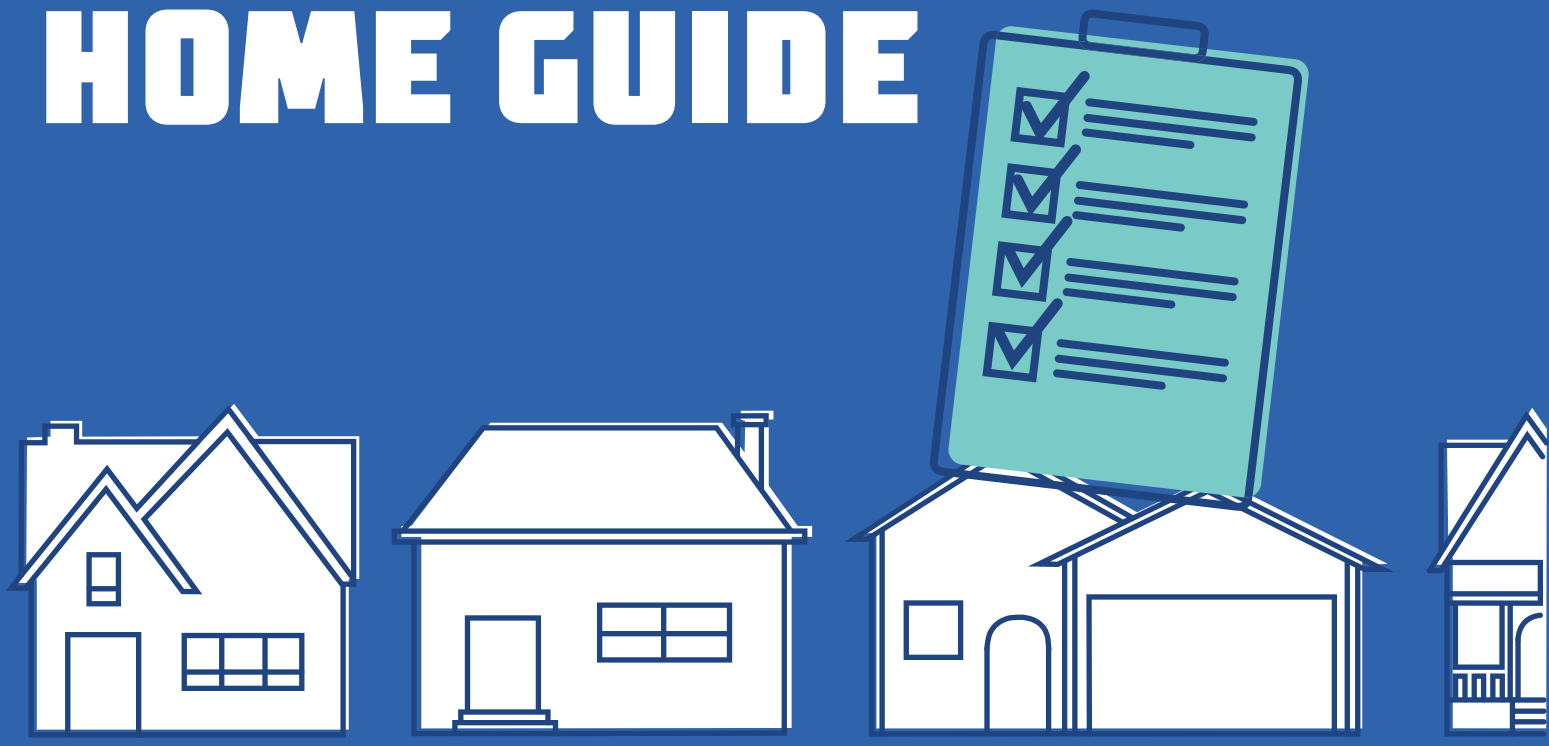
CLIMATE RESILIENT HOME GUIDE



Edmonton

This guide was developed to accompany the virtual home. To explore climate adaptation actions using an interactive website, visit climateresilienthome.ca.

Adapted from the Climate Ready Home Guide for Calgarians

Credit
Thank you to the City of Calgary, All One Sky Foundation and the Institute for Catastrophic Loss Reduction for sharing this guide with the City of Edmonton to adapt it for use in Edmonton.

Table of Contents

1. About the Guide

1.1 What is this Guide?

Alberta is a hot spot for extreme weather. Lightning, hailstorms, tornadoes, strong wind, floods and fires—they all happen here, and they happen more often, and more severely than elsewhere in Canada. In fact, six of the 10 largest insured losses from natural disasters in Canada's history occurred in Alberta. The 2016 wildfires in Fort McMurray were the costliest ($4 billion), followed by the flooding of the Bow and Elbow rivers in 2013 that devastated the City of Calgary ($1.8 billion).[1] The severe hailstorm that struck Calgary on June 13th 2020 caused $1.2 billion dollars in insured losses, and further uninsured losses, and is now recognized as the costliest hailstorm in Canadian history. The majority of financial costs associated with climate hazard events stem from damages to homes and home contents, as well as temporary living expenses for displaced residents. More important than the financial losses, these events cause social and economic disruption, and particularly affect our most vulnerable people.

Projections of future climate change suggest that the risk associated with some extreme weather events (or "climate hazards") will increase and our City will likely see an increase in the frequency and intensity of some climate hazards. That is why the City of Edmonton is taking a proactive approach to climate risk management. The Climate Resilient Edmonton: Adaptation Strategy and Action Plan, adopted by Council in 2020, outlines five paths and 18 actions that focus on adapting Edmonton to the anticipated climate of the future. The Strategy contains five comprehensive and interconnected pathways focused on:

- Science and evidence based decisions
- Preparing for changing temperatures
- Preparing for changing precipitation
- Preparing for changing weather extremes
- Preparing for changing ecosystems

For more information and to view the Strategy, visit edmonton.ca/climateresilience.

The goal of this Guide is to help Edmontonians understand what climate hazards to expect and to make improvements to enhance the resilience of their homes and properties. Many of the impacts of climate change can be reduced through upgrading or maintaining materials and components of our homes and properties, as well as through enhanced maintenance. The measures outlined in this Guide can help you save money by avoiding costly repairs and also eliminate stress and anxiety associated with responding to and recovery from a damaging extreme weather event. The Guide is meant to provide citizens with information to prepare for and take action to respond to our changing climate.

This guide was developed to accompany the virtual home. To explore climate adaptation actions using an interactive website, visit climateresilienthome.ca.

This Guide informs choices you can make during a renovation or construction project, or to your home maintenance regime; it is not intended to supersede the Building Code. While the 2019 National Building Code (Alberta Edition) outlines the minimum required technical provisions for the design, construction and renovation of buildings in Alberta, most measures in this Guide go above and beyond those minimum required standards.

1.2 Who is this Guide for?

This Guide is designed for:

- Owners of all types of homes, from detached single-family homes to mobile homes.
- Tenants and renters, and their landlords.
- Home builders and renovation contractors.

This Guide is for you if you are:

- Making modest investments and minor changes around your home or property to make it more resilient to climate hazards.

- Initiating a major home renovation and want to integrate improvements that make your home more resilient to climate hazards.
- Constructing a new home and want to incorporate materials and practices that increase the resilience of your home to climate hazards.
- Considering changes to how you run and maintain your home or property that would make it more resilient to climate hazards.

1.3 How to use the Guide

This Guide contains six sections:

- **Section 1** is an introduction for using this guide.
- **Section 2** identifies relevant climate hazards and their potential impact on your home—namely, extreme heat, wildfires, heavy rain and flooding, hail, high winds, winter storms and drought. It also provides some quick tips for protecting your home against these climate hazards.
- **Section 3** provides specific information on home improvement measures that can be implemented to enhance the resilience of different home elements including the roof, exterior walls and siding, insulation, windows, doors, landscaping, drainage, and heating, cooling and ventilation systems. The measures in Section 3 are focused primarily on home renovations.
- **Section 4** provides information about additional climate resilience measures that are mostly applicable during new construction. These measures are in addition to the home improvement measures listed in Section 3.
- **Section 5** includes a checklist of home and property maintenance recommendations and resilience tips for each season.
- **Section 6** contains the Guide endnotes and provides additional resources and information

There are four different ways to use this Guide:

1. If you **perceive your home to be at risk to a particular climate hazard**, like hail, and you want to make your home more resilient to that hazard, then you should **start with Section 2**, which will provide you with a summary of how that hazard may affect your home and identify some key measures you can take to make your home and property more resilient to that hazard.
2. If you are **building a new home or renovating individual elements of your home**, like the roof or siding then you can go to those parts of **Section 3** which contain climate resilience measures for specific home elements.
3. If **building a new home**, you should also look at the additional measures and considerations provided in **Section 4**.
4. If you want to change how you **run and maintain your home to make it more climate resilient**, then you should go to **Section 5**.

The following table will help you quickly navigate the Guide and find the sections and content you are looking for.

I want to know how to make my home more resilient to one or more specific climate hazards.			Extreme Heat	Wildfire	Heavy Rain & Flooding	Damaging Storms	Winter Storms	Drought
			Sec. 2.1 & 4.1	Sec. 2.2 & 4.2	Sec. 2.3 & 4.3	Sec. 2.4 & 4.4	Sec. 2.5 & 4.5	Sec. 2.6 * 4.6
I am planning a renovation to my home that includes one or more of the following elements or I am building a new home and want to increase the climate resilience of one or more of the following elements	Roof	Sec. 3.2	✓	✓		✓	✓	
	Siding	Sec. 3.3	✓	✓		✓		
	Insulation	Sec.3.4	✓					
	Windows	Sec. 3.5	✓			✓		
	Doors	Sec. 3.5	✓		✓	✓		
	Landscaping	Sec. 3.6	✓	✓	✓	✓		✓
	Drainage	Sec. 3.7			✓			✓
	HVAC	Sec. 3.8	✓		✓			
I am building a new home and want to increase climate resilience during the planning and design phase.		Sec. 4	✓	✓	✓	✓	✓	✓
I want to know how to run and maintain my home and property to make them more climate resilient		Sec. 5	✓	✓	✓	✓	✓	✓

1.4 Virtual Learning

This guide was developed as an accompaniment to an interactive website, climateresilienthome.ca. The website provides the user with the opportunity to choose their home location and to explore adaptation measures for individual climate risks. Also built in is a tool for the user to choose various adaptation measures that can be downloaded and saved for further reference.

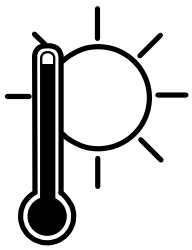
The interactive website was developed in partnership with various municipalities across the Edmonton region, and therefore includes both urban and rural settings and situations.

2. CLIMATE HAZARDS AND THEIR POTENTIAL IMPACT ON YOUR HOME

Edmonton and the surrounding region is exposed to a variety of climate hazards, which are set to intensify as the climate changes. Depending on where you live and how vulnerable your home is, you may be at greater risk to certain impacts. This section identifies relevant climate hazards and their potential impact on your home and property. Further information can be found in the following City resources:

- Climate Resilient Home interactive website inspired the development of this guide; explore actions you can take to protect your home from climate-related impacts.
- Edmonton's Climate Change Almanac provides information about projected climate changes in Edmonton.
- Tiny Explanation videos present climate changes we can expect, in a light-hearted way.
- Climate Change 101 is a video recording, part of changeforclimate.ca/lunchboxseries.
- Seasonal Change posters capture changes according to the seasons, and can be found near the top of the climate adaptation website. Explore the site for more links: edmonton.ca/climateresilience
- Climate Resilient Edmonton: Adaptation Strategy and Action Plan identifies key climate hazards for the City.

2.1 Extreme Heat



While there is no standard definition of an **extreme heat event,** it is generally described as hot weather conditions that have the potential to result in an unacceptable level of health effects, or negative impacts to the natural environment and/or built infrastructure. Days that reach or exceed 29°C are typically referred to as a "high heat day", and a "heat wave" is typically defined as more than three days above 29°C where nighttime temperatures remain above 14°C.

Local temperatures have steadily increased over the past century, and climate projections indicate that local temperatures will continue increasing at an accelerated rate. Edmonton's average summer temperatures are increasing and by the 2080s will be approximately 6°C warmer than they have been historically. High heat days and heat waves will become dramatically more common in Edmonton. For example, high heat days are projected to increase from 1 day per year, on average, to an average of 34 per year by the 2080s. Our hottest days will become extremely hot compared to what Edmontonians have experienced in the past. View the Seasonal Changes posters at edmonton.ca/climateresilience.

Extreme heat can make your indoor living environment unbearable and uncomfortable. This can lead to lethargy, reduced productivity, and in some cases heat-related illnesses and in extreme cases, fatalities. Extreme heat can also reduce air quality, amplifying concentrations of ground-level ozone ("smog")—a pollutant associated with a range of adverse health effects, including asthma attacks. The risk of negative health effects is higher if you work or live outdoors, have underlying health conditions, and for children and seniors. Heat waves can also result in increased electricity demand for cooling, which can lead to power outages during periods of peak demand.

High temperatures, and large variations in temperature, can also lead to the deformation of building materials (e.g., roofing and siding) causing buckling, bowing, cracking, and sometimes breakage. In addition, some chemical processes are accelerated by an increase in temperature, which can degrade and damage concrete, asphalt and steel structures over time.

Extreme Heat Vulnerability

No matter where you live in the City, extreme heat hazards may affect you and your home. If you live closer to the downtown core, or in a more densely populated area with minimal vegetation, you may be more vulnerable to extreme heat due to urban heat island effects. The urban heat island effect happens because buildings and paved surfaces amplify and trap heat. In addition, cities also generate their own heat, which is released from furnaces, air conditioners, and vehicles.[2]

Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to Extreme Heat:

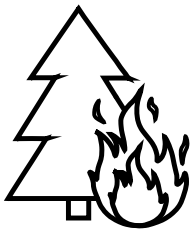
- ✓ Do you live close to the downtown core, or in a more densely populated area with minimal vegetation?
- ✓ Does the interior of your home get uncomfortably hot in the summertime?
- ✓ Do you have older, single-pane or low-quality windows?
- ✓ Are most of your windows fixed and non-opening?
- ✓ Do you have air leaks in your windows and doors?
- ✓ Do you have walls or an attic that is poorly insulated?
- ✓ Does your property lack trees or other forms of shading (awning, covered porch, etc.) to direct sunlight?
- ✓ Do you have dark coloured materials on your roof, exterior walls, deck and landscaping that absorb heat?

To reduce the impacts to your home of extreme heat, consider the following:

- If you have a flat roof or a moderately sloped roof (5–15 degrees), or you are building new, consider a vegetated (living) roof, and consider using lighter colours that absorb less heat (Section 3.2).
- Ensure your walls and attic are well-insulated. If renovating your attic space, consider adding insulation for increased R-value (see Box 1, pg. 25) (Section 3.3). If replacing your siding, consider installing exterior insulation and siding options with a higher R-value (Section 3.4).
- If building new, or replacing your windows, go with triple pane windows (Section 3.5). Ensure you have at least some windows that can open, to the prevailing wind direction (south-west), to provide ventilation.
- Plant deciduous trees on the south, east and west exposures. They provide shade in the summer and shed leaves in the winter to let sunlight in (Section 3.6).
- You can install a window air conditioner unit in rooms that cannot be cross-ventilated effectively (Section 3.8). For new homes, installing central air conditioning may also provide opportunities to filter outside air that may be contaminated with pollen, dust or wildfire smoke (Section 2.2).

2.2 Wildfires

Any fire that is burning strongly and out of control in an area of grass or forest can be referred to as a **wildfire**. Although wildfires are a natural part of wildland ecosystems, living where wildfires can occur puts your home at risk. Edmonton is not as exposed to wildfire as northern and mountain communities adjacent to large, forested areas; however, we have experienced multiple grass fires, such as those along Jasper Ave. in 2021, as well as along Yellowhead Trail in 2020 and 2019. Recent wildfires in Alberta such as the Slave Lake (2011), Fort McMurray (2016) and Waterton (2017) fires are a testament to the devastating impacts of wildfires on our community, economy and quality of life.



Climate change is amplifying three major factors that influence wildfire: having dry fuel to burn, frequent lightning strikes that start fires, and dry, windy weather that fans the flames. As climate change makes summers longer, drier and hotter, and with more intense storm events, wildfire risk in Alberta will continue to intensify. Increased wildfire risk will lead to increased smoke and air quality issues in Edmonton.

In an urban setting, wildfires can grow by catching trees, leaves, plants, dried grasses, and other fuels, and spread to structures, including your home. Sparks and embers from a wildfire as far as two kilometres away from your home can also ignite materials and cause severe damage to your home.

Wildfire Vulnerability

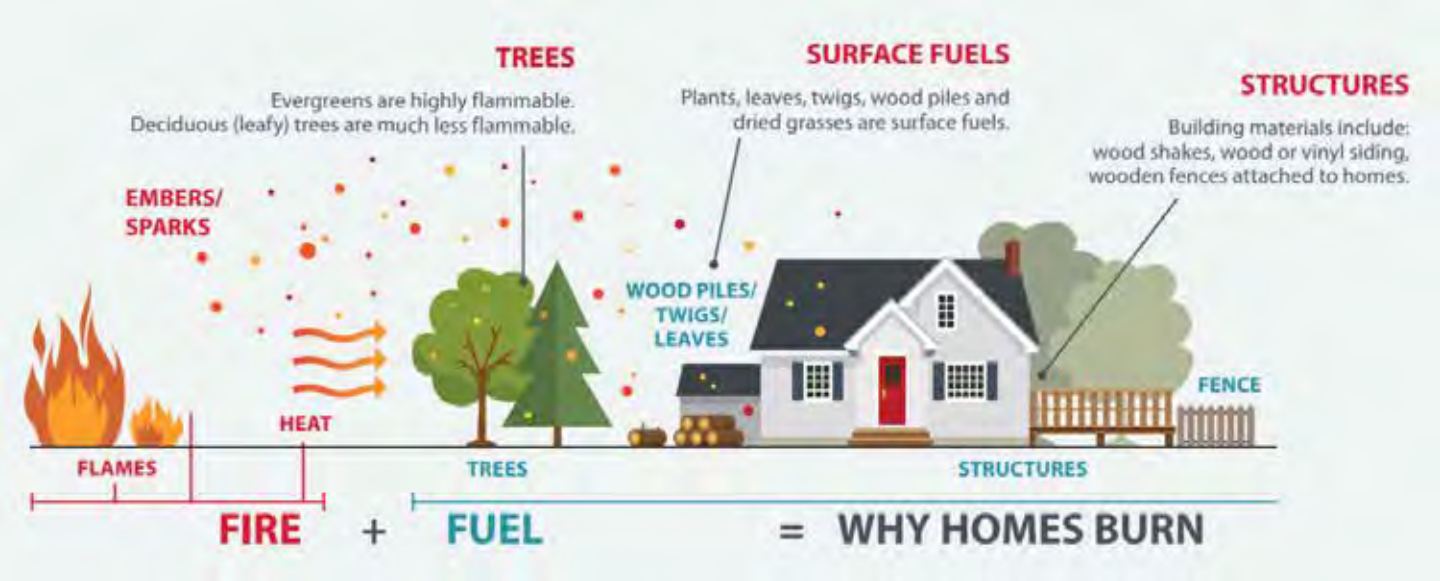
If you live in close proximity to dense, continuous forests or unmanaged grasslands, you may have an elevated risk from wildfires. Large urban parks include the Edmonton River Valley, Lois Hole Centennial Provincial Park, Hawrelak Park, and Rundle Park to name a few.

Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to Wildfires:

- ✓ Do you live in close proximity to dense, continuous forests or unmanaged grasslands?
- ✓ Do you have combustible materials and/or trees in close proximity to your home?
- ✓ Do you have wooden shake roofing materials?
- ✓ Do you live on the mid to upper portion or crest of a hill or slope (fire moves faster uphill and may put your home at higher risk)?
- ✓ Is your exterior siding made of wood or vinyl?
- ✓ Does your property lack trees or other forms of shading (awning, covered porch, etc.) to direct sunlight?

To reduce the impacts to your home of wildfires, consider the following[3]:

- Asphalt shingles, metal or clay tile are the best roofing materials for fire protection (Section 3.2).

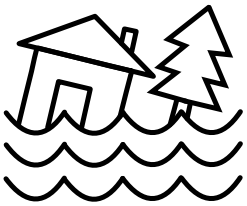


Source: Alberta FireSmart Homeowners Manual, FireSmart Zones

- Cement board, stucco, brick or metal are the best siding options for protection against wildfires (section 3.3).
- Install fire resistant windows and doors (Section 3.5). Triple-pane windows provide some fire protection and also protect against extreme heat (Section 2.1).
- An indoor air purification system can protect against wildfire smoke (Section 3.8).
- FireSmart your property (Section 3.11):
    - Within 1.5 metres of your home should be a non-combustive zone.
    - Within 1.5 to 10 metres from your home should be a fire-resistant zone; if possible, free of all materials that could easily ignite from a wildfire.
    - Greater than 10 metres from your home, if possible, thin and prune evergreen trees and regularly clean up fallen branches, dry grasses and needles.
- Clean your roof and gutters—remove needles, leaves and other combustible materials (Section 3.11).

2.3 Heavy Rain and Flooding

In Edmonton there are different types and causes of **flooding**. For example, flooding can occur during intense summer storms, prolonged rainfall, rain-on-snow, ice jamming, river flooding or combinations of all these events. Every time it rains or snow melts, the City's stormwater management system of storm drains, storm ponds, and wetlands carry the water to an outfall and into the river. EPCOR manages Edmonton's drainage system.[4]



In some cases, for example during a heavy rainfall event, water can build-up and accumulate in low-lying areas and impact your home and property.

With climate change, the amount and intensity of extreme precipitation events is increasing. For Edmonton, our annual precipitation of approximately 458 millimeters (mm) is expected to increase by 50 mm by the 2050s and 54 mm by the 2080s. We can expect more heavy rainfall events and urban flooding events in the future. The overall increase in precipitation is not so much of a concern as the weather events that will lead to a lot of rain falling in a very short period of time, which can easily lead to overland flooding. The ground is often unable to absorb heavy rain, like it might a gentler rainfall.

For your home and property, the primary concern is basement flooding. Basement flooding can be caused by either overland flooding (flooding that results from heavy rainfall) entering your home through openings or sewer backup from the sanitary or storm systems. Inadequate or poorly constructed infrastructure (e.g., roads and sidewalks) can also lead to failures that can flood your home. If you have a finished basement, flooding may have a greater impact; for example, if you have furniture and expensive electronics in your basement. Flooding and water that enters your home can also cause mold to grow, leading to long-term health impacts if not appropriately addressed. In some of the worst-case scenarios, damage may occur to your home structure and foundations, making your home unlivable. Flood waters are also frequently contaminated with debris and pollutants, including sewage.

Heavy and wind-driven rain can also enter your home through openings in your exterior walls or roof (e.g., because your roof shingles are in need of repair) causing structural damage.

Flooding Vulnerability

The majority of homes in Edmonton have the potential to be impacted by basement flooding. The risk can increase if you live in a low-lying area, or in close proximity to a natural water body.

Importantly, the climate resilience measures identified in this Guide will not protect your home from river flooding. Residential structures are unable to withstand the forces associated with even minor floodwater depths unless specifically designed to do so. You should check the Province of Alberta's flood map to determine if your home is located in the floodway, flood fringe or overland flow zone. If you live in North Saskatchewan River Valley covered by the Area Redevelopment Plan, Cloverdale, Riverdale or Rossdale, additional development and building regulations apply.[5] Some of the climate resilience measures outlined in Section 3 may provide some protection if your home is located in the flood fringe or the overland flow area, if your home is inundated by shallow overland floodwater.[6]

If you live in Cloverdale, Riverdale or Rossdale, you can sign up for EPCOR's Storm and River Level Alerts.

Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to Flooding:

- ✓ Do you live in a floodplain area (floodway, flood fringe or overland flow zone), low-lying area or in close proximity to a natural water body?
- ✓ Has your basement ever flooded?
- ✓ Do you have a finished basement?
- ✓ Are there any unsealed cracks in your foundation or basement floor?
- ✓ Does the grading of your lot, or your driveway, slope *towards* your house?
- ✓ Do you have downspouts that direct water towards your home, or that drain close to your foundation walls?

To reduce the impact to your home of Flooding, consider the following:

- Choose flood-damage-resistant building materials for walls, ceiling, insulation, flooring, and doors (Section 3.2, 3.3 and 3.5).[7]
- Install eavestroughs and downspouts if your home does not have them and ensure downspout extensions direct water well away from your house (Section 3.2).
- Whether building new or landscaping your yard, an effective means of protecting your home from flooding is to ensure your lot drains away from your house (Section 3.6).
- Install a sewer back up valve to help protect your home from sewage system backups associated with extreme rainfall events and stormwater flooding (Section 3.7).
- Permeable materials[8] on driveways and walkways are better at absorbing water (Section 3.7). Permeable surfaces can also help protect against extreme heat (Section 2.1).
- Clean your roof, gutters and downspouts by removing needles, leaves and debris (Section 3.11).

Learn More

- To learn more about protecting your home from flood impacts, visit edmonton.ca/Flooding&Prevention.
- To book a flood prevention home check-up or for information about a backwater valve subsidy, visit epcor.com/products-services/drainage/flooding-flood-prevention.

2.4 Damaging storms

Damaging storms can be defined as short-duration, high-intensity convective storms which often include high wind and hail. These storms are small in spatial extent but can produce significant, high-cost impacts. According to climate projections, the frequency and intensity of these events are likely to increase in the future, and there is increasing potential for them to occur throughout more of the

year.

Heavy rain is often associated with damaging storms and can lead to overland flooding and water infiltration into your home. Potential impacts of heavy rain are included in Section 2.3 (Heavy Rain and Flooding), and under the related resilient measures for heavy rain and flooding. Lightning can also be associated with damaging storms and can result in power outages and damage to vegetation and property. Home resilience measures to reduce disruption from power outages are provided in Section 5.1 (Emergency preparedness).

2.4.1 Hail

Hail is one of many hazards associated with damaging convective storms. **Hail** is a form of precipitation that is made up of ice and snow. Hail stones can range from pea size to golf ball size, and up. There has been an increasing trend in hail in Alberta over the past four decades. Although climate projections for hail cannot be definitively determined,[9] it is expected that the upward trend will continue based on the increasing atmospheric energy and frequency of damaging storms. Additionally, the increasing duration of the "hail season" or convective storm season will likely contribute to Edmonton experiencing more hail events.

On average Edmonton gets about four hail storms per year. Most recently, in August 2019 a hail storm that struck Edmonton damaged house siding, windows, and vehicles, costing an estimated $90 million in insured losses. The hailstorm that struck Calgary in June, 2020 caused $1.5 billion dollars in insured losses and further uninsured losses and was the fourth costliest insured loss in Canadian history. In addition to this event, storms in 2010, 2012 and 2014 collectively caused more than $1.6 billion in insured losses in Alberta.[10]

Building envelopes will increasingly be impacted by hailstorms in at-risk areas such as Edmonton. Depending on the size of hailstones, the wind speed and the duration of a storm, hail can cause significant damage to your home's roof, exterior walls, doors and windows, and outdoor structures like porches and decks. Moreover, damage to these aspects of your home's envelope can allow water in, leading to even more damage.

Hail Vulnerability

All communities within the City are equally exposed to hail. Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to Hail damage:

- ✓ Has your home previously been damaged by hail?
- ✓ Do you park your vehicle (if you own one) in an unprotected area at home (e.g., not in a carport or garage)?
- ✓ Do you have a flat or almost flat roof?
- ✓ Do you have skylights?
- ✓ Do you have aluminum or vinyl siding?
- ✓ Do you have an older roof with low-quality roofing material that is not impact resistant rated?
- ✓ Do you have older, low-quality windows that are not impact resistant rated?

To reduce the impact to your home from hail, consider the following:

- If you are building new, hip roofs are the most resilient to hail damage, and the steeper the slope of your roof, the less susceptible it will be to hail damage (Section 3.2).
- If you are replacing your roof or siding, check Table 1 and Table 2, respectively, to see how well different materials perform against hail (Section 3.2 and Section 3.3).

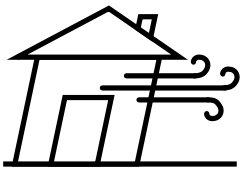
- Purchase and install impact resistant windows and doors and put a safety film on your windows (Section 3.5).
- Install protective shutters (roll shutters or storm shutters) on the outside of your windows (section 3.5). These will also offer protection against extreme heat events (Section 2.1).

Follow these links for more information about preparing for and rebuilding after a storm:

- Alberta Government
- City of Calgary

2.4.2 High wind

High winds are typically defined as gusts greater than or equal to 90 km per hour. In Edmonton, the strongest winds are usually caused by severe thunderstorms, intense low-pressure centers and cold fronts. High wind events occur fairly frequently in Edmonton and can last from minutes to hours. For example, in January 2021 a high wind event toppled trees, downed power lines, and damaged roofs with wind gusts reaching up to 107 kilometers per hour and on October 25, 2019 a window washer had to be rescued from a tower downtown during a major windstorm. On January 19, 2020, the first ever snow squall warning was issued for Edmonton, causing major damage to homes, businesses, and trees. The intense wind gusts reached between 87 to 107 km/h, causing Edmonton Fire Rescue Services to respond to nearly 100 events in a two hour period. Epcor also reported that approximately 20,000 customers experience a power outage as a result of the snow squall. Tornadoes are also possible in Edmonton, but less likely.



High winds can damage a wide variety of infrastructure including homes, buildings, traffic signals, streetlights and signs. Strong winds can also turn tree branches and garden furniture into weapons, which can damage roofs, exterior walls, windows and doors. Overhead power lines are also at risk during high wind events with the potential for power interruptions or outages. Injuries or fatalities as a result of high wind events in Edmonton have been rare but have occurred on occasion.

With a changing climate, we expect to see an increase in the frequency of high wind gust events in Edmonton.[11]

High Wind Vulnerability

All communities within the City are equally exposed to high winds. Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to damage from high winds:

- ✓ Do you have a complex roof design?
- ✓ Do your roofing materials (e.g., shingles) appear to be worn and/or damaged?
- ✓ Check your roof edge attachments. Is the edge of your roofing material (e.g., shingles) starting to peel back or is it poorly connected to the roof structure? For example, can you easily peel them back?
- ✓ Are your soffits, fascia and gutters old and/or showing signs of damage?
- ✓ Were your roofing materials installed without underlayment?
- ✓ Do you have a number of items stored outdoors which are not anchored down (e.g., trampoline, playground equipment, tables, etc.)?
- ✓ Do you have older windows and doors which are not pressure-rated or reinforced?

To reduce the impact to your home from high wind, consider the following:

- If replacing your roof or siding, check Table 1 and Table 2 to see how well different materials perform against high winds (Section 3.2 and 3.3).
- If replacing windows or doors, consider impact

resistant options or put a safety film on your most exposed windows (section 3.5)

- Plant coniferous (evergreen) trees in a row on the prevailing wind side of your house (section 3.6). If possible, trees should be planted far enough away that falling branches will not cause damage to your house, and adhere to FireSmart recommendations.
- Securely anchor outdoor accessories and equipment.

2.5 Winter storms

Winter storms can be defined as any precipitation event with potential to cause damage that occurs near or below 0˚C. This can include snowfall events, freezing rain, ice storms, and rain-on snow events. Winter storms can happen in the spring and fall, not just in winter. On November 8, 2019, a major winter storm on a Friday evening started as rain and then transitioned to snow resulting in over 365 car collisions.

The most significant and high impact frozen and freezing precipitation events require very specific weather conditions to occur (cool season weather conditions near 0˚C). These snow events may be accompanied or followed by rainfall, resulting in extremely heavy loading on trees and overhead infrastructure. In Edmonton, average winter temperatures are projected to increase but still remain below 0˚C, on average, by 2080s, and winter precipitation is projected to increase. Edmonton will continue to experience high impact winter storm events in future decades.

The possible increase in winter snow loading due to the potential for rain-on-snow events has potential to damage buildings and property. Snow and ice storms can also damage infrastructure and cause power failures (e.g., downing of overhead power lines), and result in more injuries due to increased traffic accidents or slips and falls. Around your home, a really heavy snow load or ice storm can put significant stress on your roof, with the potential to damage (collapse) your roof and cause ice dams. An ice dam is a ridge of ice that develops at the edge of your roof or around drains that prevents snow or water from melting off your roof. It is caused by heat escaping from the interior of your house.

Winter Storm Vulnerability

All communities within the City are equally exposed to winter storms. Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to Winter Storm damage:

- ✓ Has your home ever been damaged by heavy snowfall or freezing rain?
- ✓ Do you have a flat or almost flat roof?
- ✓ Do you have a complex roof design with obstructions where snow and ice can collect?
- ✓ Do you have skylights?
- ✓ Is there any vegetation that overhangs your roof and contributes to blockages in roof drainage systems or that could break off and damage your roof or property?
- ✓ Is your attic/roof poorly insulated? If not, snow loads on your roof can melt and cause ice damming.

To reduce impacts to your home from Winter Storms, consider the following:

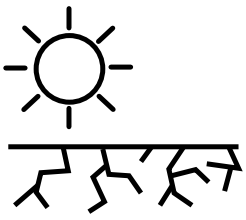
- If building new, choose a hip roof structure with a steeper slope. More complex roof structures, and flatter roofs, are more susceptible to damage from winter storms (Section 3.2).
- If building new or replacing your roof, install an appropriate moisture or ice-and-water shield over the entire roof surface to protect against water and ice penetration (Section 3.2).

- Improve insulation and venting of your attic to reduce risk of ice damming on your roof (Section 3.4).
- After a major snowstorm, check the exterior of your home, particularly the roof of your home or garage, porches, decks and other overhangs, for signs of ice damming or heavy snow load. Rake or shovel heavy snow loads off of your roof, deck or porch, and look for water leaks originating from the roof or attic area, difficult to open doors, new cracks in your drywall or plaster, or sagging on the ridgeline of your roof (Section 3.11).

2.6 Drought

Meteorological **drought** is a lack of adequate precipitation over an extended period of time, resulting in a water shortage. Climate projections of increased summer temperatures and decreased summer precipitation tell us drought conditions may become more common and widespread.

The consequences of a multi-year drought are far reaching. In addition to the impact on local agriculture, droughts affect the health of plants, wildlife, wetlands, forests, parks, open spaces, recreational facilities and private yards. Drying out of forests and grasslands increases the risk of wildfires, which impact both local air quality and even water quality if they occur upstream of Edmonton's water supply. Trees and plants also become more susceptible to pest and disease outbreaks (e.g., pine beetles) since lack of water can stress trees, limiting their ability to react to these attacks.



Drought Vulnerability

All communities within the City are equally exposed to meteorological drought. Consider the following questions. The more questions you answer as YES, the more vulnerable your home may be to the impacts of Drought:

- ✓ Do you have trees, shrubs and flowerbeds that require large amounts of water?
- ✓ Does your property have a large lawned area?
- ✓ Does your household use large quantities (excessive) of water?
- ✓ Do you grow fruit, vegetables or herbs in your garden?
- ✓ Are cracks visible in your interior and exterior walls, around the corners of walls and windows?

- To reduce the impacts to your home and property during drought conditions, consider the following:
- Plant drought tolerant trees, shrubs and grasses (Section 3.6).
- Get a rain barrel(s) or rainwater cistern(s) (Section 3.7).
- Help conserve water (Section 5):
  - Water early in the morning before the heat of the day.
  - Use a soaker hose, drip irrigation or water by hand, rather than sprinkling.
  - Do not mow your lawn too short. Keep it 2 or 3 inches high to shade the soil.
  - Add mulch around trees and shrubs to retain moisture.
  - Capture water in a rain barrel or cistern and use it for your garden.
  - Sweep your sidewalk and driveway rather than washing with water.

The City of Edmonton also has useful information about water quality and usage in the City, as well as additional pages about water efficiency and consumption.

These City websites have more information about **drought resistant plants** and how you can prepare for **climate change and drought** in Edmonton.

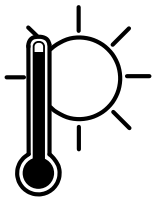
Through a regional collaboration, research was conducted on invasive species and urban forests in a changing climate. Find results at **All One Sky Foundation**.

3. CLIMATE RESILIENCE MEASURES FOR HOME RENOVATIONS

This section contains:

- General advice for all Edmontonians that own or rent a home (Section 3.1).
- Measures and practices that can be implemented to increase the resilience of your home, during a home renovation project or as part of the design of a new home (Sections 3.2 through 3.8).

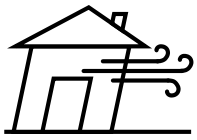
The climate hazards addressed by the resilience measures and practices described below are indicated with icons:


Extreme heat

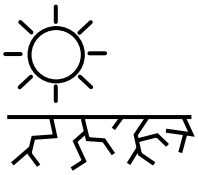

Wildfire


Heavy rain & flooding


Hail


High winds


Winter storms


Drought

For more information about climate resilience measures for renovations you can also visit Edmonton's Climate Resilient Home website where you can virtually explore and learn about modifications that can make your home more climate resilient.

This Guide does not provide an exhaustive list of all climate resilient measures for home development and improvement. Instead, it identifies key measures to reduce the impacts of the most severe climate hazards we anticipate in Edmonton. The information is based on best management practices from accessible existing information.[12]

3.1 General advice to consider before getting started

This section provides advice for all users before getting started with their home resilience efforts.

Talk to your insurance provider:

- Are you covered for damage from climate hazards, such as wildfire, flooding, hail, wind, freezing rain and heavy snow? Sometimes specific types of damage can be excluded depending on your policy, or policy deductibles may vary depending on the cause of damage.
- Does that coverage include other structures and belongings, or just the house itself?
- Does your policy have a deductible? Are there separate deductibles for different parts of your home coverage (e.g., a separate deductible tied to your "water damage" or basement flooding endorsement)?
- Do you have coverage for living expenses if the damage is sufficiently severe that you cannot stay in your home?
- Are discounts or other incentives available for resilient home measures? Speak with your insurance provider to verify how installing any of the measures listed below might affect your insurance policy. Some of the measures, notably those focused on basement flooding, may make you eligible for improved coverage or savings on insurance premiums.

Talk to a professional contractor:

- Because each home is different, building inspectors may be able to offer important insights into your home's capacity to withstand climate hazards.
- If you have basement flooding issues, you

should talk to a licensed plumber to help you understand your risk and which basement flood protection measures will be most effective for you. Investigating options to reduce basement flooding almost always requires an inspection of your home's sewer connection (i.e., the underground pipe that connects your home to the city's sewer system) before work can begin.

- Whether you are landscaping, building a new fence or deck, or planting a garden, disturbing the ground on your property can cause damage to a buried utility. Before you disturb the ground, contact Alberta One-Call (1-800-242-3447) to request that the buried utilities on your property be located and marked.
- The City of Edmonton website has detailed information about required permits and bylaw information for residential home construction and renovation projects, including the types of projects and renovations that require professional qualifications.
- A professional energy advisor can provide detailed information on protecting your home from extreme heat, and also reducing your energy bills.

Talk to the City:

- A Building Permit is designed to address life and safety issues of a structure. It gives authorization to erect, demolish, relocate, alter or repair a structure, or change the use or occupancy of a space. A Building Permit application is reviewed for compliance with the Alberta Building Code by a plans examiner to ensure that our built environment is safe. Check the City of Edmonton website to find out if your home renovation projects require a building permit and about the process and timelines.
- A development permit allows the City to review a development to see if it meets the Edmonton Land Use Bylaw requirements and any other relevant policies or plans, such as Area Redevelopment Plans and the Municipal Government Act. Development permits are required for new projects, changes in use or additions to existing structures. Plan reviews, approvals and site inspections are provided, to ensure that development meets the approved planning, engineering and environmental policies. The process looks at land use, site development, streetscape, planning principles, densities, landscaping, transportation, parking and more. Special regulations apply for development in flood risk areas. When undertaking a new project, it is always best to consult with the Edmonton Service Centre to find out what kinds of permits you will need. Phone 311 or email developmentpermits@edmonton.ca.
- Learn how to prepare for an emergency; find tips on the City's Emergency Preparedness website.
- Ensure your renovation meets (and perhaps exceeds) the 2019 National Building Code (Alberta Edition). The 2019 version was adopted on April 1, 2019 but enforced on December 1, 2019.

If your home is damaged by a climate hazard, you

Infrastructure Canada's Climate-Resilient Buildings and Core Public Infrastructure Initiative aims to integrate climate resilience into building and infrastructure design, guides, and codes, with the goal of addressing climate resilience in the National Building Code 2025 edition. The program will also result in the publication of new guidance on protecting buildings and homes against hazards like wildfire, flooding, and other hazards.

should:

- Most importantly, keep you and your family safe.
- Report property damage to your insurance provider as soon as possible.
- Record information about the event and the extent of damage to your home. Information can

be recorded through written documentation, photographs and/or videos, and can be used to support your insurance claim.

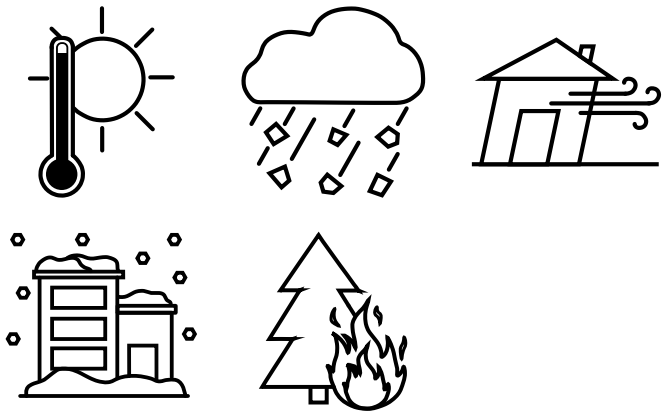
- If it is safe to do so, try and record any information about how flood waters entered your home (e.g., through a drain or bathroom in the basement, from the surface, through the basement floor or walls). This information will help you understand what is needed to protect your home against future flood events.

3.2 Roof

A roof includes the structure, slope, attic, and different types of roofing materials, including membranes underneath the roofing. The roof also includes items that are attached to the roof such as gutters, solar panels, or a chimney.

When planning a roof renovation (re-roofing) the climate resilience measures outlined in this section can help enhance the resilience of your roof as well as help to protect the rest of your home from damage. The most important aspects of a climate resilient roofing system are a durable sheathing material that is securely fastened to the roof structure, roofing underlayment, and installation of a climate resilient roofing material. The best option for roofing material will be based on your personal preference and budget.

Roofing Materials



When it is time to replace your roof, there are several roofing material options to consider. Shingles are by far the most common roofing material, and standard, inorganic 3-tab asphalt shingles are the least expensive. If you are installing asphalt shingles and want to enhance the resilience of your roof, consider upgrading to either laminated architectural shingles, or impact resistant shingles. Rubber, aluminium and steel roofs are also quite resilient to climate hazards but are more expensive than asphalt shingles. Roofs made of a clay, concrete, or slate are very resilient and long-lasting, but can be cost prohibitive for most. Wood shingles and green roofs are less expensive roofing options than tiles but offer less resilience with respect to some climate hazards; respectively, wildfire and drought. Green roofs do nonetheless offer multiple co-benefits.

Most roofing materials, and asphalt shingles in particular, should be installed in warmer months. Shingles installed during the cold months are more likely to not have adhered properly and may be more vulnerable to damage from climate hazards, including blow off from moderate wind events.

Table 1 provides a description of different roofing materials, including some potential co-benefits of each material, as well as a comparison of their relative cost.

Table 1: Comparative summary of roofing materials

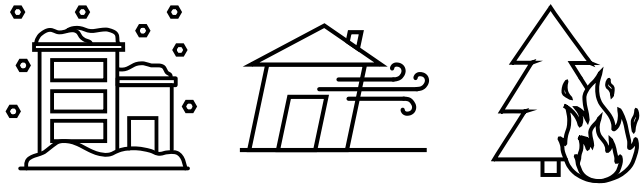
Roofing Material	Description	Installed Costs[13]
Asphalt shingles	Asphalt shingles (Standard 3-tab Class A inorganic shingles) are a popular and inexpensive roofing option. They do well in moderate wind conditions and most hailstorms because they are flexible and have a low risk of damage when debris makes contact with the roof. However, a severe storm can cause significant damage to asphalt shingles. With a flame-retardant fiberglass core, asphalt shingles provide excellent fire resistance. Most products have a life expectancy of up to 20 years.	-
Laminated architectural asphalt shingles	A type of asphalt shingle built with a heavier base and multiple layers of a more refined type of asphalt. Laminated architectural shingles have the strength of standard asphalt (3-tab) shingles and can withstand stronger winds and more intense weather conditions. Laminated shingles are easier to install and typically last longer than standard shingles, with a life expectancy of 30 years or more (premium shingles). Class 4 (impact resistant) shingles provide improved impact resistance, and increased resistance to tears, splits and hence water damage. Nevertheless, when exposed to large, wind-driven hail, impact resistant asphalt shingles can still experience damage.	+25% [arch. shingles] +45% [Class 4 IR]
White (cool) shingles	Cool roof shingles are specialized manufactured shingles with high albedo, designed to reflect sunlight and decrease the amount of heat transferred into your home. Light colored roofs reflect between 55 and 90 percent of sunlight reaching the roof surface. As a result, they lower internal temperatures, reducing heat stress and cooling bills in summer months. Lighter surfaces, if used throughout a region/neighbourhood, may also assist in reducing urban heat island. In Edmonton, however, where the majority of your annual energy costs come from heating your home, installing a cool roof is not likely to save you money on your annual energy bill. This is because the same technology that keeps your home cooler in the summer also keeps it cooler in the winter; cool roofs may increase your heating costs, depending on how energy efficient your home is, among other things. A cool roof system can also be achieved by using light coloured roofing materials or painting your roof white.	+45%

Roofing Material	Description	Installed Costs[13]
Rubber	Rubber roofs are one of the most climate resilient roofing types, as they offer a tremendous level of impact resistance due to their energy absorbing and dispersing nature. They can also handle heavy rain, heavy snow and extremes in temperature and temperature variances that can cause splitting, peeling, cracking and rotting in other roofing materials. Rubber roofs offer some fire resistance but can be treated with fire-retardant to reduce its combustibility. They can last 30-50 years, requiring little maintenance if installed correctly. Rubber roofs can be made from recycled tires, sawdust, and slate dust, making them an eco-friendly option.	+80%
Metal roofs (aluminum and steel)	Metal is a durable, fire-resistant, lightweight roofing option that offers greater longevity, lasting up to four times longer than asphalt shingles. Metal roofs can withstand high winds and provide good protection against winter storms. Metal roofs can generally take the impact of a hailstorm; however, you can be left with visible dents if the hail is of substantial size (1.5" or greater). The type and thickness of metal material matters; steel can resist hail better than aluminum. Importantly, dents from hail do not generally affect the rest of the roof below. Metal roofing is extremely resistant to snow and ice formation, with ice sliding right off. When installed correctly metal roofing can also withstand strong winds and does a great job of preventing water from penetrating your home. Metal helps preserve a cooler temperature within your property because it can effectively reflect heat coming from the sun. It is often made from recycled metals making it an eco-friendly option	+185% (steel) +215% (aluminum)
Wood shingles (Class B fire resistant)	Wood shakes and shingles are typically made from western red cedar and come in a variety of types and grades, categorized according to their level of resistance to wind, impact and fire. Wood shakes and shingles provide good insulation, helping protect your home from extreme heat (and cold) and thus reducing annual energy costs. They are also fairly durable and are not affected by things like hail. If considering wood shakes or shingles, look for a minimum of Class A or B fire resistance. Class A is difficult to achieve with cedar and requires that a Class B fire retardant-treated shake or shingle be installed above a heavy asphalt cap sheet.	+245%

Roofing Material	Description	Installed Costs[13]
Green roof[14]	A green roof consists of a thin layer of soil, with live vegetation established on the top of your house. They are fairly lightweight and can be installed on roofs with a pitch from 0 to 30 degrees. They are virtually maintenance-free once set up and do not require irrigation. For an extensive green roof, expect to pay $1.00 to $1.30 per square foot in maintenance costs each year. Green roofs can help keep your home cooler during extreme heat events and have been shown to reduce cooling costs for buildings by as much as 25%. They also help reduce heating costs, can help attenuate and reduce stormwater runoff from your property, and can improve local air quality when installed in urban environments or on large, city-wide scales. Green roofs have shown significant resistance to the effects of strong winds. In addition, they capture and store carbon and provide habitat and biodiversity benefits.	+260%
Concrete tiles	Concrete tiles have good thermal resistance when compared to other tile types, which means they reduce the heat homes gain from sun exposure without the need for additional insulation. This reduces the thermal load by as much as 45% when compared to asphalt shingles, reducing the need for as much attic insulation and ventilation. Concrete tiles have a Class A fire rating, making them a good choice for homes in areas prone to wildfires. In contrast to clay tiles, they are less prone to cracking from freezing and thawing cycles in colder climates. They are also resistant to hail and high winds when installed correctly, but not as water resistant as slate and clay; the water absorption of concrete is higher than these other materials. In some homes, the installation of concrete tiles may require the roof framing to first be reinforced to support the added weight.	+265%
Slate shingles	Because it is a natural stone, slate shingles are extremely long-lasting (anywhere from 70 to 200 years) and provide great protection against many climate hazards, including from hail and wildfire, and from large tree branches and other debris resulting from high wind events. Another benefit of slate shingles is that they work well on sloped roofs, making them perfect for shedding snow. The density of slate can also help regulate the temperature in your home, providing protection from extreme heat and also reducing energy consumption and saving you money on your energy bills. Slate is, however, extremely heavy and can require additional structural support prior to installation.	+355%

Roofing Material	Description	Installed Costs[13]
Clay tiles	Clay roof tiles are quite resilient but can be prone to damage in large hailstorms and suffer cracking from freezing and thawing cycles in colder climates. Their resistance to high winds is largely determined by the fastening system rather than the material; so long as the tiles are installed correctly, they should resist high winds. Clay does a great job of blocking heat from the sun thus preventing radiant heat. Clay tiles are energy efficient, available in many types and colours and are also fire and water resistant. Like slate shingles, clay tiles are heavy and may require structural reinforcement of your roof prior to installation.	+370%

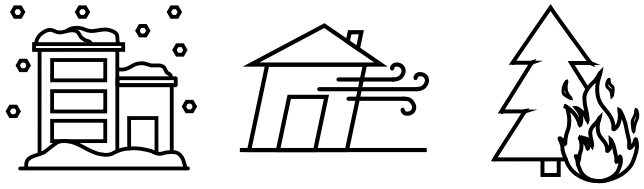
Roof sheathing



Roof sheathing is the panel of material (usually OSB or plywood) fastened to the structure to provide a surface for water protecting membranes and roofing material such as shingles. A roof that is sheathed completely will provide greater stability in severe wind and is better at handling the additional weight of a heavy snow event. Fire rated sheathing material can be used to bolster the fire resistance of the roof. In general, choosing a thicker roof sheathing material (11.1 mm or 7/16" in lieu of 3/8" sheathing), with longer nails (e.g., 2.5" rather than 2") that are spaced closer together along both the edges of the sheathing panel and the interior supports (150 mm, rather than 300 mm), reduces the risk of damage associated with sheathing failure.

If the sheathing is being replaced, you should also replace your roof underlayment while the area is exposed.

Roof underlayment

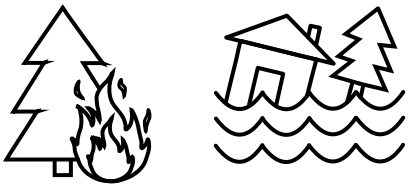


Roof underlayment is a membrane that goes over the roof sheathing. For increased resilience to climate hazards, you should install new roof underlayment when re-roofing your house. For better protection from heavy rainfall and winter storms, consider using two layers of underlayment that are cemented together, or an ice-and-water shield underlayment. Roof underlayment can be bought as a fire barrier with a class A fire rating, although not all underlayment is fire resistant. The fire resistance rating of your shingles may also depend on your underlayment, and some shingle installations may require new underlayment, according to manufacturers' instructions. Reflective roof underlayment (or a radiant barrier) can be used to protect against extreme heat impacts and reduce cooling costs; though in colder climates it is likely to be more cost-effective to increase your attic insulation, which would also help reduce heating demand.

Make sure underlayment is installed well in roof valleys, and around your chimney and other roof

obstructions (skylights, dormers, etc.), where snow and ice can collect during the winter. Roof underlayment is required by Code on the eaves of your roof to prevent ice damming and water back up into the attic.[15]

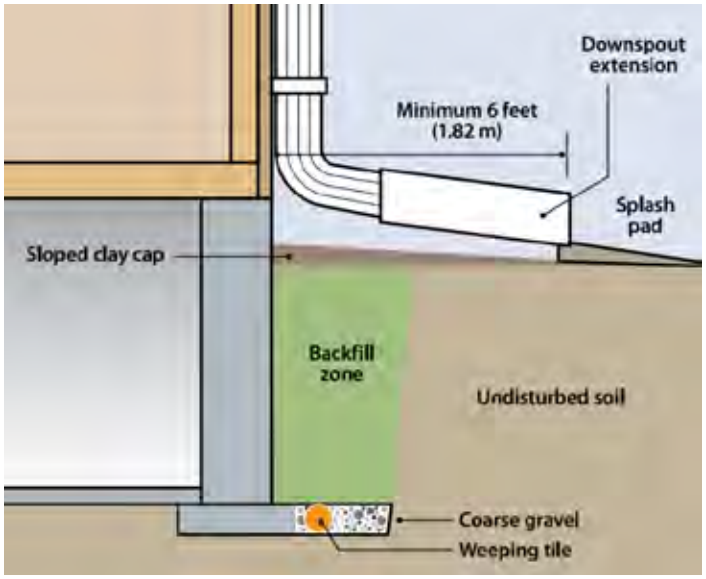
Eavestroughs and downspouts



Eavestroughs are the system of gutters attached to the eave of your roof which collect rainwater that flows off your roof. Downspouts direct rainwater from eavestroughs down from your roof to the ground and away from the house. Eavestroughs and downspouts help protect your home from flooding and water damage and can help keep your building and building components (including the structure) dry; if your home does not currently have them, you should have them installed.

Recommendations for installing and maintaining eavestroughs and downspouts:

- Consider screening your eavestroughs with metal mesh, or another method to reduce debris accumulation.
- Edmonton no longer allows downspouts to be connected to the storm or sanitary sewer system. However, there is an exception to this rule as downspouts may have been connected to the property's sanitary service pipe in older Edmonton homes. In most cases, your eavestroughs should not be connected to the sanitary sewer system. Depending on your neighbourhood and the underground sewer services that are available, your eavestroughs may be allowed to drain to the storm sewer system. Refer to the **Homeowner's Guide to Lot Grading and Drainage** to verify if your downspouts should be disconnected from the sewer.
- Downspouts should discharge water well away from your house, ideally at least two metres away from the foundation. Water from downspouts should discharge to a lower point in the landscape that can absorb the water, such as a rain garden or swale, or onto a splash pad that directs water away from the house and to a permeable surface. The **Community Standards Bylaw** prohibits the discharge of water from eavestroughs and downspouts towards an adjacent premise if it is likely the water will enter that premise.
- Ensure discharged water does not cause issues on your property or for your neighbours.
- Install a rain barrel or rainwater cistern to collect rainwater from your downspout, which can then be used to water your lawn and garden (Section 3.7 provides additional details). Make sure that the rain barrel can safely overflow away from your home and your neighbourhood's homes if you forget to drain it.

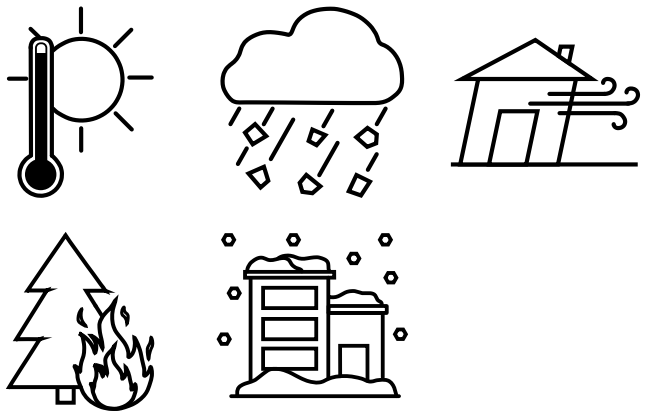


Extend downspouts away from the building to prevent recirculation of roof drainage at the foundation. Source: The City of Calgary

3.3 Exterior Walls and Siding

The exterior walls of your house start at the foundation and extend to the base of your roof. Your exterior wall, and notably your siding (or cladding) material, play a major role in shielding your home from extreme weather and climate hazards, namely wildfires and damaging storms with hail, high winds and heavy rain. The climate resilience measures outlined in this section can help enhance the resilience of your exterior walls and siding to these hazards. The most climate resilient wall system comprises a correctly installed durable and securely fastened sheathing material, a wall air barrier, and a climate resilient siding material.

Siding Materials



If building new, or re-siding your house, there are several siding material options to consider.

Vinyl siding is the most common and least expensive cladding material. However, if you want to improve the resilience of your home, you should consider upgrading to a more resilient and durable material. Aluminum, wood composite, fibre cement and cementitious stucco are all more robust options.

Box 1: R-Values

The R-value is a measure of how well a two-dimensional barrier, such as a wall, window, or ceiling, resists the conductive flow of heat. The higher the R-value of a material, the better it is at insulating; protecting you from extreme heat (and cold) and also reducing your energy bills. The R-value depends on the type of material, its thickness, and density. The National Building Code (Alberta Edition) requires an R-value of 17 for above grade walls for a home's walls as a whole; siding choice typically rates less than a 1 on this scale. As such, your choice of wall assembly and insulation is far more important in protecting from extreme heat (or cold) than is your siding choice, unless siding is specially designed for insulating properties (see Table 2).

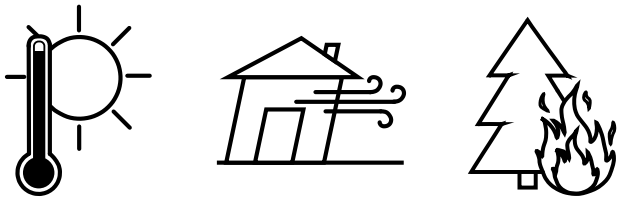
Table 2 provides a description of different siding materials, including potential co-benefits of each material installation, as well as a comparison of their relative cost.

Table 2: Comparative summary of siding materials

Siding Material	Description	Installed Costs[16]
Vinyl siding (standard)	Vinyl siding is the least expensive, and most common siding material in Edmonton. However, vinyl siding is not recommended in climate resilient homes. Since vinyl is made of manufactured plastic, it quickly melts when exposed to the high heat of a wildfire. Cheaper vinyl can also get damaged by extreme heat, can crack with fluctuating weather, and is easily damaged by hail and high winds.	–
Aluminum siding	Aluminum siding is quite resilient and can withstand extreme heat and wildfire. Hailstorms and debris driven by high winds can cause aluminum siding to dent or scratch but will not affect the integrity of your home. Scratched and dented panels can also be easily replaced. Aluminum siding does not crack during freezing and thawing cycles in colder climates. As with vinyl, it is possible to purchase insulated aluminum which has an increased R-value, providing greater protection against extreme heat. Aluminum siding can be environmentally friendly, containing up to 30% recycled content.	+35%
Wood composite	Wood composite siding is a blend of wood fibre and cement that creates an aesthetic material that is resilient to most climate hazards. Wood composite siding can be fairly fire-resistant, but less so than some other materials like fibre cement board, metal and brick. It does offer good impact resistance compared to other sidings like vinyl and aluminum. Also, it handles extreme heat and freezing and thawing cycles without warping or deteriorating.	+45%
Insulated vinyl siding	Insulated vinyl uses a foam board backing to fill what is otherwise gaps behind the material for airflow. This provides some impact resistance against hail and high winds. Insulated vinyl siding can be tested to withstand wind pressures associated with wind speeds of up to 190 kilometres per hour.[17] Insulated vinyl greatly enhances R-value and performance in extreme heat, having an R-value of between 2.0 and 5.0, compared to 0.6 to 1.0 for standard vinyl siding. It is also energy efficient and can help reduce your heating bills in the winter.	+60%
Fibre cement board	Fibre cement board is one of the most resilient siding types for wildfire, hail and high wind. Many fiber cement products carry a Class A fire rating and can withstand several hours of heat before failing. Water that can accumulate from the freezing and thawing cycles can damage the siding if it is not correctly maintained (painting it with water-resilient paint). It has also been proven to stand up to the worst storms without sustaining damage. The R-Value for fiber cement is fairly low (at 0.50) and is considered below average in terms of insulation.	+65%

Siding Material	Description	Installed Costs[16]
Cementitious stucco	Stucco is fire resistant because it is composed of lime, sand and cement, and will hold up well to flying debris in severe wind and hail because it is fairly robust. However, stucco does not handle moisture well, and is not ideal for protection against heavy rain or winter storms; moisture and snow can cause stucco to shrink and crack. Stucco typically has a lower R-value (around 0.2), unless you use a three-coat finish, in which case the R-value can go over 1.0 and provide protection against extreme heat.	+70%
Steel	Galvanized or coated steel siding is an extremely robust material and stands up well to wind, rain, hail, and winter storms. In addition, steel siding is non-combustible; it will not ignite and spread fires. As with vinyl, it is possible to purchase insulated steel siding which has an increased R-value, providing greater protection against extreme heat.	+100%
Natural wood	Natural wood siding, common on older homes, is prone to damage by climate hazards, notably wildfire, high winds and hail. Wood siding can be treated with chemical flame-retardant sprays to improve its fire-resistance, but fire can still penetrate the stud cavity through the joints of the siding assembly. If you want to use wood siding on your home for aesthetic reasons, make sure to use high-quality wood, metal flash corners, and seal the joints well—in addition to using a water-resistant paint.	+160%
Brick	Brick cladding is highly resilient against fire, hail and high winds, assuming the fastening system or mortar is adequate, and not corroded. Brick also provides great protection against extreme heat, effectively cooling your home and reducing your energy bills.	+195%
Stone	Stone siding is resistant to fire and will not damage in high winds. It is susceptible to cracks from freezing and thawing cycles. It is surprisingly not very energy efficient unless insulated; with R-values for natural stone ranging from 0.01 to 0.41, depending on the type of stone.	+455%

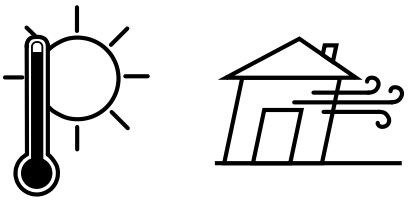
Wall sheathing



Wall sheathing is the panel of material (usually OSB or plywood) that is fastened to the structure to provide a surface for the weather protecting membrane and siding material. Walls that are sheathed completely and properly will provide greater resilience to multiple climate hazards. It will create greater shear strength and

stability in severe wind, as well as providing proper backing for weather barrier membranes on the exterior walls. Fire-rated sheathing can be used to bolster the fire resistance of a wall assembly. Plywood provides increased resilience over OSB due to its improved water resistance and drying ability. Rigid insulation should not be used alone as a wall sheathing as it does not provide adequate lateral load resistance from high winds. In addition, wall sheathing should not be tightly sealed as the glue in a panel material can create a double vapour barrier trapping moisture inside of the wall cavity. Gaps between the panels are essential to permit breathability and allow any trapped moisture to dry out.

Wall air barrier



A wall air barrier is the material (typically felt paper, or polyethylene or polypropylene wrap) that goes on the outside of your wall sheathing, before you put your siding material on. Air barriers are intended to stop air leakage through differences in air pressure between the inside and outside of your home and to allow vapour to permeate through. A reflective wall air barrier can also be used to protect against extreme heat impacts. However, as with roof underlayment, if you want to reduce energy bills all year round, you would be better advised to install more thermal insulation in the exterior walls.

An airtight home lowers heating bills, prevents cold drafts, and can help protect your home against extreme heat. If replacing your exterior siding, consider replacing or repairing the exterior air barrier too. Providing a continuous air barrier, with adequate structural support, will help resist wind and air pressure loads as well.

3.4 Insulation

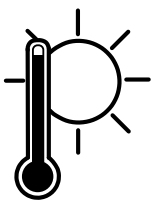
Thermal insulation is material designed to prevent heat transfer from one area to another—like in and out of your home. It can work in several different ways, but typically incorporates materials that consist of millions of tiny pockets of air; air is a very good insulator, and trapped pockets of air are what give most types of insulation their high thermal resistance or R-value (see Box 1, pg. 25). Properly insulating your home reduces both heating and cooling costs

The Building Code requires a permeable (breathable) air barrier on the exterior wall surface beneath the cladding.

and improves comfort. Insulation can also dampen sound transmission and help with noise control.

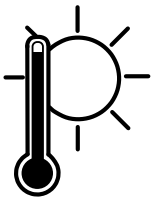
Thermal insulation is usually found in walls (including basement walls) and attics, especially the outside walls of a home where heat is most likely to be gained or lost. When increasing the insulation in your home, you can choose from many types of insulation and materials (see Box 2, pg. 30). The most appropriate insulator will depend on where you want to add insulation and the recommended R-values for Edmonton. You must install at least the minimum levels of thermal insulation according to the 2019 National Building Code (Alberta Edition). But you can and should exceed these values where it is both practical and economical.[18] Adding insulation during a renovation is an ideal time.

Exterior wall insulation



When replacing your siding, installing an additional layer of exterior wall insulation is an option for improving the thermal comfort of your home, and reducing impacts of extreme heat. Exterior insulation is usually mineral stone wool insulation or extruded polystyrene (XPS) insulation. Mineral wool is more effective for fire resistance, and XPS is water resistant, although mineral wool will regain its insulation value once dried out. Rigid insulation should never be used alone for wall sheathing as it does not provide adequate lateral load resistance from high winds.

Interior wall insulation

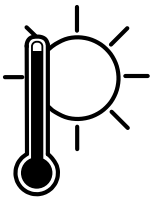


Interior wall insulation (between the studs in the wall) is the typical way most older homes are insulated. This is one of the main building components for maintaining occupant comfort.

You must install at least the minimum levels of thermal insulation according to the 2019 National Building Code (Alberta Edition). But you can and should exceed these values where it is both practical and economical. This can help keep your home comfortable, your energy bills low, and protect against extreme heat.

Mineral wool insulation is the most fire resistant, and spray foam insulation is the most water resistant, although mineral wool will regain its insulation value once it has dried out if affected by water ingress through leaks in your home's envelope. Fibreglass batt or cellulose insulation is less ideal because it can clump together or slump over time, which permanently reduces the insulation value unless replaced. Ideally, in a new build situation, a homeowner should consider an exterior wall insulation option (out-board of the structure) [see exterior insulation]

Roof/attic insulation



Because hot air rises to escape, ensuring roof insulation is effective is one of the most important factors in protecting a home from extreme cold, extreme heat and heavy snowfall. For drywall ceilings that are nailed directly to the joists, cellulose insulation can be installed in the attic. Additional fiberglass batt insulation can be added on top to augment the insulative value. The attic of your roof must be well vented to allow for airflow to dry out any condensation, leakage or other moisture build-up. A badly vented attic can cause major moisture and mould problems as well as a loss in the effectiveness of your insulation.

Foundation wall insulation

If your foundation walls are exposed on the inside, you can increase the energy efficiency of your home by insulating your interior foundation walls.

3.5 Windows and doors

Windows and doors are an integral part of your home's envelope, along with the roof, walls,

Icicles hanging off your roof and gutter could be a sign of poor roof and attic insulation.

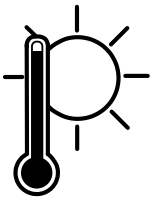
foundations and floors. Doors provide access to the inside of your home and to rooms within your home. They are secured in an opening (the doorway) and held in place by door frames, which

Box 2: Types of Insulation[41]

Type	Material	Where applicable	Advantages	Installed costs[42]
Blanket batts and rolls	Fiberglass Mineral (rock or slag) wool Plastic fibres Natural fibres	Unfinished walls, including foundation walls Floors and ceilings	Do-it-yourself Suited for standard stud and joist spacing that is relatively free from obstructions	$0.50–0.06 per sq ft to increase R-value by 1 unit, depending on facing and material
Foam board and rigid foam	Polystyrene Polyisocyanurate Polyurethane	Unfinished walls, including foundation walls Floors and ceilings Unvented low-slope roofs	High insulating value for relatively little thickness	$0.22–0.29 per sq ft to increase R-value by 1 unit, depending on material
Loose fill and blown-in fill	Cellulose Fibreglass Mineral (rock or slag) wool Natural wool	Enclosed existing wall or open new wall cavities Unfinished attic floors Other hard-to-reach places	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions	$0.04–0.06 per sq ft to increase R-value by 1 unit using blown fibreglass, cellulose or mineral wool Natural wool can cost 3 to 5 times more
Sprayed foam and foamed-in-place	Cementitious Phenolic Polyisocyanurate Polyurethane	Enclosed existing wall Open new wall cavities Unfinished attic floor	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions	$0.15 per sq ft to increase R-value by 1 unit (closed cell polyurethane foam)

can be constructed from a range of materials (Box 3). Windows are openings in the walls of your home that serve several functions, such as providing natural lighting and ventilation and peepholes to the outside world. Doors and windows also play an important role in shielding the interior of your home from the elements, as well as contributing to its overall appearance. They prevent water ingress, provide fresh air during warmer months, help slow down heat loss and reduce solar heat gain, and manage noise. They are important determinants of the energy efficiency of your home. Windows, doors and skylights account for up to 35% of energy loss in your home.[19]

Window types



Old, inefficient windows will allow heat to escape your home in winter. They will also allow the sun;s heat to enter the home in summer, making your air conditioner work harder, or if you do not have one, potentially make your home extremely uncomfortable on hot days. Not only will this drive up your annual energy bills it will also increase your exposure to heat stress and related illnesses in summer. New, energy efficient windows will significantly cut down on heat loss and solar heat gain. The most efficient Energy Star® certified windows are about 40% more efficient than standard windows.[20]

Windows are available in a wide variety of materials, including vinyl, wood, fiberglass, aluminum, steel and wood. Windows made from metal are less energy efficient as they conduct heat more readily. Vinyl and fiberglass frames both have attractive insulating properties—they can be formed with air pockets or interior chambers that can be foam filled to increase efficiency. While they have similar insulating properties, fiberglass units are more durable than

Box 3: Door and window frame components

Door and window frames can be constructed of steel, aluminum, wood or wood composites, plastics (e.g., PVC), or polymer composites (e.g., fiberglass), or combinations of these materials. Wood frames are susceptible to moisture uptake and decay, and the sealant products often used to render metal frame components weathertight degrade with age. Properly constructed frames of any of these materials are expected to last beyond 25 years. Important considerations to ensure the longevity of window and door components are correct selection of performance specifications and proper installation practice.

Polymer-based components of windows and doors, such as the jointing compounds and preformed gaskets used to ensure the weathertightness of the window or door assembly, are more susceptible to degradation from heat and the effects of UV radiation.

Three key properties to look for when purchasing energy efficiency windows are:

The U-factor: this is the rate at which a window conducts non-solar heat flow. The lower the U-factor, the more energy efficient the window. [Range: 0.62–1.98]

The solar heat gain coefficient (SHGC): this is the fraction of solar radiation admitted through a window. The lower the SHGC, the more effective the window is at blocking heat gain from the sun. [Range: 0.01–0.69]

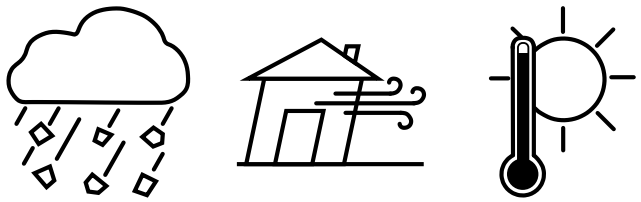
The energy rating (ER): This balances a window's U-Value with its SHGC and airtightness (another energy efficiency property). A higher energy rating indicates a more energy-efficient product.

vinyl alternatives, but cost about 10–20% more.[21] Metal frames typically cost more the vinyl and fiberglass alternatives. Any frame material type or design can include high-efficiency glass and Low-e coatings,[22] though hinged windows (e.g., casements) are more air-tight than sliding windows.

Replacing your older and inefficient windows will not only result in energy savings over time it will also increase the resale value of your home.[23]

Impact resistant (IR) windows

Tempered glass windows are required by Code where the window area exceeds 0.5 metres squared and is less than 900mm from the floor.



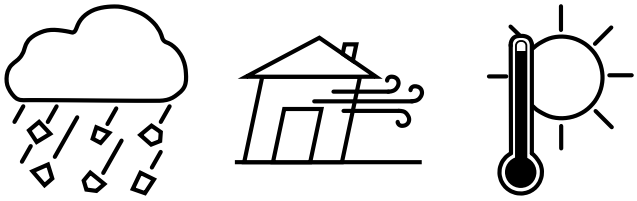
Impact resistant (IR) windows are composed of both tempered glass and laminated glass. Tempered glass is heat-treated which compresses the surface and edges of the glass. This helps to make it about 5–10 times stronger than conventional glass. It is considered impact-resistant, not only because of its added strength, but also because if it does break, it shatters into small pebbles without sharp edges, reducing the risk of injury from flying glass. Laminated glass is made by bonding together two or more panes of glass with a thin layer of film or vinyl in between.

The laminated plastic acts like fly paper, catching broken glass should the window shatter during a wildfire event, high winds or a hailstorm. It is designed so that the outer pane may shatter, but the member holds the pieces together, so the inner plane is not penetrated, preventing rain and water from entering your home.

The strongest glass is only as good as the frame that holds it in place. The window frames holding impact resistant glass are therefore generally thicker than regular residential windows and made from higher-strength materials like aluminum and vinyl. A storm window would be at least 2.75 inches deep with a wall thickness of 0.06 inches or more to withstand strong winds. Not only is the window frame made from sturdier materials it is affixed better to its glass.

Impact resistant windows will cost roughly 2–3 times more than standard windows, though they will help manage solar heat gain, improve the energy efficiency of your home and reduce energy bills.

Window films



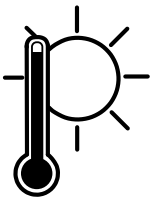
Applied safety film is a very cost-effective solution for window (and door) glass that can help mitigate damage against high winds (and related flying debris) and hail. These films can be applied to your current glass surfaces to make them impact resistant and shatter proof, holding glass fragments in place if the window is damaged. The film should be 4mm thick minimum. Safety film can also help protect against intruders, UV rays and solar heat gain, as well as improve privacy. Films designed primarily to mitigate solar heat gain and UV infiltration are much thinner—a fraction of 1 mm.

Safety films offer a lower-cost solution to IR

windows for the retrofit market; in particular, if your home has large areas of glass that would make other options prohibitively expensive or if you do not want to block views with external yawning or other window attachments. However, they can reduce solar gain in the winter increasing heating costs and may increase the need for lighting.

A professionally installed safety film can cost roughly $10–15 per sq ft of window area.[24] Film to block solar heat gain is a little more expensive at roughly $12–22 per sq ft installed.[25]

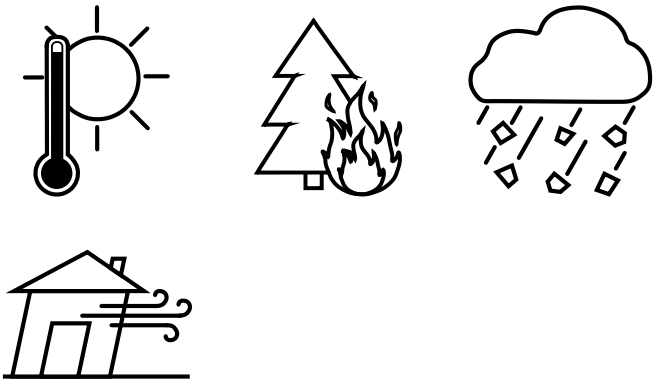
Window coverings and shading technologies



There are a wide variety of shades, screens and blinds on the market to help control solar heat gain in your home. They can be installed inside or outside, on windows, doors, patios, decks, etc. In addition to applied films discussed above, options for the interior of your home include cellular shades, louvered shutters and blinds, roller shades, among others. Cellular or honeycomb shades, which trap air within their core, have excellent thermal properties and provide the added benefit of reducing heat loss in winter months. They also are cost competitive with other internal shading options, with an average cost of about $240 per window.[26]

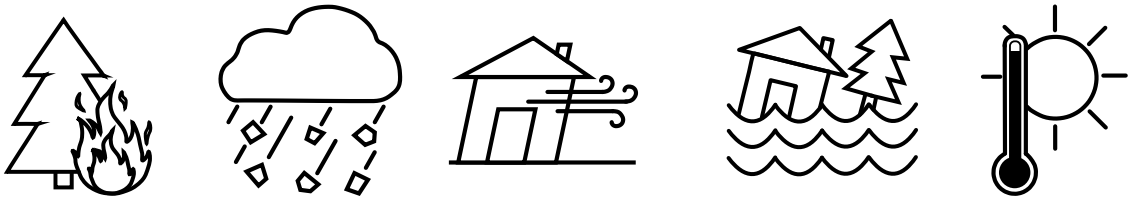
Outside the home you can install roller shades (fabric) or roller shutters (aluminum or plastic slats) to help reduce solar heat gain. The latter provide additional protection against other climate hazards (see below). You can also install either fixed or retractable awnings to manage solar heat gain. An additional benefit of both types of awning is that they direct water away from your home. However, awnings do not reduce heat loss through windows, in contrast to the other options, and thus do not help with home heating bills. Though, retractable awnings can be closed to enable solar gain in colder months. For the same window or door, awnings range considerably in cost, depending on the material (metals costing about 12–15% more), whether it is fixed or retractable (retractable costing about 100–200% more), and whether retraction is manual or motorized (automated retraction increases costs by about 130–300%).[27]

Window shutters



External window shutters are a cost-effective solution for multiple climate hazards. Roll shutters can reflect heat and prevent heat transfer through the windows (this is more effective than interior blinds). In contrast to exterior roller shades, which are typically made of fabric, roller shutters are made of interlocking aluminum or plastic slats that form a rigid protective barrier over the window. As a result, they are also very effective in reducing impacts from wildfire, hail and high winds, preventing the glass from being blown out or debris from hitting and shattering the glass. They also offer a high degree of privacy and security. A roller shutter can cost about $30–70 per sq ft installed.[28]

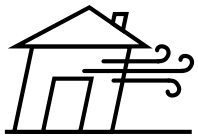
Impact and fire-rated doors



Entry doors and your garage door should be impact doors and fire-rated to protect against wildfire, high winds and hail. These doors are made of materials that have been tested and approved to withstand severe weather. Strengthened door frames and reinforced hinges are used to keep the door in place. Garage doors in particular are often the weakest point on a home in severe wind. For severe wind protection, they can be reinforced and laterally braced on either side, especially if there is living space above. Impact resistant garage doors are naturally heavier. As a result of the extra weight, more often than not you will need to change your springs, track attachments, hinges and rollers.

Impact-rated doors serve to both protect contents, including the door itself, as well as reduce the risk of a "dominant opening" in a high wind or tornado event, that could result in lifting of the roof from the structure.

Install a heavy-duty bolt on double doors



If you have double entry doors, install a heavy-duty bolt or slide bolt at the top and bottom of the inactive door to help them resist strong winds.

Weatherproofing and sealing

Weather proofing your home—making sure it is well-sealed—is an important first step to creating an energy-efficient home. It will make your home cooler in summer and warmer in winter and reduce your energy bills. Gaps between and around windows and doors, where pipes penetrate walls, and between walls and the roof can allow hot air in summer and cold air in winter to infiltrate your home. Drafts are easy to detect; for example, can you see daylight under doors or around window frames, do your windows rattle in their frames during storms, can you feel air moving against your hand, or do your blinds or curtains move when it is windy?[29]

Windows and window frames should also be weatherproofed and sealed to reduce the likelihood of water entry through and around windows.

3.6 Landscaping and yard

Lot grading

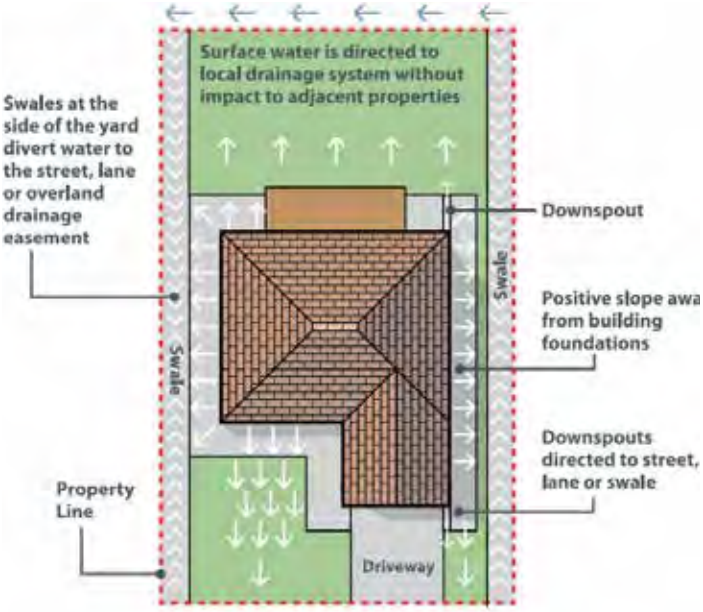
Whether building new, or landscaping your yard, the most effective means of protecting your home from flooding is to ensure your lot drains away from your house. In many older homes, the "backfill zone"— or the part of your yard that directly abuts your building, and that was excavated to build your foundation—may be vulnerable to settling, causing low spots directly beside your building. This is because the soil and fill that was placed back into the excavation after your basement was constructed is

less compact than other soil in your yard. Make sure this area is well graded away from your home.

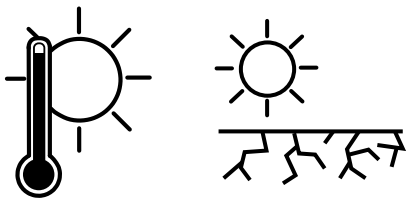
Ideally, in the "backfill zone" of your yard (perhaps within 1.5 or more metres of your home), you should have a 5% slope, and a 1.5% slope beyond that to ensure water drains away from your house.[30] You should ensure that your deck, fence, landscaping and other yard works to not compromise the integrity of your lot grading and drainage.

To learn more about lot grading, check out The Homeowner's Guide to Lot Grading and Drainage in Edmonton.

Bee friendly landscape



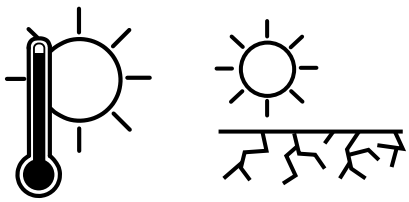
Positive lot drainage. Source: The City of Calgary



Pollinator bees and other insects are being negatively impacted by climate changes, including extreme heat and drought conditions. Provide flowering plants such as milkweed and speedwell that help bees and other pollinator insects thrive.

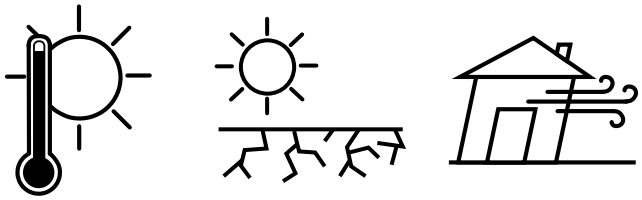
Visit Edmonton & Area Land Trust to learn about pollinators and backyard gardening for pollinators in Edmonton.

Drought tolerant landscape



Plants that are naturally tolerant to drought are used in yards and gardens as they require little to no watering and will come back to life after a rainy day. Trees should be selected for long life and as opportunities to capture and convert carbon.

Climate resilient planting



With a little research and a simple layout, it is possible to produce a landscape that will help cool your home in summer and tame the winter winds. In

general, this means planting deciduous trees on the south, east and west exposures of your house, as they provide shade in the summer and shed leaves in the winter to let sunlight in. Coniferous (evergreen) trees can be planted in a row on the prevailing wind side of your house (south-west), or on the side where there is the least amount of sunshine, to protect against high winds.

When siting trees on your lot, remember to place them to avoid collisions with power lines. Planting trees near the foundation of your house should also be avoided to reduce risk of root intrusion to your foundation and potential basement flooding. If your home is vulnerable to wildfire risk, you should plant trees in accordance with FireSmart guidelines, and ideally not within 10 metres of your home.

Select fire resistant trees and shrubs. Some plants are more resistant to fire, such options will likely have moist, supple leaves and watery, scentless sap. The FireSmart Guide to Landscaping provides a comprehensive list of tree species, including their Hardiness zone, sun/shade preferences and water use requirements. From the Alberta FireSmart Homeowners Manual deciduous (leafy) trees that are resistant to wildfire and include: Poplar; Birch; Aspen; Cottonwood; Maples; Alders; Ash; and Cherry.

Evergreen trees with cones and needles (conifer trees) are highly flammable and should not be within 10 metres of your home. This includes: Spruce; Fir; Pine; and Cedar.

For more information about climatically suitable tree species in Alberta see the Guide to Urban Forest Management in a Changing Climate.

Decks and balconies

Many decks are built out of combustible materials such as wood and plastic. If your home is vulnerable to wildfire risk, your deck should ideally be built out of non-combustible material. Enclose the underside of all balconies and decks with flame resistant material such as fibre cement board.

3.7 Drainage and water management

Sump pump(s)

Some homes have a collection basin or pit called a "sump" in the floor of the lowest part of a basement floor. The purpose of a sump pump is to discharge water from the foundation drainage system (or weeping tiles) when it is not possible to drain your foundation drainage system directly into a municipal sewer.[31] If your home does not have a sump pump, and you do not have moisture issues in your basement, it is unlikely you need one. If you have a sump pump, consider the following:

- Get a sense of how frequently it cycles. If it cycles frequently (e.g., daily or more frequently), you may be at high risk of flooding from pump failure, and you should consider installing a separate backup pump which triggers if the primary pump fails.
- All sump pumps should have a backup power supply installed. Do not use potable-water

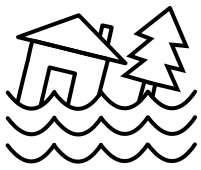
powered backup pumps. Instead, use a backup generator or battery backup system.

- Make sure a check valve is installed on the discharge pipe to prevent recycling of pumped water.
- Discharged water should clear the backfill zone of your foundation. If not, you may be recycling pumped water.
- Install a moisture alarm in the sump that detects water level rising to a critical level. Some types of alarms will alert smartphones. The alarm should also be set to trigger when the primary pump fails to engage.
- Ensure the sump lid has an airtight seal to prevent the ingress of Radon gas.
- Inspect and maintain your sump pump to ensure it is properly draining. You can do this by pouring water into the sump pit and seeing whether or not the pump starts automatically.
- Replace your pump at least every 10 years.

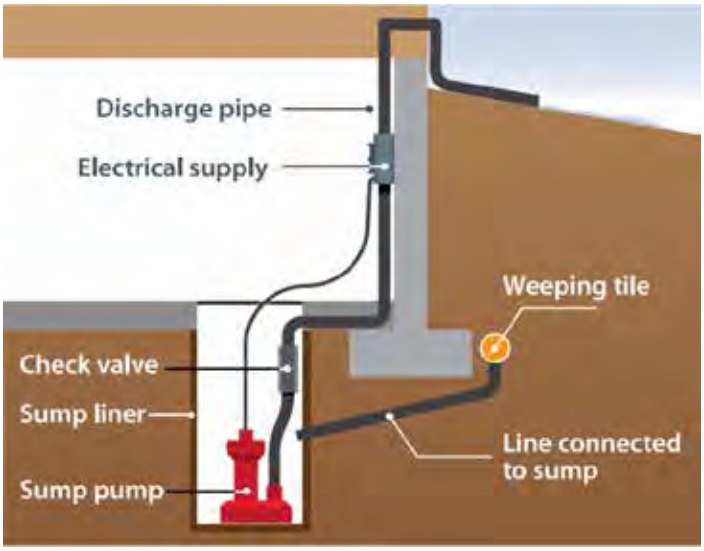
EPCOR has more information about **basement flooding, including sump pump tips**.

View the **Change for Climate Lunchtime series** webinar, Flood Prevention at Home for more tips.

Sewer back-up valve



In the event of a flood, the municipal sewer system will be at capacity, and could cause a reversal of flow of water and sewage through the underground pipes that connect your home to the municipal sewer systems. This is called a "sewer backup".[32] A sewer back up valve (or backwater valve) can be installed in your main sewer line or branch lines of other below grade fixtures. The valve closes when the main sewage line is full and can help stop sewage



Weeping tile with sump pump. Source: The City of Edmonton, adapted by The City of Calgary

and floodwater from backing up into your home. It is important to make sure that your foundation drains do not drain into the same pipe that you place your backwater valve in. This could result in "self flooding".[33]

A backwater valve can help with two types of flooding. One type is "urban flooding"—this occurs when isolated, very heavy rainfall events overwhelm city sewer systems, causing sewage to backup into homes. These types of events may be wide-spread and can occur outside of "river floodplain" areas. In most cases, this is the only scenario where backwater valves will be useful.

Backwater valves may also help mitigate risk from river flooding, in some instances. It is important to note that backwater valves will not protect your home from "infiltration" or "seepage" flooding—where floodwaters migrate through soils and enter your home through cracks in the foundation wall and basement floors.

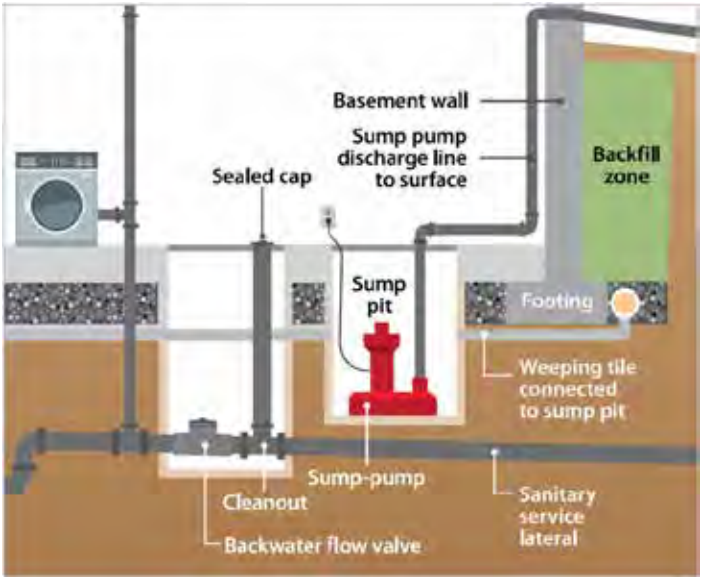
If you do not have a backwater valve installed in your home, check with the City's Planning & Development Department on whether you require one. If you live in the area covered by the North Saskatchewan River Valley Area Redevelopment

Plan, Cloverdale, Riverdale or Rossdale, specific floodplain regulations may apply. Be sure to check for any development and building regulations that may apply.[34, 35]

A plumbing permit is required to install a sewer back up valve. For proper installation of sewer back up valves, the grade of the valve is critical. The valve should be graded down toward the municipal sewer (at least 2% grade, but more is better); otherwise debris could build up, significantly affecting performance of the valve.

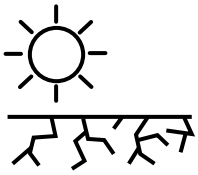
If you have a sewer back up valve installed in your home, ensure it is properly serviced and maintained by a licensed plumber or contractor.

EPCOR offers free Flood Prevention Home Check-ups and a subsidy for Backwater Valves.



Backwater valve and sump pump. Source: The City of Calgary

Rain barrels and cisterns

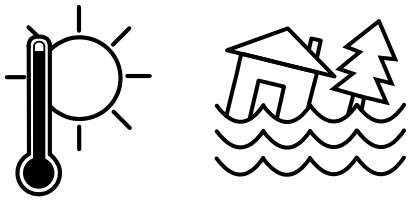


Rain barrels collect rainwater from a home's downspout or other run-off, which can then be used to water gardens. Choosing to use rainwater for landscaping and gardening reduces demands on potable water supplies. Rain barrels should be emptied before winter to avoid cracking and damage to the barrel or waterspout. Rainwater cisterns are a larger version of a rain barrel, collecting rainwater for use on the property. Common to rural properties, rainwater cisterns are a way of reducing freshwater use and the stored water can be used in the event of a water supply disruption. Make sure that the rain barrel can safely overflow away from your home and your neighbourhood's homes.

Visit the City website to learn more about the water savings of a rain barrel and EPCOR's website to learn about setting up and maintaining your rain barrel.

Collected rainwater is not potable, which means you should not drink it. While there is a low risk of contaminating food crops from water collected in rain barrels, be sure to water directly into the soil and avoid contact with stems, leaves, fruit and flowers of edible plants.

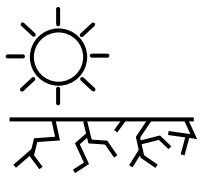
Permeable pavement



Permeable pavement, similar to pervious or porous paving, is a type of hard surfacing that allows rainfall to percolate around or through the material, rather than standard asphalt and concrete which are considered to be "impermeable". Conventional permeable pavements include porous asphalt pavements, pervious concrete pavements, pervious cast concrete pavement, and permeable interlocking concrete pavements. Non-conventional options include vegetated permeable pavements, that use plastic, metal, or concrete lattices for support and allow grass or other vegetation to grow in the interstices. Whether building new, or re-doing your driveway or sidewalks, permeable pavement can be used instead of standard asphalt or concrete.

Permeable pavements reduce stormwater run-off and help prevent water from ponding on your property. In doing so they filter and remove pollutants, lower runoff water temperatures, and thereby improve water quality. They also promote evaporative cooling which reduces pavement temperatures and consequently the air temperature.

Low water use appliances and fixtures



Low water use fixtures are designed to use less water while maintaining the same level of performance. Install low flow water showerheads and faucets in your home and replace your toilet with a low water use toilet when it is time for replacement.

Visit **EPCOR** for information and tips on conserving water.

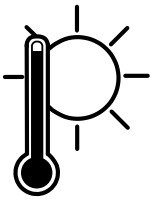
If you live in a flood area identified within the **Edmonton Land Use Bylaw section 812**, the Flood Protection Overlay regulations apply. The Overlay regulates building Height, the location and geodetic elevation of openings into buildings, the Use in portions of buildings, the design Grade of the Site, and Landscaping, to mitigate the potential negative effects of a flood event.

3.8 Heating, ventilation and cooling

Heating, cooling and ventilations (HVAC) systems move air between indoor and outdoor areas, and heat and cool your home. They keep you warm and cozy in the winter and feeling cool and fresh in the summer. They also filter and clean indoor air to keep you healthy and maintain humidity at comfortable levels. The most visible components of your home HVAC system include the furnace, vents and thermostat.

NOTE: The City of Edmonton website has detailed information about **permit requirements** for heating, cooling and ventilation systems.

Air conditioning



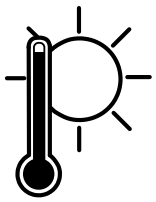
There are three main types of air conditioning to choose from[36]:

1. Central air conditioning generates cool air from a central unit and distributes that air to the entire house through the ductwork. This is the most expensive option and may only be a practical and economical option for new builds. A central unit could set you back $3,500 to $10,900 for a 185 square metres (2,000 square foot) home depending on if the necessary ductwork is already installed.
2. Window units that pull air in from the outside, cool it, and push it indoors. These units sit on the windowsill. This is the least expensive option. But they only cool one room. Prices for window units vary depending on the size of the room you want to cool and thus the size of the unit. For example, you will need to spend about $400 to $600 to cool a 35 square metre room, and $150 to $250 to cool a 15 square metre room.
3. Split (or ductless) air conditioning units are installed on the side of the home, half inside and half outside. Split units work like window units but can cool multiple rooms. This is the mid-range cost option. Depending on the size of the unit and how easy the install is, a split unit can cost between $2,800 and $4,400.

Air conditioning (and heating) needs can also be met with the use of a heat pump, which is more efficient than a standard air conditioning unit. A heat pump is an electrical device that extracts heat from one place and transfers it to another. A heat pump can provide year-round climate control for your home—heating in winter and cooling and dehumidifying in summer. An air-source heat pump absorbs heat from the outdoor air in winter and rejects heat into outdoor air in summer. It is the most common type of heat pump Canada, however ground-source (or geothermal) heat pumps, which draw heat from the ground or ground water, are becoming more widely used.[37]

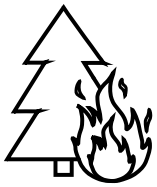
Ground source heat pumps (also referred to as geothermal systems) can be used in more extreme climates without the need for a back-up heat source. They are extremely energy efficient but can cost between $20,000 to $30,000 to install, due to the underground infrastructure requirements.[38] Air-source heat pumps on the other hand are significantly more economical but have limitations on heating in cold climates.[39]

Fans



Ceiling fans or free-standing portable units use a fraction of the electricity that air conditioning units would use and still provide occupant comfort.

Indoor air purifier



If building new, or replacing your HVAC system, consider incorporating an air purifier into your central air system. Alternatively, you can purchase a free-standing portable unit. An air purifier is a device that purifies the air of particulates or gases.[40]

4. RESILIENCE OPPORTUNITIES FOR NEW CONSTRUCTION

This section outlines opportunities to improve the resilience of your home during new construction. It includes planning, design and construction considerations for enhancing resilience to the climate hazards identified in Section 2 – extreme heat, wildfire, heavy rain and flooding, damaging storms, winter storms, and drought.

4.1 Extreme heat

To protect your home from extreme heat, consider incorporating the following into your planning and design[43]:

- Provide shading overhangs for all south-facing windows, as well as for east and west facing windows.
- Operable windows should be placed on opposite sides of the building, and/or at different heights, and in each habitable room, to allow for natural ventilation.
- Incorporate glazing on windows to reduce solar heat gain.
- Maintain as many trees and as much natural vegetation cover on your lot as possible, before construction.
- Plant deciduous trees on the south, west and east side of the house to provide shading. If possible, maintaining existing trees is preferred as newly planted trees take time to establish before they provide shading.
- Choose solar reflective landscaping and hardscaping materials (driveways, sidewalks, etc.) which can be light-coloured, high albedo, or vegetation cover.
- Choose a compact building shape and open floor plan to improve energy performance and promote cross ventilation (passive cooling).

4.2 Wildfire

To help protect your home from wildfire, particularly if you are building in an area that is in close proximity to dense, continuous forests or unmanaged grasslands, implement FireSmart measures[44]:

- Choose fire resistant roof and exterior wall materials. A Class A fire-rated roof cover offers the best protection, and can be made of metal, asphalt, clay or rubber. For siding, stucco, metal, brick, and fibre cement offer the best fire resistance.[45]
- Ground to siding clearance should be a minimum of 15 centimetres.
- Install non-combustible material for all vents. Vents should also be fitted with a screen or filter to prevent sparks and embers from entering your attic (maximum 3 mm mesh aperture).
- Soffits and fascia should be fitted on your eaves to reduce the risk of embers and heat reaching the wooden rafters of your home.
- Tempered, thermal (double paned) windows are recommended. Single pane windows provide little resistance to wildfire impacts.
- All doors, including garage doors, should be fire rated and have a good seal.
- Enclose the underside of decks and balconies to prevent the collection of flammable materials, and sheath with fire resistant materials.
- Sheds and outbuildings within 10 metres of your home should be treated the same as your home—apply the points above.
- Wooden fences create a direct path for fire to your home and should be separated with a metal gate or section next to your house.
- Plant fire-resistant trees and shrubs, which are those that have moist, supple leaves, accumulate minimal dead vegetation, have water-like sap, and have a low amount of sap or resin material.

- Liquified petroleum gas (LPG) tanks on the exterior of your home should be on a non-combustible surface extending 1.5 m outward in all directions, 3 m zone where all vegetation is trimmed, clearances between LPG tank and building.

4.3 Heavy Rain and Flooding

The following is a summary of climate resilience measures that can help protect your home from heavy rain and flooding[46]:

- Appropriate site grading and drainage is the primary means of protecting your home from heavy rains and flooding. The minimum elevation of the lot, at the house, should be 450 mm above highest elevation at the property line.
- The top of foundation walls should be well above grade, a minimum of 200 mm.
- Foundation drainage and moisture protection approaches should be applied to manage groundwater that cannot be directed away from the building through site grading and drainage approaches. Most commonly, this involves installing weeping tile around the perimeter of the foundation wall footing and covering it with granular material prior to backfilling.
- Backfill around foundation walls should be capped with an impermeable surface and have a minimum 5% slope away from your house.
- Reverse slope driveways, that drain towards the house, should be avoided.
- Lower-than-grade windows and doors should be avoided.
- All utilities and services (such as electrical boxes/panel, furnaces, hot-water heaters and major appliances) should be raised above the basement floor as high as possible, and ideally should be located on the main floor.
- Utility penetrations should be located well above ground level to prevent water seepage into the building

If you live in the area covered by the North Saskatchewan River Valley Area Redevelopment Plan, Cloverdale, Riverdale or Rossdale, additional development and building regulations apply.[47]

The overlay regulates building height, the location and geodetic elevation of openings into buildings; the use in portions of buildings, the design grade of the site, and landscaping, to mitigate the potential negative effects of a flood event.

NOTE: *"Overlay" is a term used by planners that refers to a special set of regulations applied to a property, in addition to the standard regulations of a land use zone.*

Other recommendations provided by the City for new developments which can be affected by high groundwater levels include:

- Below-grade spaces should not be utilized for the storage of immovable or hazardous materials that are flammable, explosive or toxic.
- Below-grade spaces should not be developed, should be finished using flood-proof and easily cleanable materials, and may only contain easily movable items.
- A sump pump with battery backup should be provided in the basement.
- A separate electrical circuit should be provided for the sump pump with the operating switch located above the designated flood level.
- Installation of backflow prevention valve (s) on sewer lines or the elimination of gravity flow basement drains.
- Building design must prevent structural damage from elevated groundwater levels (i.e., to grade). Elevated groundwater levels during a river flood may impact foundation de-watering, foundation waterproofing and structural design.

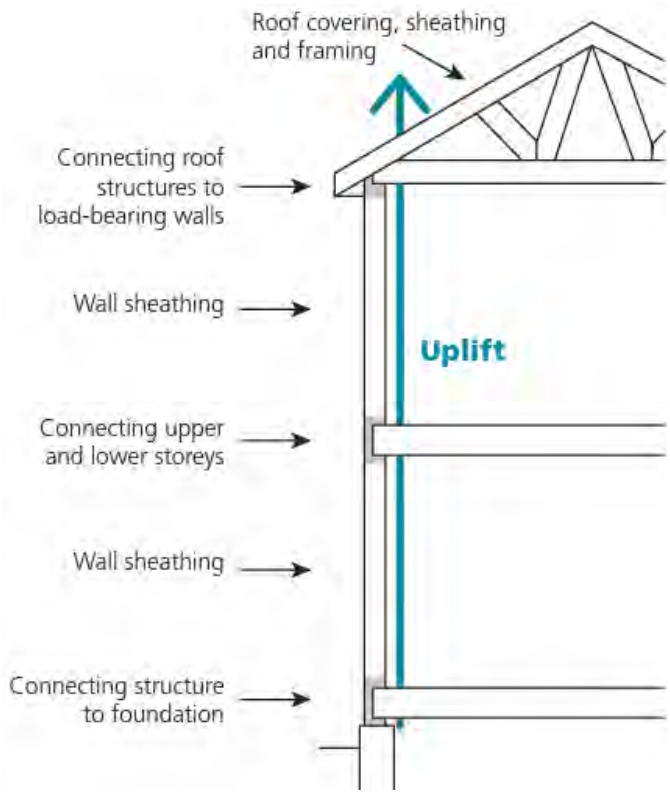
Alberta Municipal Affairs and the Safety Codes Council, via the Alberta Building Code STANDATA, provide additional information on flood mitigation measures for homes being (re)built in flood fringe areas. Examples include "high and dry" measures that involve elevating the home above the predicted flood level, and "wet-flood mitigation" measures which are based on the assumption that water will enter the building, and the goal is to minimize moisture damage and allow for rapid restoration of materials and equipment.[48] For additional information, explore EPCOR's flood prevention programs.

4.4 Damaging Storms

4.4.1 High wind

Roofs are particularly exposed to damage from high winds. To protect your home from high winds, consider the following[49]:

- Simple roof designs, such as a hip roof, are less susceptible to wind damage than more complex roof structures and gable end roofs. In general, roofs that are built using prefabricated, engineered trusses are considered to be more resistant to high wind impacts. The fewer obstructions you have on your roof, such as chimneys, skylights or dormers, the better.
- The steeper the slope of your roof, the more indirect the angle of impact, and the less likely you will experience high wind damage.
- Ensure your home has a secure "continuous vertical load path". A continuous vertical load path requires that major structural systems—including roofs, walls and upper and lower stories—are well connected, and that the entire structure is securely connected to the foundation. Ensuring that the building is securely fastened to the foundation using anchor bolts will also contribute to the continuous vertical load path of the home.
- Roofs that overhang exterior porches are prone to damage during high wind events. To protect porch overhangs from high winds, ensure supporting posts are well connected to the foundation, install additional support posts, and ensure connections at both the tops and bottoms of posts are well connected.



Elements in a continuous vertical load path.
Source: Increasing High Wind Safety for Canadian Homes, Figure A

- When selecting roofing materials, choose more wind resistant materials (see Table 1) and look for, or ask your contractor about, products that meet high wind resistance standards.[50] Most importantly, make sure that your roof cover is installed properly. This would include ensuring installation during the warm months of the year.
- Choose impact resistant skylights, windows and doors.

NOTE: The City of Edmonton website has detailed information permit requirements for uncovered decks and balconies.

- Roof and wall sheathing can be pulled off during high wind events, resulting in water intrusion and additional damage. Choose thicker sheathing materials (e.g., 12.7mm or ½"), combined with longer nails that are spaced closer together along both the edges of the sheathing panel and along the interior supports.
- Garage doors rated for high winds can reduce the risk of garage door failure. Additionally, securing the continuous load path from the garage roof to the foundation will help reduce the risk of garage roof failure should a door fail during a storm.
- High winds can expose vents to high air pressure and may cause them to peel away. Use durable vents rated for high winds.
- Ensure your wall air barrier is continuous and properly installed. Gaps in the wall air barrier can increase air pressure loads.

4.4.2 Hail

To protect your home from hail[51]:

- The steeper the slope of your roof, the more indirect the angle of impact, and the less likely you will experience hail damage.
- When selecting roofing materials, choose more hail resistant materials (see Table 1) and look for, or ask your contractor about, products that meet hail and impact resistance standards.[52]
- Choose a siding material that is more resilient to hail, such as steel, fibre cement, Cementitious stucco, or brick (see Table 2).
- Roof underlayment should be installed over the entire roof deck prior to installation of the roof cover, and a self-adhering waterproofing underlayment (ice-and-water shield) should be installed.
- Choose impact resistant skylights, windows and doors.
- Incorporate vehicle covers in your design—either a garage, carport or other covered parking space, to protect your vehicle from hail.

4.5 Winter Storms

To protect your home from winter storms[53]:

- Simple roof designs, such as a hip roof, are less susceptible to winter storm damage than more complex roof structures and gable end roofs. The fewer obstructions you have on your roof, such as chimneys, skylights or dormers, the fewer places for snow and ice to build up and cause ice damming.
- The steeper the slope of your roof, the more indirect the angle of impact, and the less likely you will experience damage caused by excessive rain and snow. Steep roofs are more resilient to heavy snow-fall damage such as roof collapse, ice damming and roof leaks.
- Choose water and moisture resistant roof and exterior wall materials (see Table 1 and Table 2).
- Roof underlayment should be installed over the entire roof deck prior to installation of the roof cover, and a self-adhering waterproofing underlayment (ice-and-water shield) should be installed.
- Insulate your attic [beyond the Code requirement?] to prevent snowmelt, ice damming and roof damage.
- Winter storms can lead to power outages. To protect your home from power outages, incorporate a back-up power supply into your home design.

4.6 Drought

- Incorporate xeriscaping into the design of your home, and plant drought tolerant trees, shrubs and grasses.
- Install an efficient lawn irrigation system. Irrigating a landscape is a method of providing water to plants that they need to survive drought conditions and thrive.[54]
- Select water efficient fixtures and appliances.
- Plan your yard with tips from Front Yards in Bloom, Veg Instead! and Calgary's YardSmart.
- Incorporate a rainwater collection system (rain barrel or cistern) into your design.
- Use tiered gardens, rock gardens, low water-use shrubs or flowering trees and groundcover instead of grass lawn. These garden features use less water and act as wonderful filters and sponges to help absorb rainwater.
- Rainwater should be retained on site, through incorporation of permeable surfaces and water retention systems, to reduce surface runoff to the stormwater system and drying out of your lawn and garden.
- Rain gardens are a great landscaping feature that can be placed in a low-lying area of your garden. Rain gardens are shallow depressions filled with loose soil and planted with beautiful, hardly low-maintenance water-wise plants. The rain garden will naturally filter the runoff before it enters the stormwater system.

To learn more about rain gardens visit EPCOR's website.

5. HOME AND PROPERTY MAINTENANCE AND RESILIENCE TIPS

Your home requires ongoing care and maintenance to ensure the safety of all who live there and to safeguard the financial value of your asset. There are many changes you can make to how you run and maintain your home that can make it more resilient to climate hazards. This section gives you some tips to help keep your home in tip top shape.

5.1 Emergency preparedness

Ensure you and your home are prepared for emergencies:

- Have an emergency preparedness kit: An emergency preparedness kit gives a household the security of having certain items to help them in a disaster. This kit can include an array of items. Some important items are a radio, batteries, flashlight, first aid kit, non-perishable food and drinking water.
- Ensure you are signed up to receive emergency alerts and notifications.
- Consider having a back-up battery power source. A back-up battery power source can prevent problems when the power goes out, which could be caused by extreme heat, wildfires, flooding, hail/ice storms, high winds or winter storms. A battery-type source of power could be charged using solar PV panels (climate resilience measure listed below), which would be an environmentally sustainable addition to a home and can be used to charge your phone or other devices. Learn more about using solar power in Edmonton. ***NOTE:*** *solar PV is primarily grid-connected in Edmonton.*

5.2 Annual Maintenance Check

You should inspect the exterior of your home annually, and also after a wind, hail or snowstorm.

Look for:

- Broken or dead tree branches that may pose a safety hazard. Contract a certified arborist to prune.
- Broken, cracked or torn roofing materials that could cause water penetration or blow off in the next windstorm.
- Missing shingles or exposed roof deck that could allow water ingress.
- Check for signs of moisture and water pooling in your basement/crawl space, on your roof, and in your yard that could leak into your home.
- Check for water pooling near foundation walls, including in window wells and stairwells.
- Icicles hanging from your gutters (eavestroughs) in the winter. An indication that you have poor insulation in your attic (Section 3.4) or that your gutters are blocked with debris.
- Signs of ice damming or heavy snow load on your roof, such as water leaks originating from the roof or attic area, difficult to open doors, new cracks in your drywall or plaster, or sagging on the ridgeline of your roof.[55] Icicles hanging from the bottom edge of your roof are an indication that you may be vulnerable to ice damming.
- Ensure vents are not blocked by debris. Dryer vents and interior flexible ducts should be checked for lint build-up.

5.3 Spring Maintenance Check

In preparation for the spring and snow melt and rain and to protect your home against basement flooding:

- Seal cracks in foundation walls and basement floors to help reduce basement flooding in your home. In many cases, cracks can be effectively sealed from the inside, for example with hydraulic cement.

- Identify and seal other points of entry for moisture such as framing around windows and doors, gaps around pipes and wiring and cracks in brickwork.
- Ensure storm grates and drains near your home are clear of debris and blockage. In a flood or heavy rain event, if the storm grate near the house is blocked, it could cause additional and unnecessary flooding to your property.
- Clean your roof, gutters (eavestroughs) and downspouts by removing needles, leaves and debris to reduce wildfire risk, and ice damming from heavy snow or freezing rain.
- Trim back any trees or vegetation overhanging your roof.

To protect your home against basement flooding:

- Direct stormwater away from your house, ideally towards your garden.
- Have your exterior sewer lines checked. If it is more than 30 years old, you should have it inspected by a licensed plumber to verify that it is in good condition.
- If you have a sump pump, ensure it is properly draining by pouring water into the sump pit and seeing whether or not the pump starts automatically.
- Make sure battery backup systems are operating properly.
- Make sure your backwater valve is maintained.
- Contact EPCOR for a **flood prevention inspection**.

5.4 Summer Maintenance Check

If your home is located near a forest or unmanaged grasslands, become familiar with FireSmart principles.

- FireSmart your landscaping and property, and view the **FireSmart Guide to Landscaping** for more information.
    - Zone 1A (1.5 m): Non-combustible zone—remove any potentially combustible materials, including mulch, furniture, plants, etc.
    - Within 10 metres of your home, you should have no combustible materials.
    - Within 10–30 metres, thin and prune evergreen trees and regularly clean up fallen branches, dry grasses and needles.
    - Beyond 30 metres, look for opportunities to create a fire break by thinning and pruning trees.
- To help protect against wildfire, lawns should be well maintained, mowed and watered. Grasses shorter than 10 centimetres in height are less likely to burn intensely.
- Vents should be fitted with a screen or filter to prevent wildfire sparks and embers from entering your attic.
- Conserve water and protect your home against drought conditions:
    - Water early in the morning before the heat of the day.
    - Use a soaker hose, drip irrigation or water by hand, rather than sprinkling.
    - Do not mow your lawn too short. Keep it 2 or 3 inches high to shade the soil.
    - Add mulch around trees and shrubs to retain moisture.
        - Be FireSmart and choose non-combustible mulches (see pg. 7)
    - Capture water in a rain barrel or cistern and use it for your garden.
    - Sweep your sidewalk and driveway rather than washing with --and wasting-- water.
- To protect against extreme heat, install interior cellular insulating blinds on your windows; a cost-effective way to reduce heat gain and loss in your home.

- Securely anchor outdoor accessories and equipment to protect against high winds and summer storms.
- If you do not have a garage or covered space for your vehicle, or recreation equipment (boat, camper, ATV, etc.), consider installing a semi-permanent hail protection structure, or a temporary hail protection cover (e.g., hail protection blanket).
- Purchase a portable air purifier: A portable air purifier removes toxins, pollen, dust and wildfire smoke from the air to ensure healthy indoor air quality.

5.5 Fall Maintenance Check

In the fall, you should be preparing your home and property for the winter:

- If you have a wood burning fireplace, ensure your chimney is clean, and has a spark arrestor to prevent embers from floating out of the chimney and igniting the roof or any other nearby flammable material.
- Install a smart thermostat. A smart thermostat that provides information to your smartphone is an excellent way to check on your home when you are away and also receive information on potential hazards. For example, many smart thermostats provide information on indoor humidity that can alert you to high risk of water leaks or flooding within the home. They may even provide alerts for low or high temperatures that can provide warning of pipes freezing or fire hazards when you are not home.
- Incandescent light fixtures in the ceiling below your attic can often generate enough heat to melt snow on a roof. These fixtures should be replaced with more efficient low heat emitting fixtures such as LED.
- Clean and properly disconnect your rain barrel to prevent it from leaking or freezing and cracking.
- Turn off your outdoor water supply and controller and ensure lines and low spots are empty of water.

5.6 Winter Maintenance Check

In the wintertime, you should be most concerned about winter storms and cold temperatures.

- If you notice ice damming on your roof, you can treat it with a chemical de-icer by making holes in the ice to expose the roof and placing de-icer in each hole.
- If you have persistent issues with ice build-up and damming on your roof, you can install de-icing cables on your roof and gutters. De-icing cables give off heat to melt snow and ice on your roof.
- A very large snowfall may put your roof at risk of structural failure or collapse. A simple way to prevent this is by using a snow rake to remove excess snow from the roof by dragging it off the edge to the ground.
- Winter storms can produce extremely heavy snow and slippery conditions. Snow shoveling is a known trigger for heart attacks. Be cautious not to over-exert yourself; a high-quality shovel can assist in moving snow in a safer way.
- In the case of a power outage, if water is no longer coming into your home, turn off the main water valve coming into your home. Open all taps to clear the remaining water in the pipes to avoid pipe freezing.
- Explore inside your attic for any penetrations that could leak warm air into the attic. Also check to see that there are no big gaps in the insulation, to reduce winter storm and extreme heat impacts.

Endnotes

1 Source: IBC 2020 Facts of the Property and Casualty Insurance Industry in Canada, Insurance Bureau of Canada

2 For more information on urban heat island effects see: Health Canada (2020) Reducing Urban Heat Islands to Protect Health in Canada.

3 For more information on protecting your home from wildfire see the Alberta FireSmart Homeowner's Manual

4 EPCOR has more information about the City's stormwater management facilities, information about flooding and prevention in Edmonton, and helpful tips for during and after flooding events.

5 You can use Province of Alberta's flood map to check if your property is in the floodway, flood fringe, or overland flow zone. If so, specific land use regulations will apply. For more information on official and recommended flood elevations, and the development and building regulations that apply in each designated flood zone, refer to Edmonton's Land Use Bylaw, Section 812 Floodplain Protection Overlay (FPO), or contact The City's Planning Department (or call 311).

6 The **floodway** refers to the area of the river where velocities and depths will equal or exceed 1 m/s and/or 1m depth during a 1:100 flood event. This is the area where the greatest amount of flow is concentrated during a flood and the flow is considered the most erosive and damaging. The **flood fringe** is the section of river where the flood waters are below 1m depth and 1m/s velocity during a 1:100 flood event. **Overland flow zones** are areas which become inundated by shallow overland floodwater during a 1:100 flood event. Groundwater becomes an issue for below-grade structures such as basements and parkades, during flood events as low as a 1:5 flood.

7 A list of flood-damage-resistant building materials is provided in STANDATA Building Code Bulletin 06-BCB-009R1, Disaster Recovery Program Flood Mitigation Measures.

8 Permeable materials or surfaces allow water to readily move through and percolate into the soil. Examples of permeable surfaces include individual unit paving blocks or cobble stones and specialty mixes of both concrete and asphalt with high porosity.

9 One study by Brimelow et al (2017) finds that the frequency of small hail events will decrease in our region in summer, but that the frequency of large hail events will increase, resulting in an overall increase in hail damage potential.

10 Source: Institute for Catastrophic Loss Reduction (2018). Hail Climatology for Canada: An Update

11 Source: Cheng, C.S., et al., 2014, Possible impacts of climate change on wind gusts under downscaled future climate conditions—updated for Canada. Journal of Climate, 27: 1255-1270.

12 The measures outlined in this section are based on best available standards and guidelines. For more detailed information see the following resources:

- CSA Z800-18: Guideline on basement flood protection and risk reduction
- CSA S478-19, Standard for the Durability of Buildings
- The Designed for Safer Living program, and home protection booklets produced by the Institute for Catastrophic Loss Reduction

- Primers, and information from the Mobilizing Building Adaptation and Resilience project
- Publications from the US Federal Emergency Management Agency (FEMA) focused on home and building safety and resilience to high winds, flooding, and snow storms
- Increasing High Wind Safety for Canadian Homes: A Foundational Document for Low-Rise Residential and Small Buildings
- Durham Region Climate Resilience Standard for New Houses (2018)

13 Note: "Installed costs" are for professional installation including all materials and are presented as the percentage difference in the total installed costs of each roofing material relative to the total installed costs of standard (Class A) asphalt shingles (on a square foot basis). For example, the total installed cost of an architectural shingle is about 25% more than a standard (Class A) asphalt shingle per square foot; a Class 4 impact resistant shingle is about 45% more per square foot. Total installed costs include material costs, labour costs, equipment costs where relevant, and overhead and profit for the installation contractor. For each material, a cost range was generated from RSMeans 2020 for Edmonton; the values in the table are based on the mid-points of those ranges.

14 For more information about green roofs in Edmonton check out this factsheet.

15 For more information on roof underlayment and options, see: https://disastersafety.org/11149509-2

16 Note: "Installed costs" are for professional installation including all materials and are presented as the percentage difference in the total installed costs of each siding material relative to the total installed costs of standard vinyl siding (on a square foot basis). For example, the total installed cost of aluminum siding is about 35% more than standard vinyl siding per square foot; wood composite siding about 45% more per square foot. Total installed costs include material costs, labour costs, equipment costs where relevant, and overhead and profit for the installation contractor. For each siding material, a cost range was generated from RSMeans 2020 for Edmonton; the values in the table are based on the mid-points of those ranges.

17 See FEMA Recovery Advisory: Best Practices for Minimizing Wind and Water Infiltration Damage, June2019

18 The Wood Council of Canada provides an online tool to calculate the R-value of different wall assemblies for comparison with energy efficiency provisions in national and provincial building codes.

19 Source: Natural Resources Canada web page: Windows, doors and skylights.

20 Natural Resources Canada provides a tool to help you find Energy Star certified products, including windows.

21 RSMeans 2020 Residential Cost Data.

22 A fine metal coating on the glazing which can reduce heat loss and solar gain by as much as 30%.

23 A study in Edmonton found the presence of terminology in the realtor's home description related to windows ("New windows", "Updated windows", "High efficiency windows", "Triple pane", "Triple glazed") increased a home's expected sale price by just over 5%. This equates to a price premium on the average detached single-family home of $21,400. [Boyd, R., Ryan, J. and Cuell, C., 2019: Hedonic Property Price Analysis: Energy Home Labelling Program. All One Sky Foundation, Edmonton, p. 45.]

24 RSMeans 2020 Residential Cost Data.

25 RSMeans 2020 Residential Cost Data.

26 Source: Home Depot Canada, "How much do blinds cost to install".

27 RSMeans 2020 Residential Cost Data.

28 RSMeans 2020 Residential Cost Data.

29 There are many guides on how to air seal your home. For example, Chapter 4 in Natural Resources Canada's "Keeping the Heat In" guide and the U.S. Department of Energy's "Air Sealing you Home" guide.

30 See: Z800-18 National Standard of Canada: Guideline on Basement Flood Protection and Risk Reduction. Section 6.3 (Site Grading and Drainage).

31 See an **animated video** on weeping tiles and sump pumps.

32 See an **animated video** on backwater valves.

33 See an **animated video** on backwater valves and foundation drains.

34 You can use Province of Alberta's flood map to check if your property is in the floodway, flood fringe, or overland flow zone. If so, specific land use regulations will apply. For more information on official and recommended flood elevations, and the development and building regulations that apply in each designated flood zone, please refer to Edmonton's Land Use Bylaw, Section 812 Floodplain Protection Overlay (FPO), or contact The City's Planning Department (or call 311).

35 For comprehensive guidance on installing a sewer back up valve in your home, see EPCOR's **Flood Prevention Homeowners Programs** and the Institute for Catastrophic Loss Reduction's **steps for backwater valve installation**.

36 Cost estimates based on: **Home Depot** and RSMeans 2020 Residential Cost Data.

37 Source: **Government of Canada: Heating and Cooling with a Heat Pump**.

38 Price information from **https://www.furnaceprices.ca/geothermal/geothermal-heating-system-buying-guide**

39 For more information on heat pumps see: **Government of Canada: Heating and Cooling with a Heat Pump**.

40 If you want to know more about air purifiers see **"Air Purifier—From A to Z: The Complete Beginners Guide"**.

41 Descriptions of insulation types are from US Department of Energy web page—**Types of Insulation**; costs estimates are based on RSMeans Residential Cost Data 2020. The Insulation Institute **compares** the main types of insulation materials.

42 Costs are indicative and for comparing insulation types; determine actual thicknesses, desired R-value and costs with local building supplier and/or contractor.

43 Content from: Durham Region Climate Resilience Standard for New Houses (2018), and the Institute for Catastrophic Loss Reduction—Protect your home from extreme heat booklet.

44 Information from the Alberta FireSmart Homeowners Manual

45 Fire resistance is based on two test standards: UL 790 and ASTM E108. There are three leels of fire resistance; Class A is the highest level

- Class A: Effective against severe test exposure, affords a high degree of fire protection
- Class B: Effective against moderate test exposure, affords a moderate degree of fire protection
- Class C: Effective against light test exposure, affords a light degree of fire protection

46 Content from: Z800-18 National Standard of Canada: Guideline on Basement Flood Protection and Risk Reduction, and the Edmonton Land Use Bylaw.

47 You can use Province of Alberta's **flood map** to check if your property is in the floodway, flood fringe, or overland flow zone. If so, specific **land use regulations** will apply.

48 See: the STANDATA Building Code Bulletin 06-BCB-009R1- **Disaster Recovery Program Flood Mitigation Measures**, and STANDATA Building Code Bulletin 06-BCB-010- **Disaster Recovery Program Flood Mitigation Measures for Homes Being Rebuilt**.

49 The majority of content for this section was taken from the Institute for Catastrophic Loss Reduction Research Paper—**Increasing High Wind Safety for Canadian Homes: A Foundational Document for Low-Rise Residential and Small Buildings**, and CSA S478:19 National Standard of Canada: Durability in Buildings. Annex F.

50 For example, the American Society for Testing and Materials (ASTM) has standard test methods for roofing products and materials. For Asphalt shingles, look for shingles rated as **ASTM D7158** Class G or better which are rated to withstand winds up to 200 kilometres per hour. The **Insurance Institute of Business & Home Safety** also conducts research and provides standards for hail resistance. The Standards Council of Canada is currently working on a **Standard for High Wind Safety (CSA S520)**, to provide guidance on wind resistant building design, materials, and techniques for low-rise residential and small buildings. However, it will be some time before this standard is released.

51 Content from: the Institute for Catastrophic Loss Reduction—**Protect your home from hail booklet**.

52 For example, **UL 2218** is a test method for evaluating impact resistance of roof covering materials. When tested to UL 2218, materials can achieve an impact-resistance rating from Class 1 through 4, with a Class 4 rating being the highest. The I**nsurance Institute of Business & Home Safety** also conducts research and provides standards for hail resistance.

53 Content from: the Institute for Catastrophic Loss Reduction—**Protect your home from snow & ice storms booklet**.

54 City of Calgary **irrigation setup and maintenance tips**.

55 For more detailed information on dealing with extensive roof icing and ice dam problems see the **Removing Ice on Roofs** publication from the Canadian Mortgage and Housing Corporation.