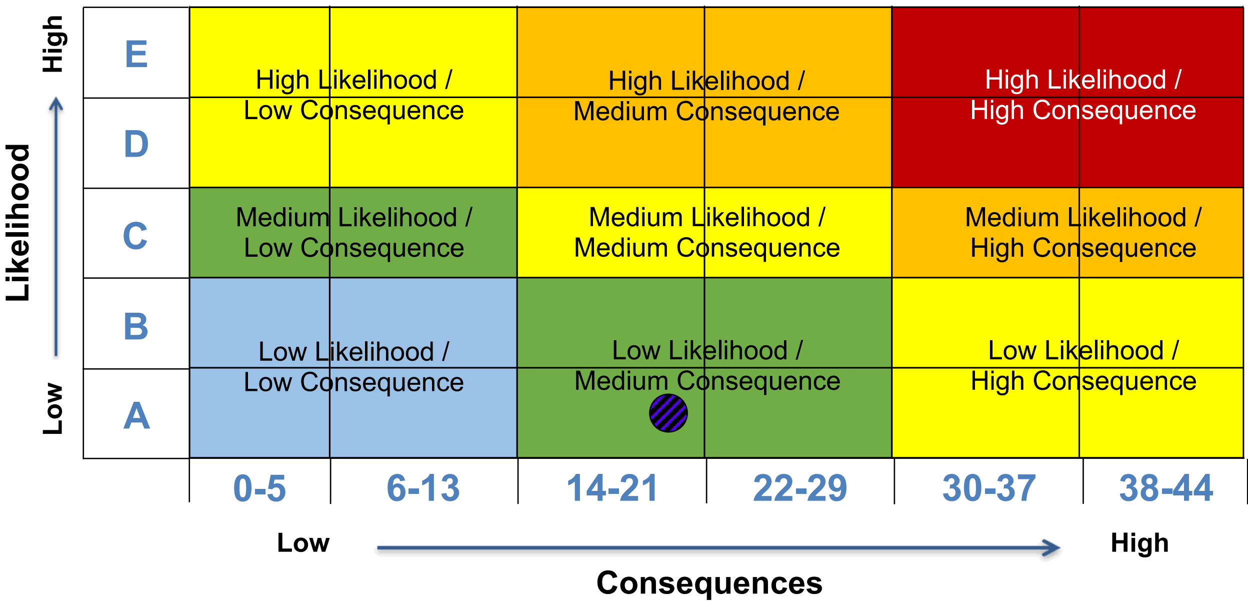
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
DAM AND SPILLWAYS FAILURE	A	20	Low Likelihood/ Med Consequence	B

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Dam and Spillways Failure

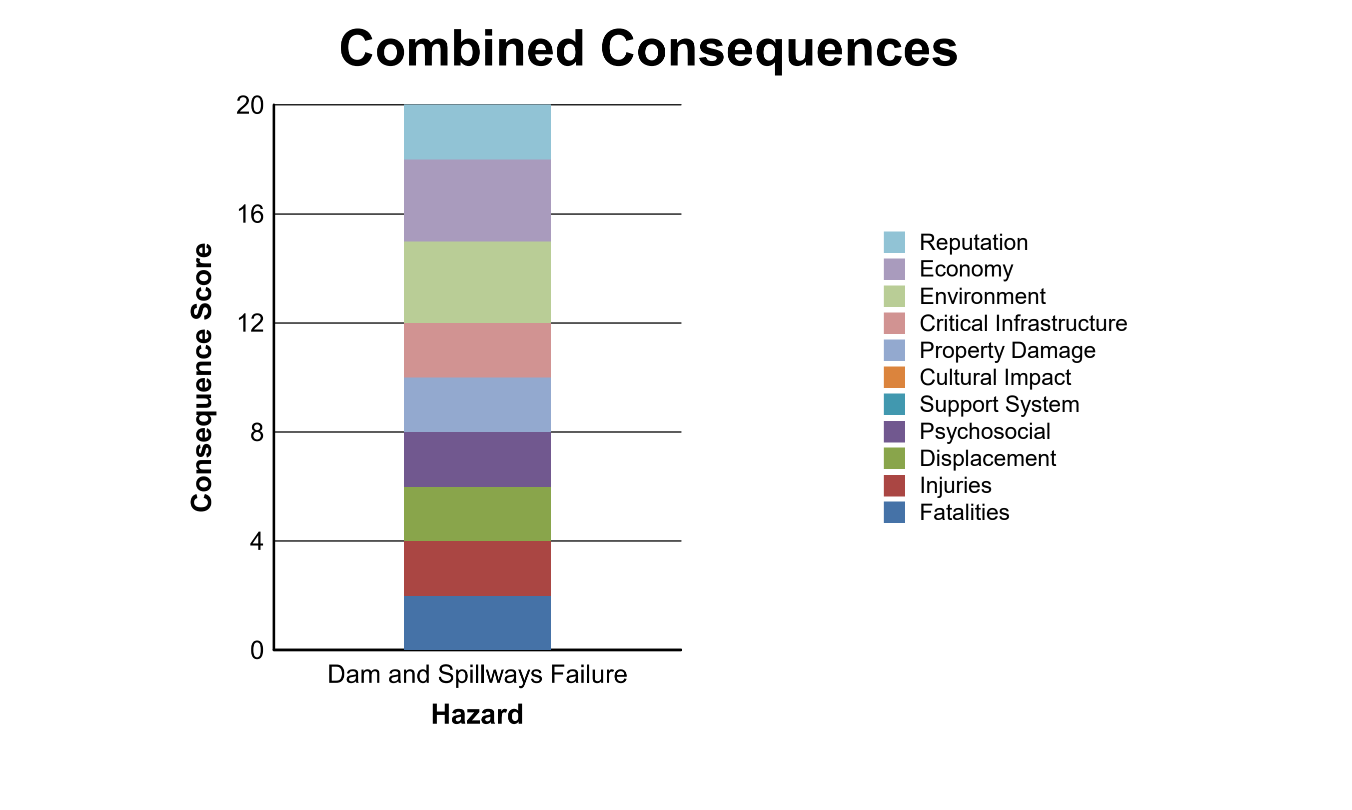


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of dam/spillway failure in Summerland.

Changes Observed to Date Summary

There are no noted incidents of dam/spillway failure in Summerland.

Future Changes Expected Summary

Due to extensive controls and risk avoidance measures, it is unlikely that dams/spillways will fail in the future. However, there is potential for more frequent overtopping and algal growth in reservoirs due to changes in climate.

Existing Risk Reduction Measures

- The district is installing early warning systems on dams in case of breach or unusual increase in flow.
- The Water Utility Emergency Response Plan (ERP) outlines responses to various emergency scenarios related to water supply and distribution, including dam and spillway failure.
- Regulatory monitoring and maintenance to maintain permit
- Possible use/respirator if air raid siren notification
- Improvements to dam(s) currently happening (grant received)

New Risk Reduction Measures

- Establish community emergency siren to warn of spills/emergencies at dam

Individual Hazard Breakdown

Hazard: WASTEWATER INTERRUPTION Priority: 24

Hazard Score: 18

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
WASTEWATER INTERRUPTION	B	18	Low Likelihood/ Med Consequence	C

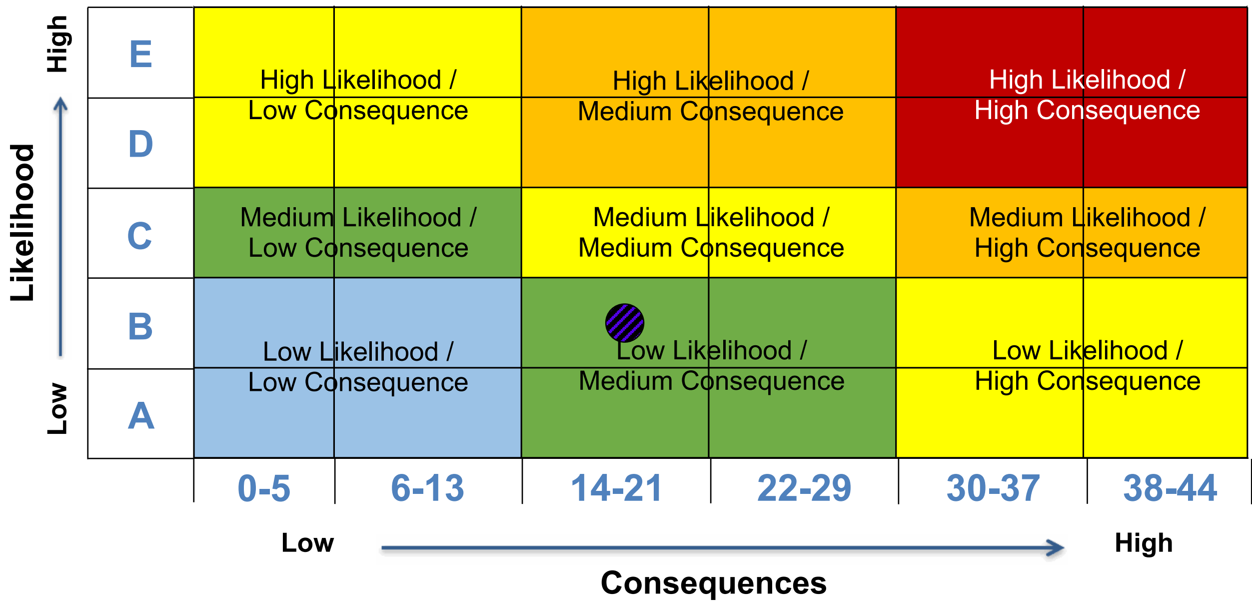
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Wastewater Interruption

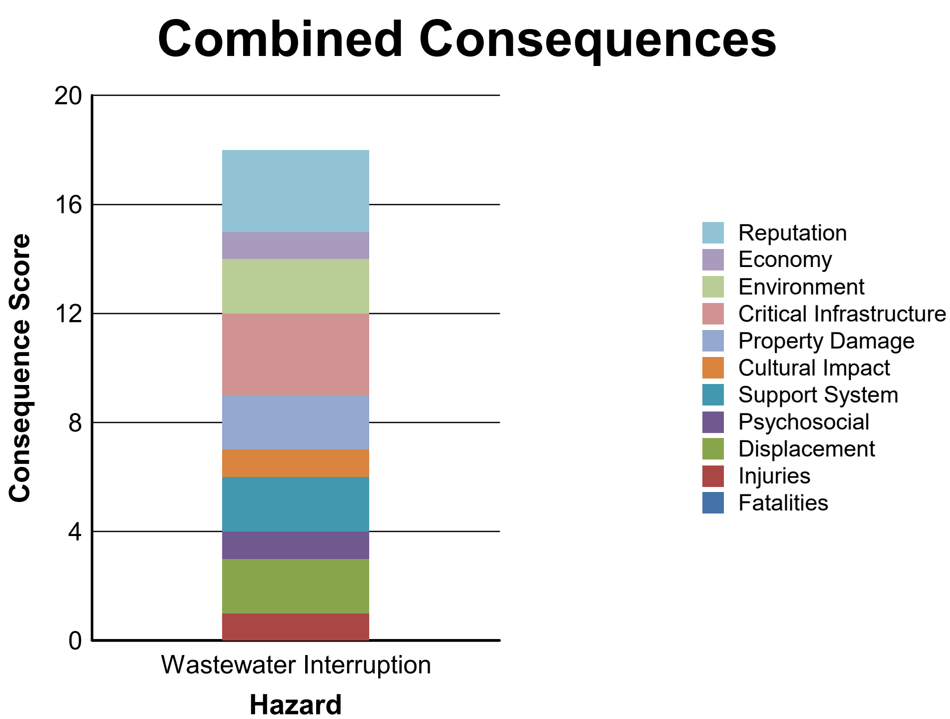


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Wastewater capacity is currently sufficient and additions are made as developments occur. Developers are required to pay for installation of sanitary piping for new developments.

Changes Observed to Date Summary

Wastewater capacity is currently sufficient and additions are made as developments occur. Developers are required to pay for installation of sanitary piping for new developments.

Future Changes Expected Summary

Wastewater capacity is currently sufficient and additions are made as developments occur. The population of Summerland is growing rapidly, and sanitation/wastewater requirements have the potential to exceed the rate at which wastewater infrastructure can be installed.

Existing Risk Reduction Measures

- The Wastewater Treatment Plant (WWTP) has been upgraded, including higher efficiency boilers, reduction of chemical use, and optimized equipment operation. When development occurs, the developer pays for necessary adjustments to sanitary piping.
- Mobile wastewater treatment plant EA is available on the market
- Summerland controls water supply, so can reduce wastewater effluent
- Wastewater Emergency Response Plan is 5 year capital program
- EOC (Emergency Operations Centre) would be involved if a disaster or event of the WWTP occurred with IH providing support during the event
- IH usually provides support during events, but more so after events to help with community outreach

Individual Hazard Breakdown

Hazard: HURRICANE/TYPHOON/HIGH WIND EVENT Priority: 25

Hazard Score: 15

Individual Hazard Summary Table

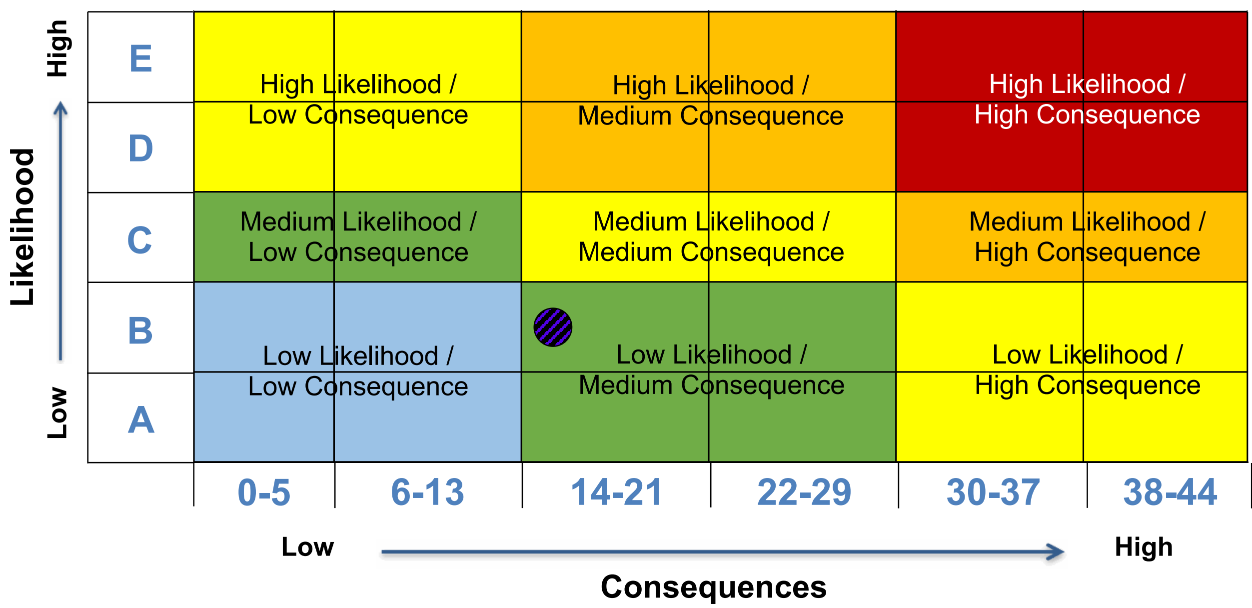
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
HURRICANE/TYPHOON/HIGH WIND EVENT	B	15	Low Likelihood/ Med Consequence	C

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Hurricane/Typhoon/High Wind Event

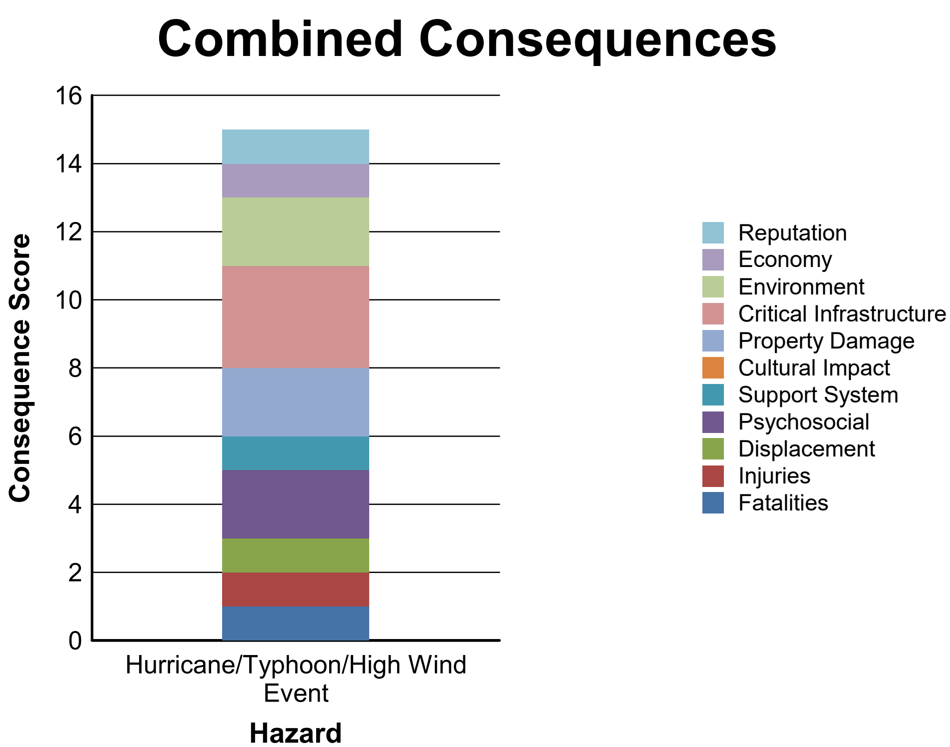


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

High wind event threshold used was wind gusts greater than or equal to 90km/hr. Historical occurrence was 1 in 100+yrs. Data Source: ECCC Station (ID: 112G8L1)- there are only 2 days when wind gusts are 90km/hr or more within 34 years of record.

Changes Observed to Date Summary

Occurrence of high wind events is projected to remain stable into the 2030s. Data Source:
ECCC Resilience Report- Wind Pressure Table 5.1

Future Changes Expected Summary

Occurrence of high wind events is projected to increase by the 2050s. Data Source: ECCC Resilience Report- Wind Pressure Table 5.1

Existing Risk Reduction Measures

- Increased budget for tree brushing.
- More proactive less reactive. Specifications are written “per tree” as go out to R.F.P. Brushing program now in place.

New Risk Reduction Measures

- Like Firesmart put out public information and advice
- Possibly turning of sections of town during high winds and drought/high heat to reduce chance of wires sparking fires
- Transition to underground utilities

Individual Hazard Breakdown

Hazard: NATIONAL SECURITY THREAT **Priority:** 26

Hazard Score: 14

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
NATIONAL SECURITY THREAT	A	14	Low Likelihood/ Med Consequence	C

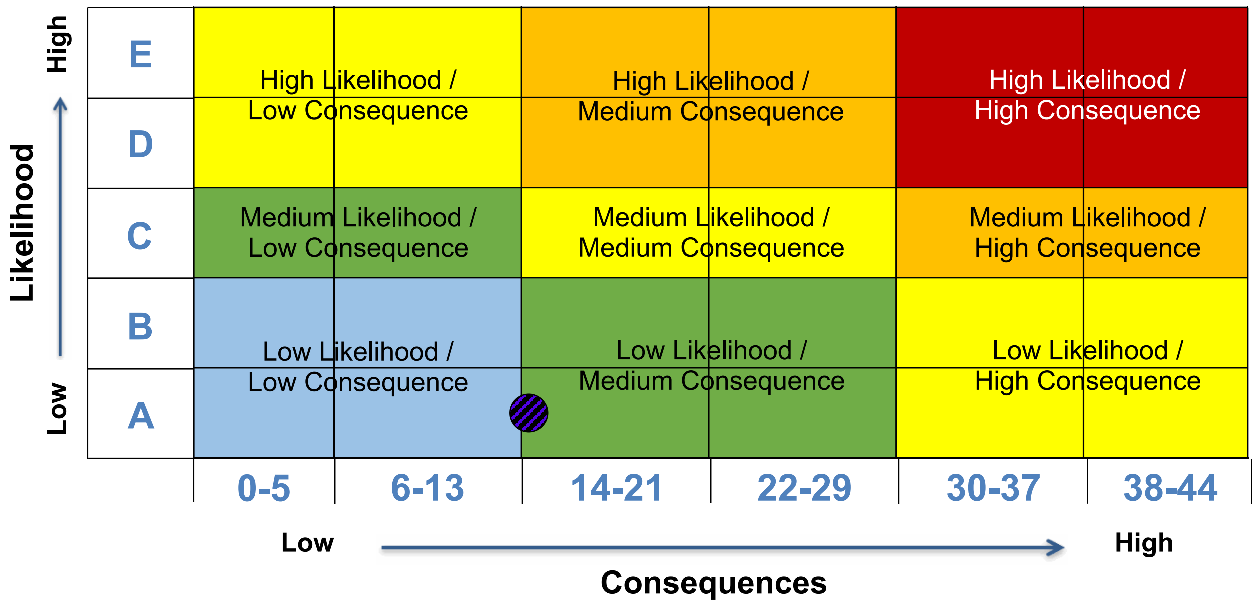
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For National Security Threat

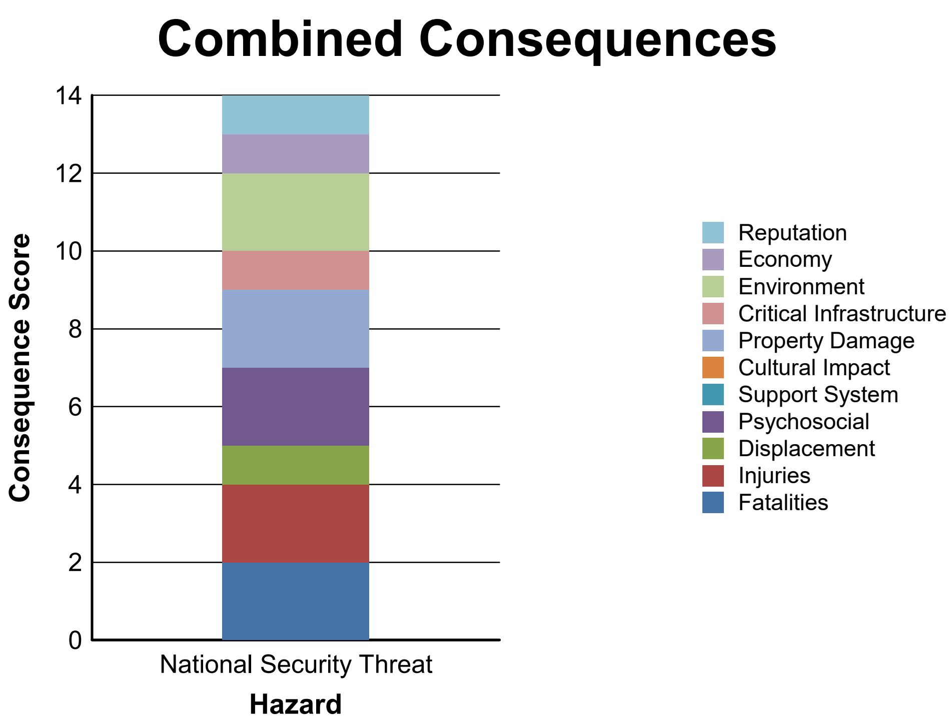


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of national security threats in Summerland.

Changes Observed to Date Summary

There have been no noted incidents of national security threats in Summerland.

Future Changes Expected Summary

National security threats have not historically affected Summerland. However, the Federal Agricultural Research Station located in the District could potentially become a target.

Existing Risk Reduction Measures

- Well protected facility
- Emergency response plan has civil defense considerations

Individual Hazard Breakdown

Hazard: HAIL Priority: 27

Hazard Score: 13

Individual Hazard Summary Table

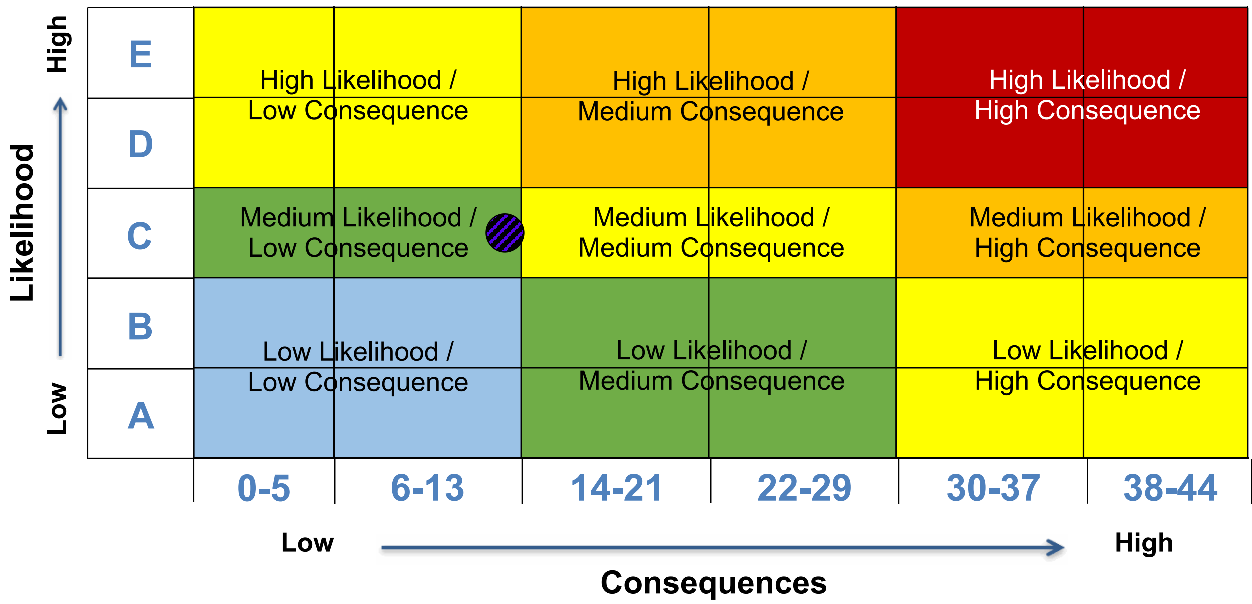
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
HAIL	C	13	Medium Likelihood/ Low Consequence	D

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Hail



Individual Consequence Breakdown

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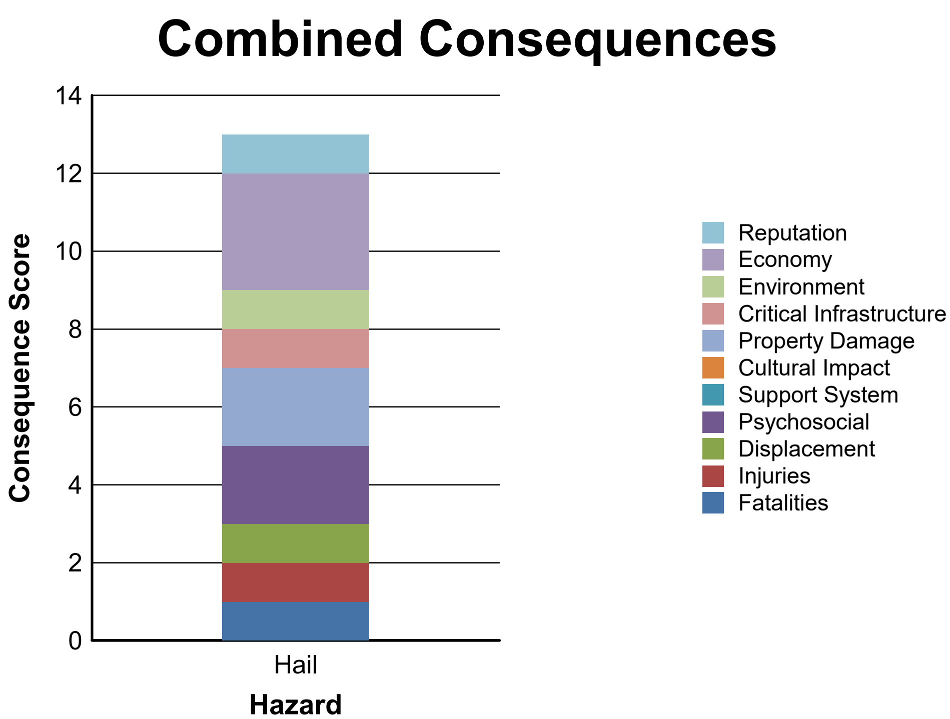
Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was Number of Severe Hail Days (Ds >= 2cm) in Summer. Data Source: Etkin (2018) - ICLR. Hail Climatology for Canada.

Changes Observed to Date Summary

Occurrence of hail events is projected to remain stable into the 2030s. Data Source: Etkin (2018) - ICLR. Hail Climatology for Canada; Brimelow, J.C. (2017) The Changing hail threat over North America in response to anthropogenic climate change (Fig 1.e)

Future Changes Expected Summary

Occurrence of hail events is projected to increase by the 2050s. Data Source: Etkin (2018) - ICLR. Hail Climatology for Canada; Brimelow, J.C. (2017) The Changing hail threat over North America in response to anthropogenic climate change (Fig 1.e)

Individual Hazard Breakdown

Hazard: SEICHE Priority: 28

Hazard Score: 13

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
SEICHE	C	13	Medium Likelihood/ Low Consequence	C

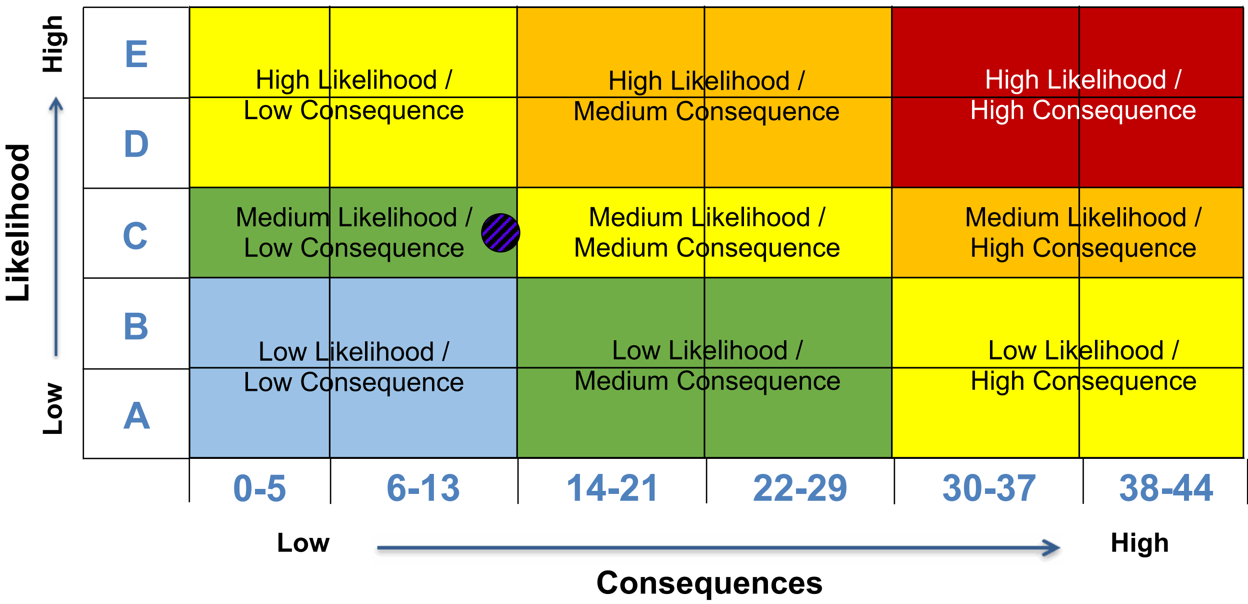
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Seiche

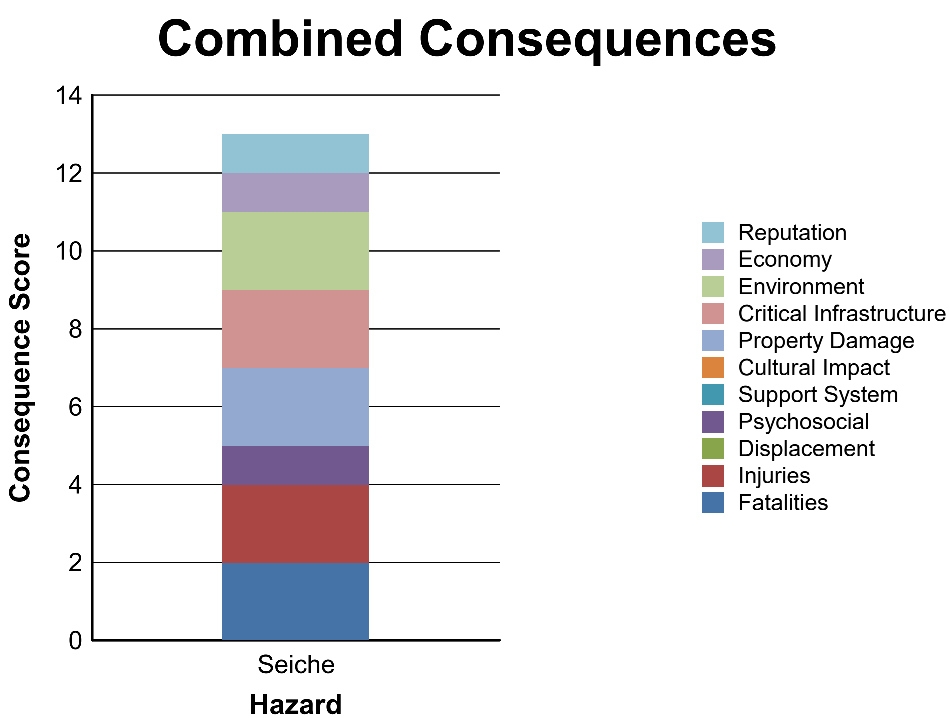


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was occurrence of seiche in Lake Okanagan. Historically, seiche events have occurred annually. Data Source: Multiple seiches are noted each year, with varying depths. Fall seiches cause more mixing of the lake, where summer/spring seiches are limited to upper water depths.
https://a100.gov.bc.ca/pub/acat/documents/r20321/Tapassessment_1291137702701_bcea1aee0f00ad4139dcc6733b7da40033839ebeed296579eb9250ba7b777b96.pdf

Changes Observed to Date Summary

Seiche occurrence is projected to remain steady into the 2030s.

Future Changes Expected Summary

Seiche occurrence is projected to remain steady into the 2050s.

Individual Hazard Breakdown

Hazard: FOG Priority: 29

Hazard Score: 3

Individual Hazard Summary Table

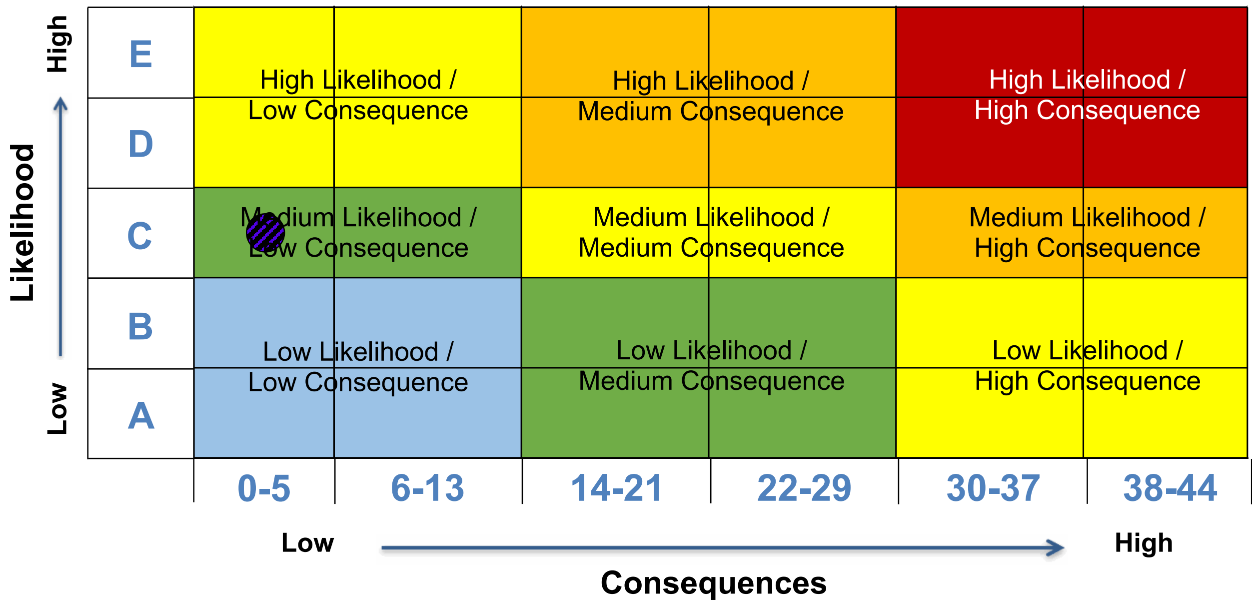
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
FOG	C	3	Medium Likelihood/ Low Consequence	D

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Fog

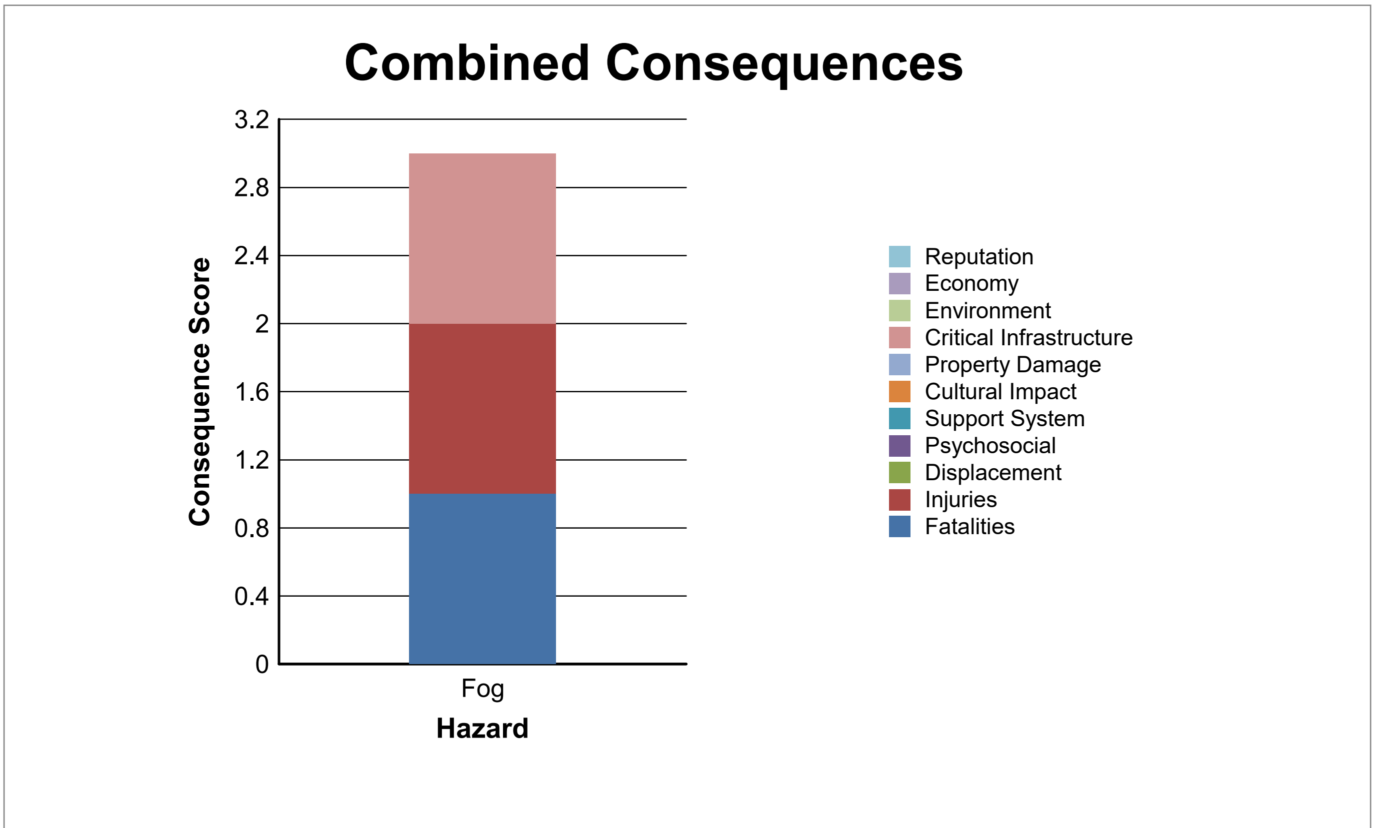


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Scientific Data Summary

Threshold used was visibility. Data Source: Airport - Kelowna A, hourly Visibility

Changes Observed to Date Summary

Occurrence of fog events is projected to increase by the 2030s.

Future Changes Expected Summary

Occurrence of fog events is projected to increase by the 2050s.

Individual Hazard Breakdown

Hazard: STRUCTURE FAILURE **Priority:** 30

Hazard Score: 13

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
STRUCTURE FAILURE	A	13	Low Likelihood/ Low Consequence	A

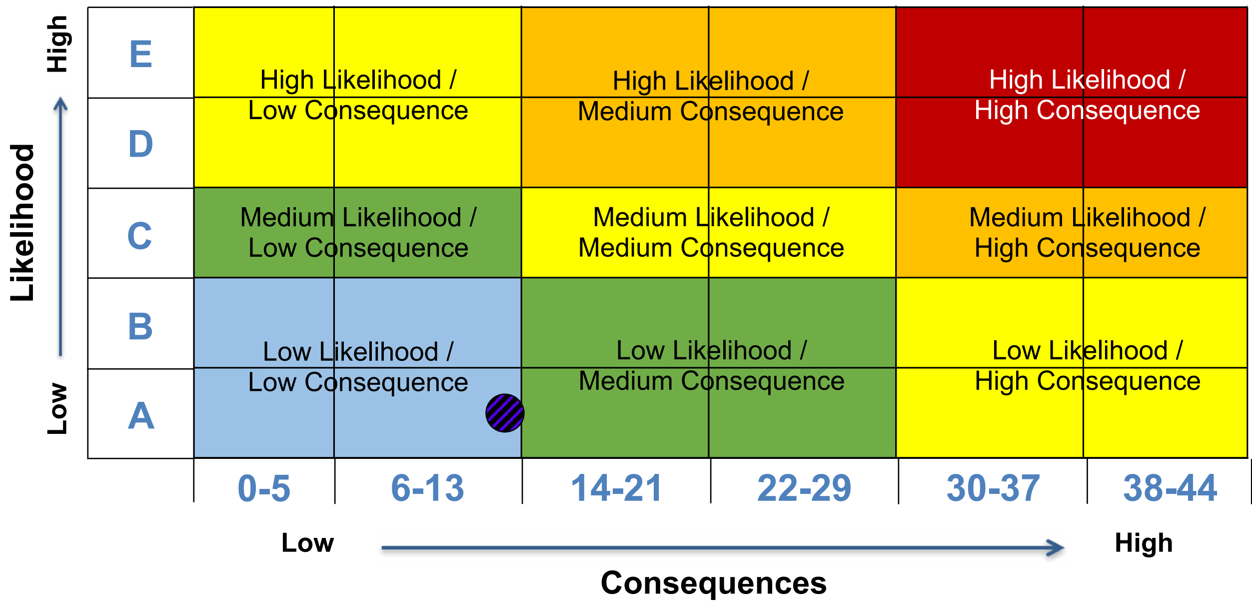
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Structure Failure

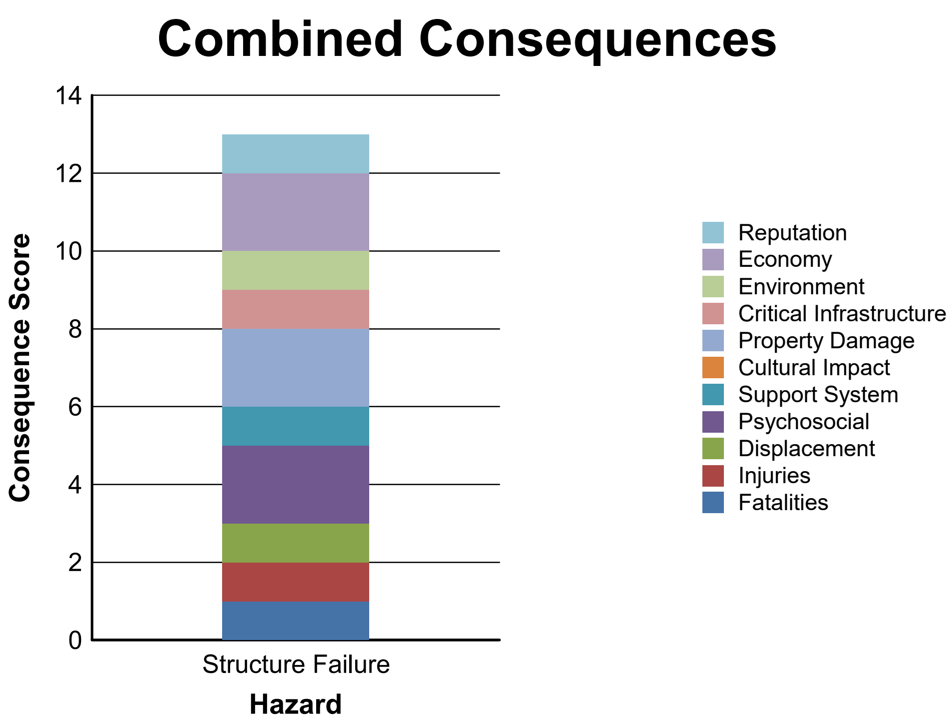


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of structure failure in Summerland.

Changes Observed to Date Summary

There are no noted incidents of structure failure in Summerland.

Future Changes Expected Summary

Structure failures are likely to continue to occur at a similar rate in the District, given that they are not typically impacted by changing external influences. Structure failure is unlikely to occur in the District.

Existing Risk Reduction Measures

- Full-service department – On-call person at all times
- Access to external capacity/human resources/regional support
- ESS (Emergency Support Services) e.g., Psychosocial support system
- Backup communications system if one fails
- Pre-fire plans (assess building materials/construction, start-to-finish assessments)

New Risk Reduction Measures

- On-going courses for Fire Department to continue understanding buildings structure failures

Individual Hazard Breakdown

Hazard: TELECOMMUNICATIONS INTERRUPTION Priority: 31

Hazard Score: 12

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
TELECOMMUNICATIONS INTERRUPTION	B	12	Low Likelihood/ Low Consequence	C

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence

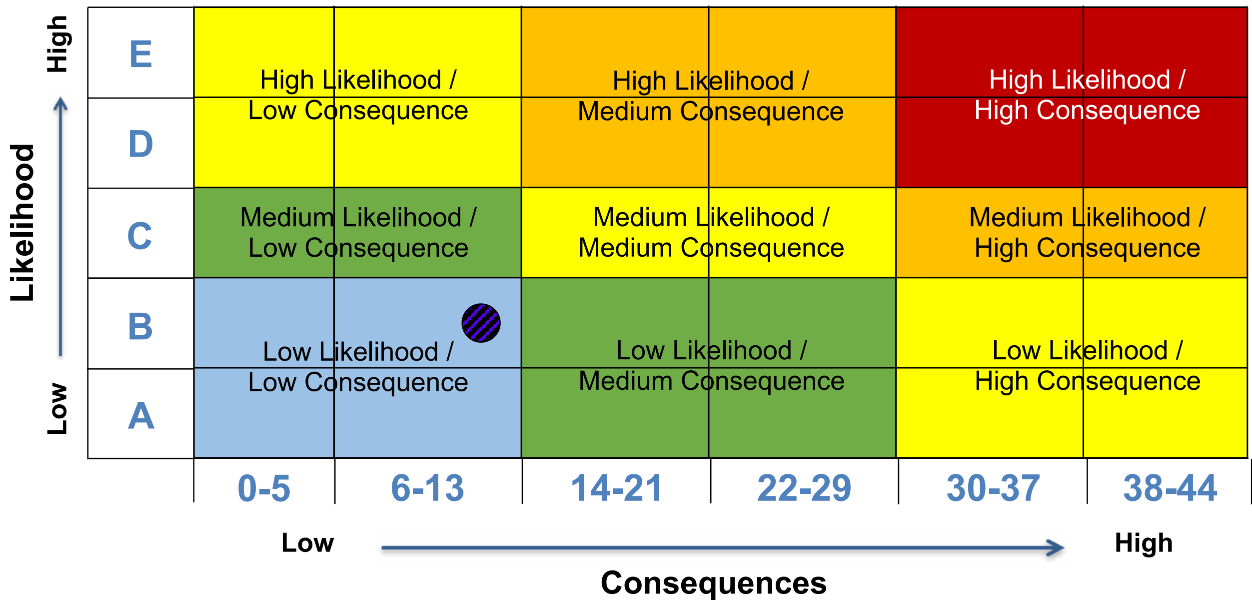
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Telecommunications Interruption

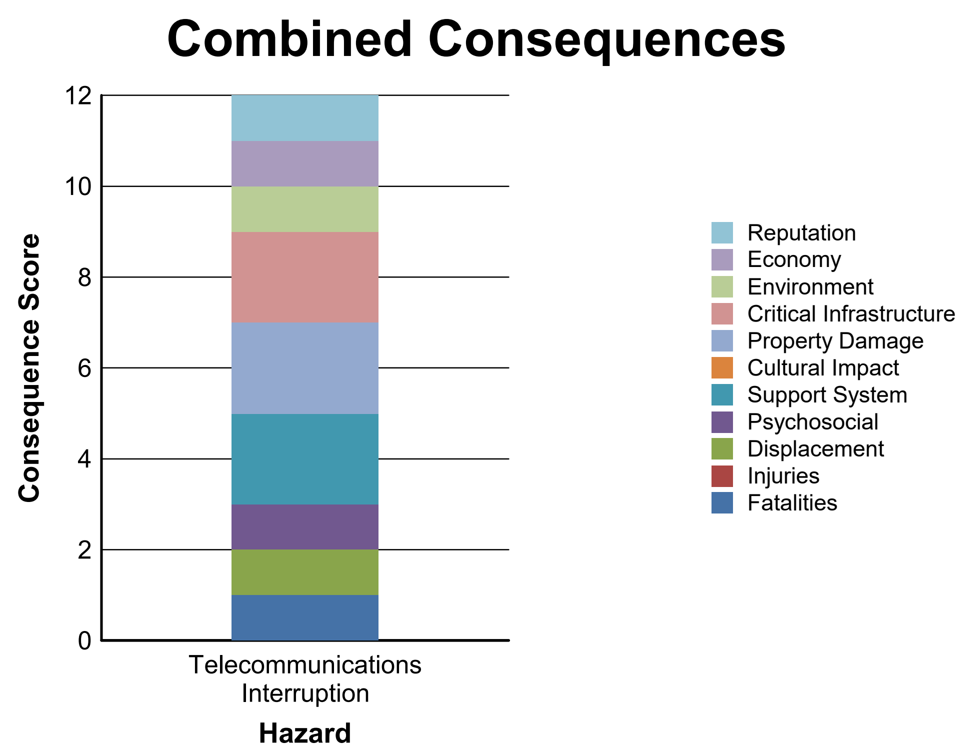


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Telecommunications interruption has historically occurred at low frequency due to infrastructure damage from hazards such as wildfires. Communication towers are located in Summerland and Naramata.

Changes Observed to Date Summary

Telecommunications interruption occurs at low frequency due to infrastructure damage from hazards such as wildfires. Communication towers are located in Summerland and Naramata.

Future Changes Expected Summary

Telecommunication systems are vulnerable to intensifying climate variables (e.g., high winds, wildfires) and are likely to intensify as a result.

Existing Risk Reduction Measures

- Fire Department has a back-up system through phones

New Risk Reduction Measures

- Expansion of radio system
- Split providers across work phones to reduce impact of future outages, such as Shaw, Telus, Rogers.
- Transition from landlines to handheld phones. Current issues with office landlines causing short-term disruptions

Individual Hazard Breakdown

Hazard: CYBER SECURITY THREAT **Priority:** 32

Hazard Score: 12

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
CYBER SECURITY THREAT	A	12	Low Likelihood/ Low Consequence	C

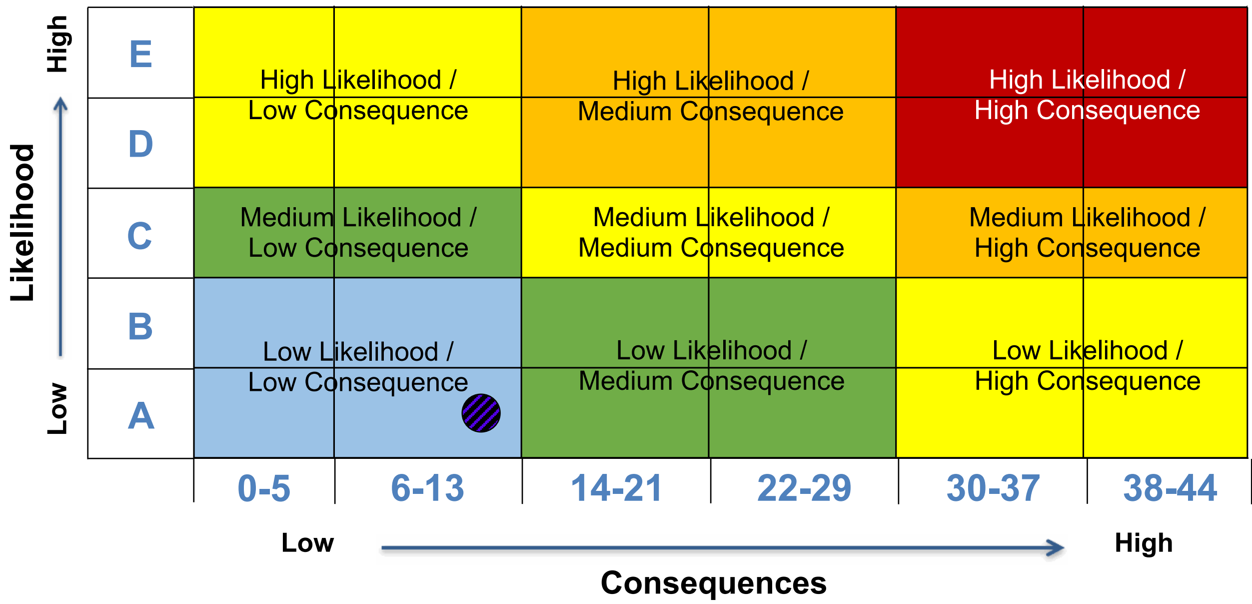
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Cyber Security Threat

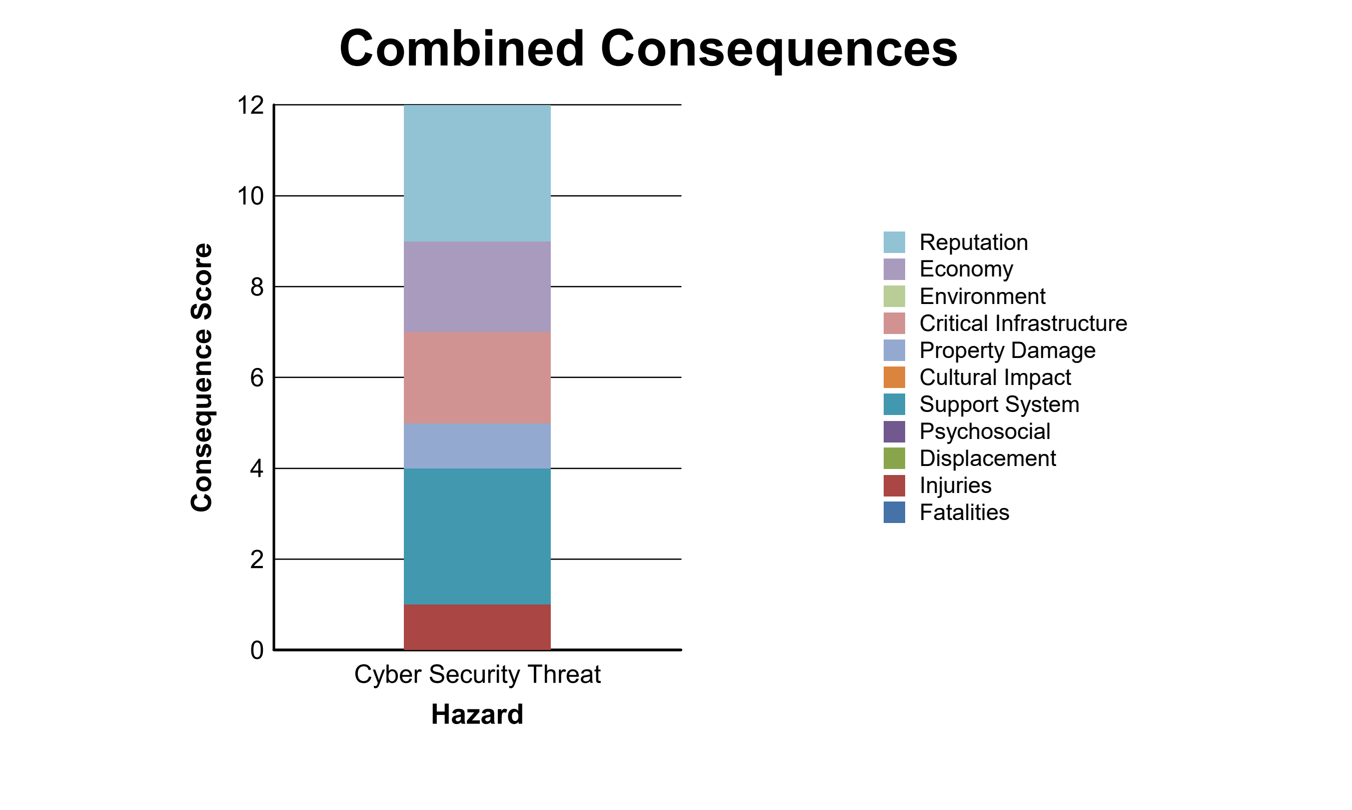


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of cybersecurity threats in Summerland.

Changes Observed to Date Summary

There have been no noted incidents of cybersecurity threats in Summerland.

Future Changes Expected Summary

Cybersecurity breaches are not known to have occurred in Summerland, but have occurred in other parts of the Okanagan region (e.g., Okanagan College data breach in 2023). Cybersecurity threats are on the rise globally and smaller communities are often targets due to less resources and protective measures. There is potential for such a threat to occur in Summerland by the 2050s.

Existing Risk Reduction Measures

- Continuously monitoring
- IT Department actions include increasing password security

New Risk Reduction Measures

- Move control systems offline

Individual Hazard Breakdown

Hazard: HAZARDOUS MATERIALS SPILL **Priority:** 33

Hazard Score: 11

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
HAZARDOUS MATERIALS SPILL	B	11	Low Likelihood/ Low Consequence	C

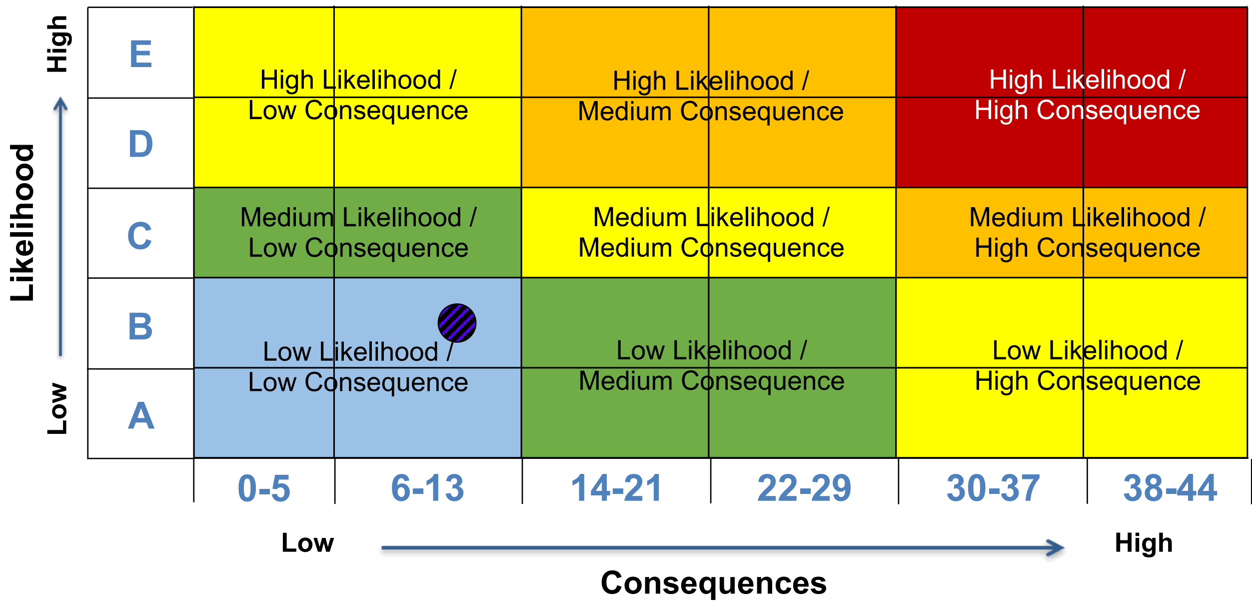
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Hazardous Materials Spill

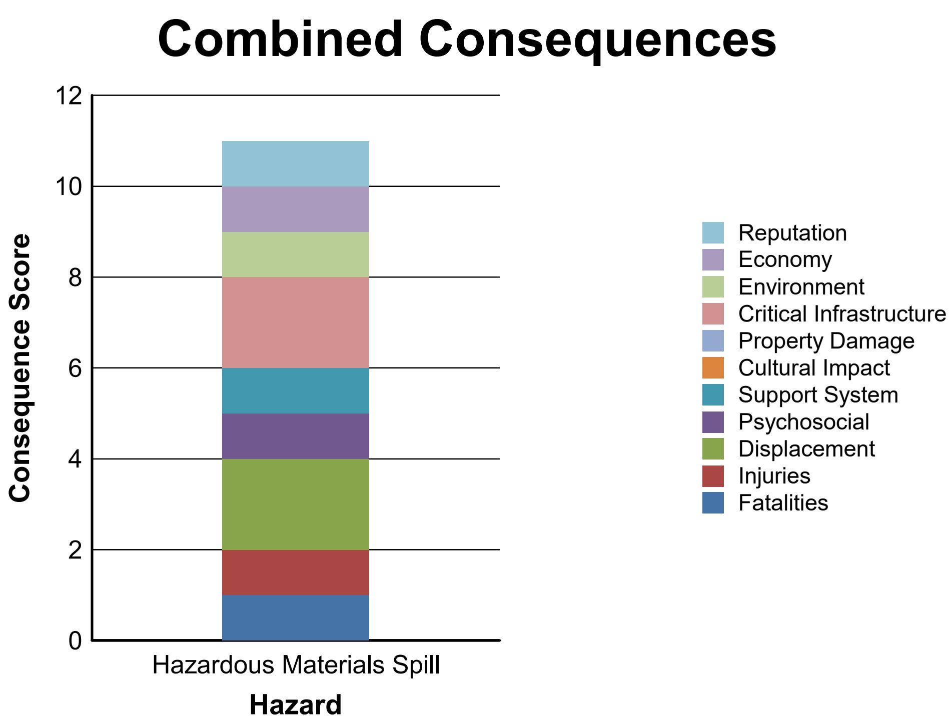


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

As of the publication of District's previous HRVA (2006), the District had dealt with small hazardous materials accidents at low frequency, e.g., two spills in 2004 and two spills between Jan 1 and Nov 30, 2005.

Changes Observed to Date Summary

A hazardous materials spill could potentially be caused by water treatment plant backflow due to a design error, a highway accident involving trucks carrying hazardous materials, or ammonia plants.

Future Changes Expected Summary

A hazardous materials spill could potentially be caused by water treatment plant backflow due to a design error, a highway accident involving trucks carrying hazardous materials, or ammonia plants. Due to the potential for increasingly hazardous conditions along transportation routes (e.g., flooding, ice accumulation, landslides, wildfires), it is likely that these events will increase in frequency.

Existing Risk Reduction Measures

- Removing chlorine from WTP
- Emergency Response Plans
- Emergency Response Guidebook. Fire Department can respond to some incidents.

New Risk Reduction Measures

- Voyent Alerts to residents signed up
- Social media posts to notify public
- Ensure alarms at plants and facilities are working when a spill occurs
- Ensure safety procedures at plants and facilities are up to date (Safety Coordinator would be responsible)

Individual Hazard Breakdown

Hazard: OIL OR GAS PIPELINE SPILL Priority: 34

Hazard Score: 11

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
OIL OR GAS PIPELINE SPILL	B	11	Low Likelihood/ Low Consequence	C

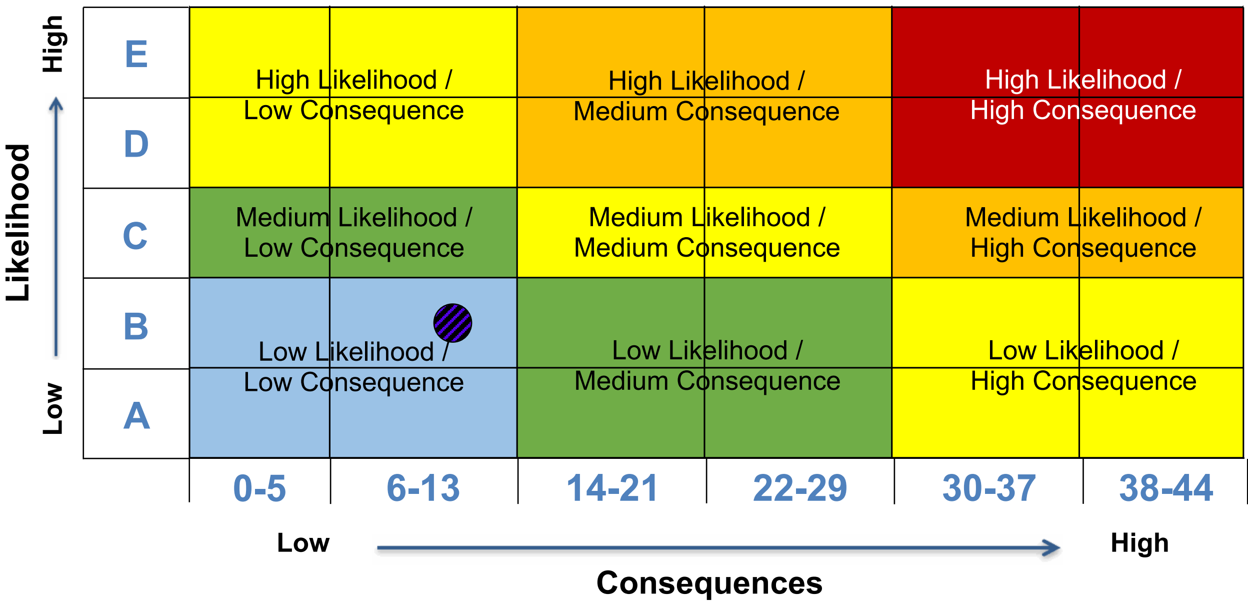
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	
	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Oil or Gas Pipeline Spill

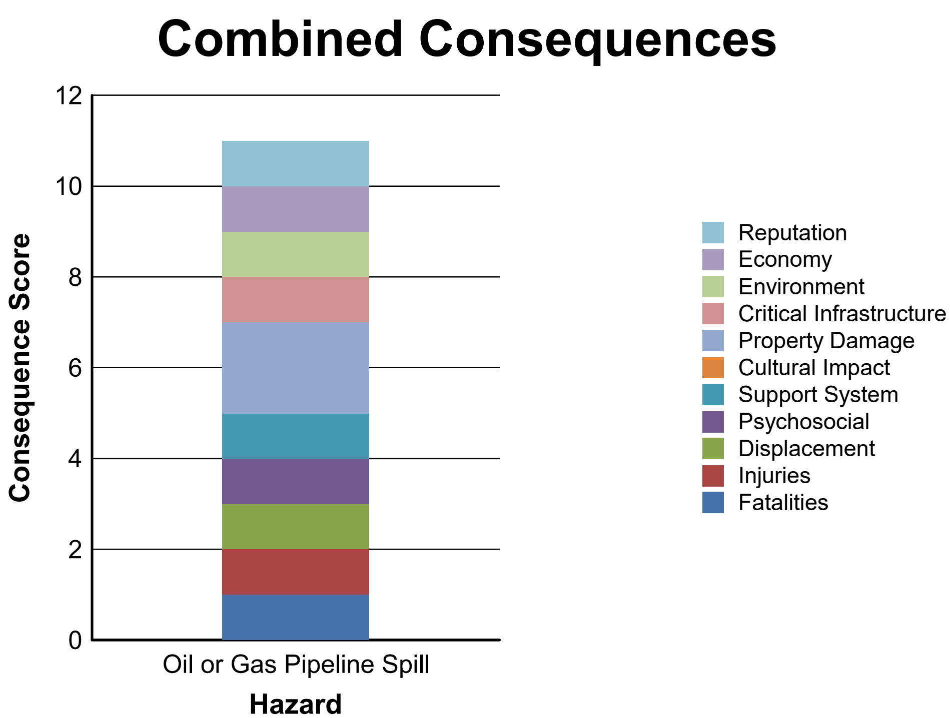


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There have been past gas pipeline spills and consequent explosions in the District with low frequency of occurrence. For example, in a June 2002 incident, lightning hit the underground natural gas line and caused an explosion. The incident destroyed a home and killed two residents. The blast reverberation was felt up to 1km away. A gas pipeline runs along the length of the District.

Changes Observed to Date Summary

There have been past gas pipeline spills and consequent explosions in the District with low frequency of occurrence. There is potential for a gas pipeline rupture due to collision with the pipeline or environmental hazards (e.g., lightning), which may result in explosions.

Future Changes Expected Summary

There is potential for a gas pipeline rupture and consequent explosion. There is also a gas pipeline that runs along the length of the District. Incidents are likely to increase in frequency, given that they can be caused by intensifying environmental hazards, e.g., lightning, wildfires.

Existing Risk Reduction Measures

- Signage
- Regulations

Individual Hazard Breakdown

Hazard: EXPLOSIONS Priority: 35

Hazard Score: 10

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
EXPLOSIONS	B	10	Low Likelihood/ Low Consequence	C

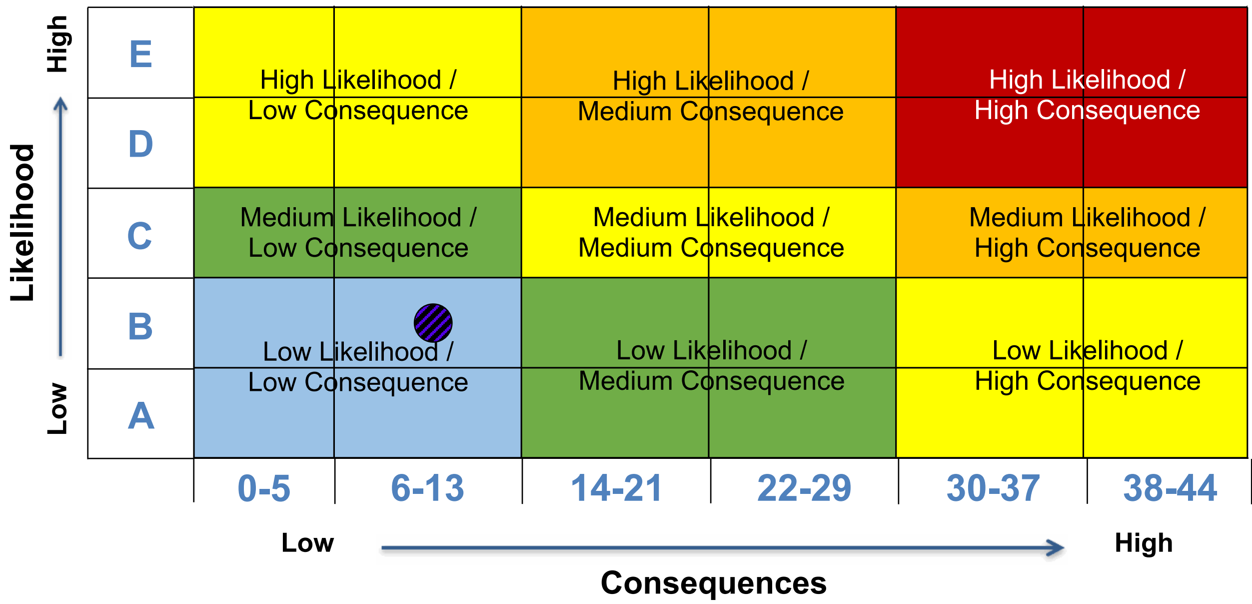
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Explosions

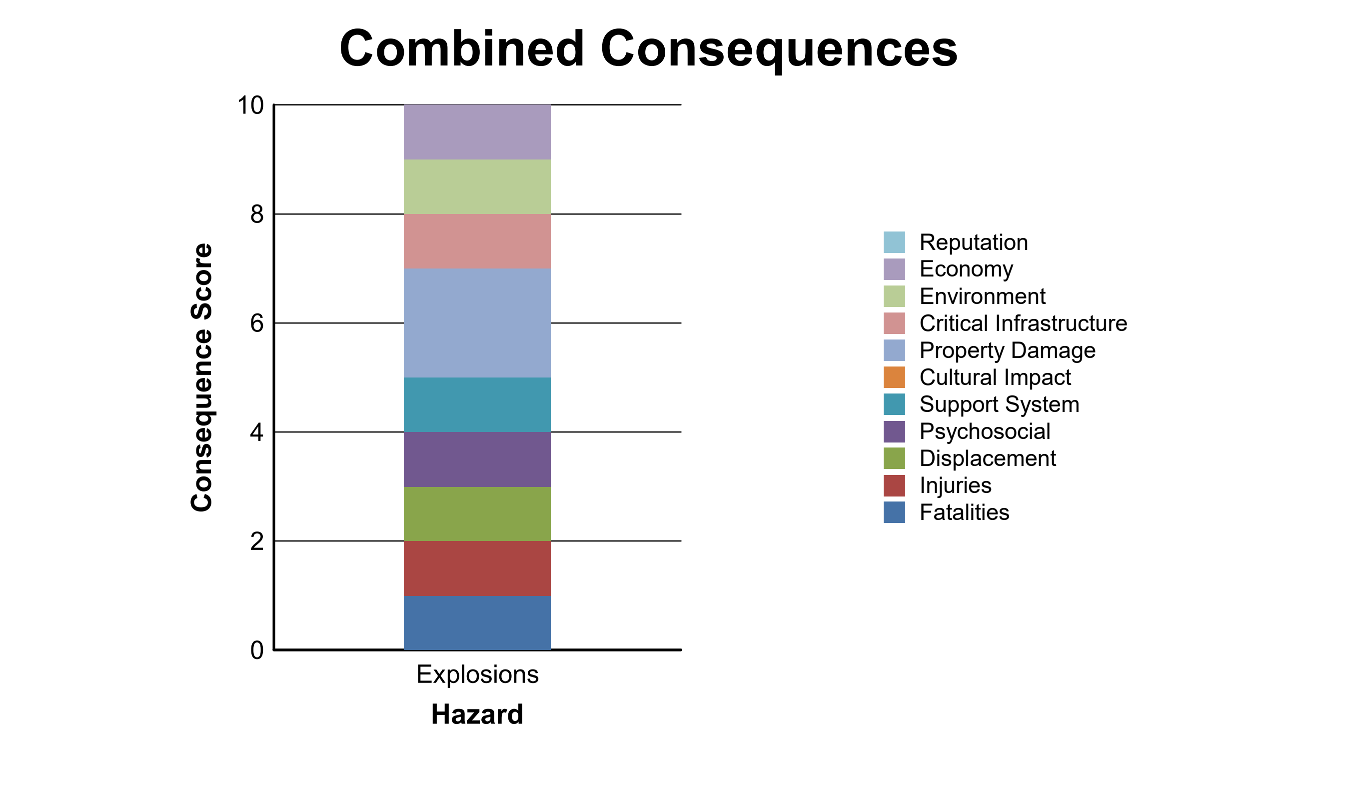


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There have been past gas pipeline spills and consequent explosions in the District with low frequency of occurrence. For example, in a June 2002 incident, lightning hit the underground natural gas line and caused an explosion. The incident destroyed a home and killed two residents. The blast reverberation was felt up to 1km away. A gas pipeline runs along the length of the District.

Changes Observed to Date Summary

There have been past gas pipeline spills and consequent explosions in the District with low frequency of occurrence. There is potential for a gas pipeline rupture due to collision with the pipeline or environmental hazards (e.g., lightning), which may result in explosions.

Future Changes Expected Summary

There is potential for a gas pipeline rupture and consequent explosion. There is also a gas pipeline that runs along the length of the District. Incidents are likely to increase in frequency, given that they can be caused by intensifying environmental hazards, e.g., lightning, wildfires.

Existing Risk Reduction Measures

- BC 1 Call
- District measures e.g., yellow signs, strong regulations, ongoing relations with Fortis
- In GIS systems

Individual Hazard Breakdown

Hazard: FUEL SOURCE INTERRUPTION **Priority:** 36

Hazard Score: 9

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
FUEL SOURCE INTERRUPTION	B	9	Low Likelihood/ Low Consequence	B

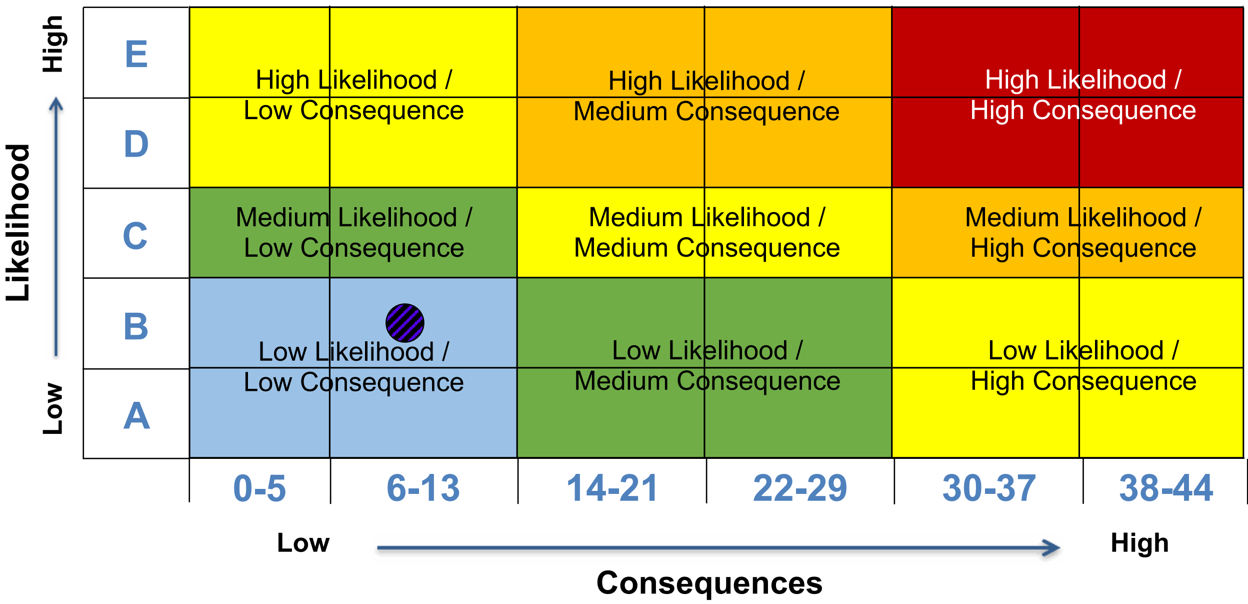
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Fuel Source Interruption

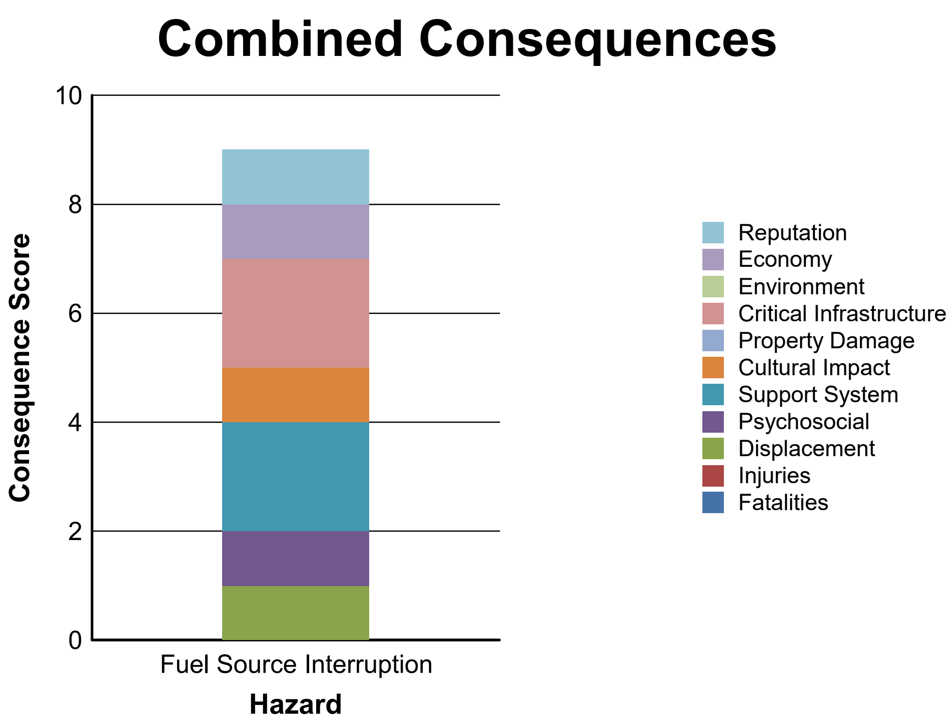


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There is no record of past fuel source interruptions in Summerland. The District stores fuel for critical services in case of emergency.

Changes Observed to Date Summary

There is no record of recent fuel source interruptions in Summerland. The District stores fuel for critical services in case of emergency.

Future Changes Expected Summary

There is potential for fuel supplies to be impacted by changes to transportation routes (e.g., highway closures due to flooding). However, the District has fuel stored for critical services, is converting some fleet vehicles to EV, and is completing a solar facility to reduce dependence on fossil fuels.

Existing Risk Reduction Measures

- Fleets are being transitioned to electric vehicles to avoid fuel source interruptions and reduce emissions.
- Public works may have mass fuel supply as well as agriculture
- Through the EMP – LG has the ability to fix this resource at private businesses
- Installing EV charging stations (Public and Workplace)

New Risk Reduction Measures

- Backup generator at public works yard for fueling fleet vehicles?
- Investment into alternative fuel sources (fuel and vehicle)

Individual Hazard Breakdown

Hazard: PUBLIC DISTURBANCE **Priority:** 37

Hazard Score: 9

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
PUBLIC DISTURBANCE	A	9	Low Likelihood/ Low Consequence	C

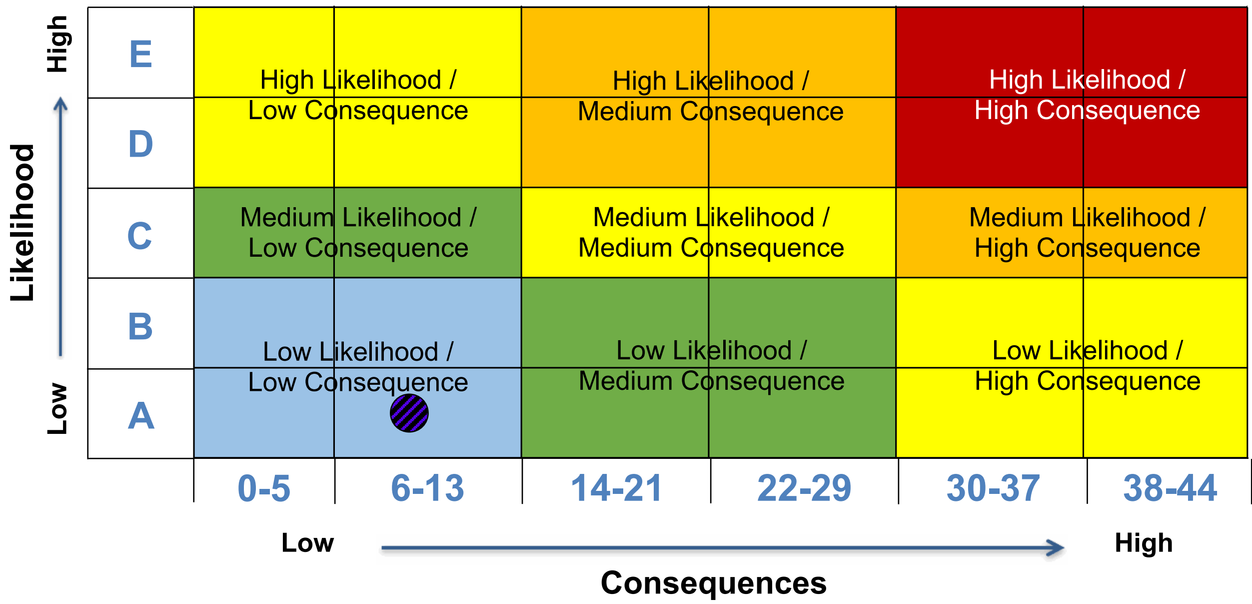
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Public Disturbance

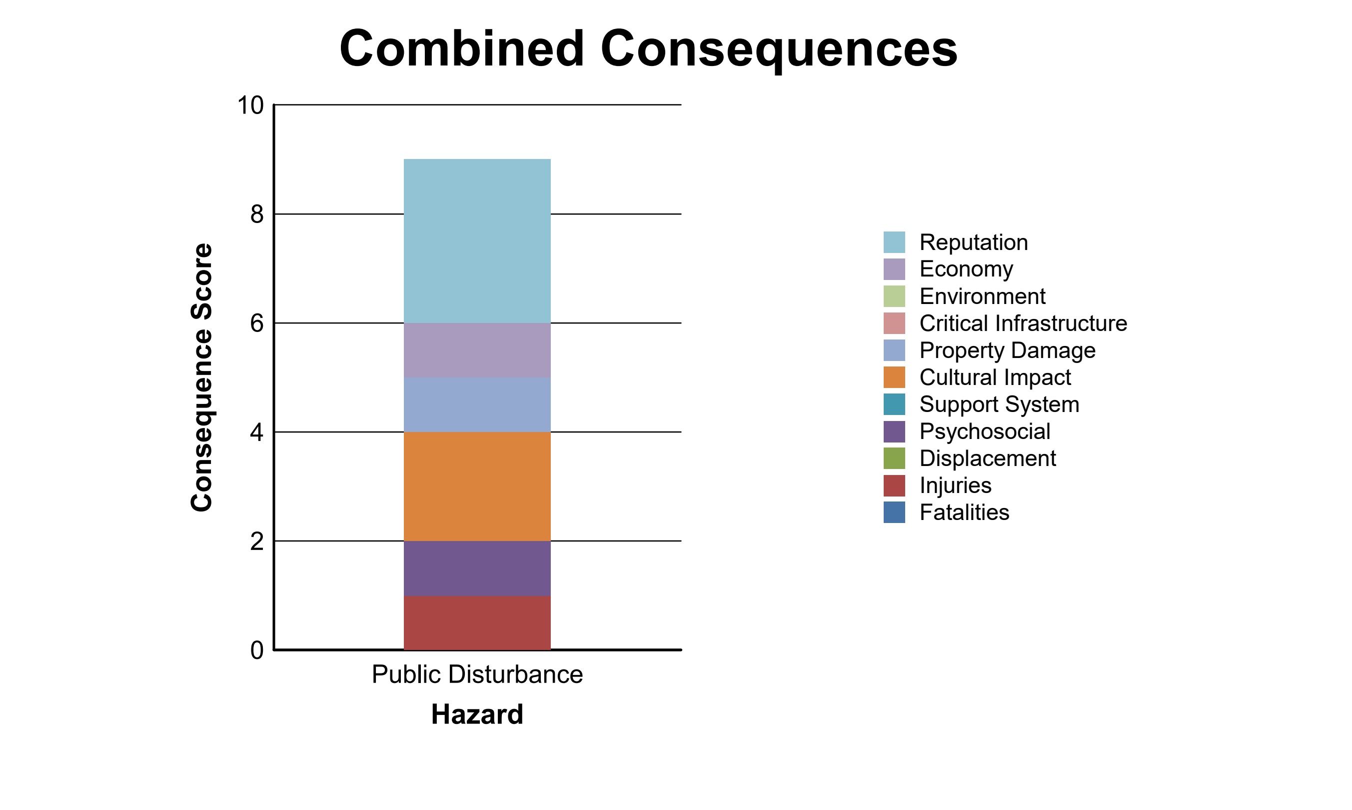


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of public disturbance in Summerland.

Changes Observed to Date Summary

There have been no noted incidents of public disturbance in Summerland.

Future Changes Expected Summary

There is a low risk of riots in Summerland, but there is potential as they have occurred in nearby Penticton and Kelowna. Conflicts are likely to arise due to climate change driven water shortages and global supply chain interruptions.

Existing Risk Reduction Measures

- Awareness initiatives, e.g., ‘Diversity’ mural on the Summerland Middle School

New Risk Reduction Measures

- Increase RCMP budget
- Policy or process document for when public disturbances become overwhelming. This way the District has next steps to refer to rather than coming up with ideas on the spot.

Individual Hazard Breakdown

Hazard: DIKE FAILURE Priority: 38

Hazard Score: 8

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
DIKE FAILURE	A	8	Low Likelihood/ Low Consequence	B

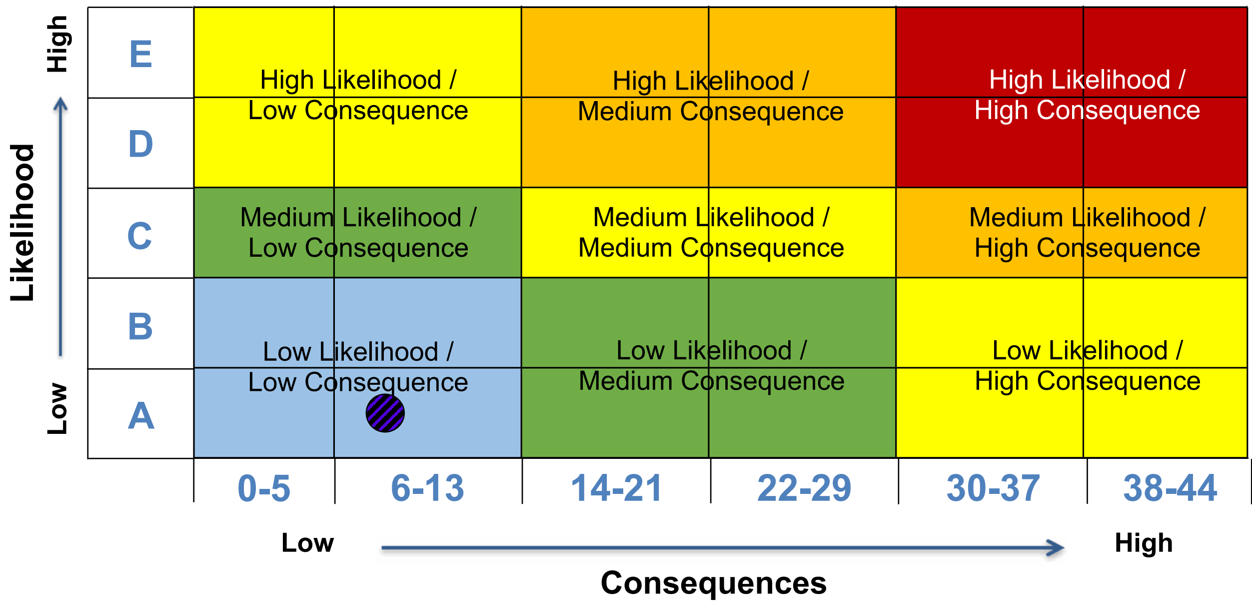
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Dike Failure

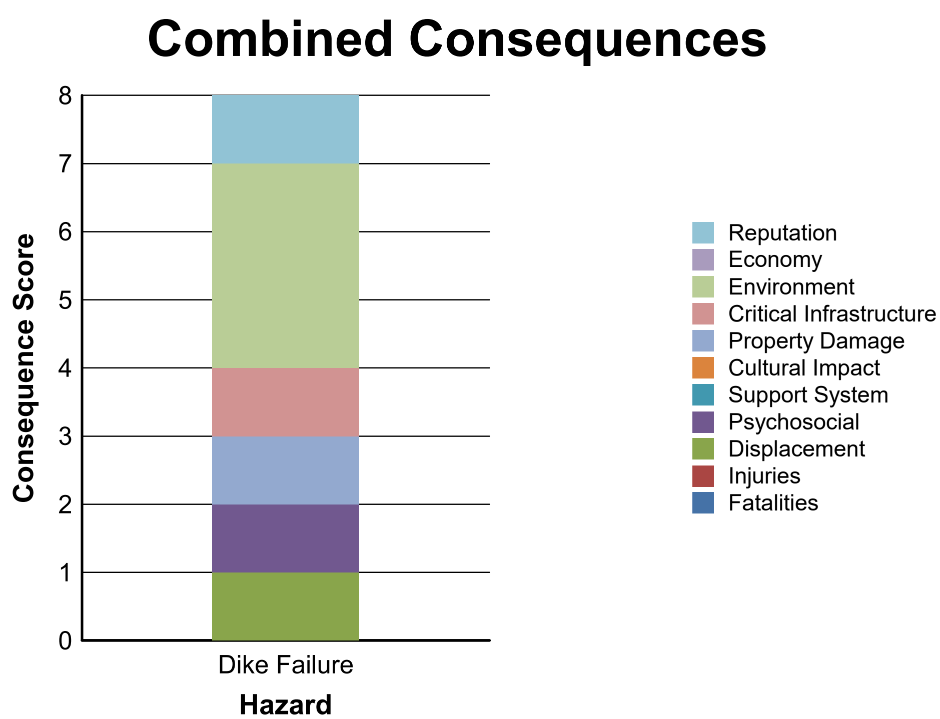


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of dike failure in Summerland.

Changes Observed to Date Summary

There are no noted incidents of dike failure in Summerland.

Future Changes Expected Summary

Due to extensive controls and risk avoidance measures, it is unlikely that dikes will fail in the future. However, there is potential for more frequent overtopping due to more frequent flooding.

Existing Risk Reduction Measures

- The district is installing early warning systems on dams in case of breach or unusual increase in flow.
- The Water Utility Emergency Response Plan (ERP) outlines responses to various water related emergency scenarios.
- Regulatory monitoring and maintenance
- There is a current project with PIB/RDOS/ONA to restore natural floodplain at Trout Creek
- Routes of contamination from Summerland landfill to Summerland Reservoir are monitored via active monitoring wells to prevent contamination

Individual Hazard Breakdown

Hazard: RAIL INCIDENT Priority: 39

Hazard Score: 8

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
RAIL INCIDENT	A	8	Low Likelihood/ Low Consequence	A

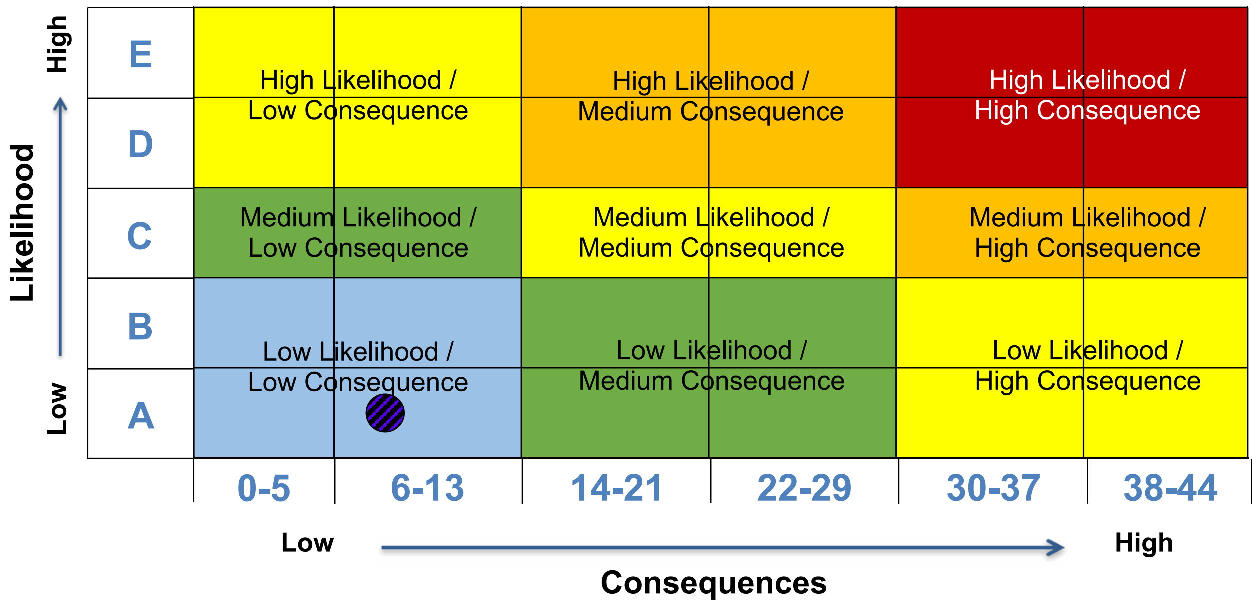
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Rail Incident

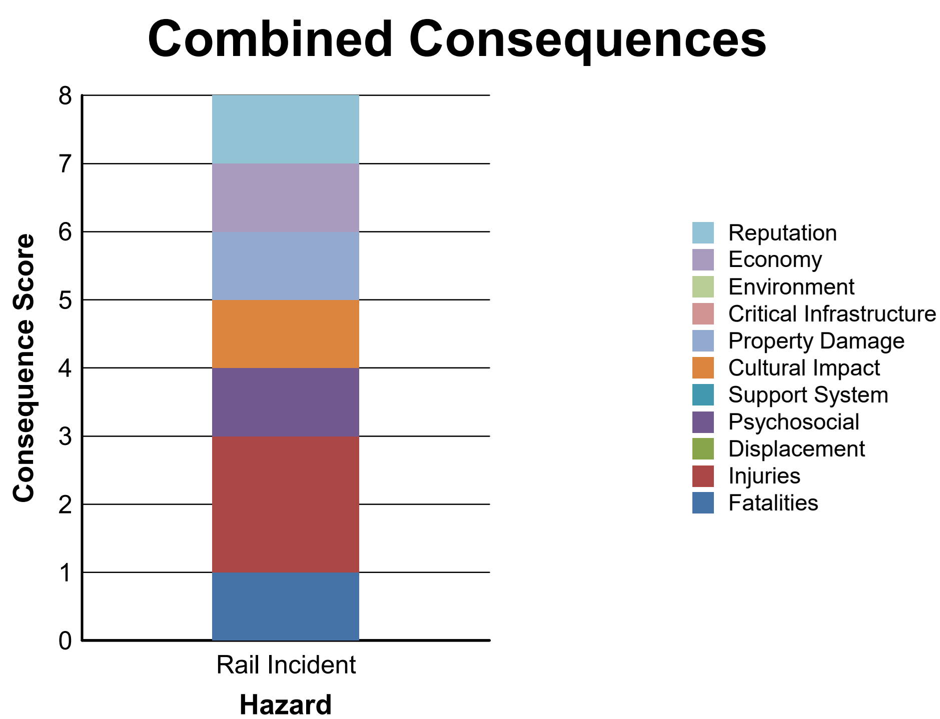


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There is no record of past rail incidents in Summerland.

Changes Observed to Date Summary

There is no record of recent rail incidents in Summerland.

Future Changes Expected Summary

Rail incidents are likely to remain rare in Summerland given the limited rail use and extensive risk mitigation protocols in place.

Existing Risk Reduction Measures

- Kettle Valley Rail has a water management plan for summers and a fire management team that follows the train when it is operating to splash water onto the tracks.
- DoS has liaison on KVR non-profit – includes reviews of safety requirements
- Fire safety measures in place during hot weather

Individual Hazard Breakdown

Hazard: ELECTRICAL OUTAGE **Priority:** 40

Hazard Score: 7

Individual Hazard Summary Table

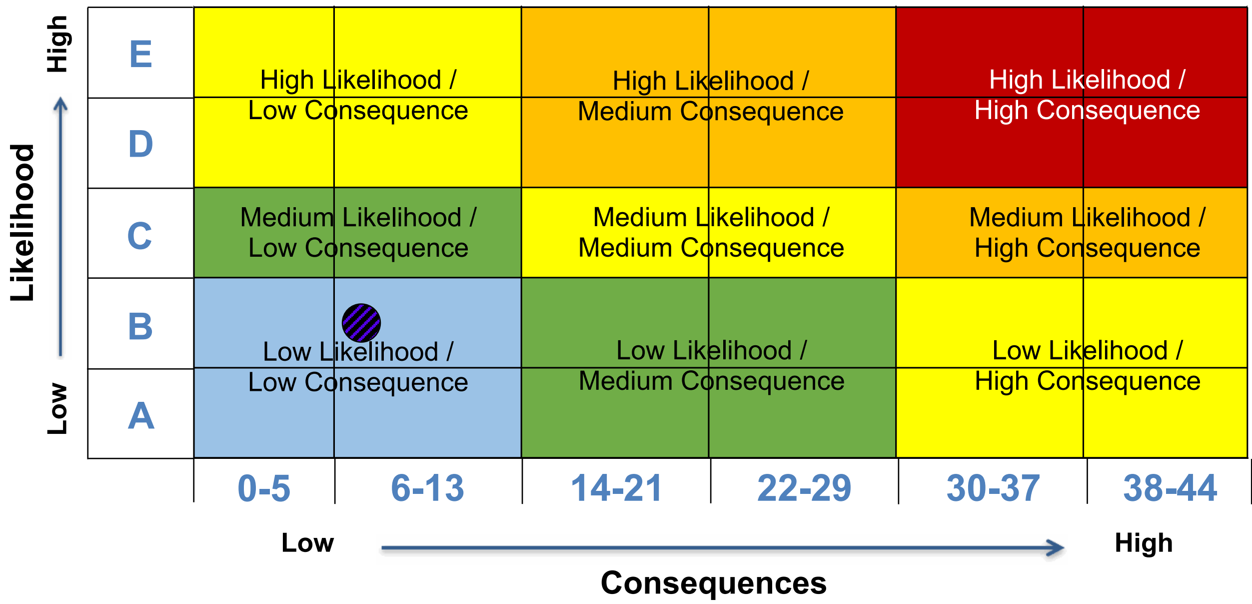
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
ELECTRICAL OUTAGE	B	7	Low Likelihood/ Low Consequence	C

Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Electrical Outage

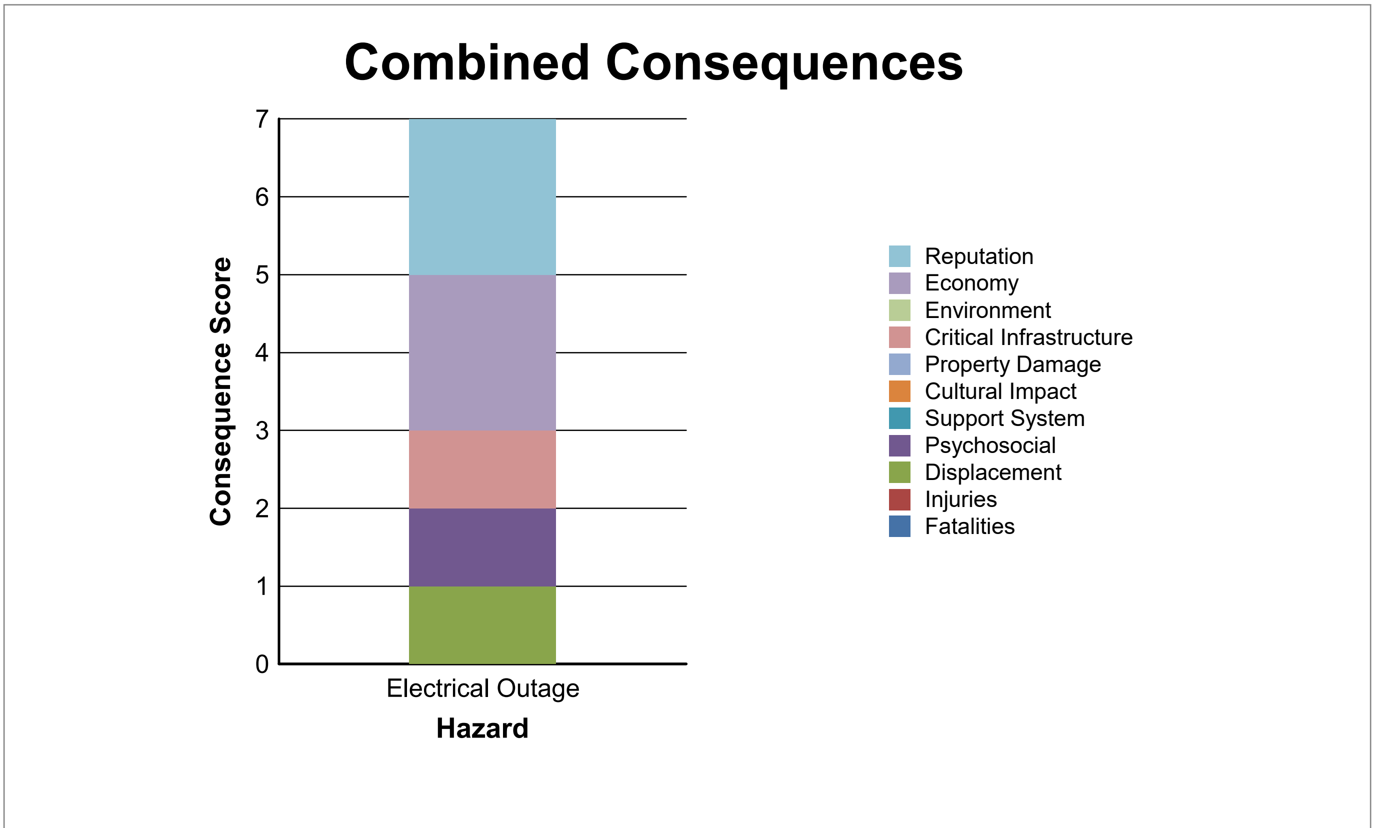


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Electrical outages have historically been infrequent in the District. There has been low impact on heating, given that many residents have wood burning stoves or fireplaces. Impacts on critical services and other amenities have been dependent on duration of outages, which is not typically long enough to cause extensive damage.

Changes Observed to Date Summary

Electrical outages are infrequent in the District due to the comprehensive electrical service risk mitigation measures in place.

Future Changes Expected Summary

Electrical outage incidents are likely to increase in frequency by the 2050s. Electrical distribution infrastructure is vulnerable to intensifying climate variables, e.g., freezing rain, wildfires. It is also likely that there will be changing demands on electrical services in the future due to increasing need for cooling, heating, and other services. Several electrical service risk mitigation measures are in place, which reduces the likelihood of system failure despite increasing likelihood of these environmental hazards. A solar farm is also in progress to reduce grid dependence and increase power availability.

Existing Risk Reduction Measures

- A solar facility is being developed to provide an alternative power source and improve energy independence. Solar photovoltaic (PV) systems have been installed in some District buildings, e.g., Arts and Cultural Centre, Municipal Hall.
- Use of Voyent alert for outages to residents and those who sign up
- Critical facilities have backup gensets
- 3 years of recurring planned community wide outages have prepared the community

New Risk Reduction Measures

- Increase battery energy storage capacity
- Is there alternate to internet for communication for the public?

Individual Hazard Breakdown

Hazard: FOOD SOURCE INTERRUPTION (SUPPLY CHAIN, OR COMMUNITY **Priority:** 41

Hazard Score: 7

Individual Hazard Summary Table

Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
FOOD SOURCE INTERRUPTION (SUPPLY	B	7	Low Likelihood/ Low Consequence	C

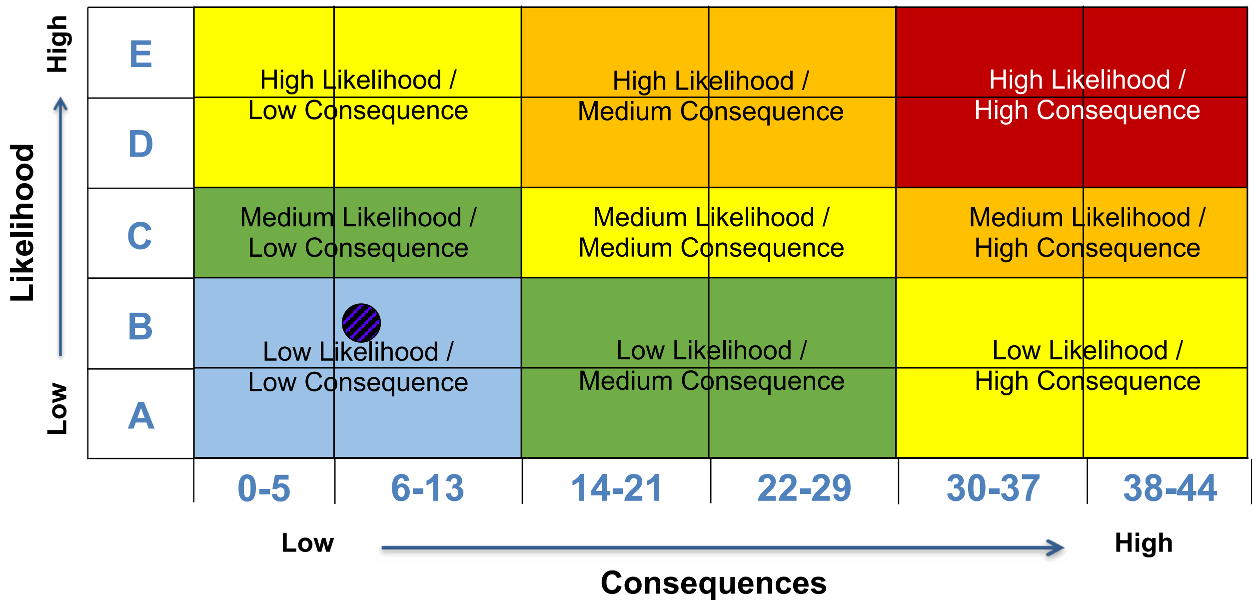
Risk Level Colour Codes	Low Likelihood / Low Consequence	Med Likelihood / Low Consequence	Med Likelihood / Med Consequence	Med Likelihood / High Consequence	High Likelihood / High Consequence
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain

Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Food Source Interruption (supply chain, or community food stores)

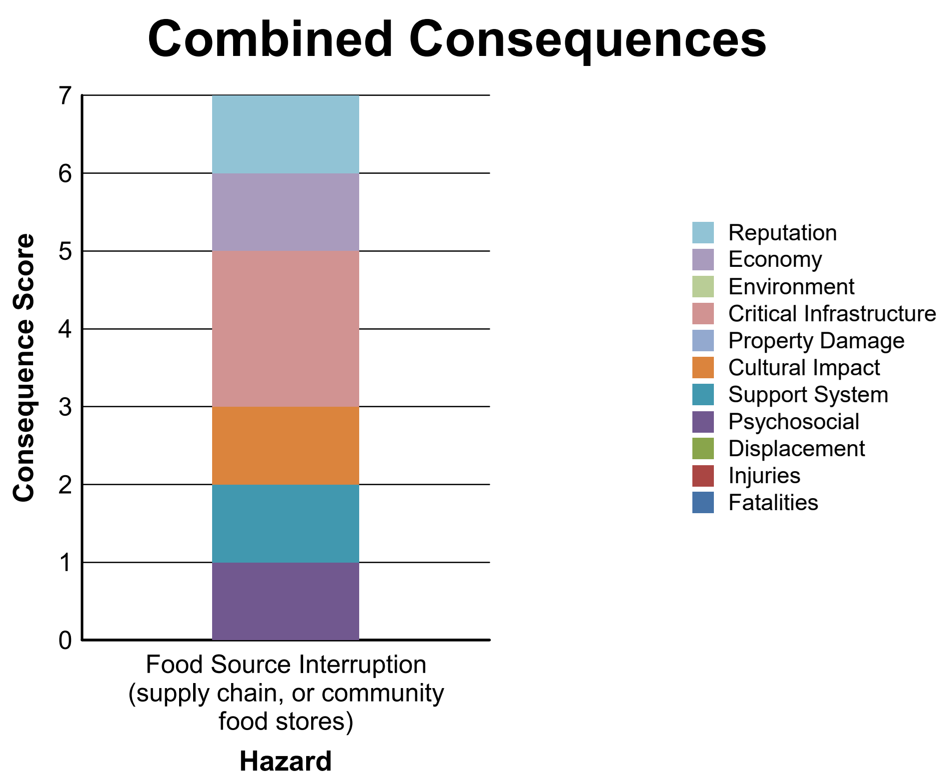


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

Food source interruption has historically occurred at low frequency in the District. Summerland is a strongly agricultural community with a focus on food security. Food production has been impacted in the past by water service interruptions caused by extreme heat, flooding, or other incidents that have resulted in low water volume.

Changes Observed to Date Summary

Food source interruption occurs at low frequency in the District, typically due to water service interruption.

Future Changes Expected Summary

Food supply may become less reliable if there are extended challenges, e.g., highway closures during atmospheric rivers, global supply chain issues, longer droughts, higher temperatures, flooding damage to agricultural land. As a result, food source interruptions are likely to increase in frequency.

Existing Risk Reduction Measures

- The Food Hub project has been prioritized to try to develop a value-added processing center to help with food security
- Service and deliveries routed through Calgary (in instance of Coquihalla closing)

New Risk Reduction Measures

- Examine accessibility and equity of local food resources/sources (assessment?)
- Work towards resilience of our food system through funding support, tourism, or spaces like the Food Hub to produce, manufacture and distribute locally
- Establish community gardens in Summerland to support local food growing operations
- Collaborate with Okanagan Syilx nation to better understand the local foods and to include these plants in landscaping
- Engage with neighbouring communities in the Region to establish food sharing when service routes elsewhere are interrupted

Individual Hazard Breakdown

Hazard: AIRCRAFT INCIDENT **Priority:** 42

Hazard Score: 7

Individual Hazard Summary Table

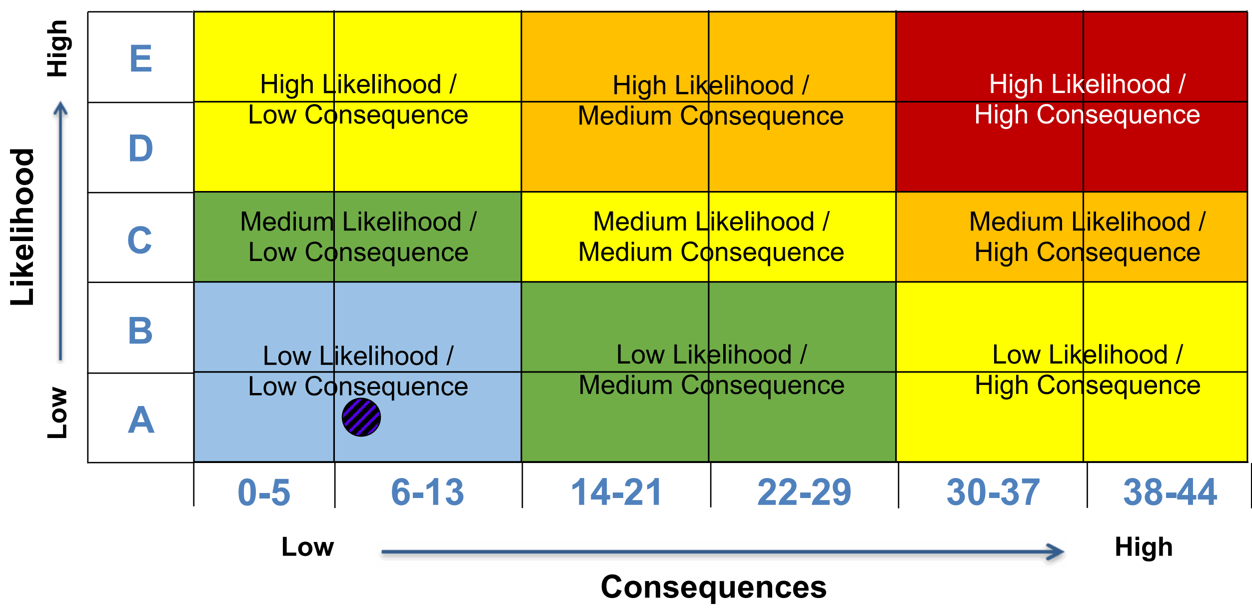
Hazard	Current Likelihood	Consequence Total	Risk Level	Future Likelihood
AIRCRAFT INCIDENT	A	7	Low Likelihood/ Low Consequence	A

Risk Level Colour Codes	**Low Likelihood / Low Consequence**	**Med Likelihood / Low Consequence**	**Med Likelihood / Med Consequence**	**Med Likelihood / High Consequence**	**High Likelihood / High Consequence**
Likelihood Scoring	A - Rare	B - Unlikely	C - Possible	D - Likely	E - Almost Certain
Consequence Total	Combined scores of 11 specific categories - Maximum possible score of 44				

The preceding table is produced from the values input into the Current and Future Likelihood Tables of the EMCR HRVA Tool, as well as the Consequence Assessment Tables. Data calculations alone do not always account for the core values of the community, and a specific hazard(s) priority number may have been intentionally adjusted to better reflect local concerns.

RISK MATRIX TABLE

For Aircraft Incident

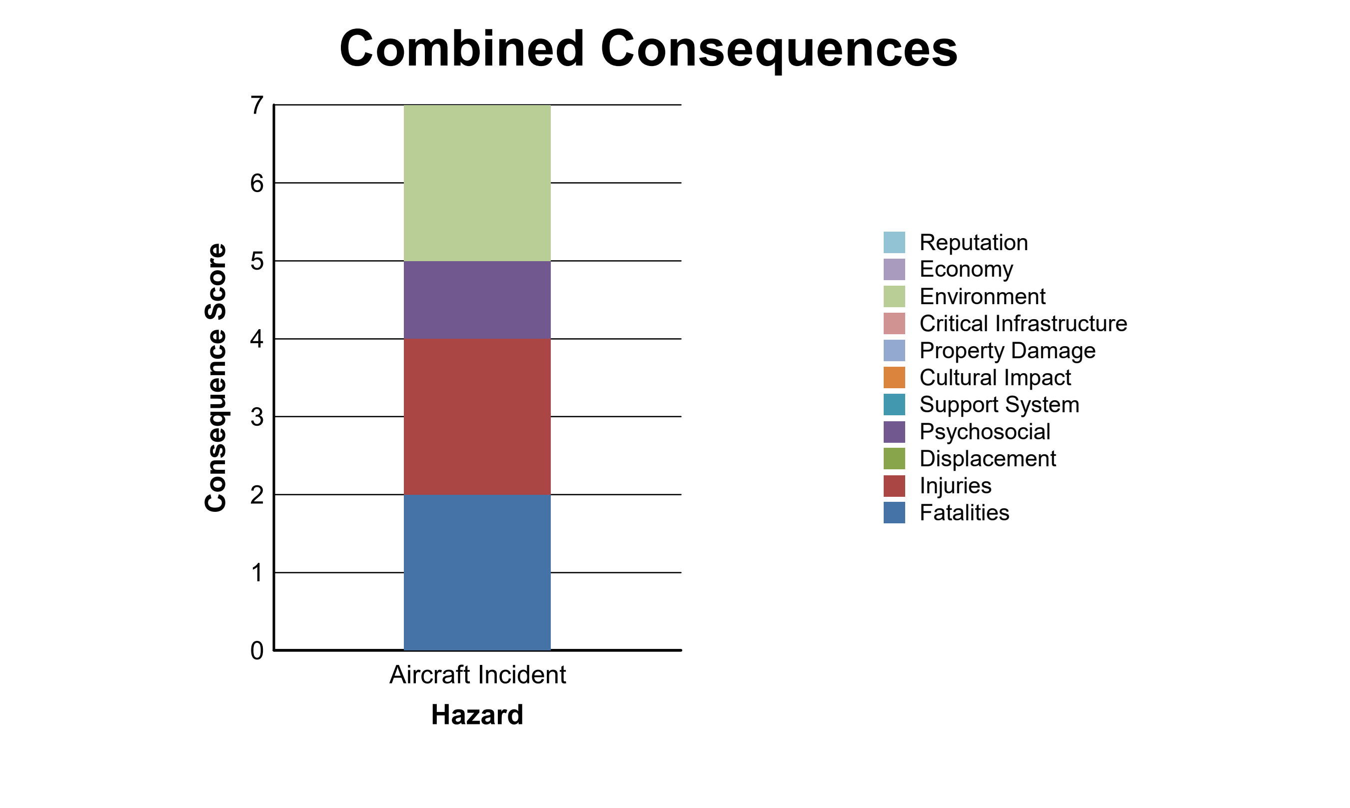


Individual Consequence Breakdown

Consequence Scores are an amalgamation of 11 specific categories found within the EMCR HRVA Consequence Tables. Each individual consequence category is scored from 0 - 4 (None - Extreme), with a possible combined high score of 44 for any single hazard. A visual breakdown of the total scores into each of the sub-categories is reflected in the consequence stacking table. Only categories that received a numerical score of 1 or higher are shown on the graph.

Individual Consequence Scoring	0 - None	1 - Low	2 - Medium	3 - High	4 - Extreme

Consequence Stacking Table



Local Knowledge Summary

There are no noted incidents of aircraft incidents in Summerland, given its location outside the flight path of Penticton Airport.

Changes Observed to Date Summary

There have been no noted incidents of aircraft incidents in Summerland, given its location outside the flight path of Penticton Airport.

Future Changes Expected Summary

Aircraft incidents are likely to remain rare in Summerland, given its location outside of the major flight paths of surrounding airports.

Existing Risk Reduction Measures

- Fire Department carries minimal amount of foam that can help put out a fire

District of Summerland HRVA: Climate Change Risk Assessment

September 29, 2023

Prepared for:
District of Summerland

Prepared by:
Stantec Consulting Ltd.

Project Number:
160925227

Table of Contents

Executive Summary

The District of Summerland (The District) has engaged Stantec Consulting Ltd. (Stantec) to complete a Hazard, Risk and Vulnerability Analysis (HRVA) with a Climate Change Risk Assessment (CCRA) to identify the hazards that currently affect the District and determine the impacts they may have should they occur. Conducting a HRVA-CCRA helps to prioritize potential problems or risks by assessing the probability of the hazard occurring and estimating what consequences may occur should the hazard interact with the assets or systems of concern. The addition of a CCRA to the HRVA also provides a stronger understanding of climate-related hazards that may affect the District's infrastructure assets. This report is a summary of the findings of the CCRA and serves as an appendix to the HRVA.

The portfolio-level CCRA was conducted with guidance from the HRVA toolkit, as well as risk assessment guidelines and best practices, such as:

- Hazard, Risk, and Vulnerability Analysis (HRVA) Companion Guide (2nd Edition)
- PIEVC Large Portfolio Asset Management (LPAM) tool and High-Level Screening Guide (HLSG), which align with the following standards:
- ISO 31000 Risk Management Framework
- ISO 14090:2019 Adaptation to Climate change – Principles, Requirements, and Guidelines
- ISO 14091:2019 Adaptation to Climate Change – Guidelines on Vulnerability, Impacts, and Risk Assessment
- ISO 14092:2020 Adaptation to Climate Change Requirements and Guidance on Adaptation Planning for Local Governments and Communities

The hazards with the greatest proportion of high to extreme risk in the baseline are wildfire, landslides, lake/river/stream flooding, and flash flooding. The biggest shift in risks (from low/medium to high/extreme) between the baseline and future climate periods occurs because of SDHI, freezing rain/drizzle, drought, and flash flooding. SDHI and lake/river/stream flooding are risks to all assets. All 14 assets assessed are at moderate or higher risk from at least one hazard in the baseline and future time horizons. The assets at highest risk to any hazard are the Water Treatment Plant (WTP) and utilities. There are extreme risks to 21% of assets in the baseline (reservoirs, water treatment plant, and utilities) and 57% by the 2080s (dams, reservoirs, water treatment plant, water supply distribution network, wastewater treatment plant, road network, waste management facilities, and utilities). Some specific findings of higher risk include the following:

- Flooding events are extreme risks to dams, reservoirs, water supply distribution network, wastewater treatment plant, road network, and waste management facilities and high risks to all assets.
- Wildfires are extreme risks to the WTP and utilities and high risks to pumphouses, lift stations, road network, municipal facilities and community buildings, and waste management facilities.
- Landslides are extreme risks to reservoirs and high risks to water supply distribution network, wastewater collection network, parks and outdoor recreation, road network, and utilities.

1 Introduction

The District of Summerland (The District) has engaged Stantec Consulting Ltd. (Stantec) to complete a Hazard, Risk and Vulnerability Analysis (HRVA) with a Climate Change Risk Assessment (CCRA) in order to identify the hazards that currently affect the District and determine the impacts they may have should they occur. Conducting a HRVA-CCRA helps to prioritize potential problems or risks by assessing the probability of the hazard occurring and estimating what consequences may occur should the hazard interact with the assets or systems of concern. The addition of a CCRA to the HRVA also provides a stronger understanding of climate-related hazards that may affect the District's infrastructure assets.

This report is a summary of the findings of the CCRA and serves as an appendix to the HRVA.

2 CCRA Objectives

In determining the probability of a hazard's occurrence, the annual frequency of a climate hazard is compared to the historical climate trends and a threshold relevant to the asset or system being considered. Priority climate risks arise because of the confluence of vulnerability, probability, and consequence. The overall risk rating serves to prioritize impacts for adaptation planning and risk reduction measures. This process was used to help the District identify and prioritize hazards and critical infrastructure/assets that are at high risk through a HRVA and CCRA.

The portfolio-level CCRA was conducted with guidance from the HRVA toolkit, as well as risk assessment guidelines and best practices, such as:

- Hazard, Risk, and Vulnerability Analysis (HRVA) Companion Guide (2nd Edition)
- PIEVC Large Portfolio Asset Management (LPAM) tool and High-Level Screening Guide (HLSG), which align with the following standards:
- ISO 31000 Risk Management Framework
- ISO 14090:2019 Adaptation to Climate change – Principles, Requirements, and Guidelines
- ISO 14091:2019 Adaptation to Climate Change – Guidelines on Vulnerability, Impacts, and Risk Assessment
- ISO 14092:2020 Adaptation to Climate Change Requirements and Guidance on Adaptation Planning for Local Governments and Communities

The purpose of the CCRA was to identify high-level risks at the asset systems level to identify what infrastructure is most at risk to hazards. For each asset system, consequences of exposure to each hazard were determined and considered individually. This allowed for identification of critical infrastructure and asset systems (e.g., wastewater, drinking water, road network, parks) that are at high risk and the specific hazards that are likely to drive these risks.

3 Asset Overview

The District's critical assets were identified through District reports, interviews with local knowledge holders, and community workshops. The assessment was limited to District owned infrastructure and did not include private properties. Assets were grouped for the purposes of the CCRA to allow for a wide range of infrastructure types to be assessed. The asset list is presented in Table 1, along with the infrastructure considered under each asset.

Table 1. Critical Asset List for the District of Summerland CCRA.

Assets	Considerations
Dams	Dams
Reservoirs	Reservoirs
Water Treatment Plant	Water Treatment Plant
Water Supply Distribution Network	Water Mains/Service Pipes
	Pressure Release Valves
	Waterways/Creeks
Pumphouses	Pumphouses
Wastewater Treatment Plant	Wastewater Treatment Plant
Wastewater Collection Network	Sanitary Mains/Service Pipes/Manholes
Lift Stations	Lift Stations
Stormwater Collection Network	Storm Mains/Manholes
	Catch Basins/Stormwater Ponds
Parks and Outdoor Recreation	Parklands
	Trails
	Playgrounds/Sports Fields & Courts/Campgrounds
	Beaches
Road Network	Roads/Highway
Municipal Facilities and Community Buildings	Municipal Hall
	Works & Utilities Office
	Electrical Warehouse
	RCMP Station
	Fire Hall
	Health Centre
	Aquatic Centre
	Museum
	Heritage Buildings/Cultural Sites
Waste Management Facilities	Landfill
	Recycling Depot
	Organics Facility

Assets	Considerations
Utilities	Electrical Substation/Distribution System
	Transformers
	Utility Vaults
	Gas Pipeline
	Solar Facility

4 CCRA Methodology

4.1 Climate Hazards and Likelihoods

A key step of the CCRA was identification of hazards that are likely to impact the community and its assets. The climate hazards used in this CCRA were selected from the atmospheric, fire, geological, hydrological, and flooding categories of HRVA hazards. These were shortlisted based on information from District reports, interviews with knowledge holders, news reports, and workshops. A climate profile was then developed for the District using scientific data from various sources. The time horizons used were baseline (1981-2010), 2030s (2011 to 2040), 2050s (2041 to 2070), and 2080s (2071 to 2100). The projected climate values represent the projected average over a 30-year time period in the future. The climate hazards and indicators used in this assessment are shown in Table 2 below.

Table 2. Climate Hazards and Indicators used in the CCRA.

Climate Hazards	Threshold
Air Quality	Fire Occurrence (proxy)
Extreme Heat	Days/ year with Tmax ≥ 32°C
Extreme Cold	Days/ year with Tmin ≤-15°C
Fog	Visibility
Freezing Rain or Drizzle	Median annual hours of freezing rain
Hail (Thunderstorm)	Number of Severe Hail Days (Ds >= 2cm) in Summer
High Wind Event	Wind gusts greater than or equal to 90km/hr
Lightning	Average number of days with lightning (within 25km)
Snowstorms and Blizzards	Heavy Snowfall- 10 cm or more snowfall in 24 hrs
Wildfire	Fires greater than 200 hpa (within 100km)
Landslide/ Debris Flow	Occurrence of Landslides in the region
Drought	Standardized Precipitation Index (SPI or SPEI) of less than -1 (12-month scale)
Seiche	Occurrence of seiche in Lake Okanogan
Lake/ River/ Stream Flooding	Max 5-day precipitation (proxy)
Flash Flooding	Short duration high intensity rainfall (proxy)
Short Duration High Intensity rainfall (SDHI)	15 mm or more rainfall in 1 hr

Short duration high intensity rainfall (SDHI) was used as a proxy for stormwater flooding.

The climate profile will be referenced in this CCRA and has been submitted as a separate appendix.

The likelihood of occurrence of each climate hazard (Acute/Chronic) is based on the expectation that a climate event will exceed a defined threshold above which the event may result in damage, or an interruption of service provided by the infrastructure component. The likelihood for the climate hazard is defined as the expected recurrence of a climate event as described in Table 3 and Table 4 for acute and chronic hazards, respectively. For chronic hazards, the "middle-baseline" approach is used to translate chronic hazard frequency/intensity to a likelihood score, based on the relative changes compared to the baseline period.

Table 3. Acute Climate Hazards Rating Table

Score	Qualitative Descriptor	Descriptor	Occurrence
1	Very Low	Not likely to occur within period	> 1:50 year
2	Low	Likely to occur at least once between 30-50 years	1:30-50 year
3	Moderate	Likely to occur at least once every 10 to 30 years	1:10-30 year
4	High	Likely to occur at least once per decade	1:1-10 year
5	Very High	Likely to occur once or more annually	>1/year

Table 4. Chronic Climate Hazards Rating Table

Score	Change in Event Frequency/Intensity Compared to Baseline Climate	Descriptor
1	50-100% reduction compared to baseline	Likely to occur much less frequently than baseline climate
2	10-50% reduction compared to baseline	Likely to occur slightly less frequently than baseline climate
3	Within +/-10% compared to baseline	Likely to occur about as frequently as in the baseline climate
4	10-50% increase compared to baseline	Likely to occur slightly more frequently than baseline climate
5	50-100% increase compared to baseline	Likely to occur much more frequently than baseline climate

The likelihood scores for the identified acute and chronic climate hazards are presented in Table 5 for baseline climate as well as the 2020s, 2050s, and 2080s. It should be noted that the frequency of occurrence can change while the likelihood score does not. For example, a climate hazard may have a likelihood score of 4 for all three-time horizons but with an increasing frequency of occurrence from 1-in-8 years in the baseline climate to 1-in-5 years in the 2050s to 1-in-2 years in the 2080s (e.g., frequency remains within the 1:1-10-year occurrence interval).

Table 5. Climate Hazard Likelihood Scores used in the CCRA.

Climate Hazards	Likelihood Score				Chronic or Acute	Trend
	Present	2030s	2050s	2080s		
Air Quality (Wildfire as a proxy)	3	3	4	4	C	↗
Extreme Heat	3	5	5	5	A	↗
Extreme Cold	3	1	1	1	C	↘
Fog	3	3	4	4	A	↗
Freezing Rain or Drizzle	3	3	4	5	A	↗
Hail (Thunderstorm)	3	3	4	4	A	↗
High Wind Event	2	2	3	3	A	↗
Lightning	5	5	5	5	A	↗
Snowstorms and Blizzards	3	3	4	4	A	↗
Wildfire	5	5	5	5	A	↗
Landslide/ Debris Flow	4	4	4	4	A	→
Drought	3	4	4	5	C	↗
Seiche	3	3	3	3	C	→
Lake/ River/ Stream Flooding	2	3	3	3	A	↗
Flash Flooding	2	3	4	4	A	↗
Short Duration High Intensity rainfall	2	3	4	4	A	↗

4.2 Vulnerability and Impacts

The vulnerabilities of the District and past hazard impacts on critical infrastructure were assessed to determine whether there was any exposure between each asset and the selected hazards. This was done by using information obtained in previous steps to identify impacts that hazards have had on critical assets. Surveys were also circulated to local knowledge holders help to identify vulnerabilities and historical hazard impacts to narrow the focus of the assessment to the District's most vulnerable areas.

The process involved consideration of the social and economic, physical and environmental, and underlying disaster risk drivers as guided by the HRVA. In addition to exploring impacts, existing risk reduction measures in place in the District were used to determine the extent to which these impacts might occur. This initial screening process allowed the assessment to target key interactions that have resulted in or have the potential to result in consequences for each asset.

4.3 Assessing Consequences

Consequences were assessed through engagement with local knowledge holders in an in-person workshop held in the District of Summerland on July 25 – 26, 2023. Scoring was carried out for each hazard – asset interaction using the 'Critical Infrastructure Impact' consequence response criterion of the HRVA on a scale of None (0) to Extreme (4). Where it was determined that there was no interaction, no score was assigned.

Scoring guidance for the 'Critical Infrastructure Impact' criterion is shown in Table 6.

Table 6. Consequence Scoring Table.

Rating	Critical Infrastructure
None (0)	Not likely to disrupt critical infrastructure services.
Low (1)	Low percentage of the population impacted by few service disruptions. Disruptions last hours to days.
Med (2)	Either a high % of the population impacted by a few services OR a low % of the population impacted by a major or multiple service disruptions.
High (3)	High % of the population impacted by a major or multiple service disruptions.
Extreme (4)	High percentage of the population is impacted by long-term outages.

4.4 Risk Assessment

A risk assessment was then conducted using the results of the vulnerability screening, climate profile, and consequence scoring. A risk score was determined for each interaction between a hazard and asset using the following equation:

Risk = Likelihood of Climate Hazard Occurring x Consequence of Impact

Likelihood represents the likelihood of occurrence (return period) of a climate hazard above a defined threshold. Likelihood scores range from 1 (Rare) to 5 (Almost) (Section 4.1).

Consequence is a measure of the expected impact/damage/loss of service to the asset should the climate event occur. Consequence scores range from 0 (None) to 4 (Extreme) (Section 4.3).

The assessment was carried out for the baseline (1981-2010), 2030s (2011 to 2040), 2050s (2041 to 2070), and 2080s (2071 to 2100). The result was a risk register that showed which assets were likely to be at greatest risk to hazards. This helps the district to identify priority areas for short to long term climate adaptation planning. The risk scoring matrix is presented in Table 7.

Table 7. Risk Scoring Matrix.

Risk Scoring Matrix							
Climate Hazard Likelihood	Very High	5	0	5	10	15	20
	High	4	0	4	8	12	16
	Moderate	3	0	3	6	9	12
	Low	2	0	2	4	6	8
	Very Low	1	0	1	2	3	4
			0	**1**	**2**	**3**	**4**
			None	**Low**	**Medium**	**High**	**Extreme**
			Consequence Score				

Legend:	Negligible	Low	Moderate	High	Extreme

5 Results of the Risk Assessment

5.1 Vulnerability and Exposure

Local knowledge holders and Stantec's desktop literature reviews identified several vulnerabilities and hazard impacts in the District, including the following examples:

- There is high vulnerability to flooding, which affects many major assets. For example:
  - Eneas Creek floods roadways and properties and must be diverted
  - Stormwater drainage overflows
  - High turbidity and mud passes through Water Treatment Plant and lift stations
- Landslides blocks major roadways (e.g., Highway 97). The Perpetual Slide has the potential to dam Trout Creek and cause overflow.
- Wildfires are burn risks, change dynamics of watersheds, and cause air quality issues.
- Extreme heat leads to heat stress in residents and algal growth in reservoirs.
- Inadequate healthcare capacity in the District is a concern, particularly due to the high population growth rate and older demographic. Planning is underway to improve capacity.

- Dam failure or damage to the main trunk of the Water Treatment Plant due to environmental hazards would result in loss of water supply.

A detailed description of the District's vulnerabilities can be found in the HRVA.

A summary of exposed assets resulting from the risk assessment is presented in Table 8. Exposures were revised where necessary based on feedback from local knowledge holders during the workshop and were used to guide the consequence scoring process.

5.2 Consequence Scoring Results

Consequence scoring was carried out during the workshop and revised where necessary based on discussions. Participants were tasked with discussing impacts of each hazard on each asset and assigning a consequence score by placing a sticky note onto the provided poster (Figure 1). Consequence scores are presented in

Table ***9***.

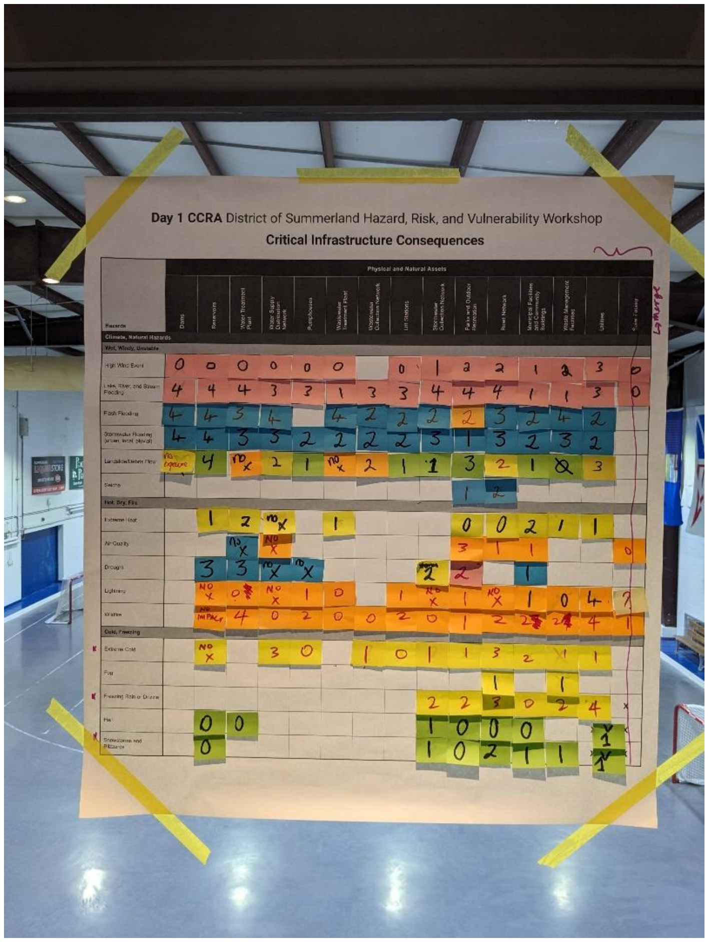


Figure 1. Results of the Workshop Consequence Scoring Activity.

Table 8. Exposure of Assets to Climate Hazards.

Assets	Air Quality	Extreme Heat	Extreme Cold	Short Duration High Intensity Rainfall	Fog	Freezing Rain or Drizzle	Hail	High Wind Event	Lightning	Snowstorms and Blizzards	Wildfire	Landslide/ Debris Flow	Drought	Seiche	Lake/ River/ Stream Flooding	Flash Flooding
Dams				X				X							X	X
Reservoirs		X		X			X	X		X		X	X		X	X
Water Treatment Plant		X		X			X	X	X		X		X		X	X
Water Supply Distribution Network			X	X				X			X	X			X	X
Pumphouses			X	X				X	X		X	X			X	
Wastewater Treatment Plant		X		X				X	X		X				X	X
Wastewater Collection Network			X	X							X	X			X	X
Lift Stations			X	X				X	X		X	X			X	X
Stormwater Collection Network			X	X		X	X	X		X	X	X	X		X	X
Parks and Outdoor Recreation	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Road Network	X	X	X	X	X	X	X	X		X	X	X		X	X	X
Municipal Facilities and Community Buildings	X	X		X		X	X	X	X	X	X	X	X		X	X

Assets	Air Quality	Extreme Heat	Extreme Cold	Short Duration High Intensity Rainfall	Fog	Freezing Rain or Drizzle	Hail	High Wind Event	Lightning	Snowstorms and Blizzards	Wildfire	Landslide/ Debris Flow	Drought	Seiche	Lake/ River/ Stream Flooding	Flash Flooding
Waste Management Facilities		X	X	X	X	X		X	X	X	X	X			X	X
Utilities		X	X	X		X	X	X	X	X	X	X			X	X

Table 9. Consequence Scores Assigned by Asset and Hazard.

Assets	Air Quality	Extreme Heat	Extreme Cold	Short Duration High Intensity Rainfall	Fog	Freezing Rain or Drizzle	Hail	High Wind Event	Lightning	Snowstorms and Blizzards	Wildfire	Landslide/ Debris Flow	Drought	Seiche	Lake/ River/ Stream Flooding	Flash Flooding
Dams				4				0							4	4
Reservoirs		1		4			0	0		0		4	3		4	4
Water Treatment Plant		2		3			0	0	0		4		3		4	3
Water Supply Distribution Network			3	3				0			0	2			3	4
Pumphouses			0	2				0	1		2	1			3	
Wastewater Treatment Plant		1		2				0	0		0				1	4
Wastewater Collection Network			1	2							0	2			3	2
Lift Stations			0	2				0	1		2	1			3	2
Stormwater Collection Network			1	3		2	1	1		1	0	1	2		4	2
Parks and Outdoor Recreation	3	0	1	1		2	0	2	1	0	1	3	2	1	4	2
Road Network	1	0	3	3	1	3	0	2		2	2	2		2	4	3
Municipal Facilities and Community Buildings	1	2		2		0	0	1	1	1	2	1	1		1	2

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Assets	Air Quality	Extreme Heat	Extreme Cold	Short Duration High Intensity Rainfall	Fog	Freezing Rain or Drizzle	Hail	High Wind Event	Lightning	Snowstorms and Blizzards	Wildfire	Landslide/ Debris Flow	Drought	Seiche	Lake/ River/ Stream Flooding	Flash Flooding
Waste Management Facilities		1	1	3	1	2		2	0	1	2	0			1	4
Utilities		1	1	2		4	1	3	4	1	4	3			3	2

5.3 Risk Assessment Results

Risk scores are presented in Table 10. Results of the CCRA show that the hazards with the greatest proportion of risks are SDHI (10%), lake/river/stream flooding (10%), high wind event (10%), flash flooding (10%), wildfire (9%), and landslides (8%) (Figure 2). The hazards with the greatest proportion of high to extreme risk in the baseline are wildfire (20%), landslides (17%), lake/river/stream flooding (18%), and flash flooding (15%) (Figure 3). The biggest shift in risks (from low/medium to high/extreme) between the baseline and future climate periods occurs because of SDHI, freezing rain/drizzle, drought, and flash flooding. SDHI and lake/river/stream flooding are risks to all assets.

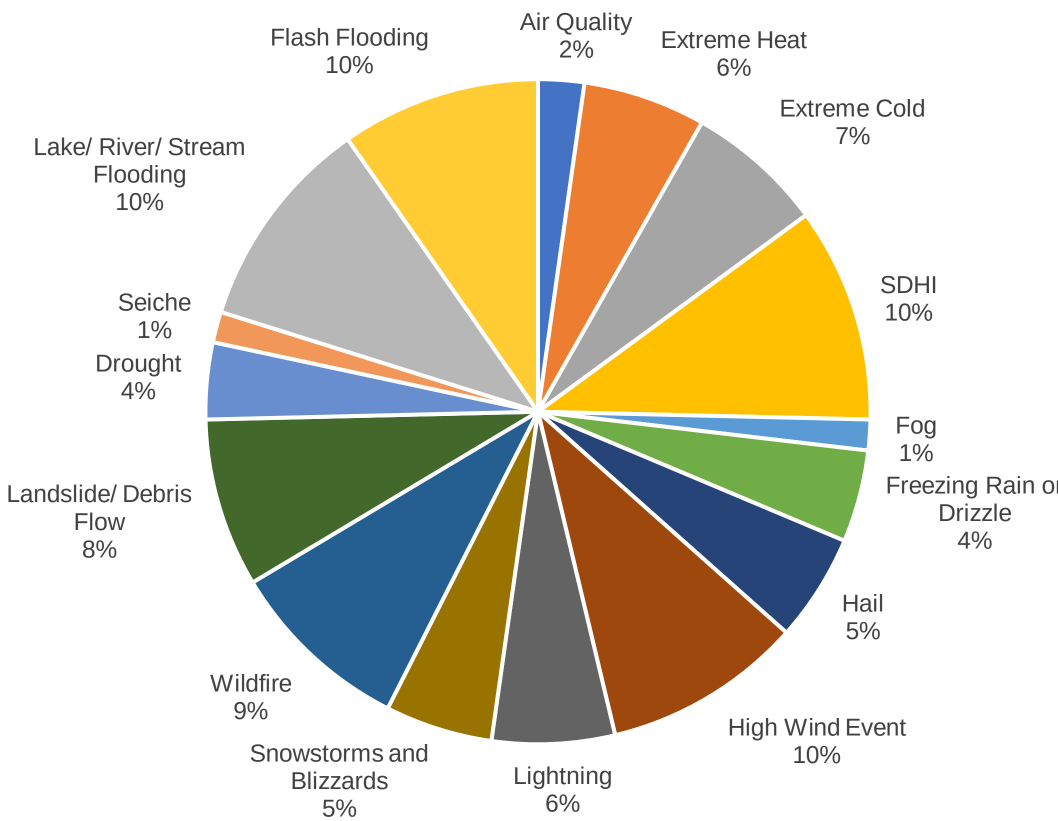

Figure 2. Proportion of Total Baseline Risks by Hazard.

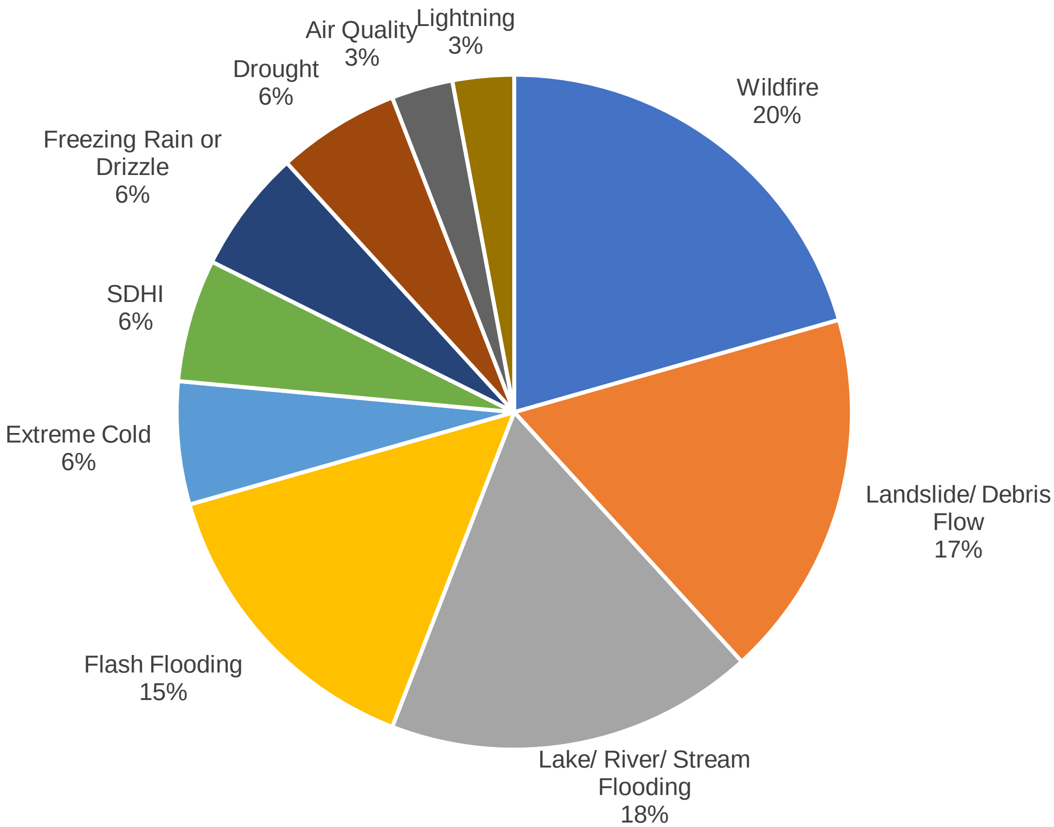

Figure 3. Proportion of High/Extreme Baseline Risks by Hazard.

Results show that all 14 assets assessed are at moderate or higher risk from at least one hazard in the baseline (present) and future time horizons. The assets at highest risk to any hazard are the Water Treatment Plant (WTP) and utilities. Parks and outdoor recreation, road network, and municipal facilities and community buildings are exposed to the greatest number of hazards (Figure 4). There are extreme risks to 21% of assets in the baseline (reservoirs, water treatment plant, and utilities) and 57% by the 2080s (dams, reservoirs, water treatment plant, water supply distribution network, wastewater treatment plant, road network, waste management facilities, and utilities).

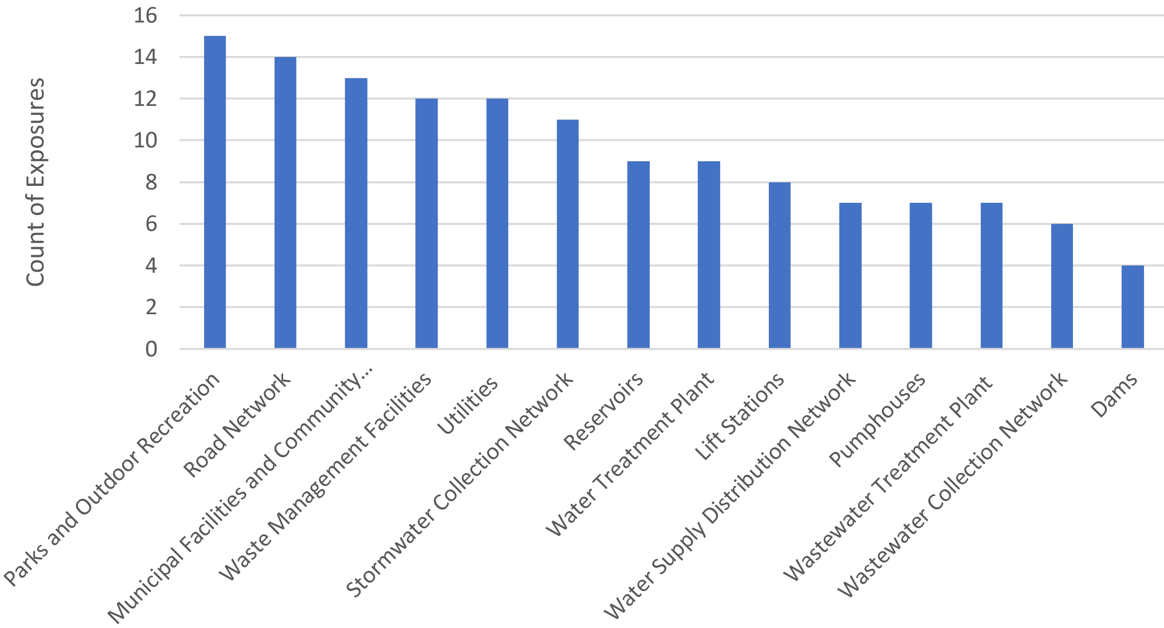

Figure 4. Count of Baseline Exposures.

Flooding events were identified in the background research and discussions as major concerns for the District. SDHI events are projected to increase in likelihood from 2 (low) in the baseline to 4 (high) by the 2080s. SDHI was used as a proxy for stormwater flooding and flash flooding. Historically, the District depended primarily on natural drainage and diversion of runoff to water bodies. SDHI events have become more intense, which has increased the need for stormwater drainage infrastructure. Lake/river/stream flooding events (maximum 5-day precipitation as proxy) are projected to increase in likelihood from 2 (low) in the baseline to 3 (moderate) by the 2080s. In Summerland, this is reflective of flooding from creeks, particularly Eneas Creek and Trout Creek. Eneas Creek is a high flood risk to the downtown core. It has been diverted from its natural course multiple times in the history of the District's development and now overflows due to extended rainfall events, freshets, and extreme cold (creek freezes from the bottom up). Flooding events also contribute to slope instability, which can lead to landslides. Flooding events are extreme risks to dams, reservoirs, water supply distribution network, wastewater treatment plant, road network, and waste management facilities and high risks to all assets.

Wildfires are projected to remain steady in likelihood at 5 (very high) from the baseline to the 2080s. Wildfires can damage all natural and physical assets. The District experiences wildfires annually and has risk reduction measures in place to mitigate burn damage, e.g., rapid response from the Summerland Fire Department, reduction of fuel load along wildfire interfaces, and mutual aid agreements with neighbouring cities. The combination of more extreme heat and drought events projected for the District makes wildfires a growing concern for natural resources, water supplies, infrastructure, and health and safety of residents. Wildfires are extreme risks to the WTP and utilities and high risks to pumphouses, lift stations, road network, municipal facilities and community buildings, and waste management facilities.

Landslides are projected to remain steady in likelihood at 4 (high) from the baseline to the 2080s. The most frequent and damaging landslide events in the District are those that occur along Highway 97 and the Perpetual Slide along Trout Creek that has been active since 1914. Landslides along Highway 97 vary in annual frequency, but can cause substantial disruption of transportation along the region's major north-south highway. The rockslide that occurred on August 28, 2023 resulted in closure of sections of the highway and establishment of detour routes for commuters. Historically, the Perpetual Slide has made Trout Creek muddy and hindered operations at the WTP. It also has the potential to slide as a large mass, which would block water flow along the creek and cause widespread flooding with little warning. Landslides can increase reservoir turbidity and expose and break water and sewer in-ground pipes, thereby impacting water supply and wastewater collection. Landslides are extreme risks to reservoirs and high risks to water supply distribution network, wastewater collection network, parks and outdoor recreation, road network, and utilities.

Table 10. Risk Scores.

Assets	Air Quality				Extreme Heat				Extreme Cold				SDHI			
	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s
Dams													8	12	16	16
Reservoirs					3	5	5	5					8	12	16	16
Water Treatment Plant					6	10	10	10					6	9	12	12
Water Supply Distribution Network									9	3	3	3	6	9	12	12
Pumphouses									0	0	0	0	4	6	8	8
Wastewater Treatment Plant					3	5	5	5					4	6	8	8
Wastewater Collection Network									3	1	1	1	4	6	8	8
Lift Stations									0	0	0	0	4	6	8	8
Stormwater Collection Network									3	1	1	1	6	9	12	12
Parks and Outdoor Recreation	9	9	12	12	0	0	0	0	3	1	1	1	2	3	4	4
Road Network	3	3	4	4	0	0	0	0	9	3	3	3	6	9	12	12
Municipal Facilities and Community Buildings	3	3	4	4	6	10	10	10					4	6	8	8
Waste Management Facilities					3	5	5	5	3	1	1	1	6	9	12	12
Utilities					3	5	5	5	3	1	1	1	4	6	8	8

Assets	Fog				Freezing Rain or Drizzle				Hail				High Wind Event			
	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s
Dams													0	0	0	0
Reservoirs									0	0	0	0	0	0	0	0
Water Treatment Plant									0	0	0	0	0	0	0	0
Water Supply Distribution Network													0	0	0	0
Pumphouses													0	0	0	0
Wastewater Treatment Plant													0	0	0	0
Wastewater Collection Network																
Lift Stations													0	0	0	0
Stormwater Collection Network					6	6	8	10	3	3	4	4	2	2	3	3
Parks and Outdoor Recreation					6	6	8	10	0	0	0	0	4	4	6	6
Road Network	3	3	4	4	9	9	12	15	0	0	0	0	4	4	6	6
Municipal Facilities and Community Buildings					0	0	0	0	0	0	0	0	2	2	3	3
Waste Management Facilities	3	3	4	4	6	6	8	10					4	4	6	6
Utilities					12	12	16	20	3	3	4	4	6	6	9	9

Assets	Lightning				Snowstorms and Blizzards				Wildfire				Landslide/ Debris Flow			
	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s
Dams																
Reservoirs					0	0	0	0					16	16	16	16
Water Treatment Plant	0	0	0	0					20	20	20	20				
Water Supply Distribution Network									0	0	0	0	8	8	8	8
Pumphouses	5	5	5	5					10	10	10	10	4	4	4	4
Wastewater Treatment Plant	0	0	0	0					0	0	0	0				
Wastewater Collection Network									0	0	0	0	8	8	8	8
Lift Stations	5	5	5	5					10	10	10	10	4	4	4	4
Stormwater Collection Network					3	3	4	4	0	0	0	0	4	4	4	4
Parks and Outdoor Recreation	5	5	5	5	0	0	0	0	5	5	5	5	12	12	12	12
Road Network					6	6	8	8	10	10	10	10	8	8	8	8
Municipal Facilities and Community Buildings	5	5	5	5	3	3	4	4	10	10	10	10	4	4	4	4
Waste Management Facilities	0	0	0	0	3	3	4	4	10	10	10	10	0	0	0	0
Utilities	20	20	20	20	3	3	4	4	20	20	20	20	12	12	12	12

Assets	Drought				Seiche				Lake/ River/ Stream Flooding				Flash Flooding			
	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s	Present	2030s	2050s	2080s
Dams									8	12	12	12	8	12	16	16
Reservoirs	9	12	12	15					8	12	12	12	8	12	16	16
Water Treatment Plant	9	12	12	15					8	12	12	12	6	9	12	12
Water Supply Distribution Network									6	9	9	9	8	12	16	16
Pumphouses									6	9	9	9				
Wastewater Treatment Plant									2	3	3	3	8	12	16	16
Wastewater Collection Network									6	9	9	9	4	6	8	8
Lift Stations									6	9	9	9	4	6	8	8
Stormwater Collection Network	6	8	8	10					8	12	12	12	4	6	8	8
Parks and Outdoor Recreation	6	8	8	10	3	3	3	3	8	12	12	12	4	6	8	8
Road Network					6	6	6	6	8	12	12	12	6	9	12	12
Municipal Facilities and Community Buildings	3	4	4	5					2	3	3	3	4	6	8	8
Waste Management Facilities									2	3	3	3	8	12	16	16
Utilities									6	9	9	9	4	6	8	8

6 Next Steps

This assessment has identified the hazards that are risks to the District of Summerland's infrastructure through analysis of climate likelihood, exposure, and consequence. The hazards with the greatest proportion of high to extreme risk in the baseline are wildfire (20%), landslides (17%), lake/river/stream flooding (18%), and flash flooding (15%). The biggest shift in risks (from low/medium to high/extreme) between the baseline and future climate periods occurs because of SDHI, freezing rain/drizzle, drought, and flash flooding. SDHI and lake/river/stream flooding are risks to all assets. All 14 assets assessed are at moderate or higher risk from at least one hazard in the baseline and future time horizons. The assets at highest risk to any hazard are the Water Treatment Plant (WTP) and utilities. There are extreme risks to 21% of assets in the baseline (reservoirs, water treatment plant, and utilities) and 57% by the 2080s (dams, reservoirs, water treatment plant, water supply distribution network, wastewater treatment plant, road network, waste management facilities, and utilities).

Some specific findings of higher risk include the following:

- Flooding events are extreme risks to dams, reservoirs, water supply distribution network, wastewater treatment plant, road network, and waste management facilities and high risks to all assets.
- Wildfires are extreme risks to the WTP and utilities and high risks to pumphouses, lift stations, road network, municipal facilities and community buildings, and waste management facilities.
- Landslides are extreme risks to reservoirs and high risks to water supply distribution network, wastewater collection network, parks and outdoor recreation, road network, and utilities.

The results of this CCRA are intended to be used towards development of a climate adaptation plan for the District by:

- Identifying gaps and opportunities internally to support education and awareness in departments for risks and hazards in the District.
- Informing improvements in how the District responds to hazards and risks at a local and regional level.
- Informing future climate change planning by enhancing understanding of climate risk and informing actions and future implementation (adaptation and mitigation based LCR).

Other relevant recommendations include the following:

- Continue to promote a collaborative approach to adaptation planning that involves relevant stakeholders and knowledge holders, such as District government, First Nations, residents, business owners, and regional agencies (e.g., RDOS, IH, OASSIS).
- Continue to implement the District's approved Asset Management Strategy by updating building condition assessments and Level I ASHRAE energy audits when necessary for critical facilities.
- Although "high" and "extreme" risks have been the focus of this analysis, there is value in developing risk reduction measures for medium and lower risk assets as well.

District of Summerland HRVA: Climate Profile

September 29, 2023

Prepared for:
District of Summerland

Prepared by:
Stantec Consulting Ltd.

Project Number:
160925277

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1 Introduction

1.1 Description of Climate Profiles

Climate is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of meteorological variables such as temperature, precipitation, and wind over a period of time. Climate profiles are important tools that describe what climate trends have been occurring in recent history (i.e., over the last 30 years or longer), and describe future climate conditions to help inform the planners, stakeholders, and decision makers to manage the climate change risks and plan for the appropriate adaptation measures. Climate profiles rely on the historical climate record (usually in the form of meteorological data measured at weather stations) to describe climate from recent history, and on climate projections (developed by global climate models or GCMs). The historical climate profile puts future climate projections into context: the performance of the infrastructure from the past can be compared to both historical and future climate to better understand what (if any) adaptation measures should be implemented to ensure better performance in the future.

When developing a profile of the historic climate of an area, the most valuable data is typically temperature, precipitation, and wind. Meteorological data from the last 30 years is preferred to help give a representative estimate of the climate of recent history at a given location – though longer periods are of even greater benefit in that they add even more to the story of an area's historical climate. Environment and Climate Change Canada (ECCC) provides the largest database of observational historical climate data in Canada. In addition to assembled climate data from weather stations, gridded data products are available and provide additional climate data resources. These gridded data products include the NRCANmet gridded dataset, produced by Natural Resources Canada (NRCan), which provides daily maximum and minimum temperature and total precipitation data on a ~10 km grid resolution over Canada for the 1950-2013 time period (Hopkinson, 2011) (McKenney, 2011.). Although observational data from a weather station is preferable, gridded datasets such as NRCANmet are well accepted and researched. While not a directly measured data set, NRCANmet is a peer-reviewed, gridded interpolation of the daily weather conditions and historical climate of any land-based location in Canada. As such, the NRCANmet datasets are well accepted and can provide reasonable approximations for locations when historic data is not inadequate for climate assessment.

Climate projections are descriptions of the future climate and are most often collected from GCMs developed by many organizations across the world. These GCMs are complex, in that they all rely on many different assumptions about how they work (i.e., they focus more on different physical phenomena to estimate future climate, whether it be greenhouse gas (GHG) concentrations in the atmosphere or absorption of solar radiation by the ocean) and also on what will happen in the future. Since different GCMs focus more than others on different physical phenomena, there is a noticeable difference in the future climate that is predicted. Therefore, it is not recommended to rely only on one or two of these GCMs to estimate future climate. Instead, an average of several GCMs tends to give a more reliable estimate of future climate. There are nearly 40 GCMs that have contributed to the Sixth Coupled Model Intercomparison Project (CMIP6), which forms the basis of the latest publications from the Intergovernmental Panel on Climate Change (IPCC). Environment and Climate Change Canada (ECCC) has taken a subset of 26 of these models to produce reliable, high-resolution downscaled climate projections localized to specific areas of interest in Canada (A.J. Cannon, 2015).

In addition to the physics of the GCMs, global progress towards meeting GHG emissions targets is also a large source of uncertainty in future climate projections. There are four Representative Concentration Pathways (RCP)[1] scenarios adopted by the Intergovernmental Panel on Climate Change (IPCC) that are based on various future greenhouse gas concentration scenarios. Additionally, there are five Shared Socioeconomic Pathways (SSP)[2] that are based on socioeconomic global change scenarios. This climate profile will focus on the "business as usual" greenhouse gas concentrations and socioeconomic pathway scenario, SSP5-8.5, and intermediate scenario, SSP2-4.5. Current global GHG concentrations are closer to following the SSP5-8.5 pathway, despite global agreements/targets for GHG emissions reductions.

> The IPCC is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.
>
> IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC). The assessments are policy-relevant but not policy-prescriptive: they may present projections of future climate change based on different scenarios and the risks that climate change poses and discuss the implications of response options, but they do not tell policymakers what actions to take.

1.2 Climate Profile for Summerland

A climate profile was required for the District of Summerland to improve the understanding of the climate of the area. The climate profile for Summerland (Figure 1) required a review of available historical observed weather data and climate projection data for the region. When developing a profile of the historic climate of an area, the most valuable data is typically temperature, precipitation, and wind data collected from nearby weather stations. There is one ECCC weather station in the District, which ranges from hourly to monthly time steps. A summary of the weather station is shown in Table 1 and Figure 1 and will be used in this

[1] RCP: Representative Concentration Pathways – a greenhouse gas concentration (not emissions) trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) for its Sixth Assessment Report (AR6) in 2021.

[2] SSP: Shared Socioeconomic Pathway – projected socioeconomic global changes adopted by the Intergovernmental Panel on Climate Change (IPCC) for its Sixth Assessment Report (AR6) in 2021.

analysis. Details of the observational station identified for use to establish the historical climate conditions for Summerland (Summerland CS, Station ID: 112G8L1) are shown in Table 1.

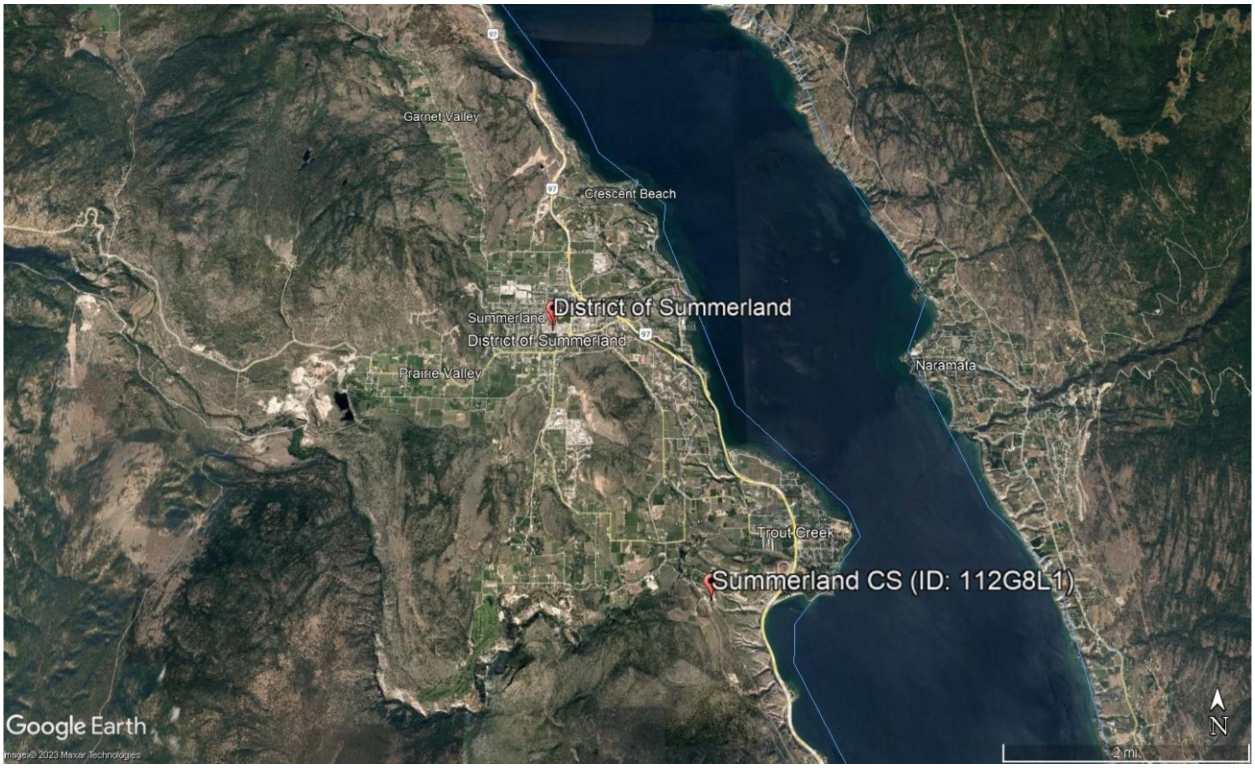

Figure 1. Historical Weather Observations in the region of Summerland

The 1981-2010 time horizon was selected as the baseline for the region of Summerland. The climate for the 2020s (time horizon of 2011 to 2040) is presented to evaluate how recent trends correlate with projections in the near future. The 2050s (2041 to 2070) and 2080s (2071 to 2100) time horizons are presented as longer-term climate projections, to highlight projected changes in the future climate of the region. This profile will guide the Climate Change Risk Assessment (CCRA), which will help to inform stakeholders and decision-makers of climate risks to the infrastructure in the region. The climate values provided represent the projected average over a 30-year time period in the future.

Table 1. Summary of weather monitoring stations in region of Summerland

Weather Monitoring Station	Latitude	Longitude	Station ID	Elevation	Distance to Asset Location
Summerland CS	49°33'45.200" N	119°38'55.300" W	112G8L1	454.20 m	5.0km

2 Mean Temperature

2.1 Mean Temperature

A summary of mean temperature trends over baseline and future climate periods for the District of Summerland is shown in Table 2. Annual and seasonal temporal averages for daily mean temperature in the region of Summerland are shown in Figure 2. Annual and seasonal mean temperature is projected to increase from the baseline with the greatest changes (+6.6°C) occurring in the summer months.

Table 2. Average Change in Mean Temperature from Baseline in Summerland, BC.

Season	Mean Temperature Climate Average 1981-2010 (°C)	Average (Change in) Mean Temperature from 1981-2010 Baseline (°C)		
		2020s	2050s	2080s
		SSP5-8.5	SSP5-8.5	SSP5-8.5
Annual	7.8	10.5 (+2.7)	11.0 (+3.2)	13.3 (+5.5)
Spring	7.8	9.1 (+1.3)	10.6 (+2.8)	12.6 (+4.8)
Summer	18.3	19.9 (+1.6)	22.1 (+3.8)	24.9 (+6.6)
Fall	7.6	9.1 (+1.5)	10.8 (+3.2)	13.1 (+5.5)
Winter	-2.5	-1.4 (+1.1)	0.32 (+2.8)	2.2 (+4.7)

Mean Temperature

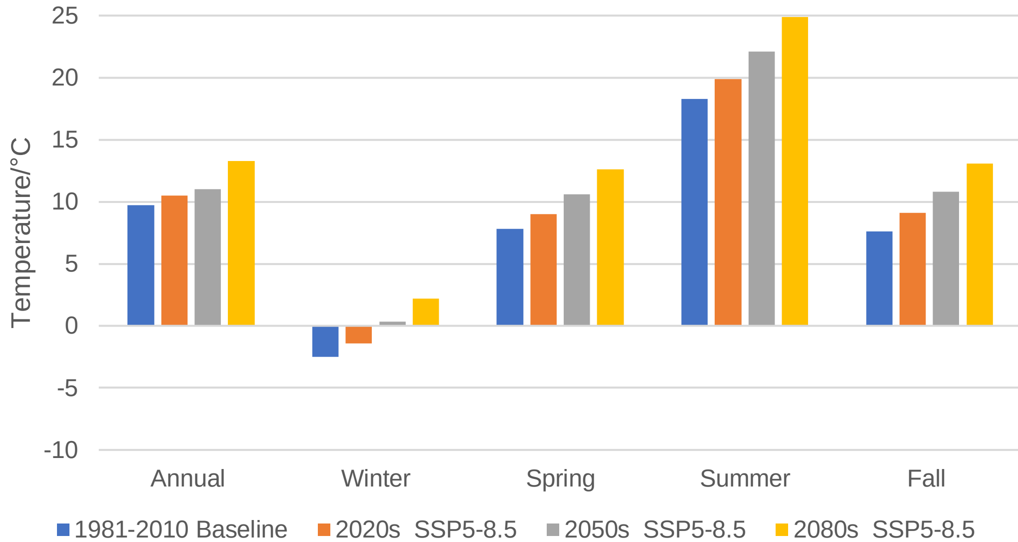

Figure 2. Annual and Seasonal Temporal Averages - Mean Daily Temperature in the region of Summerland.

3 Maximum Temperature

3.1 Annual and Seasonal Average

A summary of maximum temperature trends over baseline and future climate periods for the District of Summerland is shown Table 3. Annual and seasonal temporal averages for daily maximum temperature in the region are shown in Figure 3. The maximum annual and seasonal temperature is projected to increase from the 1981-2010 baseline with the greatest increase occurring in the summer months (+7.2°C).

Table 3. Average Change in Maximum Temperature from Baseline (RCP 8.5) in the region of Summerland

Season	Maximum Temperature Climate Average 1981-2010 (°C)	Average (Change in) Maximum Temperature from 1981-2010 Baseline (°C)		
		2020s	2050s	2080s
		SSP5-8.5	SSP5-8.5	SSP5-8.5
Annual	13.4	14.8 (+1.4)	16.6 (+3.2)	18.8 (+5.4)
Spring	14.0	15.2 (+1.2)	16.9 (+2.9)	18.9 (+4.9)
Summer	25.8	27.7 (+1.9)	30.0 (+4.2)	33.0 (+7.2)
Fall	12.9	14.4 (+1.5)	16.15 (+3.2)	18.3 (+5.4)
Winter	1.0	1.9 (+0.9)	3.3 (+2.3)	5.0 (+4.0)

Extreme Maximum Temperature Frequency

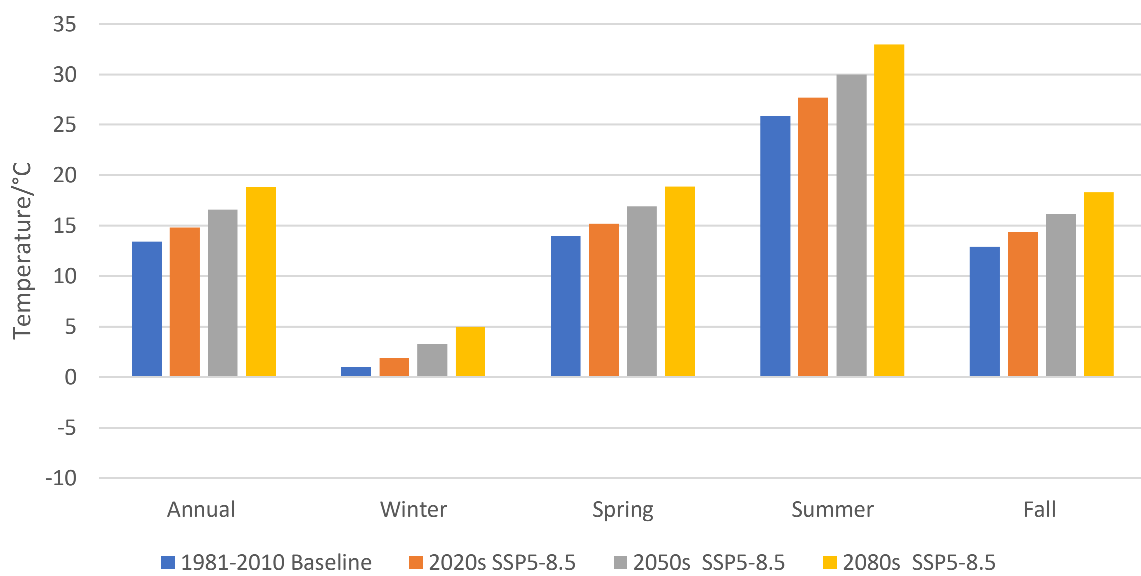

Figure 3. Annual and Seasonal Temporal Averages – Maximum Daily in the region of Summerland

3.2 Extreme Maximum Temperature Frequency

The average number of days with daily maximum temperatures greater than or equal to 30°C and 35°C in the District of Summerland for baseline and future time periods is shown in Table 4 and Table 5, respectively. The frequency of extreme high temperatures is projected to increase in the area.

Table 4. Occurrence of Maximum Daily Temperature ≥30°C, Summerland

Average Annual Number of Days with Max. Temp ≥ 30°C			
1981-2010 Baseline	2020s SSP5-8.5	2050s SSP5-8.5	2080s SSP5-8.5
28.6	37.0	55.9	79.8

Table 5. Occurrence of Maximum Daily Temperature ≥35°C, Summerland

Average Annual Number of Days with Max. Temp ≥ 35°C			
1981-2010 Baseline	2020s SSP5-8.5	2050s SSP5-8.5	2080s SSP5-8.5
4.2	7.2	19.0	39.6

4 Minimum Temperature

4.1 Annual and Seasonal Average

Summaries of mean minimum temperature and average change in minimum temperature over the baseline and future climate periods are shown in Table 6. Annual and seasonal temporal averages for daily minimum temperature in the region are shown in Figure 4. Minimum annual and seasonal temperatures are projected to increase from the baseline, with the greatest increase (+6.1 C) occurring in the summer months.

Table 6. Average Change in Minimum Temperature from Baseline in Summerland

Season	Minimum Temperature Climate Average 1981-2010 (°C)	Average (Change in) Minimum Temperature from 1981-2010 Baseline (°C)		
		2020s	2050s	2080s
		SSP5-8.5	SSP5-8.5	SSP5-8.5
Annual	2.2	3.5 (+1.3)	5.4 (+3.2)	7.6 (+5.4)
Spring	1.6	2.8 (+1.2)	4.4 (+2.8)	6.3 (+4.7)
Summer	10.7	12.2 (+1.5)	14.2 (+3.5)	16.8 (+6.1)
Fall	2.3	3.8 (+1.5)	5.5 (+3.2)	7.8 (+5.5)
Winter	-6.0	-4.7 (+1.3)	-2.7 (+3.3)	-0.5 (+5.5)

Extreme Minimum Temperature Frequency

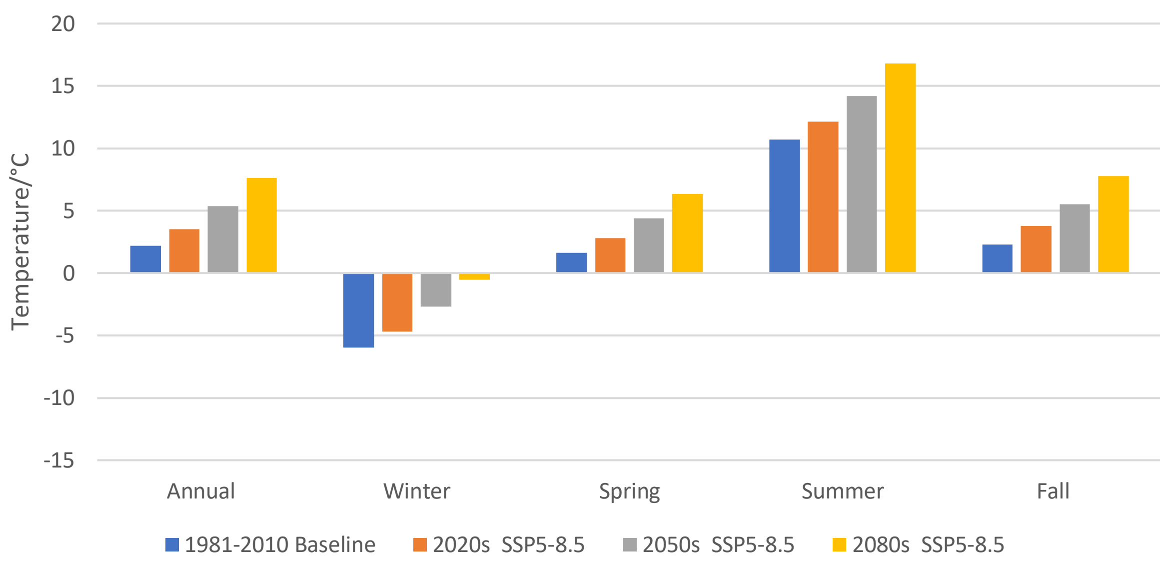

Figure 4. Annual and Seasonal Temporal Averages – Minimum Daily Temperature in the region of Summerland

4.2 Extreme Minimum Temperature Frequency

Climate projections for the occurrence of days with temperatures less than -15°C and -25°C are presented in Table 7and Table 8, respectively. The frequency of extreme minimum temperatures is projected to decrease for the region of Summerland.

Table 7. Occurrence of Minimum Temperature ≤ -15°C, Summerland

Average Annual Number of Days with Min. Temp ≤ -15°C			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
8.3	6.0	3.4	1.3

Table 8. Occurrence of Minimum Temperature ≤ -25°C, Summerland

Average Annual Number of Days with Min. Temp ≤ -30°C			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
0.6	0.3	0.1	0.0

5 Precipitation

5.1 TOTAL ANNUAL & SEASONAL ACCUMULATION

Total annual and seasonal precipitation and percent change in total precipitation from the baseline are shown in Table 9. Total annual and seasonal precipitation in the region for future climate periods is shown in Figure 5 and Figure 6. Total precipitation is projected to increase in the District of Summerland, with the largest percentage changes (+21.9%) in fall.

Table 9. Average Percent Change in Total Precipitation from Baseline (RCP 8.5) in the region of Summerland.

Season	Mean Total Precipitation Average 1981-2010 (mm)	Projected Total Precipitation and Percent Change from 1981-2010 Baseline (%)		
		2020s	2050s	2080s
		SSP5-.8.5	SSP5-.8.5	SSP5-.8.5
Annual	6916.2	7039.8 (+1.8%)	7280.3 (+5.3%)	7663.7 (+10.8%)
Winter	2047.9	2134.1 (+4.2%)	2254.3 (+10.1%)	2375.5 (+16.0%)
Spring	1511.8	1581.7 (+4.6%)	1675.2 (+10.8%)	1832.7 (+21.2%)
Summer	1800.3	1689.7 (-6.1%)	1633.1 (-9.3%)	1558.2 (-13.5%)
Fall	1556.2	1634.3 (+5.0%)	1717.7 (+10.4%)	1897.3 (+21.9%)

Precipitation

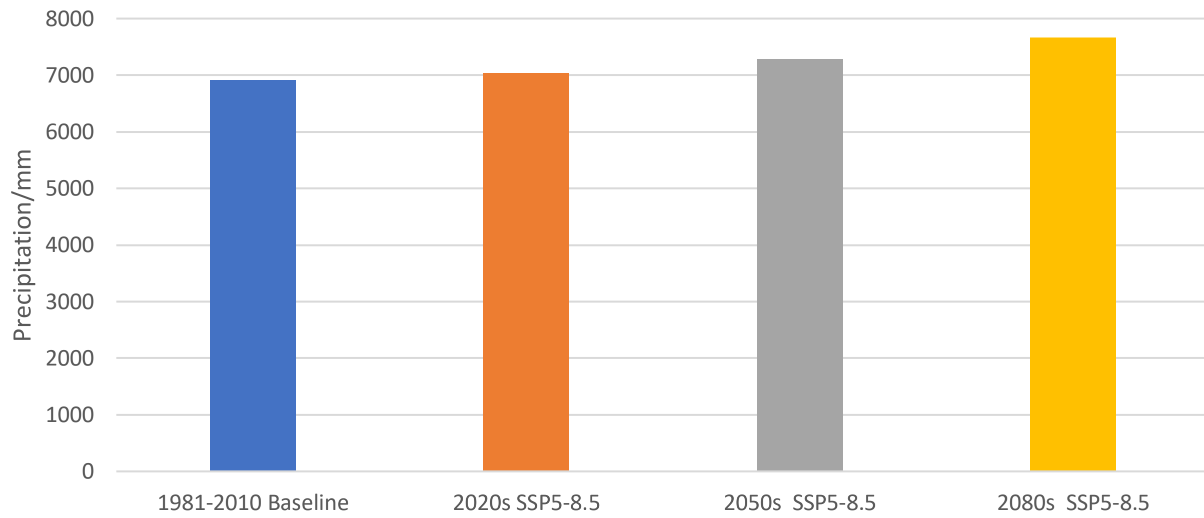

Figure 5. Average Annual Total Precipitation in the region of Summerland

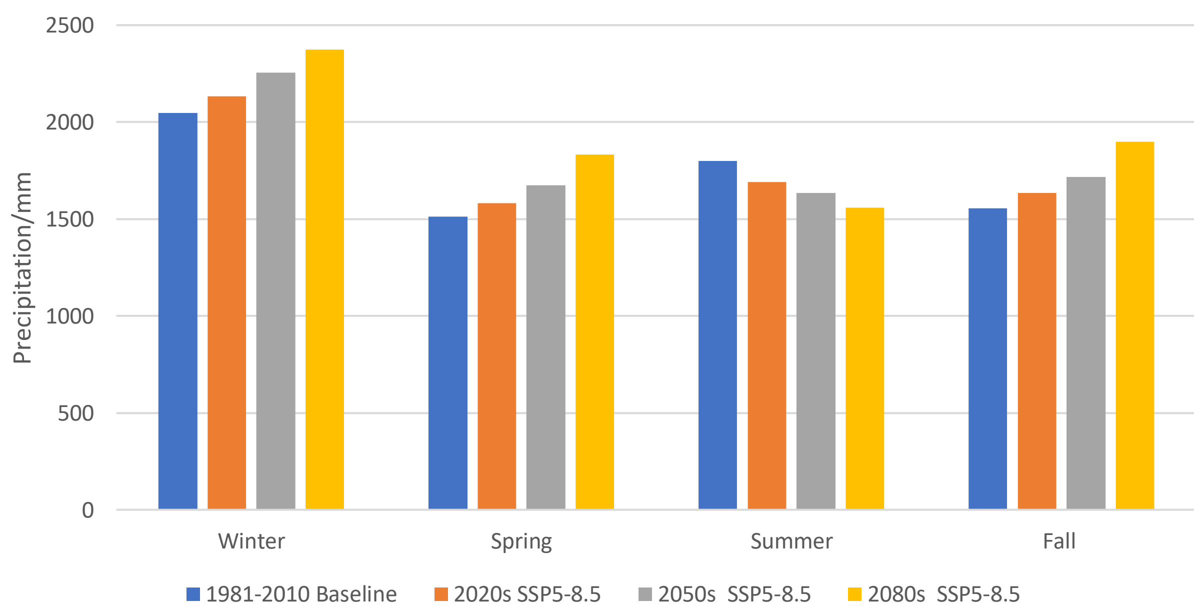

Figure 6. Average Seasonal Total Precipitation in the region of Summerland

5.2 INTENSITY-DURATION-FREQUENCY (IDF)

Evaluating historic and projected intensity-duration-frequency (IDF) data provides insight into how the intensity, duration, and frequency of precipitation events will change under future climate conditions. IDF data relates short-duration, high intensity rainfall with its frequency of occurrence. When IDF data is not available from the representative weather station within the climate zone, “ungauged” historical IDF data calculated through interpolation between Environment Canada weather stations in the region can be used. The Summerland CS (Station ID: 112G8L1) provides 40 years of record of IDF data, covering the 1955-1994 time period. Total precipitation amount (mm) and precipitation event intensity (mm/hr) in specific time intervals (5 minutes to 24 hours) for various return periods (2 years to 100 years) are provided in Table 10 to Table 17. Projections for future climate IDF data are available based on results from 24 Global Circulation Models that simulate future climate conditions. The projected IDF data presented here use the ‘temperature scaling’ method, which is being increasingly used to estimate future Canadian rainfall extremes. It is described in CSA PLUS 2013[3] and is being used to develop future rainfall estimates for the National Building Code of Canada and Canadian Highway Bridge Design Code. Temperature scaling is a simple but robust way to update IDF curves for climate change and is based solely on temperature change. The following formula is applied to project future IDF curves:

$$R_P = R_C \times 1.07^{\Delta T}$$

Where R_P is the future estimated rainfall intensity value, R_C is the current rainfall intensity value, and ΔT is the long-term (40-year mean) annual mean temperature change for the study location between the target time horizon (e.g., 2050s) and baseline period.

Table 10. Historical Precipitation Event Accumulation IDF data (mm) –Summerland CS (Station ID: 112G8L1), 1955-1994.

T (years)	2	5	10	25	50	100
5 min	3	4.5	5.4	6.6	7.5	8.4
10 min	4.2	6.2	7.4	9	10.2	11.4
15 min	5	7	8.3	10	11.3	12.5
30 min	6.2	8.3	9.7	11.5	12.8	14.1
1 h	7.8	10	11.5	13.3	14.7	16.1
2 h	9.9	12.7	14.5	16.9	18.6	20.4
6 h	13.8	18.5	21.7	25.7	28.7	31.6
12 h	16.9	22.4	26	30.6	34	37.4
24 h	20.3	26.9	31.3	36.8	40.9	44.9

[3] CSA (2019) Technical guide: Development, interpretation, and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian water resource practitioners. 125 pp.

Precipitation

Table 11. Projected Precipitation Event Accumulation IDF data (mm) for Summerland CS (Station ID: 112G8L1), 2020s (2011-2041).

T (years)	2	5	10	25	50	100
SSP5-8.5						
5 min	3.41	5.12	6.14	7.51	8.53	9.55
10 min	4.78	7.05	8.42	10.23	11.60	12.96
15 min	5.69	7.96	9.44	11.37	12.85	14.21
30 min	7.05	9.44	11.03	13.08	14.56	16.03
1 h	8.87	11.37	13.08	15.12	16.72	18.31
2 h	11.26	14.44	16.49	19.22	21.15	23.20
6 h	15.69	21.04	24.68	29.23	32.64	35.93
12 h	19.22	25.47	29.57	34.80	38.66	42.53
24 h	23.08	30.59	35.59	41.85	46.51	51.06

Table 12. Projected Precipitation Event Accumulation IDF data (mm) for Summerland CS (Station ID: 112G8L1), 2050s (2041-2070).

T (years)	2	5	10	25	50	100
SSP5-8.5						
5 min	3.88	5.82	6.98	8.53	9.70	10.86
10 min	5.43	8.02	9.57	11.64	13.19	14.74
15 min	6.47	9.05	10.73	12.93	14.61	16.16
30 min	8.02	10.73	12.54	14.87	16.55	18.23
1 h	10.09	12.93	14.87	17.20	19.01	20.82
2 h	12.80	16.42	18.75	21.85	24.05	26.38
6 h	17.85	23.92	28.06	33.23	37.11	40.86
12 h	21.85	28.97	33.62	39.57	43.97	48.36
24 h	26.25	34.79	40.48	47.59	52.89	58.06

Table 13. Projected Precipitation Event Accumulation IDF data (mm) for Summerland CS (Station ID: 112G8L1), 2080s (2071-2100).

T (years)	2	5	10	25	50	100
SSP5-8.5						
5 min	4.21	6.31	7.57	9.26	10.52	11.78
10 min	5.89	8.70	10.38	12.62	14.31	15.99
15 min	7.01	9.82	11.64	14.03	15.85	17.53
30 min	8.70	11.64	13.60	16.13	17.95	19.78
1 h	10.94	14.03	16.13	18.65	20.62	22.58
2 h	13.89	17.81	20.34	23.70	26.09	28.61
6 h	19.36	25.95	30.44	36.05	40.25	44.32
12 h	23.70	31.42	36.47	42.92	47.69	52.46
24 h	28.47	37.73	43.90	51.61	57.36	62.97

The results indicate that an increase in precipitation accumulation can be expected at the Summerland RCS weather station for most of the precipitation events. Under SSP5-8.5, the projected percentage change from the baseline for precipitation events are 12.8% for the 2020s, 25.6% for the 2050s, and 33.5% for the 2080s.

The increase in precipitation accumulation shown above correlates to increased precipitation event intensity (mm/hr) as shown below for the Summerland CS weather station.

Precipitation

Table 14. Historical Precipitation Event Intensity IDF data (mm/hr) for Summerland CS (Station ID: 112G8L1), 1955-1994.

T (years)	2	5	10	25	50	100
5 min	36.00	54.00	64.80	79.20	90.00	100.80
10 min	25.20	37.20	44.40	54.00	61.20	68.40
15 min	20.00	28.00	33.20	40.00	45.20	50.00
30 min	12.40	16.60	19.40	23.00	25.60	28.20
1 h	7.80	10.00	11.50	13.30	14.70	16.10
2 h	4.95	6.35	7.25	8.45	9.30	10.20
6 h	2.30	3.08	3.62	4.28	4.78	5.27
12 h	1.41	1.87	2.17	2.55	2.83	3.12
24 h	0.85	1.12	1.30	1.53	1.70	1.87

Table 15. Projected Precipitation Event Intensity IDF data (mm/hr) for Summerland CS (Station ID: 112G8L1), 2020s (2011-2041).

T (years)	2	5	10	25	50	100
SSP5-8.5						
5 min	40.94	61.41	73.69	90.06	102.35	114.63
10 min	28.66	42.30	50.49	61.41	69.60	77.78
15 min	22.74	31.84	37.75	45.49	51.40	56.86
30 min	14.10	18.88	22.06	26.16	29.11	32.07
1 h	8.87	11.37	13.08	15.12	16.72	18.31
2 h	5.63	7.22	8.24	9.61	10.58	11.60
6 h	2.62	3.51	4.11	4.87	5.44	5.99
12 h	1.60	2.12	2.46	2.90	3.22	3.54
24 h	0.96	1.27	1.48	1.74	1.94	2.13

Precipitation

Table 16. Projected Precipitation Event Intensity IDF data (mm/hr) for Summerland CS (Station ID: 112G8L1), 2050s (2041-2070).

T (years)	2	5	10	25	50	100
SSP5-8.5						
5 min	46.55	69.83	83.80	102.42	116.39	130.35
10 min	32.59	48.11	57.42	69.83	79.14	88.45
15 min	25.86	36.21	42.93	51.73	58.45	64.66
30 min	16.04	21.47	25.09	29.74	33.11	36.47
1 h	10.09	12.93	14.87	17.20	19.01	20.82
2 h	6.40	8.21	9.38	10.93	12.03	13.19
6 h	2.97	3.99	4.68	5.54	6.19	6.81
12 h	1.82	2.41	2.80	3.30	3.66	4.03
24 h	1.09	1.45	1.69	1.98	2.20	2.42

Table 17. Projected Precipitation Event Intensity IDF data (mm/hr) for Summerland CS (Station ID: 112G8L1), 2080s (2071-2100).

T (years)	2	5	10	25	50	100
SSP5-8.5						
5 min	50.49	75.74	90.89	111.08	126.23	141.38
10 min	35.34	52.17	62.27	75.74	85.84	95.93
15 min	28.05	39.27	46.56	56.10	63.40	70.13
30 min	17.39	23.28	27.21	32.26	35.91	39.55
1 h	10.94	14.03	16.13	18.65	20.62	22.58
2 h	6.94	8.91	10.17	11.85	13.04	14.31
6 h	3.23	4.32	5.07	6.01	6.71	7.39
12 h	1.98	2.62	3.04	3.58	3.97	4.37
24 h	1.19	1.57	1.83	2.15	2.39	2.62

The results indicate that an increase in precipitation intensity can be expected at the Summerland CS weather station for most of the durations presented above.

5.3 1,3,5 DAY ACCUMULATION

Observations from Summerland CS weather station (Station ID: 112G8L1) were used where complete datasets were available for precipitation over the baseline period. Record 1, 3, 5-day precipitation accumulations in the region are shown in Table 18. Historical and projected estimates for maximum 1, 3, and 5-day precipitation accumulation in the station are shown in Table 19. Precipitation accumulation for 1, 3 and 5- day events is projected to increase under SSP5-8.5 in the region.

Table 18. Historical Precipitation Event Accumulation (mm) – Summerland CS (Station ID: 112G8L1).

	Record Maximum Precipitation Accumulation		
	Region of Summerland (1981-2010)		
	1 day	3 day	5 day
Precipitation (mm)	65.6	73.8	73.8
Event End Date	July 19, 2007	July 20, 2007	July 20, 2007

Table 19. Historical and Projected Average Annual Maximum 1, 3, 5 Day Precipitation Accumulations in the region of Summerland.

Duration	Average Annual Maximum Precipitation Accumulation (mm)			
	1981-2010 Baseline	2020s	2050s	2080s
		SSP5-8.5	SSP5-8.5	SSP5-8.5
1-Day	16.0	16.9	17.7	19.3
3-Day	25.7	26.6	28.0	29.9
5-Day	31.4	32.3	34.0	35.9

5.4 DROUGHT

A drought is an anomalous moisture deficit based on a standard baseline. The Standardized Precipitation Evapotranspiration Index (SPEI) is designed to account for both precipitation and potential evapotranspiration (PET) in determining drought. PET was calculated using the Hargreaves evaporation method. Depending on the magnitude of a drought, it can have significant impacts on water supply, ecological processes, and the economy. Tam et al. (2019) provides a useful framework for defining drought where SPEI < -1.0 are 'moderate', SPEI < -1.5 are 'severe', and SPEI < -2.0 are 'extreme'. SPEI was calculated using the baseline period (1981-2010) and projections for RCP8.5 are based on the relative difference in moisture availability between future time horizons and present.

Table 20. Average SPEI Values per Year in Summerland

Average SPEI Values per Year			
1981-2010 Baseline	2020s	2050s	2080s
	RCP8.5	RCP8.5	RCP8.5
-0.07	-0.27	-0.31	-0.74

5.5 HAIL

Hail is described as precipitation consisting of ice particles, in various shapes, which are generally observed during thunderstorms, with a minimum diameter of 5mm (AMS, 2017). Depending on their size, hail can be destructive to buildings and infrastructure, costing insurers millions of dollars.

Due to the complex, localized, and short duration nature of hailstorm, current climate projections are not able to indicate future changes in occurrence in a quantitative way. Additionally, as hailstorm damages follow a fat-tailed distribution, the very rare extreme events account for a relatively large fraction of total consequences (Clauset, 2009). Thus, it is difficult to use annualized losses as a predictor to future risk. However, hail may become a greater issue in the future due to the potentially increasing frequency of thunderstorms (Brooks, 2014).

5.6 FREEZING RAIN

Freezing rain is described as supercooled rain that freezes on impact to form a coating of clear ice on exposed surfaces. Depending on the intensity of the event, ice accretion can cause significant structure damage by exceeding its designed load capacity. Currently, ECCC warning criteria do not include a threshold for total ice accretion amount. Therefore, it is difficult to determine the impacts of freezing rain events on the District of Summerland. Numerous freezing rain events have impacted Summerland.

Under climate change projections, research has shown that warming temperatures in the future may increase the likelihood of freezing rain event by 2050s and 2080s. Freezing rain events in winter months (January and February) could increase by about 5-20% with a 95% confidence interval in Canada for future periods respectively. For the warmer winter months (December, November, March, and April), freezing rain events are projected to remain the same for the future period (McCray, 2022). However, it is difficult to determine how freezing rain events will impact Summerland due to little supporting data and significant uncertainty.

5.7 SNOW

Historical occurrences of snowfall in Summerland based on observations from ECCC weather stations are shown in Table 21 and Figure 7. Overall, snowfall is projected to decrease in the region under SSP 5-8.5. However, large events will remain possible under climate change due to cold air outbreaks and storm tracks.

Table 21. Days with snowfall – Summerland CS (Station ID: 112G8L1), 1981-2010 Canadian Climate Normal (Environment Canada).

Snowfall	Days/year
≥ 0.2 cm	NA
≥ 5 cm	NA
≥ 10 cm	NA
≥ 25 cm	NA

Figure 7. Snow on Ground from Weather Station Summerland CS (Station ID: 112G8L1).

6 Frost Days

Frost days are days when the daily minimum temperature is less than 0°C, indicating when conditions are below freezing (typically overnight) and frost might form at ground level or on cold surfaces. Historical and projected estimates for average annual number of frost days for the District of Summerland are shown in Table 22. The frequency of occurrence of frost days is projected to decrease under SSP5-8.5 scenario in the region.

Table 22. Average Annual Number of Frost Days in Summerland

Average Annual Number of Frost Days			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
140.5	118.3	84.2	51.1

7 Ice Days

Frost days are days when the daily maximum temperature is less than 0°C, indicating when conditions are favorable for snow retention. Historical and projected estimates for average annual number of icing days in Summerland are shown in Table 23. The frequency of occurrence of icing days is projected to decrease under SSP5-8.5 scenario in the region.

Table 23. Average Annual Number of Icing Days in Summerland

Average Annual Number of Icing Days			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
35.7	28.0	18.9	12.0

8 Heatwaves

For this climate profile, a heat wave is defined as three or more consecutive days with a daily maximum temperature of 30°C or greater. The frequency of heat waves (Table 24) are projected to increase for the region of Summerland.

Table 24. Average Annual Number of Heat Waves for the region of Summerland

Average Annual Number of Heat Waves			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
3.0	4.4	5.4	5.5

9 Freeze Thaw Cycles

Freeze-thaw cycles are days (24-hr periods) when the air temperature fluctuates between freezing and non-freezing temperatures. A freeze-thaw cycle is, therefore, a day with maximum temperature greater than 0°C and minimum temperature equal to or less than -1°C. A minimum temperature threshold of -1°C (instead of 0°C) is used to increase the likelihood that water present at the surface freezes. The historic and projected annual number of freeze-thaw cycles in Summerland are presented in Table 25. The annual number of freeze-thaw cycles is projected to decrease under future climate conditions in the District of Summerland.

Table 25. Historical and Projected Annual Freeze-Thaw Cycles (Day with Maximum Temperature > 0°C & Minimum Temperature ≤ -1°C) in the region of Summerland.

Average Annual Number of Freeze-Thaw Cycles			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
84.4	69.7	47.3	27.4

10 Heating degree days

Heating Degree Days (HDD) are equal to the number of degrees Celsius the daily mean temperature is below 18°C. For example, if the daily mean temperature is 15°C, 3°C HDD are accrued. HDD are accumulated over a time period (e.g., monthly, seasonally, or annually). HDD provides an indication of the heating capacity required to maintain comfortable building conditions during cooler months. The historic and projected HDD values provided below demonstrates a decrease in heating needs under future climate conditions in the region of Summerland (Table 26).

Table 26. Average Annual Heating Degree Days for Summerland.

Average Annual Heating Degree Days (°C)			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
3852.7	3479.2	3014.4	2522.9

11 Cooling degree days

Cooling Degree Days (CDD) are equal to the number of degrees Celsius the daily mean temperature is above 18°C. For example, if the daily mean temperature is 20°C, 2°C CDD are accrued. CDD are accumulated over a time period (e.g., monthly, seasonally, or annually). CDD provide an indication of the cooling capacity required to maintain comfortable building conditions during warmer months. The historic and projected CDD values provided below demonstrates an increase in cooling needs under future climate conditions in the region of Summerland (Table 27).

Table 27. Average Annual Cooling Degree Days for Summerland

Average Annual Heating Degree Days (°C)			
1981-2010 Baseline	2020s	2050s	2080s
	SSP5-8.5	SSP5-8.5	SSP5-8.5
163.1	282.5	481.5	800.3

12 Flooding

Summerland is situated on the west side of the Okanagan Lake in the interior of British Columbia, Canada. Okanagan is one of the most environmentally vulnerable regions in Canada. Also, there are five major water features in Summerland (UBCO, 2021).

Under climate change, extreme rainfall events are projected to increase while snowmelt may slightly decrease. Additionally, lake water levels are expected to have a higher interannual and seasonal variability due to extreme spring precipitation and variable snowfall during winter. Therefore, all these key drivers can lead to a higher incidence of flooding in the region.

13 Wildfires

On average from 1970-2017, 8000 wildfires occurred across Canada annually (Canadian Forest Service 2017). However, few are deemed as a disaster and the majority are managed and result in no or few negative impacts. Thus, for this assessment, the hazard threshold is determined to be occurrence of large fires (≥ 200 ha) within 100km of the District of Summerland. However, it is important to note that severe wildfire outside the 100km radius can still affect the visibility and air quality of Summerland. Using the Canadian Wildland Fire Information System (NRCan, 2017), 441 separate large wildfires for the 1917- 2020 period were observed within a 100 km radius of Summerland.

Under climate change projections, the area burnt by wildfires is expected to increase gradually from 2020 to 2050 and exponentially from 2050 to 2100 (Balshi, 2008.). Due to the projected warmer temperatures, change in precipitation, and intensification of drought events, fire occurrences are expected to increase by 25-50% by 2090 in the Summerland area according to the Canadian Climate Center GCM (Flannigan, 2009; Wotton, 2010). Additionally, temperature has also shown a strong positive correlation with lightning, humidity and fire season. Therefore, warmer temperature may result in a longer fire season, as well as more frequent and intense wildfires. However, this conclusion is subject to a moderate amount of uncertainty due to the complex nature of wildfires, its fuel type and possible future fire management adaptation plans.

14 Wind

The Summerland CS weather station (Station ID: 112G8L1) was used to obtain daily maximum wind speed and direction data for the period of 1990-2023. The available wind data is used to generate windrose for the climate profile of the region of Summerland. Windrose shows the distribution of wind direction (direct from which the wind is blowing) observed at a particular location over a time period. The length of each line represents the frequency of the wind from that direction and, therefore, windrose provides information on the prevailing wind direction(s) at a given location. Figure 8 display hourly and daily maximum wind speed and direction observed from 1990-2023 at the Summerland.

Wind

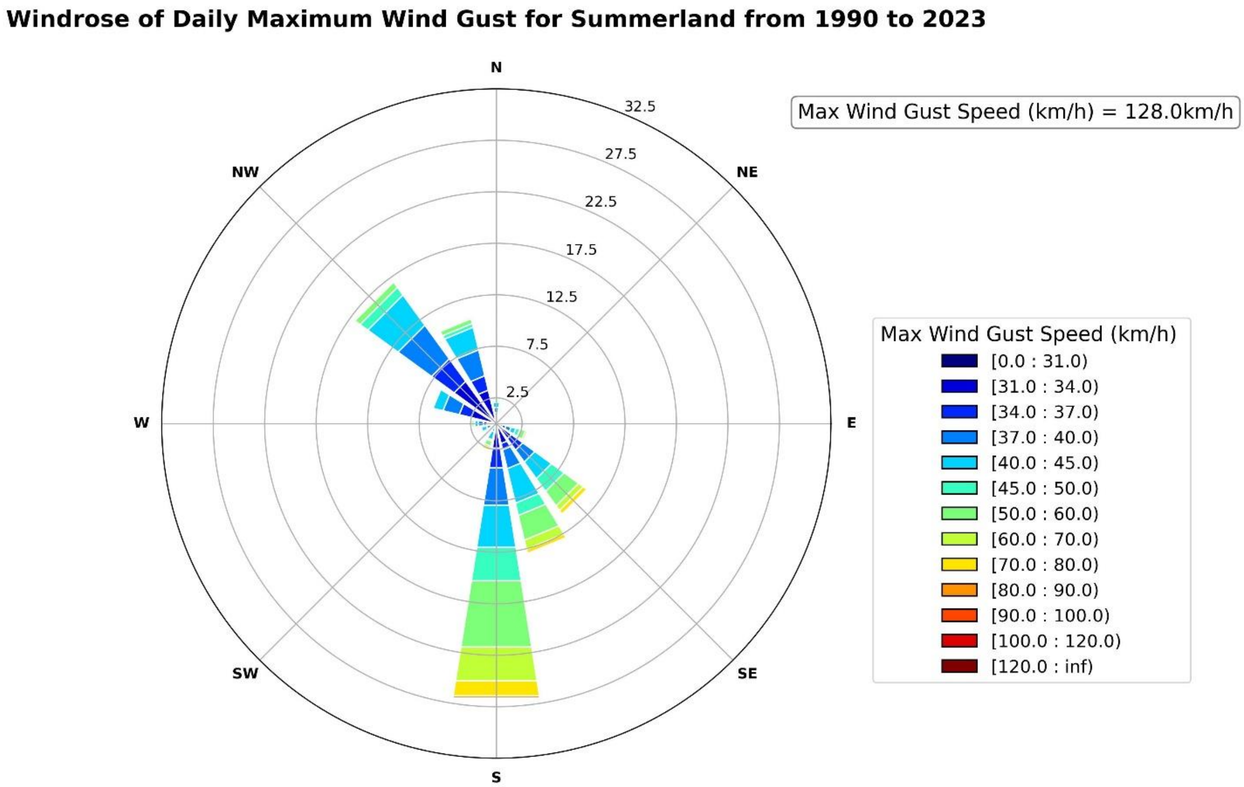

Figure 8. Daily maximum wind gust speed and direction from 1990-2023 observed at Summerland CS (Station ID: 112G8L1)

The projected climate changes with respect to wind are not as well understood as variables such as temperature. The analyses of 57 years (1953–2009) historical record of wind gusts at 104 weather stations across Canada show that for every 1°C increase in the daily temperature anomaly, the speed of daily wind gust events (≥50 km/h) increases by more than 0.2 km/h over most regions in Canada (Cheng C. L., 2014). The percentage increases in future daily wind gust events of ≥70 km/h from the current condition could be 10%–20% in most of the regions across Canada (Cheng C. L., 2014).

1.0 HIGH WINDS

High winds are defined as straight-line winds (to differentiate from tornadoes) including thunderstorm-associated winds (downbursts, microbursts) and winds from large-scale low-pressure systems of sufficient strength to cause damage to exposed vegetation, buildings, and infrastructure.

For this climate profile, the hazard threshold analyzed are gusts ≥90 km/h and gusts ≥110 km/h. These two thresholds are based on ECCC wind warning criteria (ECCC, 2017). ECCC issues wind warnings for gusts ≥90 km/h, as well as severe thunderstorm warnings for events in which severe thunderstorms may be accompanied by winds of 90 km/h or greater (ECCC, 2017). The higher threshold of 110 km/h was selected as well. This threshold generally indicates the boundary between the “threshold of visible damage” and more severe impacts to infrastructure, buildings, and trees which can pose a threat to life.

Baseline values were established from all available data measured at Summerland for gusts exceeding 90 km/h and 110 km/h. Table 28 shows days with high winds based on the historical data of Summerland CS (Station ID: 112G8L1). There are 0.059 days/year for gusts ≥90 km/h and 0.029 days/year for gusts ≥110 km/h respectively.

Table 28. Days with High Winds and projected trends – Summerland CS (1990-2023)

High Winds	Baseline (1990-2023)	2020s	2050s	2080s
≥ 90km/h	0.059 days/year	Increasing trend	Increasing trend	Increasing trend
≥ 110km/h	0.029 day/year	Increasing trend	Increasing trend	Increasing trend

Projections are based on peer reviewed published results of statistically downscaled future wind gusts above the 90 km/h threshold (Cheng C. L., 2014). The study also showed a consistent pattern of greater increases in gust frequency for successively higher thresholds. Hence, gusts above the 110 km/h threshold are expected to increase at least by the same magnitude, if not more than for the 90 km/h threshold, under climate change.

15 ThunderStorms

Severe thunderstorms are a frequent occurrence in Summerland. As severe thunderstorms can generate hail, tornados and usually accompanied by high winds, its impacts can vary from low to high. Historically, thunderstorm events have been responsible for 40 deaths and over 2.5 billion in property damages in Canada. Unfortunately, due to the complex and localized nature of thunderstorms, there are currently no quantitative trends on future events under climate change (Steven M. Huryn, 2016). Additionally, due to their relatively small scale, climate models are unable to precisely observe their impacts. However, with increasing temperature and moisture in the atmosphere, there is an increased potential for future severe thunderstorm in Summerland.

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District of Summerland HRVA: Hazard Scenarios

September 29, 2023

Prepared for:
District of Summerland

Prepared by:
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Project Number:
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Introduction

The District of Summerland (The District) has engaged Stantec Consulting Ltd. (Stantec) to complete a Hazard, Risk and Vulnerability Analysis (HRVA) in order to identify the hazards that currently affect the District and determine the impacts they may have should they occur. As part of the HRVA, hazard scenarios were developed for each hazard to aid in discussion of potential impacts and development of risk reduction measures. Hazard scenarios were developed using information on past hazard impacts obtained from District reports, interviews with knowledge holders, news reports, and workshops.

Scenarios are presented in the following table.

Table 1. Hazard Scenarios Developed for the District of Summerland.

Hazard	Scenario	Current Likelihood	Consequence Total
High Wind Event	Debris can be transported by high winds, causing collision damage to buildings and infrastructure. Communication may be hindered in water treatment and wastewater treatment facilities if antennae and rooftop equipment are damaged or blown off roofs. There is a risk of power outages resulting from damage to off-site utilities infrastructure due to debris transported by high winds. Power outages due to high winds can impair operations at all facilities not on backup power, such as some pumphouses and lift stations. High winds can down trees in parks and recreational areas. Impacts may include fatalities, injuries, and displacement of residents.	B	15
Lake, River, and Stream Flooding	Flooding due to overflow of water bodies can overtop dams, leading to additional flood inundation. Flooding can increase raw water turbidity, cause watermain breaks, and result in high flows into lift stations and the wastewater treatment plant, which can reduce the efficiency or capacity of the water supply and wastewater collection networks. Flooding can result in overflow and backup of stormwater drainage leading to property damage, road washouts, and infrastructure damage. The wastewater treatment plant, Sun-Oka Beach Provincial Park, and Trout Creek Elementary School are located in the Trout Creek floodplain, which exposes them to potential flooding from Trout Creek. Past impacts from creek flooding to natural areas include bank erosion, localized flooding, tree fall, debris buildup, and sediment accumulation. Runoff transports silt and debris into waterways, which the water treatment plant may not be able to process and may result in temporary shutdown of the plant. Stormwater drainage systems are overwhelmed when creeks overflow due to short duration high intensity rainfall, which can result in overland flow along roadways and in developed areas. Eneas Creek has flooded nearby roads and the Prairie Valley area. The creek is upslope from the Downtown core, where many of the District's municipal and community buildings are located, and is a high flooding risk. It has flooded roadways on multiple occasions, e.g., Garnet Ave. was flooded in 2018 when the creek spilled its banks. Temporary flood mitigation is in place.	C	28

Hazard	Scenario	Current Likelihood	Consequence Total
Flash Flooding	The District does not have adequate predictive tools to prevent residents from being surprised by out of season flash flooding. Flooding due to overflow of water bodies can overtop dams, leading to additional flood inundation. Flooding can increase raw water turbidity, cause watermain breaks, and result in high flows into lift stations and the wastewater treatment plant, which can reduce the efficiency or capacity of the water supply and wastewater collection networks. Flooding can result in overflow and backup of stormwater drainage leading to property damage, road washouts, and infrastructure damage. The wastewater treatment plant, Sun-Oka Beach Provincial Park, and Trout Creek Elementary School are located in the Trout Creek floodplain, which exposes them to potential flooding from Trout Creek. Past impacts from creek flooding to natural areas include bank erosion, localized flooding, tree fall, debris buildup, and sediment accumulation. Runoff transports silt and debris into waterways, which the water treatment plant may not be able to process and may result in temporary shutdown of the plant. Stormwater drainage systems are overwhelmed when creeks overflow due to short duration high intensity rainfall, which can result in overland flow along roadways and in developed areas. Eneas Creek has flooded nearby roads and the Prairie Valley area. The creek is upslope from the Downtown core, where many of the District's municipal and community buildings are located, and is a high flooding risk. It has flooded roadways on multiple occasions, e.g., Garnet Ave. was flooded in 2018 when the creek spilled its banks. Temporary flood mitigation is in place.	C	20
Storm Water Flooding (urban, local, pluvial)	Short duration high intensity rainfall (SDHI) events may slough creek beds and create high turbidity that comes through the water treatment plant, which may struggle to treat that water. Unusually high flow in waterways may overwhelm water mains or service pipes and cause breakage. Runoff transports silt and debris into waterways and can cause slope failure, resulting in landslides. SDHI overwhelms the stormwater drainage network and can clog drainage by transporting debris into stormwater systems. Sports courts and campgrounds can degrade over time from continued exposure to intense rainfall. SDHI events can result in flooding of and damage to roadways, particularly if there is creek overflow, which may exacerbate potholes or asphalt deterioration. Runoff from SDHI events can result in overland flow in populated areas, which can undermine infrastructure and flood properties.	C	19

Hazard	Scenario	Current Likelihood	Consequence Total
Landslide/Debris Flow	There is a history of landslides in the District. Notable landslide zones include areas along Highway 97 and the Perpetual Slide along Trout Creek. Landslides increase reservoir turbidities and expose and break water and sewer in-ground pipes. Landslides can cause the water to become muddy (e.g., 2022), which may result in water systems being shut off temporarily, and can break water mains. The perpetual slide into Trout Creek has the potential to form a dam if it slides as a large mass. Landslides can block and damage the roadways/highway. Landslides can damage utilities and other infrastructure and prevent access to properties, roadways, municipal facilities, recreational facilities, and other critical sites. E.g., A landslide in Garnet Valley in 2019 dug a trench along its path between two houses. There are many sand, silt, and clay formations around the District. Some residences are in hazard zones and there has been property damage in the past in lower parts of the community.	D	21
Seiche	Lake adjacent roadways are exposed to seiche risk from Okanagan Lake. A seiche may temporarily inundate beaches or slough the lake bed.	C	13
Extreme Heat	Extreme heat encourages algal growth in reservoirs when water is too warm and level is too low, which deteriorates water quality. Extreme heat increases demand for irrigation water and pressures the treatment plant. Extreme heat makes it more difficult for the Wastewater Treatment Plant to balance biological nutrients in wastewater. Extreme heat can wilt vegetation and crack/damage sports courts. Extreme heat cracks and softens asphalt- decreases durability and increases maintenance requirements. Masonry and wall/window/roof sealants can degrade over time, particularly in heritage buildings. There is a risk of heat stress and other heat related illnesses in residents, as was the case during the 2021 BC Heat Dome.	E	16
Air Quality	Smoke from wildfires frequently causes a sharp decline in air quality. Thick smoke from wildfires may overwhelm low-capacity HVAC/ventilation systems. Poor air quality reduces the direct sunlight reaching solar panels and can result in deposition of dust or other pollutants, which reduces power generation. There is an associated risk of respiratory illnesses in residents, particularly if they are active outdoors or occupying a building with poor ventilation.	C	21
Drought	Consecutive years of drought can reduce water flow in creeks and other water sources, and cause high irrigation water demand on infrastructure, e.g., water treatment plant, pumphouses, PRVs. Extended periods of drought can result in an increase in overland flow due to SDHI, which would increase stormwater runoff and potentially strain drainage systems. Drought can also cause wilting of agricultural crops and reduction of yield, thereby affecting the economy of the District.	D	21
Lightning	Lightning can damage electrical infrastructure either directly or by damaging trees, which then fall onto electrical distribution equipment. This results in power outages. Lightning can also spark fires, which can impact all natural and physical assets.	E	6

Hazard	Scenario	Current Likelihood	Consequence Total
Wildfire	Wildfires in watersheds cause issues with debris, toxins, faster or greater flow into reservoirs, and inability of the water treatment plant to treat incoming water. There is potential for wildfires to destroy watersheds and make them unusable. There is a high burn risk to greenspaces, trails, and agricultural lands in high-extreme wildfire zones. Smoke reduces the amount of solar radiation reaching the panels of the solar photovoltaic system, thereby reducing output. Displacement may occur in isolated areas and there is a lower likelihood of visitors coming to the area during the summer because of wildfires.	E	25
Extreme Cold	There is potential for freezing of water distribution systems and collection pipes and infrastructure. Freezing of water infrastructure, e.g., water mains, is an issue in extreme cold. Eneas Creek freezes from the bottom up in extreme cold, which can cause flooding. Extreme cold can wilt vegetation, crack/damage sports courts. Roadways can crack and degrade due to winter freeze thaw, and are also susceptible to heaving. Extreme cold freezes and breaks pipes (e.g., water extinguisher pipes), can damage masonry and degrade sealants. Ice accumulation may temporarily disrupt power if there is accumulation on electrical distribution lines/equipment. Ice accumulation can also pose a safety risk to residents, e.g., potential for slip and fall incidents.	E	12
Fog	Dense fog reduces visibility and may increase the likelihood of injuries due to marine or motor vehicle accidents. Commuters using Highway 97 are particularly vulnerable, given that it is a major north-south route along the Okanagan.	C	3
Freezing Rain or Drizzle	Extreme cold or freezing rain freezes and breaks pipes, can damage masonry and degrade sealants. Freezing rain causes roadways and sports/recreational courts to become slippery and difficult to use. Historically, the issue has not been severe enough to warrant road closure. Ice accumulation may temporarily disrupt power if there is accumulation on electrical distribution lines/equipment.	C	18
Hail	Hail can cause collision damage to buildings, exposed pipes, pavement, infrastructure (e.g., bridges), electrical distribution equipment, and solar panels. There is a risk to human health due to the likelihood of physical injury. Hail also causes severe damage to agriculture.	C	13
Snowstorms and Blizzards	There is potential for reduced access to dams, recreational areas, and other facilities. Snow occasionally makes roads difficult to traverse, which may complicate movement of District vehicles in watersheds (maintenance, monitoring, etc.). Snow accumulation can degrade roof finishes and block or damage HVAC rooftop components. Snowfall can reduce electricity production of photovoltaic systems and other utilities, particularly in winter and when there is accumulation.	C	19
Animal Disease	Animal diseases can cause economic loss for farmers. Where there is compatibility, diseases may spread to wild animal populations.	D	11
Human Disease	In the event of a pandemic, health services capacity may show gaps. The District does not have sufficient healthcare facilities to serve the population in the event of large-scale health concerns. There would also be resulting staffing issues for critical services, e.g., utilities departments.	D	27

Hazard	Scenario	Current Likelihood	Consequence Total
Plant Disease and Pest Infestation	Agriculture is a large component of the community and local economy, e.g., orchards, vineyards. The sector is highly vulnerable to plant diseases. Plant disease may adversely affect local economy through mortality of agricultural plants and trees. There are also potential human health risks from vector-borne diseases transmitted by pests, e.g., ticks. Numerous pests and plant diseases currently affect the forests of the Okanagan Shuswap Forest District, e.g., Douglas-fir beetle and root diseases. Pest and plant disease occurrences are increasing with changes in climate and spread of invasive species.	E	15
Public Health Crisis	In the event of a public health crisis, health services capacity may show gaps. The District does not have sufficient healthcare facilities to serve the population in the event of large-scale health concerns. There would also be resulting staffing issues for critical services, e.g., utilities departments.	D	27
Explosions	A high pressure gas main runs along the spine of the District, under roads and through private property. There is potential for a gas pipeline rupture and consequent explosion, as evidenced by the June 2002 incident where lightning hit an underground natural gas line and caused a massive explosion, destroyed a home, killed two residents, and resulted in blast reverberation was felt up to 1km away. There is also potential for explosion of chlorine systems in the Water Treatment Plant.	C	10
Hazardous Materials Spill	A hazardous material spill could potentially be caused by multiple events, including water treatment plant backflow due to a design error, release of chemicals used in the water treatment plant, a highway accident involving trucks carrying hazardous materials, or ammonia plant failure.	C	11
Oil or Gas Pipeline Spill	A high pressure gas main runs along the spine of the District, under roads and through private property. There is potential for a gas pipeline rupture and consequent explosion, as evidenced by the June 2002 incident where lightning hit an underground natural gas line and caused a massive explosion, destroyed a home, killed two residents, and resulted in blast reverberation was felt up to 1km away. There is also potential for explosion of chlorine systems in the Water Treatment Plant.	C	11
Cyber Security Threat	Cybersecurity breaches are not known to have occurred in Summerland, but have occurred in other parts of the Okanagan region (e.g., Okanagan College data breach in 2023).	A	12
National Security Threat	A national security threat may impact residents or critical infrastructure if it occurs in the vicinity of the District.	A	14
Public Disturbance	There is a low likelihood of riots in Summerland, but there is potential based on occurrences in nearby Penticton and Kelowna.	A	9

Hazard	Scenario	Current Likelihood	Consequence Total
Major Planned Event	Major planned events can disrupt economic activities and place a strain on municipal resources. For example, during the end of year Festival of Lights, more staff has to be brought in to assist, e.g., RCMP. This is arranged by the Chamber of Commerce. Some of these events disrupt the downtown core, for example, Sunday market may block roads and divert response vehicles. There may also be utility system outages as a result. There are larger events that run through the District that disrupt normal operations, such as Gran Fondo.	E	12
Structure Fire	Structure fires are most frequent in residential structures. Some houses may be more difficult to save due to their distance from the fire hall, ignition source or time of day. There may also be fires in non-residential structures (e.g., electrical fire in 2022). Rate of structure fires varies from year to year.	D	9
Structure Failure	Structure failure may occur in critical facilities or other infrastructure, particularly heritage structures that may have aging components nearing or exceeding end of service life.	B	13
Dam and Spillway Failure	Failure of dams could flood the downtown area, Trout Creek floodplain, and properties along creeks and inundation areas surrounding dams.	A	20
Dike Failure	Failure of the dike could flood surrounding areas, including private properties.	A	8
Water Service Interruption (Includes shortage and contamination)	A water service interruption could be caused by contamination from the Summerland landfill, which is above the drinking water reservoir and treatment plant. The general public is vulnerable if water quality is compromised. Irrigators are vulnerable if there is low water volume, posing potential economic impacts. There may also be resulting public health impacts and business disruption. If the main trunk of the Water Treatment Plant were to fail, there would be wide-spread damage and impact to the community.	D	14
Electrical Outage	An electrical outage may result in business disruption, livestock mortality, shutdown of critical services, and health and safety impacts for residents.	B	7
Food Source Interruption	Food supply may become limited if there are extended challenges, e.g., if highways are closed during atmospheric rivers.	B	7
Telecommunications Interruption	Telecommunications interruption may result in disruption of businesses and critical services.	B	12
Transportation Route Interruption	Disruption on Highway 97 can hinder commute into and out of the District, leading to larger potential public and emergency response impacts. This could be critical in the long term if there is no second route.	D	16
Wastewater Interruption	Wastewater interruption may cause damage to upstream properties due to sewage backup and possible damage to natural assets if leaked to ground and streams. This requires shutdown of water systems.	B	18
Fuel Source Interruption	Fuel source interruption may occur if public service trucks are unable to access the District to resupply gas stations. Most residents use personal vehicles and would be unable to commute.	B	9

Hazard	Scenario	Current Likelihood	Consequence Total
Aircraft Incident	Summerland can potentially be impacted by small aircraft travelling to or from the Penticton Airport. There is potential for collision and consequent debris spread over Summerland.	A	7
Rail Incident	There is potential for derailment of the Kettle Valley Steam Train along the historical train route through Summerland. The Kettle Valley Rail runs adjacent to an open flume. If the train were to fall against the flume and cause breakage, there may be flooding/difficulty providing water to the water treatment plant.	A	8
Marine Vehicle Incident	There is potential for recreational boating collisions, explosions, petroleum spills, human injury/death on Okanagan Lake, e.g., fatal boat accident in 2021 involving an off-duty RCMP officer. Dense fog reduces visibility and may increase the likelihood of injuries due to marine or motor vehicle accidents.	E	7
Motor Vehicle Incident	There were 101 recorded motor vehicle crashes in Summerland in 2021 with 32 resulting in casualties. Dense fog reduces visibility and may increase the likelihood of injuries due to marine or motor vehicle accidents. Commuters using Highway 97 are particularly vulnerable, given that it is a major north-south route along the Okanagan. It is also a corridor for hazardous materials transportation.	E	11