Purpose

This product is intended to assess potential critical infrastructure (CI) impacts resulting from severe winter storms within Canada. It will identify historical CI impacts of severe winter storms in Canada, and provide analysis on CI and supply chains which, if disrupted or destroyed, could have implications on public safety and economic stability.

Interdependencies between CI sectors affected by winter storms will also be highlighted. It will also discuss how Canada's response to winter storms could be impacted this season by COVID-19, and how physical distancing and absenteeism caused by COVID-19 may affect the procedures and resources required for effective winter storm response.

In addition, CI stakeholders, federal, provincial, territorial partners, and CI owners/operators that are members of the CI Gateway (https://cigateway.ps.gc.ca) can refer to the Portal to access more detailed Infrastructure of Concern information as it becomes available.

Overview

Winter storms have destructive potential and present a variety of hazards to CI and associated CI sectoral functions. A reality for all parts of Canada, winter storms can quickly become dangerous with minimal warning. Typically occurring between late October and mid-April, heavy snowfall, ice accumulation, strong winds, and/or blowing snow may be exhibited during a severe winter storm event. These severe winter storms may also impact multiple infrastructure assets and/or systems simultaneously. The Transportation and Energy and Utilities Sectors typically experience the greatest infrastructure impacts, as the effects of a winter storm may cause transportation delays and closures, and damage trees and power lines.[1] Extremely cold temperatures are common during winter storms which can create dangerous conditions, especially for individuals with health issues and vulnerabilities.[2] In Canada, winter storms and extreme cold claim over 100 lives per year. That is more than the combined number of deaths caused by hurricanes, tornadoes, floods, extreme heat and lightning each year.[3]

Nationally, winter storms with high winds occur most frequently in the Prairies, eastern Arctic and eastern Ontario. Heavy snowfalls are typical in the Atlantic provinces, British Columbia, southern and eastern Québec and areas around the Great Lakes. Freezing rain can happen throughout the country, but most often in Ontario, Québec and the Atlantic provinces. Hailstorms occur across the nation, though they are most frequent in Alberta, the southern Prairies and in southern Ontario.[4]

There is potential to experience increased impacts on CI sectors with the combination of COVID-19 and severe winter storms as CI and supply chains are already under tremendous pressure.

[1] Department of Homeland Security, National Protection and Programs Directorate, Office of Cyber and Infrastructure Analysis. Critical Infrastructure Security and Resilience Note: Winter Storms and Critical Infrastructure. December 14, 2014.
[2] https://www.redcross.ca/how-we-help/emergencies-and-disasters-in-canada/types-of-emergencies/winter-storms/winter-storms-information-facts
[3] https://www.canada.ca/en/environment-climate-change/services/seasonal-weather-hazards/be-prepared-for-winter.html
[4] https://www.getprepared.gc.ca/cnt/hzd/svrstrms-en.aspx

Historical Impacts

Winter storms are a reality across the nation. Severe winter storms have had significant impacts on CI, with the Transportation, Energy and Utilities, and Health Sectors experiencing the greatest impact. Examples of such severe storms that have occurred across Canada in recent history are the 1996 British Columbia blizzard, the 2013 Toronto ice storm, and the 2020 Newfoundland and Labrador snow storm.

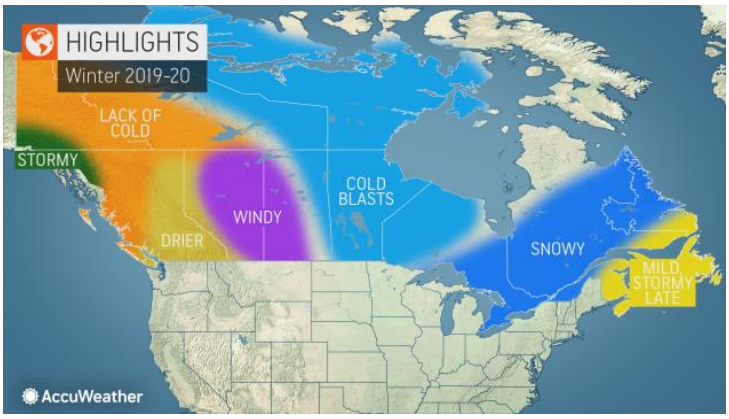

Figure 1 - 2019-20 Canadian Winter. Source: AccuWeather

British Columbia Blizzard – 1996

With little warning, British Columbia was hit with a blizzard that began on the evening of December 28th. The lower British Columbia area, which is typically temperate, received approximately 150 cm of snow within a four day period. The blizzard affected Victoria, Vancouver and the lower Fraser Valley, with Victoria receiving 65 cm and Vancouver receiving 35 cm of snow in just 24 hours.[5] The **Transportation Sector** was severely impacted as public transit systems were forced to shut down, including the Skytrain. Many flights were cancelled at affected airports, and all ferries were cancelled between Vancouver and Vancouver Island. The weight of the snow and rain destroyed several airplanes at Victoria International Airport.[6] In the Fraser Valley, the Trans-Canada highway was closed between Abbotsford and Chilliwack, leaving hundreds of drivers stranded and forced to find temporary shelter.[7] The Fraser Canyon was closed, with approximately 150 avalanches burying the highway with up to 23 metres of snow.[8] As Victoria normally receives a minimal amount of snow accumulation, the city was not equipped for the 65 cm it received. Once weather returned to seasonal temperatures, rain and mild flooding washed out some roads. The **Health Sector** was impacted in Victoria as surgeries were cancelled, and storm victims increased each day. Power outages, which impacted the **Energy and Utilities Sector**, forced thousands of people into emergency shelters.[9]

Toronto Ice Storm – 2013

Beginning on December 20th, Toronto was hit with the worst ice storm in recent history. Freezing rain and drizzle, which lasted for three days, left an ice build-up between 10 and 30 mm throughout the Greater Toronto Area.[10,11] The **Energy and Utilities Sector** was impacted as roughly 300,000 customers (approximately a million people) were without power for three days, with tens of thousands without power for over a week. The **Transportation Sector** was impacted as streetcar lines were shut down and portions of the subway lines were out of service. Difficult driving conditions due to icy roads caused several collisions. Many roads were blocked by fallen tree branches. Outages to approximately 800 traffic lights caused further transportation issues in the city.[12] Toronto's Pearson International Airport experienced many flight cancellations during the holiday season. Via Rail also experienced some delays.[13] The Toronto East General Hospital and Sunnybrook Hospital were forced to run on generators after

[5] https://www.cbc.ca/archives/entry/1996-bc-digs-out-from-massive-blizzard
[6] https://604now.com/1996-vancouver-victoria-snowstorm-of-the-century-history/
[7] https://www.cbc.ca/news/canada/british-columbia/west-coast-snowstorm-1996-1.3886575
[8] https://www.theprogress.com/community/looking-back-surviving-the-snowstorm-of-96-in-chilliwack/
[9] https://www.cbc.ca/archives/entry/1996-bc-digs-out-from-massive-blizzard
[10] https://www.cbc.ca/news/canada/toronto/toronto-ice-storm-leaves-230-000-without-power-1.2473543
[11] https://link.springer.com/article/10.1007/s11069-014-1211-7
[12] https://link.springer.com/article/10.1007/s11069-014-1211-7
[13] https://www.cbc.ca/news/canada/toronto/toronto-ice-storm-leaves-230-000-without-power-1.2473543

losing power during the storm. Lack of heat, falling ice, slippery sidewalks, consumption of spoiled food, possible electrocution, and carbon monoxide poisoning affected the health of the public, causing pressure on the **Health Sector**. The **Information and Communication Technology (ICT) Sector** experienced impacts as power outages caused mobile phones and personal computers to become inoperable. [14]

Newfoundland and Labrador Snow Storm – 2020

On January 17th, Newfoundland and Labrador experienced a severe snow storm which over 76 cm of snow accumulated in St. John's within a 24 hour period resulting in an eight day state of emergency.[15] The city of Mount Pearl received 93 cm of snow and the town of Paradise received 91 cm.[16] Heavy snowfall mixed with strong winds increased the severity of the storm. The **Transportation Sector** was impacted as St. John's International Airport closed for commercial flights and all non-emergency vehicles were banned from St. John's roads. Clearing roadways to the hospital became an issue. All businesses were ordered to shut down which had an impact on the local **Finance Sector**.[17] The **Food Sector** experienced challenges as it was difficult to ship produce after the storm. The shipping delays lead to product shortages in grocery stores.[18] Widespread power outages impacted the **Energy and Utilities Sector** as approximately 21,000 customers were without power.[19]

COVID-19 and Winter Storms

COVID-19 has made it easy to forget the regular disruptions that Canada experiences. There is potential to experience increased impacts on CI sectors with the combination of COVID-19 and winter storms as CI and supply chains are already under tremendous pressure.

The **Health Sector** may experience increased risks due to the pandemic. As COVID-19 cases rise, more pressure may be placed on hospitals dealing with cold and flu season. Respiratory illnesses in particular are common during the winter months. An increase in individuals experiencing symptoms of COVID-19 will put extra demand on the health care system as more individuals will require testing. A backlog in receiving testing results may result in an increased absenteeism rate in the workplace.

The **Safety Sector** is at an increased risk as physical distancing may be difficult in the event of a severe winter storm. Depending on the severity of the storm, a large number of first responders and essential service providers may be required in the relief efforts. This presents a risk of spreading the virus as this requires those aiding in the relief efforts to be in close proximity. If there is suspected exposure to COVID-19, it could impact response efforts due to absenteeism. In addition, in the event of a severe storm, assistance from international and inter-provincial partners may be required. Due to border restrictions, logistical issues may arise should cross-border assistance be required, such as acquiring VISAs or applying mandatory 14-day quarantine measures.

Damage caused by winter storms to **Energy and Utilities Sector** infrastructure may result in the loss of power to residents. Extremely cold temperatures are common during the winter months, and power outages can create dangerous conditions, especially for individuals with health issues and vulnerabilities. If power outages are prolonged, there may be more demand for emergency shelters.

[14] https://link.springer.com/article/10.1007/s11069-014-1211-7
[15] https://www.ctvnews.ca/canada/armed-forces-wrap-up-blizzard-response-in-newfoundland-after-historic-storm-1.4786609
[16] https://globalnews.ca/news/6434019/newfoundland-snow-environment-canada/
[17] https://globalnews.ca/news/6434019/newfoundland-snow-environment-canada/
[18] https://www.cbc.ca/news/canada/newfoundland-labrador/nl-soe-day-6-oceanex-food-security-1.5435784
[19] https://www.usnews.com/news/world/articles/2020-01-18/newfoundland-reeling-after-blizzard-buries-capital

Additional emergency shelter space may be required to accommodate physical distancing due to COVID-19. The use of hotels, university dormitories, or government facilities may need to be considered if additional shelter space is required. This close proximity of displaced people could lead to an increase risk for illnesses to spread throughout shelters. Along with normal shelter supplies, additional water, personal protective equipment (PPE), soap, disinfectants, and cleaning agents will be required to help prevent the spread of the virus. Shelters may require isolation areas for evacuees who have symptoms to remain until they can be relocated elsewhere. Shelter staff will require training on proper disinfection, temperature and health screening procedures. Adequate mission-critical materials will also be required during a severe winter storm. Alternate options for locating and procuring critical resources may need to be considered if traditional sources or methods of procurement are needed in the event of supply chain disruptions. Under normal circumstances, many volunteers aid in relief efforts to help mitigate the impact of winter storms in communities. The number of volunteers could drastically decrease due potential lack of physical distancing and the fear of contracting COVID-19.

The **ICT Sector** is essential during a winter storm, especially with the impacts of COVID-19. Due to physical distancing measures, there can be an increased reliance on information technology to communicate during an event. Government partners, private sector, and volunteer organizations may have to virtually coordinate during a winter storm. This may be difficult if the information technology is not supported in remote locations. ICT technology also plays an importation role when communicating storm updates.

Remote communities will have additional complexities which need to be considered when supporting emergency responses during a pandemic. Some remote communities may lack the basic essentials and the retailers/providers of these essentials, underlying socio-economic issues such as access to clean water and housing, transportation access and delivery prioritization, limited access to emergency response resources, and frail CI that is nearing the end of its design life. The effects of these issues may be exacerbated in the event of a severe winter storm.

Sector Impact Considerations

CI sectors may experience significant impacts during a winter storm due to their exposure or the significant impact disruptions could have to consumers or other CI sectors. In addition to the considerations outlined here, Annexes A and B include, respectively, an overview of cross-sector impacts and individual sector impact overviews for each of Canada's ten CI sectors.

Energy and Utilities

The extensive and widely dispersed above ground distribution and transmission networks of the electrical grid leaves them vulnerable to winter storm disruptions. Local distribution assets, such as insulators, bushings, and street level transformers, are susceptible to strong winds, fallen trees, ice and snow. However, automated safety mechanisms, such as industrial control systems, are common within utility grids which could and should mitigate the potential for extensive damage. The impacts to the safety mechanisms ought to be minimal as these mechanisms are intended to function during an event such as a winter storm. Damage to generating plants, transformer stations, and power lines could disrupt the supply of electricity. The disruption of one or more energy sector assets could cause performance degradation, eventually leading to cascading failures within the system, resulting in loss of service to large areas, consumers, emergency responders, and dependent infrastructure across the ten CI sectors.

Properties of certain oils can change under extreme cold temperatures. It is essential that these oils are maintained at proper temperatures to prevent clogging filters. Typically, during extreme cold weather, additives and fuel blending are used to keep oil flowing effectively. Natural gas and propane do not freeze; however, if water enters into the distribution system, it could freeze in cold temperatures, causing significant damage.

There are extensive dependencies on the Energy and Utilities Sector for the provision of electricity and fuel products. A prolonged disruption of energy sector assets could have significant impacts on the personal health of Canadians, disrupt regional or national economic activity, and disrupt recovery efforts. If widespread outages of electrical systems occur, there can be significant delays in restarting and rebalancing the electrical system as components are repaired. The capacity of local utility labour forces will be stressed, and recovery may require assistance and coordination to access additional resources. Winter storms historically have had a minimal and temporary impact on below ground petroleum products infrastructures and their distribution. At the local level, shortages of refined fuels at the pumps may impact evacuation and response efforts as fuel prioritization planning will have emergency responders and CI backup generators receive resources first. Nuclear power stations may be shut down due to the disruption in the supply of fuel for the backup generators and the water needed to maintain cooling systems for the reactors and the pools in which spent fuel rods are stored. In the event fuel supplies become limited, the commodity would be provincially controlled so that communities and CI sectors can maintain essential services.[20] The Energy and Utilities Sector has cross sector dependence on the Transportation and Manufacturing sectors for the movement of workers, delivery of components, and delivery of fuel sources. If road and rail transportation networks are disrupted, the movement of petroleum products may be impacted.

Due to COVID-19, the Energy and Utilities Sector may experience issues when considering workers' safety. For example, there may be limited ability to respond to emergencies (i.e., gas leaks) or conduct repairs (e.g., power lines) in quarantined and high risk areas if crews are not equipped with proper guidance and PPE. There may also be resistance to do critical work in remote communities for fear of transmission of COVID-19. Disruptions to operational abilities or lack of qualified/certified personnel to maintain critical services and infrastructure may occur due to increased employee absenteeism.

Finance

Winter storms may lead to the disruption of banking and financial services and the decline in local and global stock markets. Finance Sector dependencies on the Energy and Utilities and ICT sector distribution networks to support physical and digital operations make it vulnerable to winter storm disruptions. These sectors are required for the transfer of payment data, security systems, large transaction transfers, and everyday access to banking and automated tellers. Local populations within impacted areas may experience temporary inconveniences associated with power and/or telecommunications disruptions. Winter storms may have a major effect on commerce and consumer banking, as well and individuals' capacity to purchase emergency resources including food, fuel or other necessities. At a granular level, loss of service and access to funds may be observed at banks, financial institutions, and retail points of sale. While many banks and financial institutions have backup generators, they may face fuel re-supply issues that can arise during an extended power outage, particularly with disruption to the Transportation Sector. Fuel prioritization decisions would be made at the provincial level in the event of an emergency. The digital payment systems used by businesses, retailers and consumers could

[20] https://www.emergencymanagementontario.ca/english/emcommunity/ProvincialPrograms/ci/emergency_fuel_distribution_protocol.html

be disrupted by electrical or communications outages causing an increasing reliance on cash, and restricting access to or exchange of goods and services.

Due to COVID-19, many retailers are not accepting cash to reduce transmission. In addition, many bank branches are offering reduced hours, which may cause disruption in banking services, particularly in small and remote communities. Financial institution activities could also be disrupted during this time if there are disruptions to key third party suppliers.

Food

The Food Sector is vulnerable to direct physical damage at the agricultural production level, as well as disruption throughout its supply chains. The food supply chain is comprised of primarily agricultural lands, harvesting operations, processing and packaging facilities, storage and distribution facilities, and retail points of sale. Winter storm winds, ice, and snow accumulation can destroy crops destined for market or to be retained for winter livestock feed. Extremely cold temperatures may damage tender vegetation. Farm buildings and equipment may be damaged due to heavy snow or ice accumulation. Power failure or fuel shortages may impact the care of livestock. During a severe winter storm, livestock could be exposed to extreme wind chill leading to hypothermia and frostbite. In the event water sources freeze or become unavailable, deaths may occur due to dehydration. Extreme winter storms may make it more difficult to get food and water to livestock. Long-term impacts, including an inflation of prices for food products, can be observed should damage to crops, facilities, and loss of livestock occur.

The Food Sector relies on frequent orders and deliveries, typically supported by the road network and communications systems. Road closures or difficult driving conditions may impact food delivery during a winter storm. Food retailers' dependence on the Finance Sector can affect public access to food, as digital payments systems are disrupted and reliance on cash increases. Prolonged disruptions to the Food Sector or its dependencies in the Energy and Utilities, Transportation, or ICT sectors can lead to regional shortages of food that impact the health of Canadians and economic performance of businesses within the sector. Physical damage or loss of electricity to food processing, storage, and distribution centres could disrupt the production and delivery of products. Spoiling of large quantities of food could occur due to loss of refrigeration. Recovery efforts may need to focus on isolated communities and rural food deserts (limited transportation routes, lack of retail points of sale, and low socioeconomic conditions) to assist in prolonged outages within supply chains to ensure food distribution after a severe winter storm. Finally, Government Sector intervention—resources, services, and financial assistance—may be required to aid farm and agricultural businesses impacted by crop, equipment, infrastructure, and livestock loss.

Due to COVID-19, physical distancing and the closure of processing plants may affect the delivery of services as well as the delivery of goods to and from the U.S. Increased employee absenteeism would present challenges to the sector. For example, decreased capacity to provide adequate animal care at facilities may occur due to labour shortages. Easy access to federal benefits have increased absenteeism partly due to fear of working in workplaces where physical distancing is unlikely. Potential security concerns may arise if there are shortages in food supply for vulnerable populations. Truckers may also refuse to travel to areas experiencing a COVID-19 outbreak.

Government

Severe winter storms have the potential to disrupt government operations and services through physical disruption of government facilities, closure and evacuation of non-essential personnel, or through degradation of dependencies on the Energy and Utilities, ICT, Transportation, and the Water sectors. Government services could take time to resume and their restoration may be required to support response and recovery efforts. The disruption of government facilities or equipment could impact various functions at the federal, provincial, and municipal levels of government. Reduced services may be more prevalent in remote or rural communities. Disruption in the Transportation Sector could result in government employees being unable to get to work. Government communications with the public to reassure and organize could be severely disrupted, possibly leading to social disorder. Government services delivered to the public by the Internet may become unavailable. Due to the disruption of power and communications, most systems for the detection of unauthorized border crossings, port landings, or unauthorized access to vulnerable sites may fail. Local and regional governments, which endure the brunt of emergency response, may require assistance from provincial and/or federal governments. Disruptions to dependent services may also require the relocation of offenders from impacted correctional facilities. Military assets may be relocated during preparatory phases to mitigate damage sustained to specialized equipment and vehicles. During recovery efforts, government infrastructure assets may act as hubs to assist returning residents.

Due to COVID-19, service delays may be experienced due to absenteeism and/or an increase use of a virtual private network (VPN) which may slow the network.

Health

Health facilities and services are vulnerable to disruptions from physical damage due to winter storms, as well as by cascading impacts within dependent sectors, such as Energy and Utilities, Transportation, Water, and ICT. Degradation of the electrical grid could affect hospital operations including emergency care, patient care, operating rooms, and other specialty services over a long-term disruption. Often elective surgeries and day procedures are rescheduled or cancelled in preparation of impending storm events. Critical operations could proceed as long as back-up generators maintain sufficient fuel through deliveries. Lack of adequate heat may result in undue suffering and death, particularly the elderly and critically ill. Fires or carbon monoxide poisoning may occur due to misuse of generators, obstructed gas line ventilation, or alternate heating sources, potentially adding extra pressure on the Health Sector.

The Health Sector is dependent on ICT for communication, record keeping, and operating some medical devices. Disruption and reduced access to health services has the greatest impact on vulnerable patients with acute and serious illness. Structural damage of health care facilities and hospitals will directly impact the ability of emergency responders and medical personnel to provide services to patients. Disruption in the delivery of health products, biomedical materials, and supplies may impact the level of care which health services can provide.

Health Sector dependencies on the Transportation Sector could affect both land and air ambulance services, the delivery of pharmaceuticals, other essential medical supplies, and food. Finally, the provision of clean potable water and the ability of water and waste water treatment facilities to sanitize discharged water and effluence are critical to the health of patients in hospitals and long-term care facilities. Waterborne illness or the spread of bacterial infections due to contaminated water may exacerbate the potential influx of the injured.

With COVID-19 still impacting our health systems, the situation brings greater challenges. Shortages in health care supplies and drugs have occurred due to increased demand. The potential of increased absenteeism or over crowded hospitals could pose a significant risk to the Health Sector as this can increase the spread of COVID-19.

Information and Communication Technology (ICT)

Above ground transmission networks of ICT infrastructure are highly vulnerable to severe winter storm winds, fallen trees, ice, and snow. Switching stations, telecommunication facilities, and cell towers are susceptible to strong winds, and ice and snow accumulation. The ICT Sector is essential to all other CI sectors, as communications and internet connectivity support supply chains and the delivery of essential services. A prolonged disruption of ICT assets could have significant impacts on the regional or national economic activity, the effectiveness of first responders, and recovery efforts. Landline communications may be disrupted as a result of physical damage to telephone exchanges, data servers, and landlines. Cascading impacts on emergency response communications and Safety Sector functions may be observed, especially in mountainous regions with sporadic cellular coverage. The disruption to the electrical grid would affect the supply of electricity to the battery packs that support cell phone towers and telephone and data switching offices. These batteries can be charged by onsite backup generators; however, they typically stock two to three days of fuel onsite at large centres, while cell towers may only possess four to eight hours of fuel. Refueling prioritization by road network is critical to the sustainability of a communication network, and if not possible, cell coverage will begin to degrade roughly four to eight hours after disruption to the electrical grid.

Some ICT assets require the Water Sector for component cooling; therefore, cascading effects may be observed in central switching offices, data centres, and satellite ground stations. The general public's ability to request assistance also requires functioning ICT infrastructure. The operation of radio and television broadcasting stations may be disrupted either through direct damage to stations or towers, or by power failures. Although many broadcasting stations have backup generators, issues of fuel re-supply will also arise. Extreme ice or snowfall can also interfere with radio signals. ICT assets including the broadcast system and cellular networks are at the core of the government's emergency communications to the public. Disruptions to communication networks can have significant cross-sector impacts if the Supervisory Control and Data Acquisition (SCADA) systems that support the infrastructure's operations are disrupted. Remote communities with limited ICT infrastructure are more susceptible to degraded services.

Due to the pandemic, the ICT is experiencing additional pressure from increased teleworking. There may also be an increased risk of security events, and in particular cyber-attacks, due to potential for malicious actors to leverage COVID-19 to target victims through phishing or other means. Instances of disruptive vandalisms to ICT assets related to the 5G network have increased due to recent conspiracies regarding COVID-19 transmission.

Manufacturing

Severe winter storm disruption of one or more manufacturing facilities or their cross-sector dependencies could impact manufacturing supply chains and the availability of the goods or services supported by manufactured products. Work stoppages and the closing of facilities may commence before the storm as part of preparedness measures to mitigate damage and loss of equipment and infrastructure. Water, due to freezing, may be unavailable for processing, cleaning and cooling. Manufacturing infrastructure is highly dependent on its skilled and available labour force. Disruption to the transportation networks (road, rail, and marine) required for the movement of workers, may limit operation capacities and access to upstream and downstream supply chains. Disruption to electrical power and fuel supply could cause the reduction or closure of manufacturing facilities that attempt to maintain operations throughout a storm event, or those who look to initiate start up rapidly post-storm. The Manufacturing Sector is increasingly relying on cloud computing for many of its critical systems, including marketing, finance, inventory control, shipping management, inter-office communication, and others. With widespread communications outages, these operations may be severely disrupted.

There are significant interdependencies within the Manufacturing Sector for the supply of goods, components, and equipment that supports Canada's economy and the delivery of essential services. Prolonged disruption of the Manufacturing Sector could have significant impacts to the regional or national economy, disrupt Canada's imports and exports, and reduce the availability of goods and services within affected markets. Although national impacts are less probable, regional shortages of raw materials and some manufactured chemicals are possible, which in turn may inflate prices. Damage to the Defence Industrial Base and the supply chain of industries that are essential to support military readiness and operations may effect national security. Recovery time is dependent on the restoration of the electrical grid and transportation infrastructure, extent of onsite infrastructure damage, and the availability of returning labour force.

Because of COVID-19, significant economic impacts can occur due to decreased demand for manufactured goods. There may also be a shortage of key materials needed to support other CI sectors. Concerns have emerged around the production of poor quality PPE, as well as fraudulent retailers who are falsely advertising products in a time of increased demand. Increased absenteeism and physical distancing may also pose significant risk to the sector.

Safety

The primary responsibility of emergency services and first responders is to save lives during a severe winter storm event. A capable workforce is needed throughout preparedness, response, and recovery, in order to ensure safety and maintain law and order. The disruption to cross-sector dependencies between the ICT and Transportation sectors may impede rescue and recovery efforts during the aftermath of a severe winter storm, as dispatch centres and access routes may be impacted. The degradation of communications or transportation routes would affect the coordination and response time of first responders, directly impacting the welfare of citizens in need. Strain on available ambulatory care services may occur if responding to mass casualties. There is the potential for increased need for specialized emergency response as well as medical assistance. Preparatory activities, response, and recovery in the aftermath of a winter storm event may overwhelm regional capacity, resulting in the burnout of local first responders. External assistance from other jurisdictions and federal departments would help offset this local strain.

Due to increased absenteeism resulting from COVID-19, decreased capacity and longer response times by first responders may occur.

Transportation

A number of transportation systems and assets could be directly impacted by a severe winter storm. Mitigation to disrupted transportation routes may be possible through redirecting traffic but there may be economic, volume, or timing issues that could have significant impacts on the movement of first responders, repair crews, and supply chains. Highways, airports, and rail provide egress corridors for residents while providing access to emergency responders and fire crews. Delays and cancellations of chartered or scheduled rail, air, and marine services may occur due to inclement weather associated with a winter storm event, cascading into dependent CI sectors and related supply chains. The Transportation Sector may be conversely impacted by its own cross-sector dependencies on the Energy and Utilities and ICT Sectors infrastructure and services. Disruption to the electrical grid could have significant impacts across the major transportation modes, impacting the operations of control centres, passenger terminals, traffic control systems, refueling stations, and propulsion of electrically powered vehicles. The disruption of timely fuel delivery in support of vehicles and facility backup generators could have significant impacts across the major transportation modes and halt the movement of people, goods, and services. Degradation of ICT services may reduce the functionality of navigation aids, scheduling and check-in services of public and cargo carriers, and communications amongst ground staff, emergency services, and vessels/aircraft. The severity of the storm would dictate the extent of potential onsite damage and the length of time to recover.

The Transportation Sector supports CI by facilitating the movement of the goods and services Canadians depend on. For example, the Food Sector is heavily dependent on the Transportation Sector as food is frequently delivered by truck. Damage to transportation infrastructure, lack of fuel, and communication failures could lead to local food shortages in the most affected areas. Avalanches, which typically occur in mountainous regions, during or after significant snowfall, may cause traffic hazards and significant economic loss due to potential road or rail closures. The prolonged disruption of major transportation systems has the potential to create widespread secondary disruptions, as dependent sectors are in turn forced to reduce or cease operations. Response time of first responders including police, fire, and paramedic services may be substantially impacted due to poor driving conditions and road closures. Rail operations may be affected by damage to stations, tracks, bridges, locomotives and rolling stock, and the lack of electricity for operations and communication systems, including the operation of electrically-driven locomotives and automated control and signaling systems. Freight rail operations may continue during a winter storm, as locomotives are able to push through snow. However snow drifts on rail tracks may cause some service interruptions. Regional, local, and commuter rail systems are more likely to cancel or delay operations during a severe winter storm. Disruptions to port facilities due to icing on port infrastructures, lack of electricity for operations, communications, security, and navigation aids could have significant impacts on national supply chains where they support the import and export of goods. Disruption to airport operations due to poor navigation and driving conditions, damage to airport terminals, control towers, and runways, and the lack of electricity for communications systems, air traffic control, navigation and landing aids, as well as automated ticketing, check-in, baggage handling, and passenger screening systems. For these reasons, scheduled airline travel would cease. Public transportation may be impacted within cities due to poor driving conditions, accidents, road closures and the lack of electricity for traffic lights, streetcars, and subways, which may cause issues with the movement of workers.

Due to COVID-19, there may be increased challenges for the trucking industry due to travel restrictions, and potential cascading impacts on supply chains and the delivery of parts and products. Increased employee absenteeism may also disrupt the movement of goods. A significant increase of deliveries to residential clients has created a need to perform an unprecedented amount of hiring to meet demand. Rail and marine operations may also experience delays or a reduction in services.

Water

Severe winter weather including freezing temperatures, heavy snowfall, and ice can have a significant impact on water supply. Disruption to the supply of safe potable water or the degradation of treatment facilities may result in the discharge of untreated wastewater, putting human welfare at risk. Broken pipes throughout the distribution system due to freeze and thaw cycles, water quality impacts due to increased amount of road salt in storm water runoff, and surface water supply challenges as ice and frozen slush can block valves are potential disruptions to consider. The Water Sector is reliant on the Energy and Utilities Sector for electrical power for the operations of its facilities and fuel supply for backup generators. Power outages could result in the loss of power to pumps required to pressurize water delivery systems and draw water from wells, monitoring systems needed for water quality, chemical dispensers needed for water treatment, and communications systems for SCADA systems (digital infrastructure).

The Water Sector is also supported by the Transportation Sector to get staff onsite, receive fuel for backup generators, and for the regular delivery of the water treatment chemicals needed for potable and wastewater treatment. Unsafe travel conditions may reduce work force in the service area, and access to facilities may be limited due to ice roads or debris such as fallen tree limbs. Several of Canada's CI sectors rely on the Water Sector to support their operations, including electrical generation, agriculture, and a wide variety of manufacturing processes. Dams and other water control structures are often dual purpose and may provide water control, maintain drinking water reserves, support irrigation or support electrical generation.

Disruption to the Water Sector could have significant impacts on the health of Canadians, disrupt supply chains that rely on water intensive processes, impact the environment with untreated discharge of wastewater, or create secondary destruction with the failure of water control structures. There may also be potential risk of flooding due to snowpack melt and ice jams. Communication of cautionary guidelines to remote and rural residents reliant on well water and septic systems may need to be considered by regional health authorities.

Due to COVID-19 and the potential of increased absenteeism, there may be a lack of certified/licensed operators working in the water treatment facilities. Due to potential supply chain issues, delays in receiving water treatment equipment (i.e., chemicals for water treatment, including chemicals derived from steel by-products) may be experienced.

Annex A – Cross-Sector Impact Overview

		Secondary Sector Impacts									
	SECTORS	**Energy and Utilities**	**Finance**	**Food**	**Government**	**Health**	**ICT**	**Manufacturing**	**Safety**	**Transportation**	**Water**
Impacted Primary Sector	**Energy and Utilities**		• economic activity • ATMs, point of sale, security systems and internet banking • fuel re-supply issues	• electricity for food processing, storage, and distribution centres	• business operations	• hospital operations (operating rooms, medical devices, heating and cooling)	• ICT systems	• fuel • electricity for operations	• fuel	• fuel delivery and usage	• pumps and water treatment systems • Fuel for backup generators
	Finance			• payment systems							
	Food		• economic activity			• health of patients		• food production		• food delivery	
	Government										
	Health										
	ICT	• automated systems (i.e. safety mechanisms)	• ATMs, point of sale, security systems and internet banking	• food processing • communications	• business operations	• medical devices • communications		• production • business operations • communications	• communications	• communications	• automated operations
	Manufacturing	• fuel delivery • components delivery	• economic activity	• food processing and packaging	• production of military, technological and office equipment	• production of medical equipment, pharmaceuticals and food	• production of technological equipment		• production of safety equipment	• business operations	• water treatment equipment and chemicals
	Safety		• protection and security at financial institutions		• protection and security of assets	• health sector support					
	Transportation	• fuel delivery • components delivery • movement of workers	• economic activity • movement of workers	• just-in-time delivery of food • movement of workers	• delivery of goods and equipment • movement of workers	• receiving medical supplies and equipment • movement of workers	• receiving equipment • movement of workers	• shipping products • movement of workers	• receiving equipment • EM response times		• water treatment supplies • movement of workers
	Water	• energy production		• food sanitization • additives to food • drinking water for livestock/irrigation	• business operations	• business operations • sanitization	• component cooling	• business operations	• business operations		

Annex B – Sector Impact Overview

ENERGY AND UTILITIES 	• Above ground distribution and transmission networks of the electrical grid are vulnerable. • Local distribution assets, such as insulators, bushings, and street level transformers, are susceptible to strong winds, fallen trees, ice, and snow. • Disruption to Energy and Utilities Sector assets could cause performance degradation, leading to cascading failures within the system, resulting in loss of service to large areas, consumers, emergency responders, and dependent infrastructure across the CI sectors. • Prolonged disruption of Energy and Utilities Sector assets could impact the personal health of Canadians, disrupt regional or national economic activity, and disrupt recovery efforts. • Widespread outages to electrical systems could cause delays in restarting and rebalancing the electrical system as components are repaired. The capacity of local utility labour forces will be stressed, and recovery may require assistance and coordination to access additional resources. • Locally, shortages of refined fuels at pumps may impact evacuation and response efforts. • Nuclear power stations may be shut down due to disruption in the supply of fuel for the backup generators and the water needed to maintain cooling systems for the reactors and the pools in which spent fuel rods are stored. • Disruptions to road and rail transportation networks would impact the movement of petroleum products. • The Energy and Utilities Sector has cross-sector dependence on the Transportation and Manufacturing sectors for the movement of workers, delivery of components, and fuel delivery. **COVID-19 Considerations:** • Worker safety concerns related to virus transmission that can lead to a limited ability to respond to emergencies (e.g., gas leaks) or address repairs (e.g., power lines) in quarantined and high risk areas if crews are not equipped with the right information, safety gear/PPE, and permissions to perform work. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results. • Disruptions to operational abilities or lack of qualified/certified personnel to maintain critical services and infrastructure due to increased employee absenteeism. • Potential disruptions of supply chains supporting the sector such as access to critical equipment and supplies and potential unintended consequences arising from travel bans and quarantine periods. • Liquidity concerns due to business closures, market instability, and the introduction of deferred and delayed payments. • Disruptions of materials may delay critical maintenance activity, increase the risk of system outages, and delay the connection of customers to essential systems. Raising additional concern that the U.S. may enact first rights to critical materials (as seen in previous emergency situations).
FINANCE 	• Winter storms may lead to disruption of banking and financial services and decline in local and global stock markets. • Banking and financial services may be disrupted through cascading effects on dependent sectors, such as energy and ICT infrastructure. • Automated Teller Machines (ATM), point-of-sale, security systems, and internet banking depend on electricity and communications for provision of service. Prolonged outages can have effects on commerce and consumer banking within an impacted community. • Loss of service and access to funds may occur at banks, financial institutions, and retail points of sale. • Local populations within impacted areas may experience temporary inconveniences associated with power and/or telecommunications disruptions (including disruptions to digital payment systems which may cause increased reliance on cash and restrict access or exchange of goods and services). • Winter storms may affect individuals' capacity to purchase emergency resources including food, fuel or other necessities. **COVID-19 Considerations:** • Ongoing financial market volatility. • Potential disruptions to financial services in smaller/remote communities.

	• Financial institutions activities could be disrupted if there are disruptions to key third party suppliers. • Bank branches have been closing or offering reduced hours. In particular, this may cause a disruption in banking services for smaller or remote communities. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results.
FOOD 	• Physical damage to food production, processing, storage, and distribution centres could disrupt supply chains. • Crops destined for market or to be retained for winter livestock feed may be destroyed. • Farm buildings and equipment may be damaged due to heavy snow / ice accumulation. • Power failure or fuel shortages may impact the care of livestock. • If water sources freeze or become unavailable, deaths may occur due to dehydration. • Livestock could be exposed to extreme wind chill leading to hypothermia and frostbite. • Long-term impacts, including an inflation of prices for food products, could be observed should damage to crops, facilities, and loss of livestock occur. • Inflation of food prices may occur due to damaged crops, facilities and loss of livestock. • Physical damage or loss of electricity to food processing, storage, and distribution centres could disrupt the production and delivery of products. • Spoiling of large quantities of food could occur due to loss of refrigeration. • The sector relies on frequent orders and deliveries, typically supported by the road network and communications systems. • Food retailers' dependence on the Finance Sector can affect public access to food as digital payments systems are disrupted and reliance on cash increases. **COVID-19 Considerations:** • Disruptions to production, processing, and distribution facilities where COVID-19 cases are present. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results. • Challenges at food banks resulting from shortages of donations for vulnerable populations as customers are buying more items than usual. Food banks may experience a shortage of labour due to staff being volunteers. • Small and mid-sized businesses experiencing challenges such as the cost to install barriers and provide employees with PPE during a time of diminished earnings. • The food industry has experienced a significant drop in employment applications for jobs in food processing. • Physical distancing and the closure of some processing plants are affecting the delivery of services as well as delivery of goods to/from the U.S. • Potential delay in getting food to market if food inspection services have high absenteeism rates or are not permitted on site. • Seed availability is scarce, resulting in waits of up to 60 days for commercial orders with Canadian seed suppliers. • Decreased capacity to provide animal care may occur due to labour shortages. • Easy access to federal benefits have increased absenteeism partly due to fear of working in workplaces where physical distancing is unlikely. • Security concerns may arise due to shortages in food supply for vulnerable populations.
GOVERNMENT 	• Disruptions to governmental service provisions could occur as they rely on energy, communications, transportation, and water to operate. • Physical damage to government facilities and equipment could impact ability to conduct regular activities. • Disruption in the Transportation Sector could result in government employees being unable to get to work. • Government communications with the public could be disrupted, possibly leading to social disorder. • Government services delivered by the Internet may become unavailable. • Due to the disruption of power and communications, most systems for the detection of unauthorized border crossings, port landings, or unauthorized access to vulnerable sites may fail. • Local and regional governments may require assistance from provincial or federal government. • Disruptions to dependent services may also require the relocation of offenders from impacted correctional facilities. • Military assets may be relocated during preparatory phases to mitigate damage sustained to specialized equipment and vehicles.

	COVID-19 Considerations: • Service delays may be experienced due to absenteeism and/or increase use of VPN which may slow networks. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results.
HEALTH	• Health facilities and services are vulnerable to disruption from physical damage as well as disruption to their cross-sector dependencies including the Energy and Utilities, ICT, Transportation, and Water sectors. • Degradation of the electrical grid may affect hospital operations including emergency care, patient care, operating rooms, and specialty services over a long-term disruption. • Lack of adequate heat may result in undue suffering and death, particularly the elderly and critically ill. • Fires or carbon monoxide poisoning may occur due to misuse of generators, obstructed gas line ventilation, or alternate heating sources. • Disruption and reduced access to health services has the greatest impact on critically ill patients. • Structural damage of health care facilities will directly impact the ability to provide services to patients. • Delay in delivery of health care services and supplies, limiting health care professional's ability to respond to requests for routine care and/or emergencies. • Disruptions or damage to transportation infrastructure may affect both land and/or air ambulance services, delivery of pharmaceuticals, essential medical supplies, and food. • Evacuations may reduce labour force capacity or strain emergency/ambulatory staff. • Waterborne illness or the spread of bacterial infections due to contaminated water may exacerbate the potential influx of the injured. **COVID-19 Considerations:** • High absenteeism of health care workers as a result of illness and burnout in dealing with large volumes of cases presenting themselves in hospitals and clinics. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results. • Mental health issues due to high stress, including as a result of physical-distancing and self-isolation measures. • Hospitals and health care facilities may be overwhelmed by large volumes of infected individuals. • Shortages in health care supplies and drugs due to increased demand.
INFORMATION COMMUNICATION TECHNOLOGY (ICT)	• Switching stations, telecommunication facilities, and cell towers are susceptible to severe winter storm winds, fallen trees, ice and snow. • Prolonged disruption of ICT assets could have impacts on regional or national economic activity, the effectiveness of first responders and recovery efforts. • Cascading effects from disruptions to the electricity grid could cause service interruptions for customers. • Landline communications could be disrupted due to physical damage. • Disruption to the electrical grid would affect the supply of electricity to battery packs that support cell phone towers and telephone and data switching offices. • Refueling prioritization by road network is critical to the sustainability of a communication network. • Some ICT assets require the Water Sector for component cooling. • Operation of radio and television broadcasting stations may be disrupted through direct damage to stations or towers, or power failures. Extreme ice or snowfall can interfere with radio signals. • Disruptions to communication networks can have significant cross-sector impacts if the SCADA systems that support the infrastructure's operations are disrupted. • Remote communities with limited ICT infrastructure are more susceptible to degraded services. **COVID-19 Considerations:** • Instances of disruptive vandalism of ICT assets related to the 5G network have increased due to recent conspiracies regarding COVID-19 transmission. • Increased demand for bandwidth due to additional work-from-home arrangements, as well as increased gaming and streaming, could stress the system.

	• Potential service disruptions if front line staff (including those engaging with essential/critical service sectors, as well as technicians servicing failed equipment) are unable to work due to lack of PPE and absenteeism. • Travel restrictions will limit access to international contractors and specialized workers who support operations, maintenance, and repair of ICT systems. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results.
MANUFACTURING 	• Disruption to manufacturing facilities or cross-sector dependencies could impact manufacturing supply chains and the availability of goods or services supported by manufactured products. • Work stoppages, damage to facilities, or cascading effects from disruptions to the electricity grid or transportation routes may affect the sector. • Water may be unavailable for processing, cleaning and cooling. • Slower or halted production may be impacted by the closure of transportation networks of which the sector is dependent on (marine/road/rail). • Disruption to electrical power or fuel supply may cause reduction or closure of manufacturing facilities that attempt to maintain operations throughout or after a storm event. • Operations could be severely disrupted due to communications outages as the industry is increasingly relying on cloud computing. • Prolonged disruption to the sector could have impacts to regional or the national economy, disrupt Canada's imports and exports, and reduce the availability of goods and services within affected markets. • Regional shortages of manufactured goods are possible, which could inflate prices. • Damage to the Defence Industrial Base and the supply chain of industries that are essential to support military readiness and operations may effect national security. • Recovery time is dependent on restoration of the electrical grid and transportation infrastructure, extent of onsite infrastructure damage, and availability of returning labour force. **COVID-19 Considerations:** • Significant economic impacts due to decreased demand for manufactured goods. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results. • Potential shortage of key materials needed to support other CI sectors. • Potential shortages of PPE and hand sanitizer necessary to support front line medical staff and federal employees. • Concerns regarding production of poor quality PPE, and fraudulent retailers who are falsely advertising products. • Disruptions to the transportation sector (product/service delivery) may have an impact on manufacturing processes, in particular given just-in-time delivery.
SAFETY 	• Disruptions to other sectors such as communications and transportation could impede rescue and recovery efforts, as it would affect the coordination and response time of first responders. Dispatch centres and access routes may be impacted which directly impacts the welfare of citizens in need. • Strain on availability of ambulatory care services may occur if responding to mass casualties. • Could require an increase in specialized emergency response and/or medical assistance. • Preparatory activities, response, and recovery in the aftermath of a severe winter storm could overwhelm regional capacity, resulting in burnout of local first responders. **COVID-19 Considerations:** • Decreased capacity and longer response times by first responders due to increased absenteeism. • Decreased capacity for overall emergency response due to increased number of medical response calls. • Potential decreased cell and broadband coverage for emergency calls due to issues with interoperability because of increased telework measures. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results.
TRANSPORTATION	• Mitigation to disrupted transportation routes could be possible through redirecting traffic but economic, volume, or timing issues could have significant impacts on the movement of first responders, repair crews, and supply chains.

	• Disruption to the electrical grid could have impacts across major transportation modes, impacting the operations of control centres, passenger terminals, traffic control systems, refueling stations, and propulsion of electrically powered vehicles. • Disruption of timely fuel delivery in support of vehicles and facility backup generators could have impacts across major transportation modes and halt movement of people, goods, and services. • Degradation of ICT services could reduce the functionality of navigation aids, scheduling and check-in services of public and cargo carriers, and communications amongst ground staff, emergency services, and vessels/aircraft. • Damage to transportation infrastructure, poor driving conditions, lack of fuel and communication failures could lead to local food shortages. • Prolonged disruption of major transportation systems has the potential to create secondary disruptions, as dependent sectors are forced to reduce or cease operations. • Railroad operations could be affected by damage to stations, tracks, bridges, locomotives and rolling stock, and lack of electricity for operations and communication systems, including the operation of electrically-driven locomotives and automated control and signaling systems. • Disruptions to port facilities could have significant impacts on national supply chains where they support import and export of goods. • Disruption to airport operations may cause scheduled airline travel to be delayed or canceled. • Public transportation may be impacted within cities due to poor driving conditions, accidents, road closures and the lack of electricity for traffic lights, streetcars, and subways, which may cause issues with the movement of workers. **COVID-19 Considerations:** • Economic impacts on all modes of transportation due to travel restrictions and overall decreased movement of people. • Increased challenges for trucking industry due to travel restrictions and potential cascading impacts on supply chains and the delivery of parts and products. • Increased absenteeism within the sector due to occupational health and safety concerns and refusal to work situations. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results. • Potential disruption of services and deliveries if truckers do not have access to key services (gas, repairs, rest stops, food/beverages).
WATER 	• Disruption to the supply of potable water or the degradation of treatment facilities could result in the discharge of untreated wastewater. • Broken pipes in the distribution system due to freeze/thaw cycles, water quality impacts due to increased amount of road salt in storm water runoff, and surface water supply challenges as ice and frozen slush can block valves are potential disruptions to consider. • Disruption to the electricity grid could result in the loss of power to pumps needed to pressurize water delivery systems and draw water from wells, monitoring systems needed for water quality, chemical dispensers needed for water treatment, and communications systems for SCADA systems. • Dependency on the Transportation Sector to get staff onsite, receive fuel for backup generators, and for regular delivery of water treatment chemicals needed for potable and wastewater treatment. • Unsafe travel conditions may reduce work force in the service area, and access to facilities may be limited due to ice roads or debris such as fallen tree limbs. • Disruption to the sector could impact the health of Canadians, disrupt supply chains that rely on water, impact the environment with untreated discharge of wastewater, or create secondary destruction with the failure of water control structures. • Potential risk of flooding due to snowpack melt and ice jams. **COVID-19 Considerations:** • Potential upstream impacts on supply chains supporting the sector (i.e., chemicals for water treatment, including chemicals derived from steel by-products). • Temporary closures of commercial and industrial facilities resulting in increased financial losses. • An increased demand for COVID-19 testing has created backlogs, which may increase absenteeism while workers await test results.