

# LIVING WITH WATER

## ADAPTATION GUIDE FOR FLOOD-RESILIENT BUILDINGS



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# ABOUT

## ARCHITECTURE WITHOUT BORDERS QUEBEC

Architecture Without Borders Quebec (AWBQ) is an organization that helps populations affected by crises, natural disasters, or social inequalities. It works with communities to strengthen their capacities through the involvement of various actors in the field of architecture. AWBQ works overseas, with other Canadian international cooperation organizations, and in Quebec, in urban areas and with Indigenous Peoples.

Created in 2008 by the Ordre des architectes du Québec (OAQ), AWBQ is the official humanitarian arm of the architectural profession. Its members include all architects in the province, whose social responsibility and involvement in its activities it promotes. Building on this unique relationship between professional orders, AWBQ also benefits from the commitment of other trades and numerous partners in the implementation of its programs.



See:

[www.asf-quebec.org/resilience](http://www.asf-quebec.org/resilience)



## CONTEXT

The guide was developed as part of the **Living with Water: A Toolkit for Flood-Resilient Construction** project, which received \$2.72 million in funding from July 2023 to March 2025 through the Building for the Future of the Housing Supply Challenge cycle of the Canada Mortgage and Housing Corporation's (CMHC). The Challenge has supported innovative solutions that remove barriers to increasing the housing supply in Canada.

This initiative was also funded by the Blue Fund, as part of the National Water Policy of the Quebec Water Strategy, which implements concrete measures to protect, use, and manage water and aquatic environments in a responsible, integrated, and sustainable manner.

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**Living with Water: A Toolkit for Flood-Resilient Construction**

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# BUILD [BACK] BETTER



## INTRODUCTION

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# GENERAL INTRODUCTION

This guide provides information to better understand the risk before choosing a promising adaptation strategy. It also presents flood adaptation measures that, when implemented appropriately and in the right context, help reduce flood risk.

## TARGET AUDIENCE

This guide is designed to assist individuals who want to understand a building's behavior, undertake work, or take action to reduce the impacts of a potential flood, regardless of its source.

It is also intended for individuals mandated to carry out preventive adaptation work or work following a disaster, as well as local authorities wishing to support citizens in adapting buildings to flooding.

Different levels of detail provide general information on adaptation measures, up to a more technical presentation of installation scenarios. This guide thus offers a common reference for the various stakeholders to facilitate their exchanges and accelerate the adaptation of the built environment.

What does it mean to adapt a building to flooding?



## OBJECTIVE

Adapting means designing, building, and maintaining to reduce the impact of flooding. In concrete terms, this means acting on three levers:

- Reducing the amount of water that reaches a building.
- Reducing exposure (e.g., moving equipment and living spaces out of reach of water).
- Reducing vulnerability (e.g., using water-resistant materials, designing walls and floors that dry quickly).

The adaptation guide is intended for all types of buildings: small, large, and historic structures.

The effects of water on buildings vary depending on when they were built and the construction techniques used. Often designed to last, buildings require tailored interventions based on a thorough understanding of their construction methods and how they have changed over time.

Adapting a building therefore primarily involves maintaining and adjusting the existing structure to limit the impact of water on materials and assemblies.

Why adapt a building?



No one is completely safe from flooding, whether they live in an urban or rural area. Even outside of flood zones identified by mapping, flooding can result from a broken pipe or heavy localized rainfall, for example. Furthermore, extreme weather events can occur without warning, and climate change is increasing this uncertainty.

In this context, adapting buildings is a concrete response to reducing the human, socioeconomic, and material impacts of flooding and strengthening the resilience of living environments.

It makes it possible to:

- Increase personal safety.
- Protect property and reduce material losses.
- Prevent health problems (e.g., respiratory and skin diseases caused by humidity and mould growth).
- Reduce stress and psychological impacts (e.g., hypervigilance, anxiety, depression, and psychological fatigue, often exacerbated by feelings of insecurity or the complexity of recovery efforts).
- Reduce structural damage (e.g., foundation settlement).
- Slow down the deterioration of building materials (due to swelling, rot, or deformation following exposure to water).
- Maintain community vitality (by avoiding the depopulation of certain neighbourhoods and/or temporary or prolonged relocations).
- Preserve cultural landmarks and heritage (by preventing the disappearance of places, architectural elements, or buildings that hold collective memory).
- Reduce post-flood expenses for homeowners and the public sector.
- Ensure you remain eligible for insurance premiums or potentially reduce costs.
- Increase property values in certain cases.
- Promote better water management and utilization.

# PRESENTATION OF THE THREE BOOKLETS

The guide is structured in three booklets, each addressing an essential aspect of adapting buildings to flooding.



## FLOOD RISK

The **Flood Risk** booklet explains key concepts related to flooding and the specific challenges of adapting buildings. It provides resources to better understand and assess the intensity of a potential hazard, as well as the vulnerability of exposed elements.



## WATER PATHWAYS

The **Water Pathways** booklet proposes measures - or support systems - that help reduce the amount and flow of water to an exposed element. The fact sheets cover, for example, roof and foundation drainage systems, permeable flooring, retention gardens, and opening protection equipment.



## BUILD [BACK] BETTER

The **Build [Back] Better** booklet proposes measures to reduce the exposure of sensitive elements of a building and, in addition, to reduce the vulnerability of exposed elements. The fact sheets cover, for example, the resistance of architectural components and equipment, their drying capacity, and their relocation above potential water levels.

UNDERSTAND

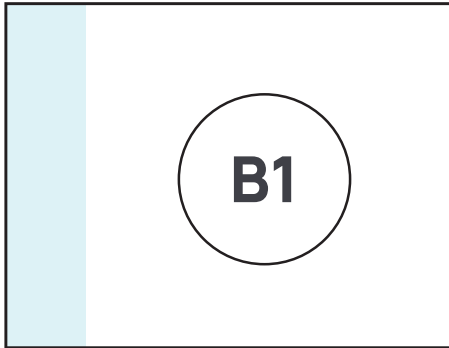
ACT

# READING GUIDE

## SYSTEM PAGE

These sheets present the systems in which the various measures are implemented.

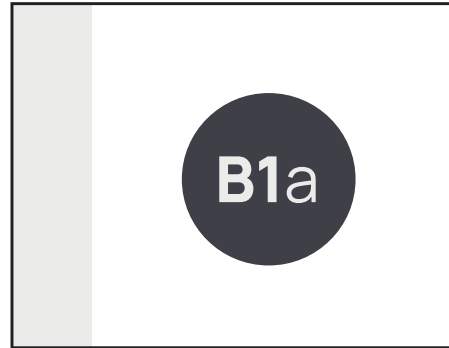
WATER PATHWAYS



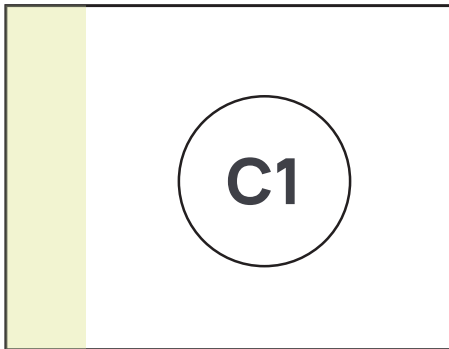
## MEASURE PAGE

These describe adaptation measures. They specify the objectives, implementation guidelines, advantages, warnings, and other relevant information.

Some include photographs of concrete examples and/or the consequences of poor maintenance.



BUILD [BACK] BETTER



## WARNING

The guide presents measures that help increase the resilience (or reduce the vulnerability) of homes and people to flooding. However, these measures are by no means definitive solutions that guarantee complete protection against flooding - such solutions do not exist.

Adaptation does not eliminate risk, but it helps to reduce it and better cope with it. Regardless of how well-prepared people are and how well adapted a building is, it is essential to follow municipal recommendations for safety in the event of flooding. Specifically, any evacuation orders issued by the authorities, whether in anticipation of or during an event, must be obeyed.

## TYPES OF BUILDINGS

See glossary



**Small-scale buildings**



**Large-scale buildings**



**Old buildings**

## LINKS



**Flood Risk** booklet



**Water Pathways** booklet



**Build [Back] Better** booklet



Related **system** sheet



Related **measure** sheet

## ADDITIONAL INFORMATION



### Regulations

Information related to regulatory, legislative, and/or normative frameworks.



### Financial assistance programs / Reduction to be negotiated with an insurance company

Recommendations from organizations or administrations to consult.



### Expertise required

Information on the types of expertise or qualifications required to assess and carry out the necessary work, as well as to estimate costs.



### Typology

Specific notes on different types of buildings to which the measures apply.

## INDICATORS

### Feasibility



Within the reach of most occupants.



Requires a qualified individual.



May require several qualified individuals or additional advice.

### Cost



Tool for comparing several measures: low, moderate, and high costs.



## NUMBERING



Indicates steps to be followed or components of a system.



Indicates different options for the same measure.

## REACTIONS



Good practices to adopt.

# GLOSSARY

## GENERAL

**Adaptation strategy:** set of measures aimed at better managing the risks associated with flooding

**Assembly:** all the elements (structural components, cladding, membranes, etc.) that, when combined using various fastening techniques (gluing, nailing, screwing, welding, etc.), make up a structure (or part of a structure).

**Basin area** (or simply a **basin**): a depression in the terrain, i.e., an area that is lower than the surrounding land. During heavy rains, floods, or pipe breaks, water tends to accumulate there.

**Branch pipe:** set of pipes connected to the sewer lateral to drain water from an appliance or part of the building.

**Combined system:** in a combined system, wastewater and rainwater flow through a single pipe, sometimes all the way to the municipal sewer system.

**Concrete\*:** a building material made from a mixture of cement, sand, aggregate, and water that is shaped using formwork.

**Concrete block foundations\*:** foundations made of concrete blocks.

**Concrete foundations\*:** foundations made of concrete poured into formwork.

**Curtain wall\*:** a lightweight building envelope consisting of glass panels assembled using a system of aluminum mullions and transoms.

**Drip edge:** device used to slow down or interrupt the flow of water, thus preventing erosion or splashing on the ground. It is often placed at the outlet of a gutter or downspout.

**Flood zones:** areas likely to be flooded by a lake or river during high water conditions, based on established recurrence and intensity ratings. In Quebec, these areas include not only places that have already been flooded, but also those that could be flooded and whose boundaries are established in accordance with sections 46.0.2.1 to 46.0.2.3 of the Act or, where such boundaries have not been established, in accordance with Appendix II of the Rmun.

**Foundation drain** or **French drain:** drainage system installed around the foundations of a building to remove groundwater and prevent infiltration

**Gutter:** a horizontal pipe protruding from the roof, used to carry rainwater away from the facade.

**Hazard:** floods, windstorms, and earthquakes are examples of hazards. A phenomenon, physical event, or activity that could cause loss of life or injury, damage to property, social and economic disruption, or environmental degradation.

**Inspection** or **cleaning chamber:** an underground system providing access to sewer or drainage pipes for inspection, maintenance, or cleaning. It is usually located at pipe junctions or strategic points in a drainage system.

**Non-return valve** or **check valve:** mechanical device installed in a pipe that allows water to flow in one direction only. It acts as a backwater valve.

**Overall resilience performance:** reflects a building's ability to limit water damage and quickly return to normal function after exposure to moisture or flooding. It is based on three key aspects:

- Rapid water drainage and effective drying: joints must allow moisture to escape to prevent it from stagnating in or between the materials.
- Physical stability: materials must retain their shape and not deform under the effect of water.
- Maintenance of functional properties: materials must retain their initial performance, such as their insulating power or mechanical strength, after being exposed to water.

**Partition wall\*:** a lightweight wall dividing the interior of a building into rooms.

**Piles\*:** foundations consisting of a set of piles that raise a structure above ground level. Also refers to a set of piles driven into the ground to support a structure on soft soil.

**Potential water height:** the height to which water is likely to rise inside a building, regardless of the source of the

flooding. →**A2b**

**Protection objective:** desired level of safety to minimize the risk of damage in the event of flooding (definition from Appendix III of the Rmun). →**A2a**

**Reinforced concrete\*:** a composite building material made of concrete containing steel reinforcement to increase its tensile strength.

**Relative humidity (RH):** in a space is the ratio of the amount of water vapor present in the air to the maximum amount of water vapor the air could hold at the same temperature and pressure, expressed as a percentage.

**Resilience:** the ability to maintain or quickly regain desired functions following a disruption; to adapt to change; and to rapidly transform systems that limit current or future adaptive capacity.

**Retention tanks and sump:** basins, with or without a pump, used to temporarily collect and drain water. They are considered sanitary appliances according to the NPC.

**Separate system:** in a separate system, stormwater and wastewater flow through separate pipes.

**Sewer lateral:** pipe that receives and directs all wastewater or rainwater from a building to the municipal network.

**Vulnerability:** a condition resulting from physical, social, economic, and/or environmental factors that predispose elements of the built environment and people exposed to flooding to harm or damage.

### For more information:

\* Definitions from Glossaire illustré de l'architecture québécoise, © Government of Quebec, 2025

## TYPES OF FLOODS

**Fluvial flooding:** flooding caused by the overflowing of a watercourse due to a large amount of water from snowmelt or heavy precipitation.

**Surface runoff flooding:** flooding lasting a few hours caused by heavy precipitation, snowmelt, or a broken pipe resulting in runoff due to soil impermeability, saturation, or sewer system capacity overload. This situation can be exacerbated in areas that are topographically lower than their surroundings, commonly referred to as basins.

**Sewer backup flooding:** flooding that occurs when sewage flows back into a building, with water coming out of plumbing fixtures that are not protected by a functional backwater valve. This occurs when the flow exceeds the capacity of the sewer system (definition from the City of Montreal).

**Ice jam flooding:** flooding caused when ice cover breaks up and drifts down a watercourse. The pieces of ice form a mass that blocks the flow of water, causing accumulation and flooding upstream. The resulting flooding is accompanied by ice debris, which can increase the danger to property and people.

**Flooding resulting from the failure of a flood protection structure (FPS)** (levees, dams, etc.).

**Self-flooding:** occurs when rainwater is collected by a combined pipe (sanitary and storm) and cannot be adequately drained due to an overload of the sewer system. For example, water from a flat roof may then come out through plumbing fixtures that are not protected by a backwater valve in the basement and on the floors of the building (e.g., sink, toilet) (definition from the City of Montreal).

The damaging effects of water can also manifest more slowly and incrementally through other weather-related hazards such as increased humidity, torrential rains, and repeated freeze-thaw cycles.

## TYPES OF WATER

Water that enters a building can have different characteristics, depending on its origin and point of entry.

**Fluvial floodwater:** comes from a river overflowing its banks and may contain sediment, hydrocarbons, and large debris.

**Clean water:** comes from drinking water pipes, water heaters, or broken pipes.

**Rainwater:** comes from rainfall and can run off the surface or overload drainage systems.

**Sewage:** wastewater other than clean water and rainwater.

**Storm sewer:** sewer carrying rainwater.

**Sanitary sewer:** sewer carrying sewage.

**Combined sewer:** sewer carrying sewage and rainwater.

**Groundwater:** comes from the water table and can rise through infiltration.

**Surface water:** all flowing or stagnant water present on the surface of the ground, regardless of its origin.

## TYPES OF BUILDINGS

**Small-scale buildings:** one to three story buildings (e.g., duplexes, triplexes, etc.) in urban, semi-urban, or rural areas. These buildings can have different uses (multi-residential, commercial, institutional, industrial, etc.)

**Large-scale buildings:** buildings with more than 3 stories that can be used for different purposes (multi-residential, commercial, institutional, industrial, etc.):

**Multi-residential:** medium or large-scale buildings consisting of several dwellings.

**Commercial:** buildings constructed or developed to house stores or commercial services.

**Industrial:** buildings constructed or fitted out for use by an industrial enterprise.

**Old buildings:** all types of buildings (residential, commercial, or industrial) constructed before 1940. This definition corresponds to the one used for heritage inventories by Quebec's regional county municipalities (RCM) and municipalities. Historic buildings may or may not be granted protected status under the Cultural Heritage Act.

The location of historic buildings (often near a watercourse) makes them particularly vulnerable to open-water flooding, which is likely to diminish our collective heritage. They are distinguished by materials and construction methods that differ from those of contemporary buildings. These elements - such as dormer windows, chimneys, stone, slate, or wood siding - serve as tangible evidence of traditional craftsmanship.

They contribute to the heritage value of a community and enhance residents' quality of life, happiness, and sense of pride. Historic buildings deserve to be preserved and adapted to limit the impact of water on their materials and construction methods.

## OLD BUILDINGS

What is heritage?



**Heritage building:** as of April 1, 2026, all regional county municipalities (RCM) will be required to adopt an inventory of heritage buildings located within their jurisdiction. This inventory must include all buildings constructed before 1940 that have heritage value, with the option to include more recent buildings if the RCM so choose. The RCM will also be required, as of that same date, to adopt a bylaw governing the occupancy and maintenance of buildings within their territory. This bylaw must apply to the buildings listed in the inventory, in order to promote the preservation of this architectural heritage

How can you tell if a building is a heritage building?



A building is considered heritage if it:

- has legal status under the Cultural Heritage Act (LPC)\* ;
- is included in the built heritage inventory of your municipality or RCM\*\* ;

\* To verify this, consult the Répertoire du patrimoine culturel du Québec: [www.patrimoine-culturel.gouv.qc.ca](http://www.patrimoine-culturel.gouv.qc.ca)

\*\* To find out, contact your local municipality directly.

Preservation: Why and How?



**Heritage preservation:** preserving built heritage does not mean freezing it in time. It is natural for an old building to undergo changes over time.

Climate change is exacerbating these needs, making it often necessary to modify older buildings to make them more resilient. The goal is to strike a balance between renovations and preserving the distinctive features of the architecture (see Illustrated Glossary).

Generally speaking, when it comes to historic buildings, the following best practices are followed:

- it is better to maintain than to repair ;
- it is better to repair than to replace ;
- and, when replacement is necessary, to do so in a way that respects the architecture.

This is especially true for historic buildings, where the goal is to preserve their heritage value.

Preserving all existing buildings, whether considered heritage sites or not, is an important step for the planet. As is often said:

« **The greenest building is the one that already exists !** »

Preserving and adapting buildings helps, in particular, to avoid the carbon emissions associated with demolition and reconstruction.

### For more information:

To learn about the legal frameworks that can be used to protect, promote, preserve, and understand our cultural heritage: [www.quebec.ca/culture/patrimoine-archeologie/protoger/statuts/types-statuts](http://www.quebec.ca/culture/patrimoine-archeologie/protoger/statuts/types-statuts)

To view the **Cultural Heritage Act**: [www.legisquebec.gouv.qc.ca/fr/document/lc/p-9.002](http://www.legisquebec.gouv.qc.ca/fr/document/lc/p-9.002)

## ACRONYMS

**AMCQ:** Association des Maîtres Couvreur du Québec

**APCHQ:** Quebec Professional Association of Construction and Housing

**AWBQ:** Architecture Without Borders Quebec

**AVFQ:** Association de vitrerie et de fenestration du Québec

**BNQ:** Bureau de normalisation du Québec

**CCQ (MCC):** Centre de Conservation du Québec

**CMAQ:** Conseil des métiers d'art du Québec

**CMM:** Montreal Metropolitan Community

**CMMTQ:** Corporation des maîtres mécaniciens en tuyauterie du Québec

**MCC:** Ministère de la Culture et des Communications

**MELCCFP:** Ministère de l'Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs

**NBC:** National Building Code

**NPC:** National Plumbing Code

**QCC:** Quebec Construction Code

**RBQ:** Régie du bâtiment du Québec

**RCM:** Regional County Municipality

**Rmun:** Regulation respecting regulatory measures for activities under the responsibility of municipalities carried out in bodies of water and on flood protection works

# ILLUSTRATED GLOSSARY

## OLD BUILDINGS

### EXTERIOR / ORNAMENTAL

- 1 **Wooden shingle:** a roofing and siding material consisting of rectangular planks, usually made of cedar.  
*Arranged in rows, the shingle has a tapered profile at one end to allow the planks to overlap. The exposed part of the shingle is called the « gauge ».*
- 2 **Brick:** a building material made of clay shaped in a rectangular mold, then dried and fired.  
*There are several types of brick bonds, including stretcher bond, header bond, English bond, Flemish bond, American bond, and composite bond.*
- 3 **Chimney:** a duct used to remove smoke and gases produced by combustion.
- 4 **Storm window:** a window installed on the exterior during cold periods of the year to increase comfort inside buildings. It also reduces energy needs.
- 5 **Storm door:** a door installed on the exterior during cold periods of the year to increase comfort inside buildings.
- 6 **Cornice:** a set of one or more projecting molded elements, generally crowning the upper part of a facade.
- 7 **Metal roofing:** roofing material made of metal sheets or panels.
- 8 **Plaster:** a set of mineral layers (mortar, lime, stucco, plaster, or cement) applied to a wall to protect it or give it a uniform appearance.
- 9 **Gallery:** an elongated exterior platform of a building, accessible via an exterior staircase. It is often covered by a roof.
- 10 **Snow guard** or **Snow stopper:** a device attached to the base of a roof slope to prevent snow or ice from falling.
- 11 **Curved roof eave:** the lower, curved portion of a roof overhang.

- 12 **Dormer:** a small structure on the roof of a building to provide light and ventilation to the attic. There are several types of dormers (segmental-arched, hipped, hanging window, pedimented, gabled, arched, shed, sloped, and gable dormer).
- 13 **Brick masonry:** a structural system consisting of a mass of bricks bonded together with mortar.
- 14 **Stone masonry:** a structural system consisting of a mass of stones bonded together with mortar.

### INTERIOR

- 15 **Wooden ornamentation**
- 16 **Paneling:** interior wall covering consisting of an assembly of wooden pieces.
- 17 **Lath and plaster:** interior wall covering made of plaster applied in layers over thin wooden strips used as a substrate.

### STRUCTURAL

- 18 **Foundation (brick, stone, dry stone, rubble stone):** the lower part of a structure that transfers the building's dead loads to the ground.
- 19 **Old timber-frame construction:** a load-bearing framework consisting of small-diameter wooden studs, joists, and rafters covered with structural panels to form the walls, floors, and roof of a building.
- 20 **Log home** or **brick-venner log home:** a structural system consisting of logs laid horizontally on top of one another. It is subject to vertical elements.
- 21 **Triple brick:** a solid load-bearing wall consisting of three courses of solid bricks bonded with mortar, typical of older buildings constructed before the advent of insulated wood-frame walls.
- 22 **Roof frame:** the set of components forming the framework designed to support the roof and its covering.

#### For more information:

Definitions from *Glossaire illustré de l'architecture québécoise*,  
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# OLD BUILDINGS



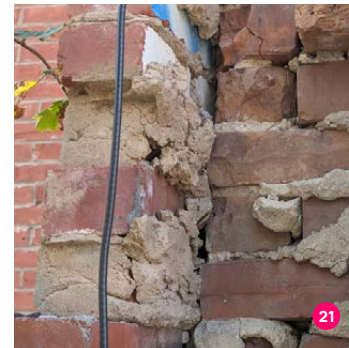
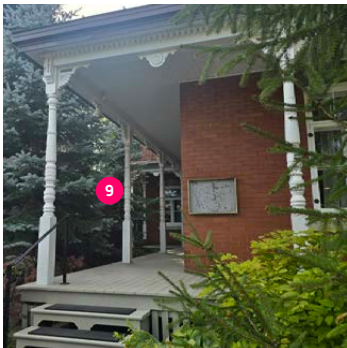
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# FLOOD RISK

The ***Flood Risk*** booklet explains key concepts related to flooding and the specific challenges of adapting buildings. It provides resources to better understand and assess the intensity of a potential hazard, as well as the vulnerability of exposed elements.



# INTRODUCTION

**RISK**, in the context of building adaptation, combines three elements: hazard, exposure, and vulnerability.

⚠ Do not confuse **flood-related risk** with the **probability of occurrence** (or frequency) of a river flood, often expressed in years, or with historical **curves**, which indicate the probability of a series of extreme precipitation events.

Adapting buildings reduces risk by acting on three levers:

## A1 HAZARD

Its intensity and evolution in the context of climate change.

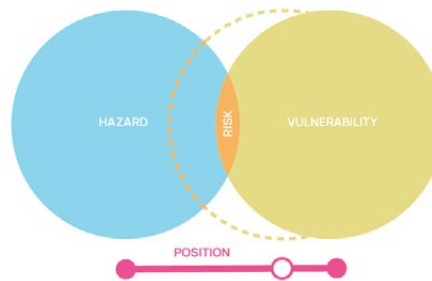


Objective: Reducing the amount of water that reaches a building.

E.g., improving drainage.

## A2 EXPOSURE

The position of vulnerable elements in relation to flooding.



Objective: Reducing the exposure of sensitive elements.

E.g., raise certain equipment and living areas above the water level.

## A3 VULNERABILITY

The sensitivity of elements exposed to flooding, including the ability to withstand and recover from it.



Objective: Reducing the vulnerability of exposed elements.

E.g., use water-resistant materials, design walls/floors that dry quickly.

# FLOOD HAZARD

A **flood hazard** occurs when water temporarily submerges an area with varying probability and intensity. In itself, a flood hazard does not cause damage unless **vulnerable** elements are **exposed** to it.

When adapting a building, it is desirable to **reduce the amount or flow of water** that could flood it.

To do this, you must first:

- Understand where the water may come from (**potential source**), taking into account climate uncertainty and aging infrastructure.
- Identify how water reaches the building.
- Understand how water flows around and into the building (**water paths**).

Where does the flooding come from?



There are many **sources of flooding**.

They can be natural or caused by human activities:

- Heavy rainfall
- Spring floods
- Ice jams
- Snowmelt
- Storm surges
- Pipe breaks
- Failure of a flood protection structure (FPS) (levees, dams, etc.)

⚠ The same **source of flooding** (e.g., heavy rain) can affect a building in different ways (e.g., runoff, backflow, etc.).

Risk assessment therefore involves considering **several flood scenarios**.

How does water reach a building?




Water can reach an exposed building in different ways:

- Through the **backflow** of one or more drainage systems.
- Through **runoff** on the soil surface.
- Through **underground infiltration** through the soil and through capillarity through materials.
- From **the inside**, due to a broken appliance or pipe.

How does water circulate around and inside the building?



There are three paths that water can take around, under, and inside a building. →  Certain characteristics of these **water pathways** influence the level of risk to a building:

- A1a** The **type of drainage system**: combined, separate, or autonomous (septic tank).
- A1b** The **external environment**: slope of the land, type of soil and surface, devices that block or retain water, depth of the water table, etc.
- A1c** The **configuration of rainwater and runoff drainage systems**: foundation drains, roof drains, submersible pumps, and sump pumps.
- A1d** The **configuration and condition of the interior drainage system**: position of check valves, condition of pumps, etc.

# A1a

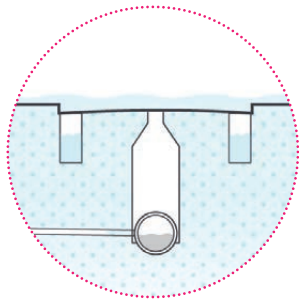
## RECOGNIZING THE DRAINAGE SYSTEM

To assess the risk, it is important to identify the **type of drainage system** specific to the building.

In an urban setting, domestic drainage systems are usually connected to a municipal drainage system. These systems can be **combined** carrying both sewage and rainwater, or separate, with each type of water having its own pipeline network.

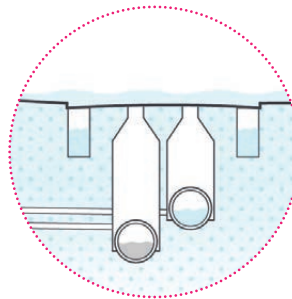
In rural or remote areas, sewage drainage is often **autonomous**, directed to a local sewage treatment system.

### COMBINED SYSTEMS



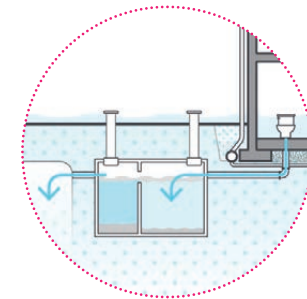
In a **combined system**, common in small municipalities or in cities/municipalities with older systems, sewage and rainwater flow through the same pipe and, where possible, to a treatment plant.

### SEPARATE SYSTEMS



In a **separate system**, rainwater and sewage travel through separate pipes. **Rainwater** and runoff are typically directed to retention ponds or directly to a watercourse or ditch. **Sewage** follows a separate route to a treatment plant.

### ON-SITE SYSTEM



A **self-contained system** usually consists of a **septic tank**, which is an underground tank that receives sewage. Rainwater is often managed separately by foundation drain and gutter systems.

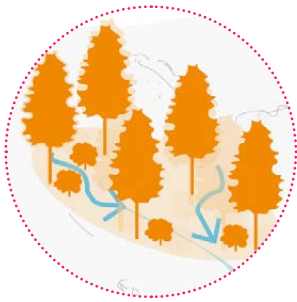
⚠ During heavy rains, the volume of water can exceed the capacity of the municipal system, leading to overflows or backups in buildings.

⚠ Without regular maintenance (emptying the tank, inspecting the leach field), the system can become saturated, causing backups.

# RECOGNIZING THE CHARACTERISTICS OF THE EXTERNAL ENVIRONMENT

To assess the risk, it is important to identify the characteristics of the **natural, landscaped, or built outdoor environment**. Several of these characteristics influence the amount and flow of water that can reach a building in the event of flooding from runoff or open water, regardless of the source.

## NATURAL



### Soil type

The type of soil directly influences water management during a flood.

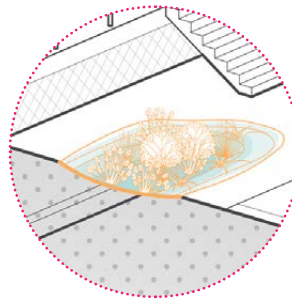
As a guide:

- **Sandy soil:** highly permeable, promotes rapid infiltration but little retention.
- **Clay soil:** not very permeable, retains water (promotes accumulation on the surface), prone to shrinkage and swelling (increases the risk of cracks in foundations).
- **Loamy soil:** intermediate, drains poorly, susceptible to erosion and runoff.
- **Organic soil** (peat, marshy): saturated with water, low load-bearing capacity.
- **Gravelly soil:** highly permeable, promotes infiltration, can quickly transmit water to foundations.

### Groundwater level

A water table located very close to the surface can quickly saturate the foundation drainage system (and the pump) and accelerate basement flooding. This factor is particularly critical during periods of prolonged rain or flooding.

## LANDSCAPED



### Type of surface

Impervious surfaces such as asphalt or concrete reduce natural water absorption and increase runoff. In contrast, vegetated or permeable soil promotes infiltration and reduces pressure on drainage systems.

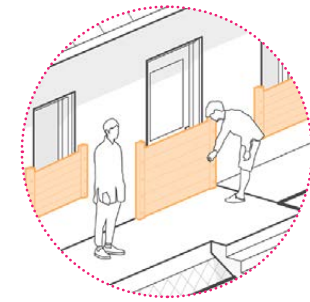
### Slope

A slope directed toward the building promotes water runoff toward the foundation and increases surface runoff. Even a slight outward slope is a measure that mitigates risk and speeds up recovery.

### Green infrastructure

Green infrastructure, such as rain gardens, retention ponds, and vegetated swales, helps capture, store, and infiltrate runoff and roof drain water. It reduces the overload on sewer and drainage systems and also decreases the amount of water reaching foundations and door thresholds.

## BUILT



### Protective devices

Existing structures such as curbs, low walls, permanent protective devices (e.g., waterproof doors and windows) or semi-permanent devices (e.g., cofferdams) can reduce, to a certain extent, the amount of water entering a building. However, their effectiveness depends on their design, installation, and maintenance.

⚠ In Quebec, in designated flood zones, the use of certain protective devices is prohibited. Consult your municipality to find out the conditions that apply in flood zones under the modernized regulatory framework for water environments.

# A1c

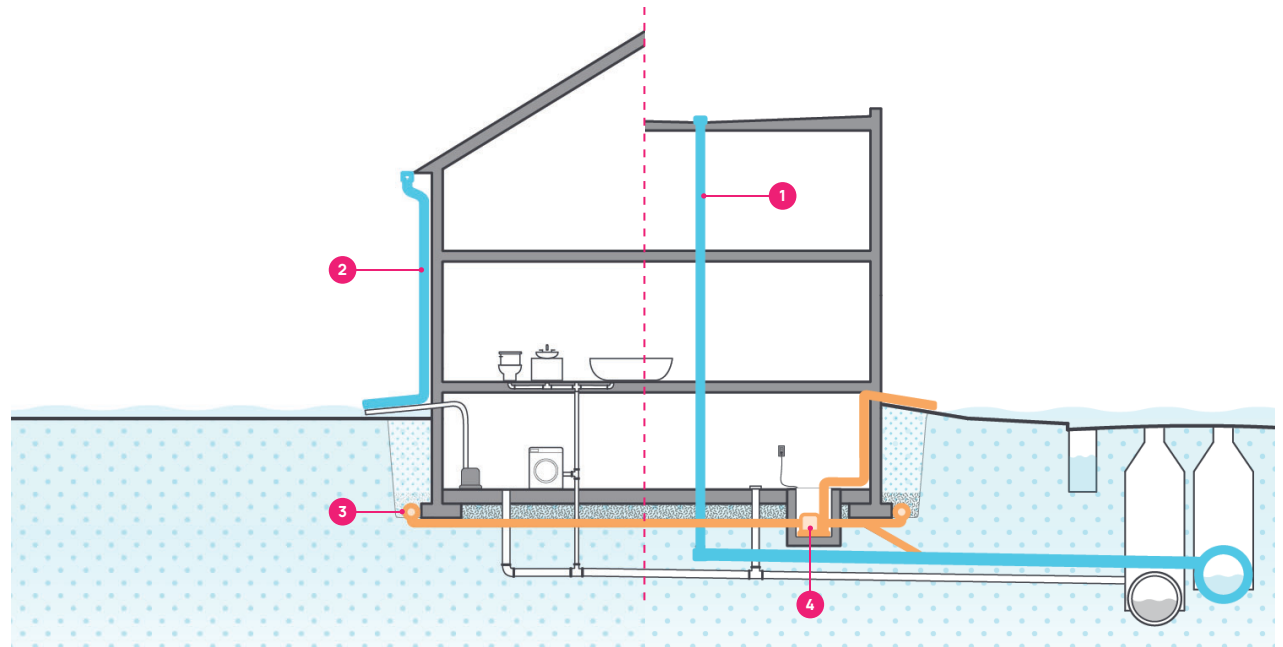
# UNDERSTANDING RAINWATER AND RUNOFF DRAINAGE SYSTEMS

The way water that accumulates on a roof and around foundations is managed and drained directly influences the risk of flooding due to **infiltration** or **backflow**. It is important to understand the different systems specific to a building and to identify their main components before defining an adaptation strategy.

— Exterior runoff drainage

— Foundation drainage

⚠ Consult the building plans or call in a plumber or drainage expert to confirm the existence and condition of the drainage system.



## ROOF DRAIN → B1 B2

### Flat roof with central interior drain 1

Water collected on the roof is often directed to a pipe that runs through the interior of the building. It is important to determine whether the downspout is connected to the domestic sewage drainage system or to an external outlet (e.g., ground, street, retention basin).

⚠ A roof drain connected to the domestic system increases the risk of sewer backup in the absence of check valves on plumbing fixtures or in the presence of a check valve on the sewer lateral.

### Roof with gutters and external downspouts 2

The collected water is drained outside the building, often near the foundation. Ensure that the gutter outlet is located at a distance from the foundation that is regulated by the municipality (e.g., Montreal: 1.8 m).

⚠ A gutter connected to or directed toward foundation drains can overload the drainage system, increasing hydrostatic pressure on the foundation and the risk of cracks and backflow.

## FOUNDATION DRAIN → B6a

The **foundation drain** 3 plays a key role in groundwater management by collecting water that accumulates around the foundation, but it is not designed to handle massive volumes. During periods of exceptional rainfall, flooding, or high groundwater levels, it can quickly become overloaded and accelerate the entry of water into the basement rather than slowing it down.

⚠ A poorly maintained drain can become clogged, causing water to accumulate near the foundation and structural damage (lifting or cracking of the slab or walls).

## SUMP PUMP CONNECTED TO FOUNDATION DRAINS → B6b

A **sump pump** 4 is not designed to protect against major flooding. It is used to remove water collected by foundation drains. Its capacity is designed to handle occasional water inflows, such as those associated with snowmelt or ordinary rainfall.

There may be a tendency to increase the pump's power. However, oversizing the pump can cause premature wear, as it may activate more frequently during normal periods.

There is the option of installing a duplex pump, i.e., two pumps operating alternately or in relay depending on the volume of water. This system offers better redundancy but does not guarantee sufficient capacity during an exceptional event.

As the pump is dependent on electricity, a backup power supply must be provided in case a power failure occurs at a critical moment and renders the system inoperative.

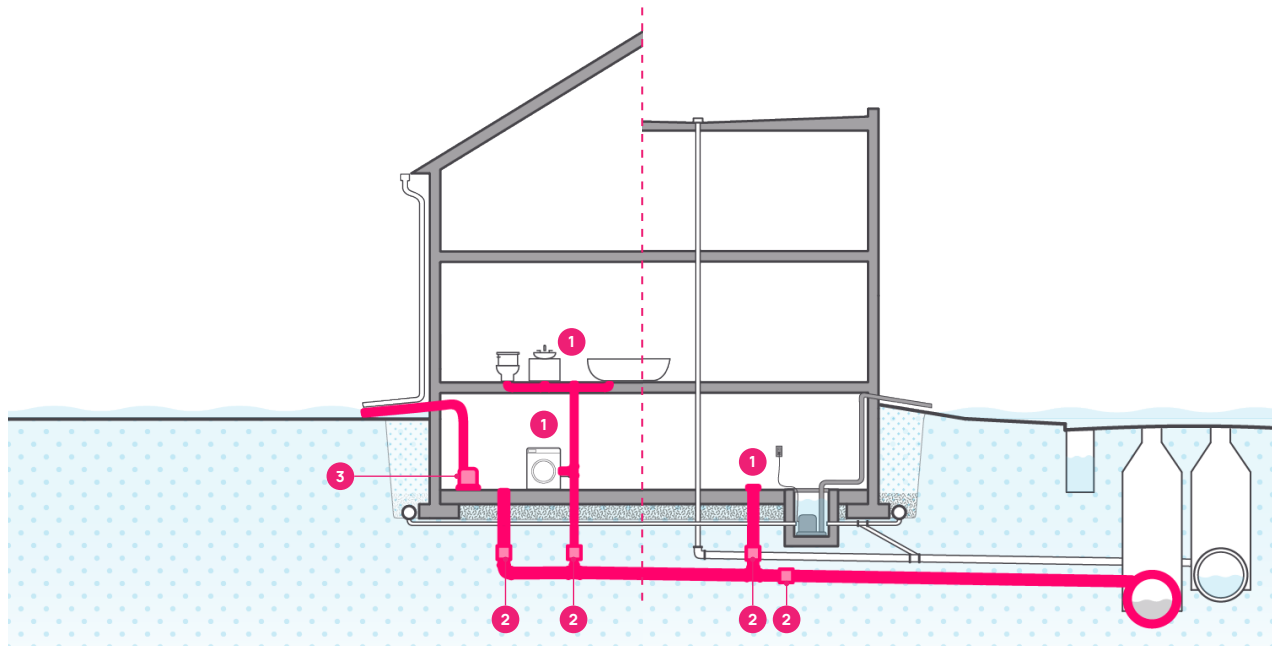
⚠ In the event of high groundwater levels, flooding, or heavy rainfall, the sump, which is connected to the drains and located in the slab, can become a water inlet and increase the risk of basement flooding. On the other hand, by allowing water to enter, it reduces the hydrostatic pressure around and under the foundation, which reduces the risk of cracking and uplift.

# A1d

# UNDERSTANDING THE INTERIOR DRAINAGE SYSTEM

The **interior drainage system** ensures the evacuation of sewage from a building. Under normal conditions, it directs water from sanitary appliances to the municipal network or an autonomous system (e.g., septic tank). However, in the event of overload (exceptional rainfall, flooding, network backflow), each connection point becomes a potential entry point for water. The network may also include various valves and pumps dedicated to flood management.

— Interior drainage



## SANITARY FIXTURES AND FLOOR DRAINS

**Toilets, sinks, bathtubs, showers, washing machine outlets, and floor drains** (1) (garage, laundry room, bathroom, basement) are all connected to the drainage system. When overloaded, they become potential entry points for water.

⚠️ The presence of this equipment below ground level greatly increases the risk of backflow flooding.

⚠️ The absence, insufficiency, or lack of maintenance of protective devices (e.g., check valves) greatly increases the risk of backflow flooding.

## CHECK VALVES → B7

A **check valve** (2) prevents water from flowing back into interior pipes when the municipal network or drainage column is overloaded. To be effective, the right type (there are several) must be correctly positioned and regularly maintained to prevent clogging or blockage.

⚠️ The absence, malfunction, or incorrect location of a valve directly exposes the building to the risk of backflow.

⚠️ If incorrectly installed on a pipe connected to a roof drain or the drainage system of other dwellings/floors, it can block the flow of rainwater and sewage and cause sewer backup.

## SPECIALIZED PUMPS → B8a

In areas prone to flooding, **pumps** (3) can be added to drain water to the outside, even if the municipal system is saturated. Their effectiveness depends on their capacity, power supply, and drainage location.

⚠️ An undersized pump or one that cannot be used in the event of a breakdown becomes ineffective at the most critical moment.

⚠️ A return too close to the foundation or to an already overloaded network remains ineffective.

# FLOOD EXPOSURE

**Exposure** refers to the position of vulnerable elements in relation to flooding, whether natural or caused by human activity.

In the context of building adaptation, reducing exposure involves moving sensitive or water-incompatible elements out of reach of flooding.

Which sectors are most exposed?



## Flood zones (FZ)

Flood zones are areas that are likely to be occupied by water from a lake or river during a flood, according to established recurrence intervals or intensity classes. In Quebec, they are delineated and mapped.

## Basin areas

Basin or depression areas present a risk because water tends to accumulate there during heavy rains, floods, or pipe breaks. Several local governments have maps identifying these risk areas.

## Areas with high water tables

A high water table promotes the accumulation of water around foundations, which can overload a drainage system, increasing the risk of flooding due to the backflow of water collected around and under the foundations.

## Areas near a rainwater collector

Areas located near a channelized watercourse or a rainwater collector that is not designed to handle exceptional rainfall are at increased risk of flooding from runoff and backflow during heavy rains.

**A2a** To identify certain types of **flood risk areas**.

How can exposure be reduced?



It is possible to reduce exposure to flooding and limit its impact through strategies applied at different scales:

- **sector:** avoid constructing a building in a high-risk area or consider relocating it.
- **building:** adopt appropriate designs, such as building on stilts or raising foundations above the potential water level.
- **interior layout:** design living spaces above the potential water level or to meet the protection objective set out in a regulatory framework.
- **equipment:** raise valuable items and sensitive installations, such as electrical appliances and networks, above the potential water level or to achieve the protection objective set out in a regulatory framework.

**A2b** To understand the concepts of **potential water level** and **protection objective**.

# IDENTIFYING AREAS AT RISK OF FLOODING

## BASINS OR LOW-LYING AREAS

In Quebec, some municipalities have produced maps to identify basin areas. These maps delineate topographically low areas that are likely to accumulate precipitation during heavy rains. They provide information on flood depth, i.e., the height of the water above the natural ground level.

Some municipalities have maps of low-lying areas.

⚠️ Check with your local government for more information.

## FLOOD ZONES

In Quebec, two types of maps are used to identify **flood zones**\*: older generation maps and newer generation maps.

These maps will only represent the following types of flooding:

- **Open water flooding\***
- **Ice jam flooding\***
- **Flooding in the presence of a flood protection structure (FPS)\***

⚠️ Flooding caused by **sewer backups\***, **runoff\***, and **coastal submersion** will not be represented in the new generation maps.

\* see Glossary



Previous generation of flood zone maps

New generation of flood zone maps

**Previous-generation** flood zone maps show two categories of areas defined according to flood recurrence:

- The **high-flow zone** (recurrence interval of 0-20 years) has a 1 in 20 probability, or 5% chance of being flooded each year. The **ice jam flood zone** is part of the high-flow zone.
- The **low-flow zone** (recurrence interval of 20-100 years) has a probability between 1 in 20 and 1 in 100, or between 5% and 1%, of being flooded each year.

These maps, referred to as older generation maps, are available from local municipalities or RCM.

**New-generation** maps present four intensity classes:

- Very high
- High
- Moderate
- Low

Each class represents the possible intensity of flooding for a given area. The classes are defined by experts using a table that combines the **probability of flooding** (between 100% and 7% probability that the area will be flooded at least once in 25 years) and the **depth of water** that can be reached from the ground during a flood.

For more information : <https://www.quebec.ca/agriculture-environnement-et-ressources-naturelles/eau/zones-inondables-mobilite-rives-littoral>

# ASSESSING POTENTIAL WATER LEVEL

## POTENTIAL WATER LEVEL (in flood zones or low-lying areas/basins)

In this document, **potential water level** refers to the height to which water is likely to rise **inside** a building, regardless of the source of the flooding.

In designated flood zones, this water level can be determined using a **flood level**. It corresponds to an elevation (in meters) above sea level.

In other areas, it depends on several factors, including the configuration of the drainage system, the duration and intensity of the potential hazard, the surface flow velocity, the groundwater level, etc. That said, more and more local governments are providing maps that indicate potential flood depth (outdoors), particularly in **low-lying areas\***.

**Potential water level** = the level to which water could accumulate above a given floor

## REFERENCE FLOOD LEVEL (in flood zones only)

The **reference flood level** indicates the level that water can reach according to a **given probability** (in years or as a %):

- expressed, in older generation maps, in **years of recurrence** (e.g., 20-year flood, 100-year flood), or
- as a **percentage of annual probability** (e.g., between 1 in 20 and 1 in 100, or between a 5% and 1% chance of flooding each year) in the new maps.

Reference flood levels are available from municipalities, RCM, or the Quebec government.

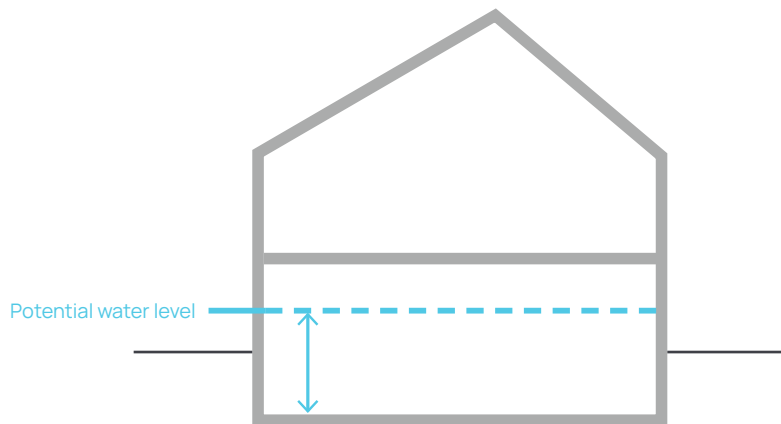
**Reference flood level** = estimated water level (altitude) based on probability

## PROTECTION OBJECTIVE (in flood zones only)

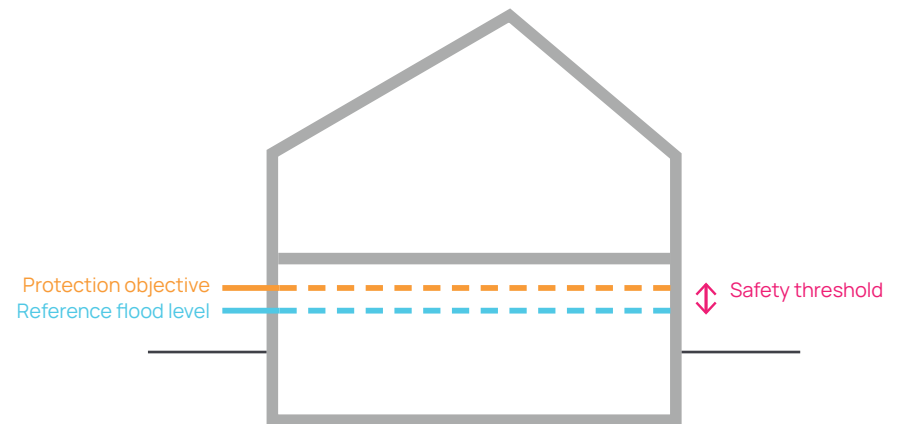
The implementation of certain adaptation measures aims to achieve a **protection objective**: this is a **safety threshold** added above the **reference flood level** in order to minimize the risk of damage in the event of flooding.

This safety threshold or margin depends on either:

- the **intensity class** of the flood (in new-generation maps).
- the **historical recurrence** of floods (in older generation maps).



outside flood zones



in designated flood zones

# FLOOD VULNERABILITY

**Flood vulnerability** is a condition resulting from physical, social, economic, and/or environmental factors that predispose built structures and people exposed to flooding to suffer harm or damage. It therefore concerns both human or socio-economic factors (the ability of occupants to react and prepare) and material factors (the physical characteristics of a building). The greater the **vulnerability**, the greater the **consequences** of a flood.

What can influence vulnerability?



## HUMAN AND SOCIO-ECONOMIC FACTORS

- Physical capabilities (mobility, physical strength)
- Cognitive and psychological abilities (understanding of risk, stress tolerance, decision-making in emergency situations)
- Financial capabilities (income, access to resources for prevention or reconstruction)
- Occupancy status (owner or tenant, temporary or permanent occupancy)
- Insurability (access to adequate coverage or refusal of insurance)

⚠️ Two households exposed to the same hazard may have different degrees of vulnerability depending on the physical, psychological, and financial capacities of the individuals involved.

## MATERIAL FACTORS THAT INFLUENCE VULNERABILITY

- Height of the lowest inhabited floor (e.g., finished or unfinished basement).
- Location of living areas and valuable possessions.
- Location of mechanical and electrical equipment.
- Capacity of materials and assemblies (walls, floors, built-in furniture, etc.) to withstand damage.

⚠️ Two properties exposed to the same hazard may have different degrees of vulnerability due to their overall shape, the stability of their foundations, the location of living areas, or the resilience of the materials they are made of.

**A3a** To identify the **potential material vulnerabilities** of a building.

**A3b** To understand the **impact of water on materials**.

**A3c** To identify **examples of damage caused by water infiltration**.

**A3d** To **become aware of the risks associated with flooding**.

# A3a

# POTENTIAL VULNERABILITIES

## EXAMPLES OF WATER ENTRY POINTS

### Openings and access points

- 1 Windows and doors located below ground level and/or below the potential water level (e.g., garage entrance with a reverse slope, balcony door with water flowing toward the building)

### Walls, foundations, roofing

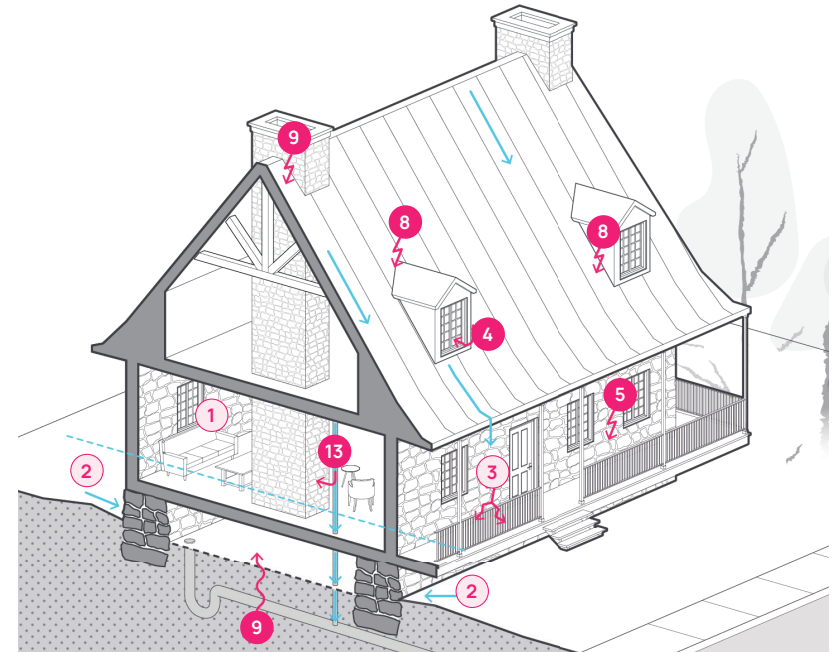
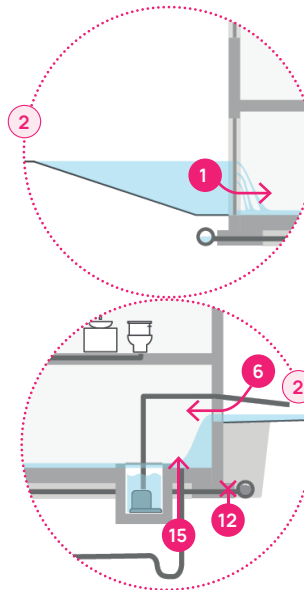
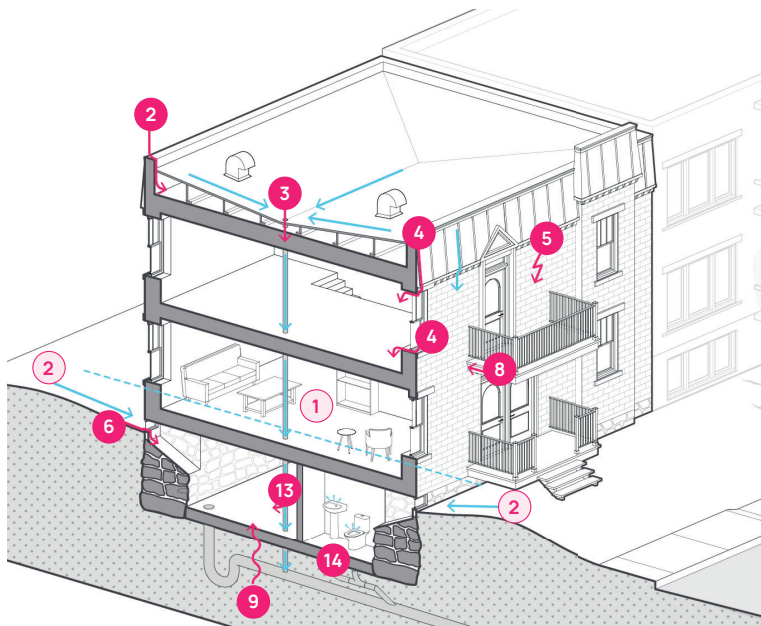
- 2 Infiltration under the parapet flashing (flat roof)
- 3 Self-flooding through the drain (flat roof)
- 4 Infiltration through openings (e.g., doors and windows)
- 5 Infiltration through the facade (e.g., cracks, holes in the mortar)
- 6 Infiltration through openings (e.g., vents, basement windows)
- 7 Infiltration through joints between different materials
- 8 Infiltration through poorly sealed joints or between the siding and the foundation
- 9 Infiltration due to rising groundwater

### Mechanical, electrical, and plumbing (MEP) systems

- 10 Infiltration through mechanical openings (e.g., air vents, ventilation outlets)
- 11 Infiltration through service entries (e.g., water supply pipes, electrical cables)
- 12 Infiltration through a cracked or clogged drain
- 13 Leak in the plumbing system
- 14 Backflow through sanitary appliance drains
- 15 Backflow through an unsealed or poorly sealed cleanout cover

## EXAMPLES OF PREDISPOSITIONS TO DAMAGE

- 1 Living space and valuable property below potential water level (or protection objective)
- 2 Slopes that direct surface water toward foundations
- 3 No gutters on a sloped roof
- 4 Combined drainage system (storm and sanitary sewer)
- 5 Non-resilient or non-resistant materials and assemblies (e.g., porous materials)



# INFORMATION CAPSULE

## IMPACT OF WATER ON MATERIALS

What are the effects of **liquid** water on an old building?



Liquid water can enter a building during a flood, torrential rain, or a sewer backup. Porous materials then absorb the water through capillary action.

Water, whether clean or contaminated, can leave marks on materials as they dry, such as carbonate stains, efflorescence, or other discoloration. When drying occurs under proper conditions and within a reasonable timeframe, these issues are generally cosmetic in nature.

Floodwater, whether from rain or rivers, generally contains suspended solids, as well as salts and other soluble components. Some of these substances may be pollutants. As it is absorbed by porous materials, the water carries these soluble substances with it. During drying, salts can crystallize on the surface—a phenomenon known as efflorescence—but also inside the materials. The formation of crystals can then generate internal pressures capable of disintegrating, for example, stone, brick, and mortar.

Some materials can dissolve upon contact with water, such as plaster. Prolonged exposure to liquid water can also promote the growth of mold and rot.

What are the effects of **frozen** water on an old building?



When liquid water freezes into ice, its volume increases by 9%. The formation of ice crystals and ice lenses can exert pressure on materials and cause them to crack. Thus, freeze-thaw cycles can lead to the separation and disintegration of masonry components (stone, brick, mortar).

On a roof, snow can melt locally when certain areas are warmer, particularly due to poor attic insulation, insulation in contact with the decking, or inadequate ventilation beneath the roof deck. The water formed in this way flows down and then freezes lower on the roof, creating ice dams that block the flow of water. The water can then back up under the roof's seal and seep into the building.

What are the effects of water as **vapor** on an old building?

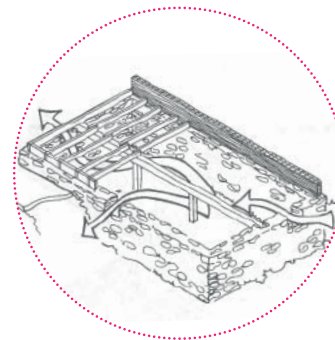


Porous materials are affected by humidity or dryness (hygroscopicity). They constantly seek to balance their water content with that of the surrounding air. They absorb water vapor when the air is humid and release it when the air is dry. For some materials, such as wood, an increase in moisture content causes swelling, while a decrease causes shrinkage.

Molds are fungi that grow on damp surfaces, while rot fungi grow within damp materials and feed on them by decomposing them.

In summer, warm, humid air enters through open windows or basement vents, which can cause condensation if there are cold spots on floor materials. Materials dry out when liquid water turns into vapor, a process aided by heat and ventilation.

Fungal growth depends on the moisture content of the porous material. If materials remain damp after a flood, repeated water infiltration, or recurring condensation, the time it takes for mold to appear depends on the type of fungus and the ambient temperature: in warm weather, it can appear in less than 72 hours.



Crawl space ventilation  
© Jules Auger

# INFORMATION CAPSULE

## IMPACT OF WATER ON MATERIALS

How do materials react to water?



Water is **one of the main causes of damage** in buildings.

Most of the materials and assemblies that make up a wall, floor, or roof react poorly to moisture and, even more so, to immersion. Their durability and performance depend on their **resistance to water absorption** and, once wet, **their ability to dry quickly**.

Some materials must be **protected from water** at all costs, such as fiberglass insulation (loose or in batt form), which, when wet, becomes compacted and permanently loses its shape and properties. The best wall, floor, or roof assembly is always one that allows **water to drain** and **moisture to escape** quickly, thereby limiting damage to materials and the building.

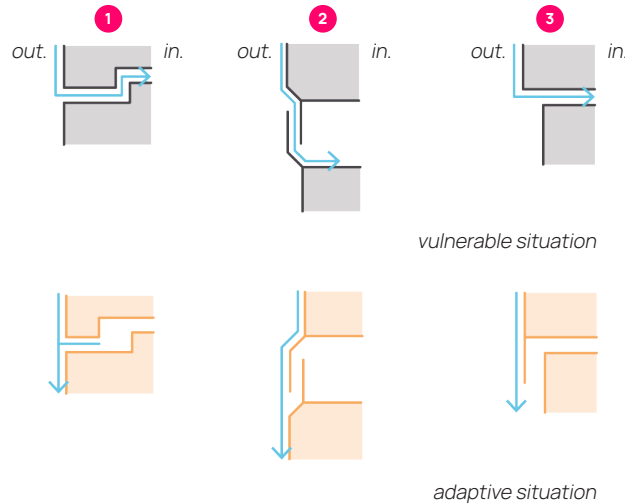
How does liquid water circulate in materials and gaps?



Liquid water flows easily through **porous materials** and the **spaces between materials** (gaps) in wall, floor, or roof assemblies through three mechanisms:

- 1 **Capillarity** (rising through pores and gaps between materials)
- 2 **Gravity**
- 3 **Pressure** (pressurized water, wind, etc.)

Most building materials are porous. This means that they are made up of a solid part and small interconnected cavities (pores) that can contain air or water. When these materials come into contact with liquid water, the water can **flow inside these pores** and **move through the material**.



What are the effects of water on materials?



When a material remains damp or submerged for too long, it deteriorates. Here are the main problems:

- 1 **Swelling**: the material swells and loses its shape (either uniformly or irregularly).
- 2 **Deformation**: through twisting or bending.
- 3 **Mold**: mold growth can occur when the relative humidity in the air exceeds 70%. On a cold surface, the risk and extent of mold growth increase as relative humidity rises.
- 4 **Rot**: optimal rot growth at a water content of 28% or above.



# INFORMATION CAPSULE

## IMPACT OF WATER ON MATERIALS

Drying and humidity control:  
what do you need to know?



The **building envelope** controls heat (insulation), air movement (air barrier), and water vapor transmission (properly positioned vapor barrier). Every movement of air carries moisture, which must be removed to prevent accumulation. To achieve this, walls and roofs must be designed with an **air barrier system** that prevents air circulation. An **interior vapor barrier** prevents vapor migration within **material assemblies capable of drying out depending on the seasons and conditions of use**. It is essential to ensure that no material on the cold side of the vapor barrier acts as a second vapor barrier. If vapor moves inside exterior walls, it may condense, especially in winter, which can cause damage.

**Moisture control and drying** are also particularly sensitive issues in **finished basements**. Historically not intended for habitation, they are particularly **vulnerable to moisture and flooding**, especially when located in basins or runoff areas. Common wall and floor assemblies can warp, lose their properties, and deteriorate rapidly as a result of infiltration or flooding, causing **damage and waste** production.



Waterproofing and water  
resistance:  
what's the difference?



**Waterproofing** consists of **preventing water from freely penetrating a surface, joint, or assembly**. It can be achieved using impermeable materials (such as plastic membranes) or porous materials with sealed joints that dry quickly, such as well-protected plywood. This is referred to as weather-resistant barrier. However, it is important to note that if water remains trapped behind a barrier that is too waterproof, it can cause dampness, mold, or rot.

**Water resistance**, on the other hand, means **completely blocking water**. However, in construction, it is unrealistic to aim for a 100% water-resistant assembly, especially in the long term. The goal is not to create a perfect barrier, but rather a system that combines **water resistance with a second line of defense**. This way, if water or vapor seeps in, it must be able to escape and allow the materials to dry.

What is overall resilience  
performance?



The **overall resilience performance** of a building reflects its **ability to limit damage caused by water and quickly return to normal function** after an episode of moisture or flooding. It is based on three essential aspects:

- Rapid evacuation of liquid water and effective drying: assemblies must allow moisture to escape to prevent it from stagnating in the materials.
- Physical stability: materials must retain their shape and not deform significantly when exposed to water.
- Maintenance of functional properties: materials must retain their initial performance, such as their insulating power or mechanical strength, after being exposed to water.

A building with high overall resilience **suffers less damage, reduces the need to replace materials, and limits the costs associated with repair and reconstruction** after a disaster.



# EXAMPLES OF DAMAGE

CAUSED BY WATER INFILTRATION THROUGH THE ROOF OR EXTERIOR WALLS



© Maisons anciennes du Québec



© Écohabitation



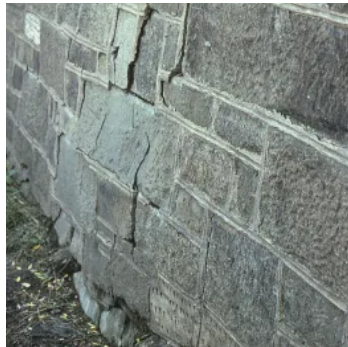
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© Centre de conservation du Québec (MCC)

# EXAMPLES OF DAMAGE

CAUSED BY WATER INFILTRATION THROUGH THE ROOF, EXTERIOR WALLS, SUBMERSION **1**, OR HYDROSTATIC PRESSURE **2**



# BECOMING AWARE OF THE RISKS

To identify potential vulnerabilities in a building, a series of steps is proposed to gain a better understanding of the building, its context, its water-related systems, as well as the people and regulations involved.

⚠ This list does not provide an accurate risk assessment.

## 1 CONTEXT

⚠ Avoid implementing any measures that could cause problems elsewhere or damage the building itself.

⚠ Always work with a qualified professional

- Specialized, accredited resources, with requests for referrals
- Make the most of the expertise of craftsmen specializing in historic buildings. Specialized resources for historic buildings: CMAQ (Conseil des métiers d'art du Québec) directory of craftsmen, Maisons Anciennes du Québec directory of craftsmen.

### Regulations

- To learn about applicable regulations, consult qualified professionals.
- Comply with the requirements of the National Building Code.
- ⚠ Not all provisions of the Code apply to older buildings. It is possible to request different and/or equivalent measures. To do so, construction professionals must be consulted.
- Obtain the necessary authorizations and permits, where applicable, before undertaking any work.
- Consult your municipality to determine the conditions applicable in flood zones under the modernized regulatory framework for water-related areas, based on the hazard intensity class.
- In certain areas, preliminary archaeological surveys may be required. If archaeological material is discovered by chance, it must be reported to the MCC (a requirement under the Cultural Heritage Act).

### Grants and consulting assistance available

- Check with certain municipalities

### Preserving the building's authenticity

- Prioritize a case-by-case approach.
- ⚠ If the building is old:
  - Check with local or regional authorities to find out if the building has a legal protection status under a law or regulation, or if it is listed in the RCM's or municipality's inventory. These same authorities can help determine the building's year of construction, as well as the list of potential renovations that have been carried out since then.
  - For any older building, prioritize reversible, minimal interventions (to preserve the integrity of characteristic features as much as possible) and customized solutions (to respect the building's uniqueness and make changes step by step).

### History of flooding:

Previously flooded

Frequency:.....

Source (flood, rain, etc.):.....

Type (runoff, infiltration, backflow, etc.):.....

Water entry points :.....

Never flooded

I don't know

### Location:

Building located in flood zones (FZ)

Area exposed to heavy rainfall

Area in basins or depressions

Area near a rainwater collector

Access route that remains passable in case of flooding

### Groundwater level:

Reaches the foundation permanently

Sometimes reaches the foundation

Deeper than the foundation

### Soil type:

Sandy soil

Clay soil

Loamy soil

Organic soil (peat, marshy)

Gravelly soil

### Water drainage systems:

Combined system (sewage + rainwater in the same pipe)

Separate system (separate sewage and rainwater pipes)

Autonomous system (septic tank and drainage field)

# BECOMING AWARE OF THE RISKS

To identify potential vulnerabilities in a building, a series of steps is proposed to gain a better understanding of the building, its context, its water-related systems, as well as the people and regulations involved.

⚠ This list does not provide an accurate risk assessment.

## 2 BUILDING CHARACTERISTICS

### Type of building:

- Year of construction: .....
- History of repairs
- Type of building
- Type and condition of foundation walls\*
- Type of crawl space (basement, utility, navigable)
- Above-ground structure (load-bearing brick, timber frame, etc.)
- Type of siding
- Shape and type of roof
- Adjacent properties (feasibility of work)

### Position of openings and access points:

- Windows and access points located below the protection objective
- Windows and access points located below ground level
- Access on a counter slope (or sunken courtyard)
- No emergency exit above the potential water level

### Envelope:

- Cracks in foundation walls
- Leaky joints around doors and windows
- Joints between the exterior wall and foundation (base plate) below the potential water level.
- Brick vents and holes in a masonry wall
- Unprotected mechanical vents and openings

### Interior layout:

- Finished basement
- Bedrooms and/or kitchen in the basement
- Finishing and insulation materials that are not water-compatible
- Electrical and mechanical equipment (e.g., electrical panel, air conditioning system, etc.) located in the basement
- Appliances located in the basement
- Valuables located in the basement

## 3 OUTDOOR WATER MANAGEMENT

### Slope of the land:

- Towards the house (increases risk)
- Away from the building
- Variable

### Flooring and green infrastructure:

- Mostly impervious (asphalt, concrete)
- Green or permeable
- Presence of retention ponds or rain gardens (not connected to roof drains)
- Presence of retention ponds or rain gardens (connected to roof drains)

### Protective devices:

- Curbs
- Low walls, levees
- Semi-permanent flood barriers
- None

### Roof drain:

- Flat roof with internal drain (connected to the network)
- Flat roof with disconnected drain
- Sloped roof with external gutters
- Sloped roof with gutters and downspouts connected to French drain
- Well maintained and inspected annually

### Foundation drain:

- Present
- Maintained/inspected regularly
- Absent (built before 1955)
- Connected to an interior sump
- No interior sump (drains by gravity to a ditch or other device)

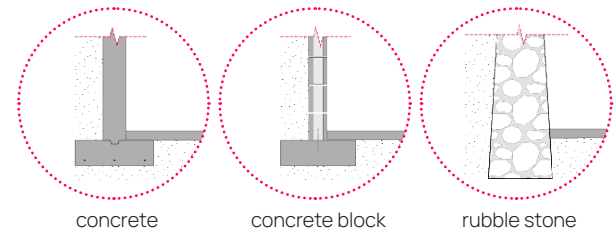
### Sump (connected to the drainage system):

- No sump
- Sump without pump
- Sump pump
- Pump with backup power supply (battery/generator)
- Pump without backup power supply
- Pumping capacity adapted to heavy rainfall
- Sealed sump cover
- Unsealed sump cover

### Pump discharge:

- Pump discharge at a safe distance from the foundation and to a suitable outlet
- Too close or to a system that may become overloaded in the event of extreme rainfall
- Well maintained and inspected annually

### Examples of foundation walls\*



# BECOMING AWARE OF THE RISKS

## 4 INTERIOR WATER MANAGEMENT

### Connection points below outdoor ground level:

- Toilets
- Washbasins
- Sinks
- Baths/showers
- Washing machines
- Floor drains at the lowest level

### Check valves:

- Normally open valve (main pipe)
- Normally closed valves on secondary pipes or appliance returns
- Sealed manhole cover
- Unsealed manhole cover
- No manhole
- Well maintained and inspected annually
- Never maintained

### Specialized pumps (for discharge/flooding):

- Installed and maintained
- Installed and poorly maintained
- Available, but not installed
- Absent
- With backup power supply (battery/generator)
- Without backup power supply

## 5 PROFILE OF OCCUPANTS

### Occupancy status:

- Owner-occupant
- Co-owner
- Tenant
- Temporarily occupied building
- Permanently occupied building

### Financial capacity and insurability:

- Access to adequate coverage
- Possession of financial resources for prevention or reconstruction
- Access to subsidies or financial assistance for prevention or reconstruction

### Cognitive and psychological capacity:

- Understanding of risk
- Able to make decisions in emergency situations
- Stress tolerance

### Physical abilities:

- High mobility and physical strength
- Good mobility and physical strength
- Reduced mobility

# WATER PATHWAYS

The ***Water Pathways*** booklet presents measures that help reduce the volume and flow of water toward an exposed structure. The sheets cover topics such as roof and foundation drainage systems, permeable paving, retention gardens, and protective coverings for openings.



# WATER PATHWAYS

There are several **measures** that help maximize water infiltration into the ground, temporarily accumulate it, or direct it away from vulnerable elements.

In order to implement a strategy that specifically aims to reduce the amount of water entering the building, it is first important to understand how water circulates around a building, both **normally** and in the event of an **extreme flood event**.

There are three pathways for water around, in, and under a building:

## EXTERIOR DRAINAGE

### B1 SLOPING ROOF

Rainwater runs off sloping roofs and into gutters, then accumulates on canopies.

### B2 FLAT ROOF

Rainwater runs off flat roofs very slowly and flows into roof drains.

### B3 LANDSCAPING

Runoff accumulates on the grounds and infiltrates the soil through various devices.

### B4 SEALING OPENINGS

Runoff that reaches the building can be blocked by protective devices at the openings.

## FOUNDATION DRAINAGE

### B5 SURFACE WATER DIVERSION

Runoff accumulates on the ground and can be directed or blocked by various devices.

### B6 GROUNDWATER MANAGEMENT

Rainwater and surface water seep into the ground (groundwater) and are collected by foundation drains, if any.

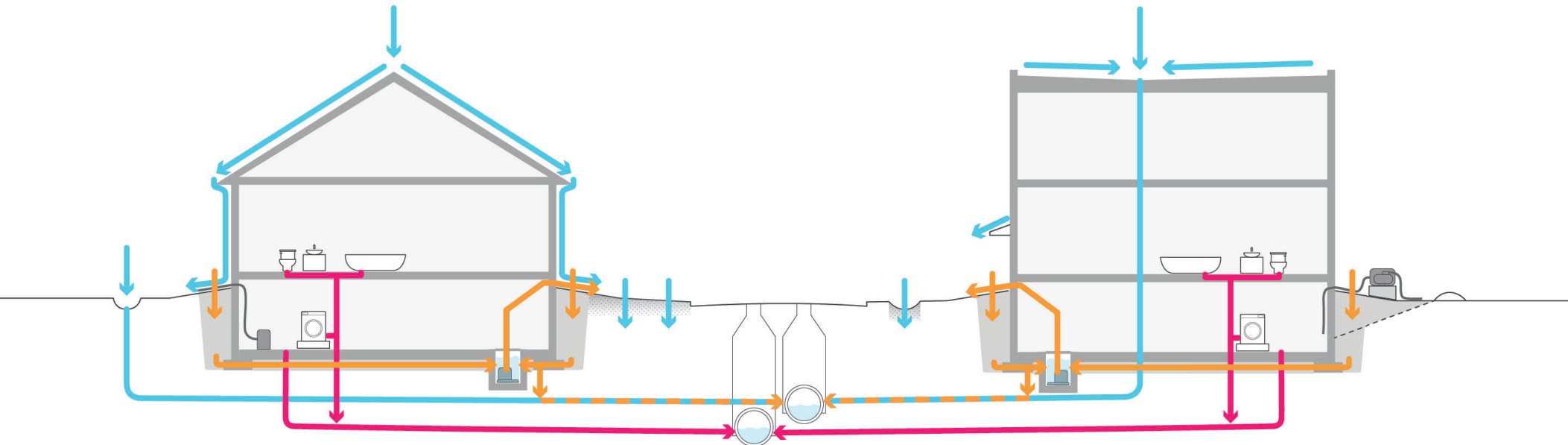
## INTERIOR DRAINAGE

### B7 CHECK VALVE

The passage of sewage is regulated by valves built into the drainage systems.

### B8 SURFACE WATER COLLECTION

Floodwater (all types) can be managed partly by pumps.



# EXTERIOR

## WATER MANAGEMENT

### B1 SLOPED ROOF DRAINAGE

**B1a** Gutter / drain disconnection

**B1b** Old roof coverings

### B2 FLAT ROOF DRAINAGE

**B2a** Control of water discharge flow rate

**B2b** Green roof

**B2c** Blue roof

**B2d** Disconnection of roof drain

1/2

**B2d** Disconnection of flat roof drain

2/2

### B3 LANDSCAPING

**B3a** Permeable and sloped surfaces

**B3b** Rain garden

**B3c** Retention and infiltration basins

**B3d** Shore development

**B3e** Outdoor parking

**B3f** Underground development

**B3g** Landscaping of entrances

**B3h** Drainage ditch

### B4 SEALING OF OPENINGS

**B4a** Permanent devices

1/2

**B4a** Permanent devices

2/2

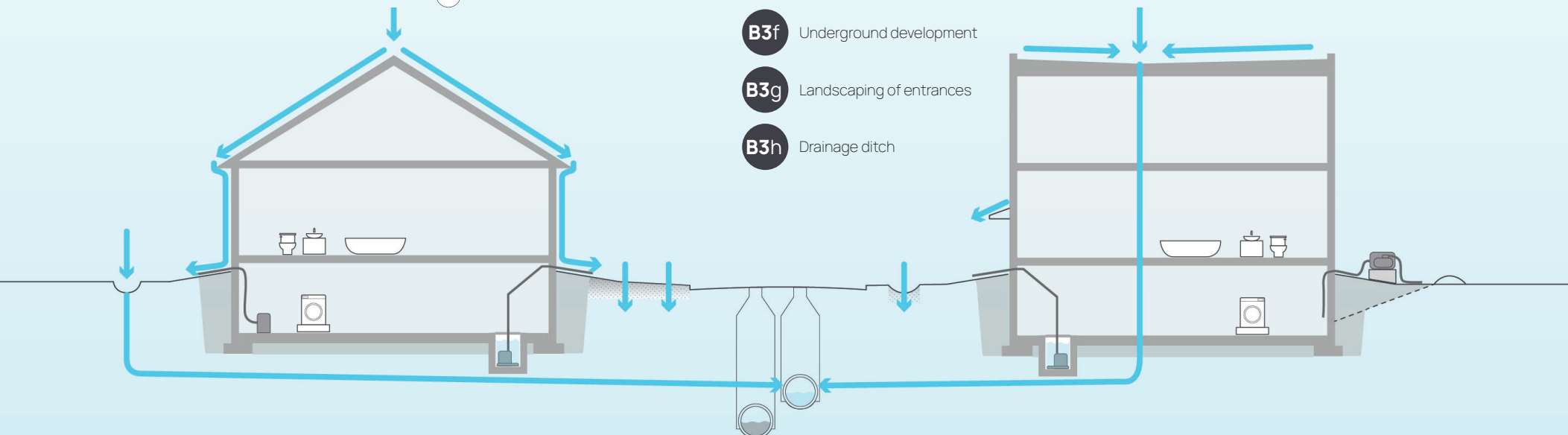
**B4b** Temporary devices

1/2

**B4b** Temporary devices

2/2

**B4c** Passive devices



# B1

# SLOPED ROOF DRAINAGE

## WHAT IS IT FOR?

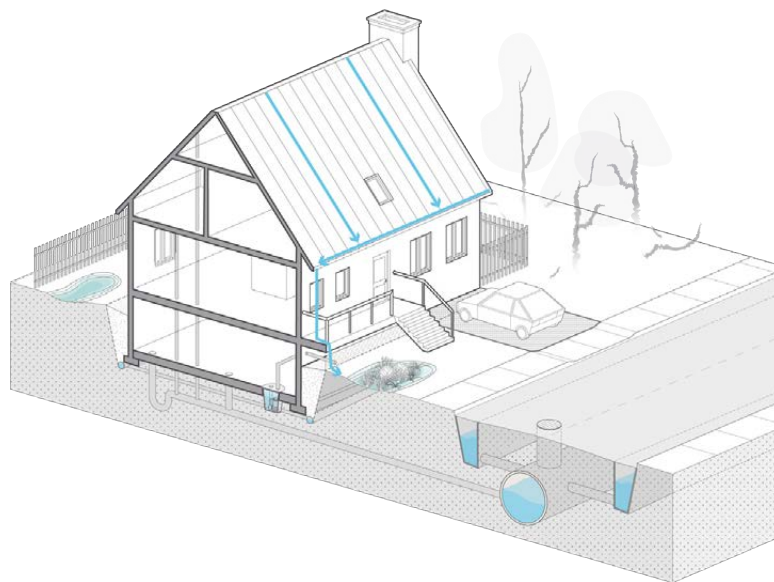
A **sloped roof drainage system** consists of gutters attached under the edge of the roof that are designed to collect and direct rainwater or snowmelt to permeable surfaces or systems designed to infiltrate or accumulate water.

Key objectives of **sloped roof drainage** in the face of flood risk:

- Direct water away from the building and towards a **permeable surface**.
- Reduce **overload on the foundation drainage system** (individual objective).
- Reduce or slow the flow of water entering the **municipal system** (collective objective).

## ADVANTAGES

- Opportunity to reuse rainwater (for toilet flushing or watering) and reduce drinking water consumption.
- Reduction of solar overheating by adding awnings.
- Reduction of the risk of premature wear caused by water running down the facades.



## WHERE TO START?

**Understand the risk** → 🏠

### Know the characteristics of the system

- Are there gutters and downspouts?
- Is there a foundation drain?
- What are the dimensions and condition of the drains and gutters?
  - Obstructions, cracks, etc.
- Where do the gutters drain?
  - On the ground towards a garden or the street, towards foundation drains, towards the city sewer system, or into a water collection system.
- Are there any areas that overflow during heavy rains?

### Identify the regulations and standards in force

- Government (modernized framework for water environments, Construction Code, etc.)
- Municipality

**Seek professional assistance** → 🚧

- Ensure that water is directed to the right place and prevent it from causing problems elsewhere.

### Choose an appropriate strategy

#### Scenario 1

The gutter drains onto the property.

Manage the direction of the water with the slopes of the property to protect the foundation and ensure that gutters are installed at the edge of the roof, that they are functional, and that they do not drain too close to the foundation.

↑↑↑ \$\$\$

#### Scenario 2

The sloped roof does not have a rainwater collection system.

Assess how gutters can be installed independently of the municipal network while respecting the infiltration capacity of the soil and without sending water onto the neighbouring property.

↑↑↑ \$\$\$

#### Scenario 3

##### GUTTER / DRAIN DISCONNECTION

Assess municipal requirements for disconnecting your gutter from the foundation drain in order to discharge the municipal system.

↑↑↑ \$\$\$

##### OLD ROOF COVERINGS

↑↑↑ \$\$\$

→ B1a

→ B1b



### Regulations

Municipalities are increasingly requiring that gutters be disconnected from foundation drains.



### Financial assistance program

Check the municipality's website for information on disconnecting gutters from foundation drains.

# B1a

## SLOPED ROOF DRAINAGE

# GUTTER / DRAIN DISCONNECTION

### Types of buildings



### Expertise required

Contractor specializing in gutters: design and installation.



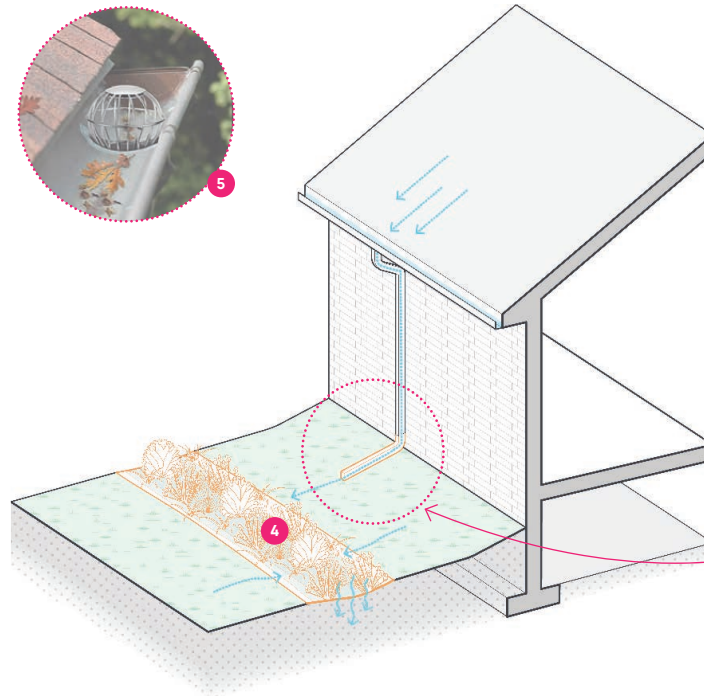
### Regulations

Some municipalities prohibit directing water from gutters onto impermeable surfaces.

Example of CMM regulations, 2008-47, section 3:

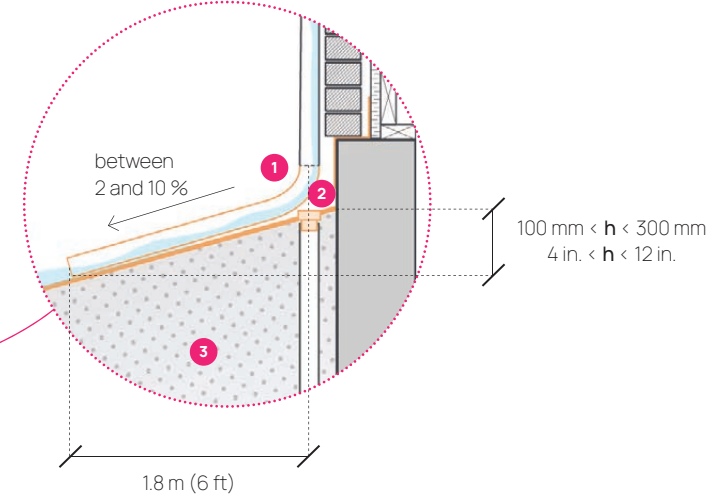
c) When roof drainage water is collected by a system of gutters and external downspouts, this water must be directed onto the ground at least 1.5 m from a building, avoiding infiltration into any foundation drain.

If the **gutters** are connected to the foundation drain or the municipal system, they must be **disconnected** to direct water away from the foundation and, ideally, to retention or infiltration area. → **B3**



⚠ Maintain your gutters twice a year to prevent clogging:

- In the fall to remove dead leaves from the horizontal sections.
- In the spring to clear the outlets



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Cut the gutter at a height of **250 mm (10 in.)** from ground level.
- 2 Close the drain that comes out of the ground with a **plug** (cleanout).
- 3 Connect a gutter extension (or deflector) of at least 1.5 m, but **1.8 m (6 ft)** is recommended to direct water away from the foundation, with a slope of at least 2%, but **10%** is recommended (1:10).
- 4 Direct water to a rain garden → **B3b**, a permeable surface → **B3a**, or a water collection barrel.

## RECOMMENDATIONS

- Install **gutters** for all drained surfaces (roofs, but also permeable surfaces such as balconies or terraces, etc.), **roof drip edge** for protruding elements, and **scuppers** in case of **overflow**.
- **Oversize** the downspout to prevent clogging.
- Ensure that the various gutter components are **securely attached** to each other to withstand water pressure.
- Install a **gutter guard** in the gutter opening to prevent leaves from entering the downspout. **5**

# B1b

## Types of buildings



## Expertise required

**Roofing contractor:** with proven experience in traditional materials and construction methods (batten seam or Canadian-style metal roofing, slate or cedar shingles, standing seam metal roofing, etc.).



## Regulations

Importance of preserving the building's heritage value.  
Obtain the necessary authorizations and permits, where applicable, prior to any work.

## For more information:

**For homeowners:**  
see APCHQ training courses.  
**For professionals:**  
see CMAQ training on sheet metal work and AMCQ.

## SLOPED ROOF DRAINAGE

# OLD ROOF COVERINGS

Effective roof water management is the first line of defense against moisture-related damage to the entire building. For a pitched roof on an older building, **drainage must:**

- Ensure rapid, unimpeded runoff of rainwater from the ridge (top of the roof) to the gutters, to prevent stagnation and infiltration that could compromise the structure.
- Protect vulnerable areas, such as penetrations (chimneys, skylights, vents) and valleys, which are exposed in winter to ice dams that can cause water to back up under the roofing material.

## CONSIDERATIONS

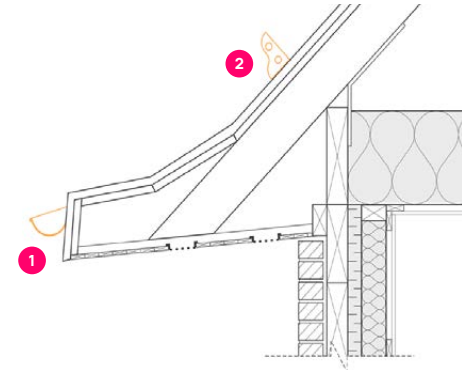
- Respect for the characteristics of the historic building: year of construction, materials, shapes, etc.
- Spot repairs on a cedar shingle roof are possible, but the degree of difficulty depends on the extent of the damage and its location on the roof.

## PRELIMINARY STEPS

### Assess the condition of the roof and identify potential vulnerabilities:

- Identify potential areas of water infiltration. During or after heavy rain, a thorough inspection can help pinpoint the source, which may be located well above the visible signs of damage.
- Identify abnormal runoff, areas of standing water, or signs of water infiltration (stains, wet wood, mold, and rot).
- Pay particular attention to spring thaw periods, which are conducive to the formation of ice dams.
- Before beginning work, remove the affected section of shingles as needed to assess the extent of the problem, and temporarily cover the opening.
- Moisture damage observed on exterior walls or interior ceilings often stems from roofing issues. Check for signs of water rings or falling plaster or drywall inside.
- Examine the condition of the exposed flashing, which must fit perfectly and be free of corrosion.
- Check the integrity of the gutters and downspouts each season, ensuring they are securely fastened, properly sloped, and free of debris.
- Identify the materials present to ensure the repair method is appropriate.

▲ Perform regular and thorough maintenance on the roof.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 Cedar Shingle Roofing

#### Maintenance and repair work:

- Use high-quality, knot-free, sapwood-free Class A or 1 shingles.
- Apply an opaque oil-based or alkyd paint or stain to the shingles to extend the roof's lifespan, except in areas with salty air and strong winds.
- Ensure adequate ventilation under the shingles to facilitate drying.
- For spot repairs, choose shingles of the same thickness as those already in place.

### 2 Metal roofing

#### Maintenance work:

- Check the fastenings and condition of nails/screws, mastic, and caulking, where visible.
- When applicable, apply a specialized paint to properly prepared surfaces.

#### Post-infiltration repairs:

- Remove sections of metal sheeting to access the wooden substrate and replace any rotten wood.
- Apply a waterproofing membrane and, if necessary, flashing.
- Reinstall the roofing.

#### Preventing gutter detachment on a metal roof:

- Position the gutter under the roof overhang and leave clearance so that falling snow can pass without dislodging the gutter.
- Ensure that the diameter of the gutters and downspouts is proportional to the size of the roof and the potential volume of water to be drained.
  - Increasing the diameter of the gutters improves water drainage during heavy rain.
- Install **sturdy ice guards** on the roof to prevent sliding ice sheets from tearing off the gutters and/or causing ice falls.

# B2

# FLAT ROOF DRAINAGE



## Regulations

Provincial - Construction Code

The maximum allowable water accumulation height for a roof is 150 mm (6 in.).

Standardize with:  
Chapter I of the QCC (Building).  
Chapter III of the QCC (Plumbing).  
PL-6 CMMTQ (RBQ).  
PL-43 CMMTQ (RBQ).  
PL-52 CMMTQ (RBQ).

See also municipal regulations for limited discharge rates (Montreal and Quebec City).

⚠ It is advisable to call in professionals to implement these scenarios in order to control the flow of water drained and reduce the risk of infiltration.

It is important to learn about maintenance: there is a high risk of drain blockages.

## WHAT IS IT FOR?

A **flat roof drainage system** allows rainwater or snowmelt accumulated on flat roofs to be drained away. It plays a crucial role in rainwater management and the prevention of infiltration or structural damage caused by water accumulation.

These systems may include drains, pipes, and emergency overflow devices.

### ⚠ Risk of self-flooding or flooding of neighbours:

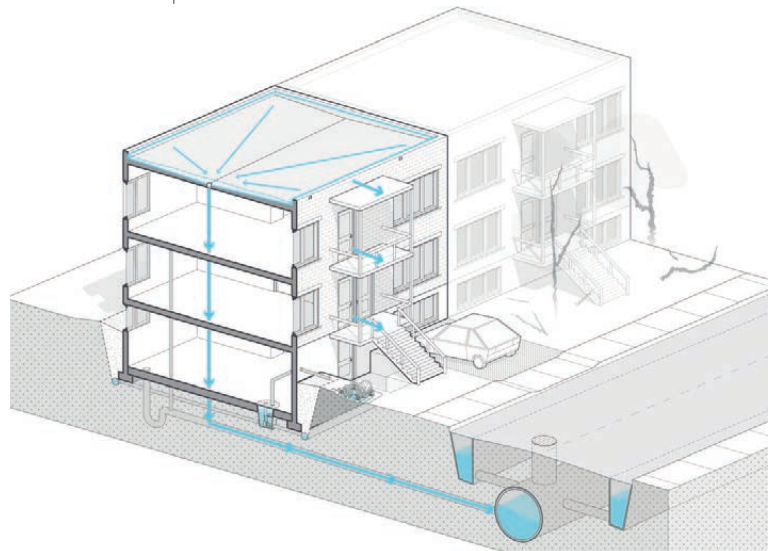
- Self-flooding occurs when rainwater is collected by a combined plumbing pipe (sanitary and storm) and cannot be properly drained due to an overload in the sewer system.  
E.g., water from a flat roof can then come back up through plumbing fixtures that are not protected by a backwater valve on the upper floors of the building.

Key objectives of **flat roof drainage** in the face of flood risk:

- 🕒 Reduce or slow down the flow of water entering the water management system (collective objective).
- 🕒 Reduce the risk of self-flooding (individual objective).

## ADVANTAGE

- Opportunity to reuse rainwater (for toilet flushing or watering) and reduce drinking water consumption.



## WHERE TO START?

Understand the risk → 🏠

### Know the characteristics of the system

- What are the dimensions and the condition of the drains and gutters?  
Obstructions, cracks, etc.
- Where do the drains discharge?  
To a combined sewer system, a rainwater system, onto the ground, or into a water recovery system
- Has there ever been an overflow from the roof drainage system?
- If the system passes through a sump (e.g., foundation drain): are there maintenance manholes? What is their condition?
- Is the roof in good enough condition? (structure, membrane)

### Identify the regulations and standards in force

- Check the limits for water accumulation on the roof.
- Check the limits for rainwater runoff at the property line.
- Check the retention requirements.
- Check the limits on outdoor areas where water can be discharged.

Seek professional assistance → 🚧

- Ensure that water is directed to the right place and prevent it from causing problems elsewhere.

### Choose an appropriate strategy (one or more combined measures)

#### CONTROL OF WATER DISCHARGE FLOW RATE

The most affordable option if regulations and roof structure allow for 150 mm (6 in.) of water to be retained without causing infiltration problems.

111 \$\$\$

B2a

#### GREEN ROOF BLUE ROOF

Same water retention as B2a, but less affordable.

Recommended for major repairs.

111 \$\$\$

B2b

B2c

#### DISCONNECTION OF ROOF DRAIN

More effective than B2a when combined with measure B3.

Ideal for flat and sloped roofs if the site allows it.

Possible for old roofs (2/2).

111 \$\$\$

B2d

# B2a

## FLAT ROOF DRAINAGE

# CONTROL OF WATER DISCHARGE FLOW RATE

### Types of buildings



### Expertise required

**Roofing:** installation of the drain, inspection of the roof and parapets.

**Architecture:** integration into the roof.

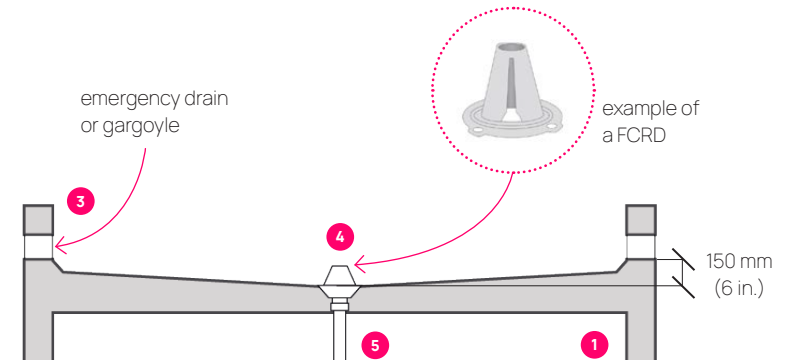
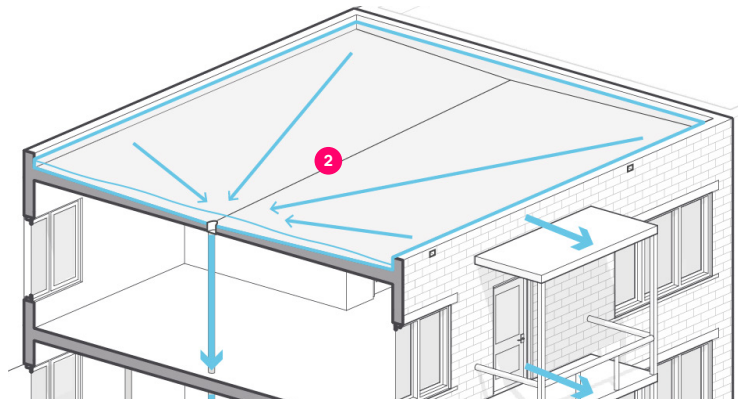


### Regulations

Chapter I of the QCC (Building).  
Chapter III of the QCC (Plumbing).  
PL-43 CMMTQ (RBQ).

See also municipal regulations for limited discharge rates (Montreal and Quebec City).

**Flow-controlled roof drains (FCRD)** are roof drainage devices designed to **modulate** the drainage of rainwater, by delaying or reducing the flow rate, preventing overload of the drainage system, particularly during heavy rainfall.



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 **Verify that the roof structure can support the additional water load.**
  - ⚠ Limit water accumulation on the roof to a maximum height of **150 mm (6 in.)** at the lowest point of the slope.
- 2 **Identify the maximum capacity of the basins.**
  - The capacity of a FCRD is 900 m<sup>3</sup> (approximately 9,700 ft<sup>3</sup>).
- 3 **Install emergency drainage systems in case of overflow**
  - Overflow: allows drainage through the internal drainage system.
  - Emergency drain or gargoyle: drainage to another roof or to the ground.
  - ⚠ Mandatory devices for draining excess water; ensure there is sufficient capacity.
- 4 **Check the correct location of the FCRD so that temporary water accumulation during heavy rains does not damage the roof.**
  - Maximum 15 m (50 ft) from the edge of the roof.
  - 30 m (100 ft) from adjacent drains.
- 5 **Consult a professional to ensure that the product chosen is suitable for your roof.**

## RECOMMENDATIONS

- Choose a **drain** that is suitable for the size of the roof and the climatic conditions.
- Comply with local **standards** and **regulations**.
- Ensure that the devices are correctly **installed** and **positioned**.
  - Check the condition of the waterproofing and integrity of the roof and new drainage elements, as well as their solid installation to withstand water pressure.

### ⚠ Perform regular maintenance.

- **Maintenance** of a FCRD system is crucial to avoid problems with water accumulation, leaks, or overloading of the drainage system.

#### By the owner:

- Inspect and clean **grates** and **filters** at least twice a year.
- Check that the **flow control mechanism** is working and clean it.
- Inspect **drainage pipes** for obstructions, cracks, or leaks.
- Monitor **system performance** after rainy periods.

# B2b

## Types of buildings



## Expertise required

**Architecture:** roof design, facade modification if required.

**Structure:** structural analysis.

**MEP:** drainage, automatic irrigation options, raising mechanical components.

**Plumbing:** addition of a water supply point.

**Landscape architecture:** choice of plants and maintenance (if required).



## Regulations

The QCC does not yet authorize green roofs. You must go through the equivalent or different measures mechanism, following the RBQ guide.

⚠ Request an exemption from the RBQ for water accumulation greater than 150 mm (6 in.) high.



## Financial assistance program

Possible subsidies from municipalities (e.g., Renoplex in Montreal).



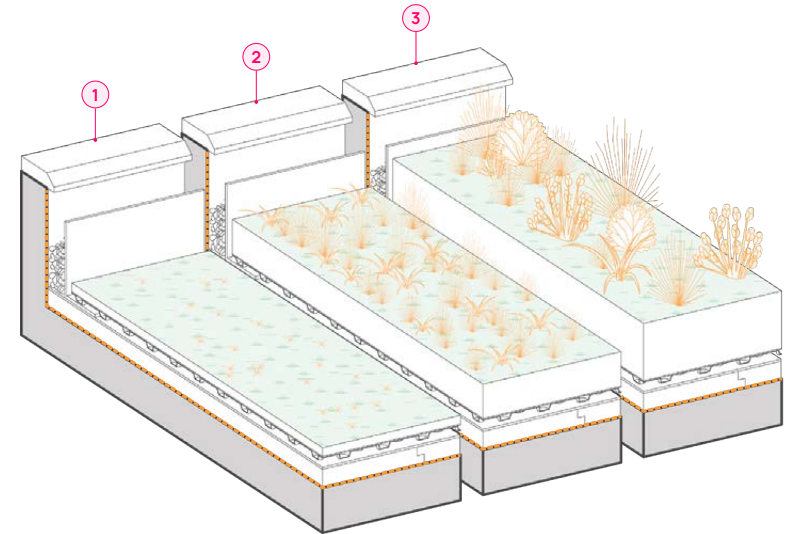
## FLAT ROOF DRAINAGE

# GREEN ROOF

A **green roof** (or vegetated roof) transforms a traditional roof into a green space. It **absorbs** and **drains** rainwater, reducing runoff and lowering the risk of sewer system overload during heavy rainfall, while ensuring waterproofing and drainage.

There are several types depending on the use and vegetation chosen:

- 1 **Extensive system:** thin layer of soil (150 mm, 6 in. substrate), little or no irrigation, with few plants.  
Load: 100 kg/m<sup>2</sup>, slope 20% max, low maintenance (1 to 2 times per year).
- 2 **Semi-intensive system:** thick layer of soil (substrate at least 300 mm, 12 in.), irrigated, with the development of perennials and shrubs.  
Load: 150 to 350 kg/m<sup>2</sup>, slope 20% max, medium maintenance (3 to 4 times per year).
- 3 **Intensive system:** thick soil layer (substrate of at least 300 mm, 12 in.), adds more weight to the roof, requires irrigation and drainage systems. The system is more complex and costly, but can offer additional uses for the roof.  
Load: > 600 kg/m<sup>2</sup>, slope 5% max, high maintenance (as much as a garden).



## ADVANTAGES

- **Improved thermal insulation** if the roof is not ventilated: reduced heating and air conditioning.
- **Reduction of urban heat islands:** lower surface temperatures.
- **Improved air quality:** oxygen production and pollution absorption.
- **Air cooling** through plant evapotranspiration.
- **Increased urban biodiversity:** habitat support (plants and animals).
- **Increased roof durability:** protection from weather and UV rays.
- **Increased usable space:** recreational space, relaxation, urban agriculture.

## CONSIDERATIONS

- A green roof must be easily accessible for maintenance and repairs.
- The load of a green roof could be supported by a wooden roof frame if the building is new, but this is difficult to achieve due to fire safety standards, structural reinforcement, and roof ventilation requirements.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### Structural reinforcement work.

### Composition :

- Suitable vegetation: type of roof, use, location, exposure, climate
- Substrate: thickness depending on the type of green roof
- Filter layer
- Drainage layer
- Honeycomb layer for rainwater storage
- Root protection layer
- Waterproofing membrane
- Support (load-bearing element)
- Insulation if required

# B2c

## Types of buildings



## Expertise required

**Architecture:** roof design, drainage basin, and facade modification if required.

**Structure:** analysis of the roof structure with the addition of weight.

**MEP:** drainage, automatic irrigation options, raising of mechanical components.



## Regulations

The QCC does not directly mention blue roofs.

However, structural requirements regarding water overload, waterproofing, and safety must be met.



## Commercial, industrial, institutional

Blue roofs are often installed, sometimes in combination with green roofs, to optimize water recovery surface area.

## FLAT ROOF DRAINAGE

# BLUE ROOF

A **blue roof** temporarily retains water (for a maximum of 24 hours) on the roof surface before it is **slowly drained** away to reduce the amount of rainwater on the ground and in the municipal system. It can be combined with a **green roof** → B2b.

This roofing system facilitates **water retention** while protecting the roof's waterproofing.

It can be finished with gravel, patio slabs, or green systems.

## ADVANTAGES

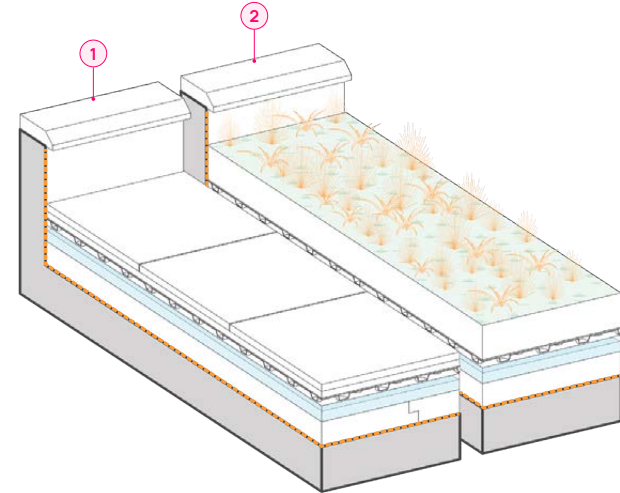
- Possibility of using **rainwater** for toilets or irrigation.
- **Regulations** of interior temperature and **reduction** of air conditioning costs.
- **Preservation of infrastructure:** reduction of runoff into sewers.
- **Increased roof durability:** protection from weather and UV rays.

## RECOMMENDATION

- Choose a high-quality **membrane** and ensure the quality of the installation to withstand water pressure.

## CONSIDERATIONS

- Plan for **structural reinforcement** work due to the weight of the water.
- Shorter **lifespan** (30 to 35 years) than a green roof, especially when exposed to freeze/thaw cycles.
- A blue roof must be **easily accessible** for maintenance and repairs.
- Respect **structural requirements** with regard to water overload, waterproofing, and safety.
- The **loads of a blue roof** cannot be supported by a wood-framed roof (with some exceptions).



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Blue roof
- 2 Green / blue roof

### Composition :

- Protective, permeable surface (paving)
- Hollow structure acting as a water reservoir and ballast
- Insulation that can be submerged in water
- Waterproofing membrane
- Flow-controlled roof drain drainage (FCRD) system → B2a
- Support: load-bearing element
- Insulation

Types of buildings



Expertise required

**Architecture:** condition of the roof and rainwater drainage system, if required.

**MEP:** verification of the drainage system and upgrading to standards if required.



Financial assistance program

Possible subsidies from municipalities



Regulations

Chapter III of the QCC (Plumbing).  
PL-52 CMMTQ (RBQ).

● check valve

↘ roof water discharge

— combined drainage

— rainwater drainage

— sewage drainage

— appliances below street level

- - - roof vent

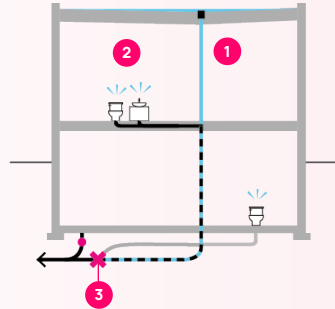
FLAT ROOF DRAINAGE

# DISCONNECTION OF ROOF DRAIN

Disconnecting the roof drain involves **separating** a building's **rainwater** and **sewage** drainage systems in order to **reduce** the amount of water entering the municipal system.

⚠️ Assess the feasibility of disconnecting from your own system as well as the municipal system with the help of a qualified professional to ensure that drains and pipes are properly sized. → ⚠️

## COMMON SITUATION



Water is directed to combined public sewers, which can overload the municipal system. When the system is overloaded, water may back up into the building or overflow from the roof.

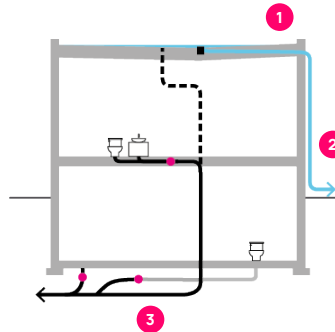
List of poor installations or potential vulnerabilities:

- 1 Combination of roof drain and sanitary system vent (from the roof).
- 2 Backflow of water from the roof through sanitary fixtures.
- 3 Backflow from the municipal combined sewer system.

## INSTALLATION SCENARIOS

Suggestions for better understanding the issues to be discussed with qualified individuals.

### DIRECT WATER TO A DRAINAGE SYSTEM OUTSIDE THE BUILDING



1 Install a new downspout with a roof drain separate from the vent that runs **outside the building**, using a gutter, gargoyle, or vertical gutter.

⚠️ If the pipe passes through a heated attic, make sure to avoid thermal bridges and interruptions in the waterproofing.

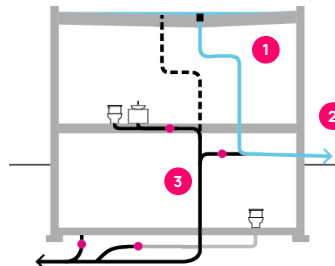
⚠️ To avoid the risk of freezing, a heating cable with a built-in thermostat can be added inside the pipe.

2 Drain water from the roof onto the ground around the building, into a cistern, or onto a suitable surface, rather than onto a mineral surface that leads directly to the municipal system. → B3

- Drainage channels or trenches can be installed to carry water to dispersion areas, such as dry wells or ditches.
- Water from the cistern can be collected and reused (watering, toilet flushing, etc.).

3 Install **check valves with cleaning ports**. → B7

### DIRECT WATER TO A PIPE SYSTEM THROUGH THE BUILDING



1 Install a new **interior** downspout with a roof drain separate from the vent.

2 In the event of municipal network overload, roof water is discharged onto the ground around the building, into a cistern, or onto a suitable surface, rather than onto a mineral surface that leads directly to the municipal network. → B3

3 Install **check valves with cleaning ports**. → B7

**Types of buildings**



**Expertise required**

**Professional plumber**, member of the Corporation des Maîtres Mécaniciens en Tuyauterie du Québec (CMMTQ): possessing in-depth knowledge of RBQ standards and sanitary and stormwater plumbing.

**Landscape architect or stormwater management specialist**: if required for exterior landscaping.



**Regulations**

Comply with the two configurations authorized by the Régie du Bâtiment du Québec (RBQ). → **B2d**

Check municipal regulations for the authorized location of stormwater discharge.

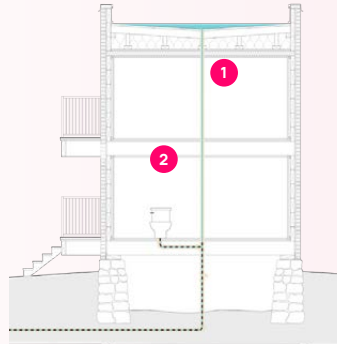
Obtain the necessary permits before beginning.

**FLAT ROOF DRAINAGE**

# DISCONNECTION OF FLAT ROOF DRAIN

In an older building with a flat roof, the roof drain may be connected to the wastewater system (toilets, sinks, showers).

**COMMON SITUATION**



⚠ Disconnecting the roof drain is a complex and costly procedure, recommended primarily for older buildings where the roof drain is directly connected to a combined sewer system and poses a high risk of backflow. Seek assistance from a qualified professional. →

During heavy rain or a backflow in the municipal sewer system, the flow may be blocked, and rainwater accumulated on the roof may then back up through the roof drain and enter the building.

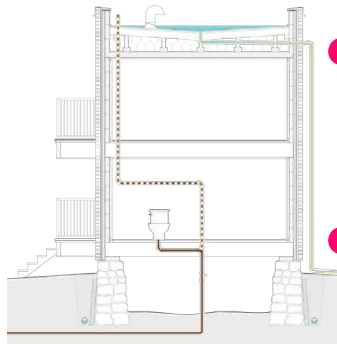
**List of improper installations or potential vulnerabilities:**

- 1 Combination of the roof drain and the roof sanitary system vent.
- 2 Backflow of roof water through plumbing fixtures.

**INSTALLATION SCENARIOS**

Suggestions for better understanding the issues to be discussed with qualified individuals.

**EXTERNAL DRAINAGE SYSTEM**

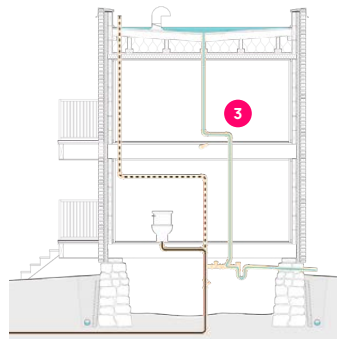


- Disconnect the roof drain from the sewer system.
- ⚠ The scope of the work will be greater if the existing roof drain is made of cast iron, as this requires careful disconnection.
- 1 Install a **roof vent** for the plumbing.
- Install **check valves** where required, with access ports for cleaning. →
- 2 Install a vent pipe to ventilate the roof and maintain the roof at outdoor temperature.

**OPTION 1**

- Reroute the roof drain pipe into the **heated attic**.
- ⚠ Plan to use a self-regulating heating cable to prevent ice blockages.
- Install a **new independent exterior downspout** that discharges water into a foundation drain, a rain garden, or a dry sump at the back of the yard.

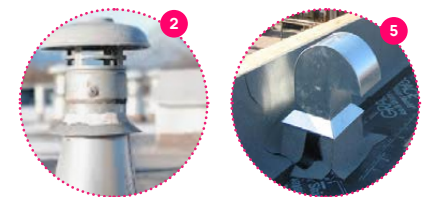
**INTERNAL PIPING SYSTEM**



**OPTION 2**

- Install a **new pipe inside** the building dedicated to rainwater that connects to the storm sewer or a sump pit.

⚠ \$\$\$



# B3

# LANDSCAPING



## Regulations

Under the modernized regulatory framework for aquatic environments, embankment construction is prohibited in flood zones (with some exceptions, see section 23, Rmun).

## WHAT IS IT FOR?

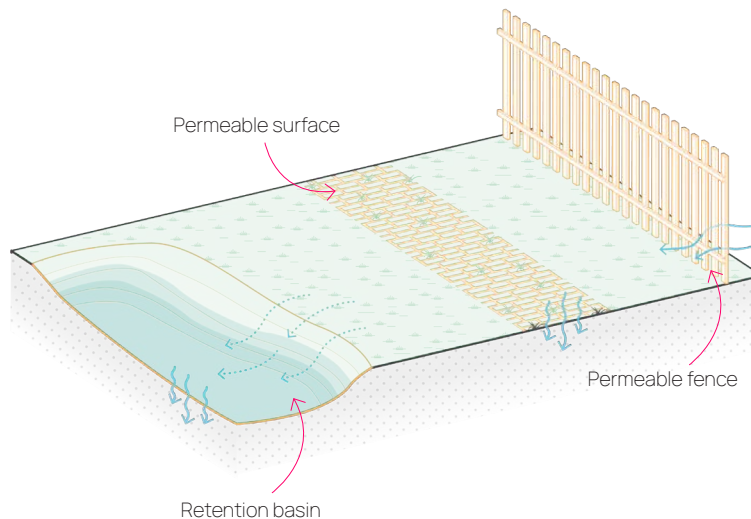
The creation of **resilient exterior spaces** reduces the effects of small-scale flooding or heavy rainfall by slowing down the flow of water and **reducing runoff**.

Key objectives of **flood-resilient landscaping**:

- **Divert water away** from the building and **direct it** to a permeable surface.
- **Reduce** or **slow the flow of water** entering the water management system

## ADVANTAGES

- Reduction of heat islands.
- Improved drainage following surface flooding.
- Reduction of the risk of water accumulation on the property during heavy rains.



## WHERE TO START?

**Understand the risk** →

**Know the characteristics of the terrain**

- What is the topography of the land?
  - Location of slopes and water flow in the event of flooding.
- What is the drainage system of the street and neighbourhood?
- What is the soil composition?
  - Sand, soil, clay, rock height, etc.
- Where are the underground utility lines located?
  - Water and gas lines.
- Are there any areas prone to overflowing during heavy rains?

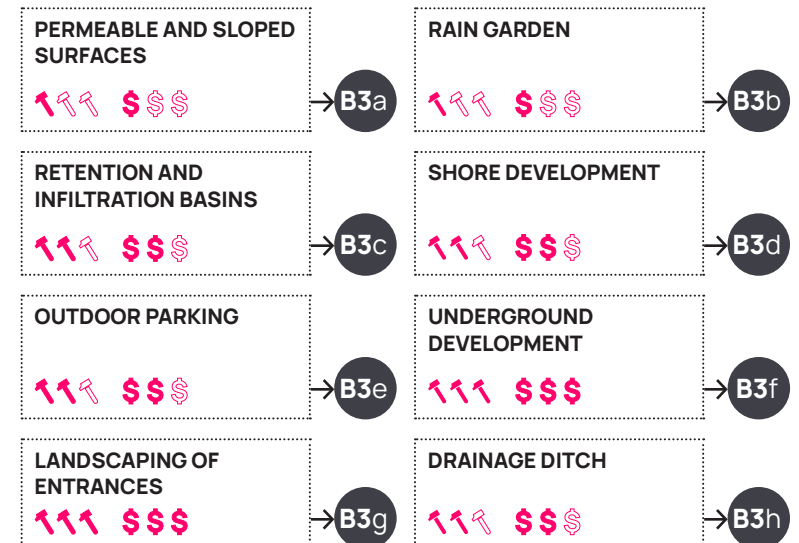
**Identify the regulations and standards in force**

- Municipality
  - Does the water need to be directed to specific areas?
  - Can the directed water be blocked by certain structures?

**Seek professional assistance** →

- Ensure that water is directed to the right place and prevent it from causing problems elsewhere.

**Choose an appropriate strategy (one or more combined measures)**



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The information presented in this report is of a general and generic nature, and its applicability to a specific situation must be verified by qualified professionals.

# B3a

## Types of buildings



## Expertise required

**Civil engineering:** exterior drainage.

**Landscape architecture:** planted areas.

**Qualified contractor:** installation.



## Financial assistance program

Possible subsidies from municipalities.



**Multi-unit residential, commercial, industrial, institutional**

Ensure that the annex room (exterior MEP equipment room) does not become a vulnerability that allows water to enter the building.

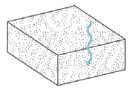
## LANDSCAPING

# PERMEABLE AND SLOPED SURFACES

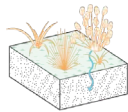
A **permeable surface** is a type of surface that allows water or other liquids to pass through it and into the ground below. It promotes the natural flow of rainwater and its percolation into the ground, reducing the inflow of water to the building and the municipal network.

⚠️ An impermeable layer such as concrete, asphalt, or paving stones on the ground surface prevents water from infiltrating.

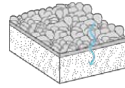
There are several types of permeable surfaces:



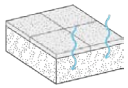
Garden (black soil)



Planted surface

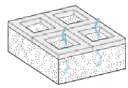


Gravel surface



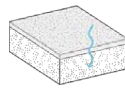
Permeable paving stones

- Durability: ~ 20 years



Honeycomb paving stones, alone or combined with resistant vegetation

- Durability: ~ 20 years and winter-resistant



Drainage concrete/asphalt

- Percolation: 200 litres of water per minute/m<sup>2</sup> (10 ft<sup>2</sup>) (Cement Association of Canada)

- Durability: high tolerance to freeze-thaw cycles

## ADVANTAGES

- Supports biodiversity.
- Reduces surface temperatures, mainly due to the presence of water (water evaporation reduces temperature).

- ⚠️ Control plant growth.
- ⚠️ Perform regular maintenance.
- ⚠️ Manage debris collected during heavy rainfall events.

A **sloped surface** allows water to run away from the building envelope, reducing the risk of water infiltration into the foundation, roof, exterior walls, and openings, thereby keeping the foundation dry and reducing hydrostatic pressure and water accumulation on the building

⚠️ Creating berms, small landscaped mounds covered with vegetation, helps divert floodwaters in the event of river flooding.

## RECOMMENDATIONS

- It is essential to choose the type of permeable surface based on the **intended use** and **maintenance capacity** to ensure optimal service life.
- ⚠️ It is not recommended to plant vegetation near foundations.
- To limit water on the ground, see water flow control options for roof drainage. → B1 B2
- Ensure that the sloped soil fill around the perimeter of the building does not settle over time.

## INSTALLATION SCENARIOS

Suggestions for better understanding the issues to be discussed with qualified individuals.

### To change asphalt to a permeable surface :

- Create drainage channels.
- Waterproof any **gaps** in the ground and the foundation that could let water in.
- Backfill the perimeter of the foundation with **compacted, sloped soil**.  
Provide a natural negative slope of at least 2% from the foundation wall. However, a slope of 10% is recommended to ensure that water is carried away.
- Direct water towards **more permeable** soil, which will help it to infiltrate.

### To add a terrace to a garden:

- Direct the **slope** of the terrace towards a **permeable surface** and not towards the building.
- Choose permeable surfaces for **under the terrace** as well.
- Ensure a proper **drainage system** is in place.  
Maintain a minimum slope of 2% from the foundation wall.
- Prioritize a permeable enclosure (**fence**) made of resilient material to allow water to pass through and prevent damage.

# B3b

## Types of buildings



## Expertise required

**Civil engineering:** exterior drainage.

**Landscape architecture:** planting.



## Financial assistance program

Possible subsidies from municipalities

## Information on precipitation

Ouranos climate portraits.

Climate Data Canada, to learn about precipitation trends over time, based on different GHG emission scenarios.

Municipalities, Environment Canada, or local organizations.

## For more information:

Franti, T. G. et Rodie, S. N. (2013). *Rain garden design, a guide* presenting the principles and uses of rain gardens

## LANDSCAPING

# RAIN GARDEN

A **rain garden** is a depression in the ground, often filled with plants and filtering substrate, which **collects runoff** and **rainwater** to allow it to **gradually infiltrate the soil**. Rain gardens reduce the volume and speed of rainwater runoff into the sewer system by **maximizing the absorption** of rainwater by the soil and its **percolation** into the groundwater.

## ADVANTAGES

- Improved **water quality** through the filtration of pollutants.
- Increased **bioretention**: evapotranspiration and biological filtration.
- Improved **aesthetics**.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 Determine the **location** of the rain garden.

- E.g., the rain garden can receive water from a gutter or driveway.
- ⚠️ Maintain a protective distance from foundations (at least 3 m).
- Choose a low point based on the drainage of the land and where the soil is permeable (not too compact).
- Provide a gentle slope towards the rain garden between 2% and 12%.  
Slope (%) = height of the difference in level / length of the difference in level x 100.

### 2 Determine the **size** (m<sup>2</sup>) of the rain garden based on three factors:

$$\text{dimension} = \frac{\text{drainage area} \times \text{precipitation quantity}}{(\text{depth} \times 100)}$$

#### **Drainage area** (m<sup>2</sup>) of the roof and permeable ground surface:

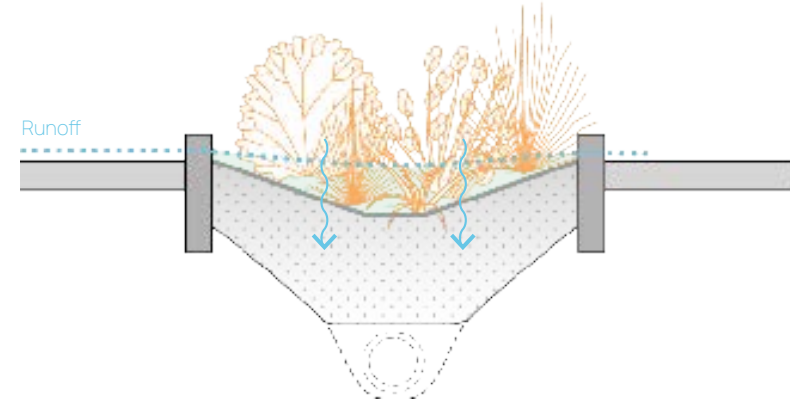
- The garden dimension represents between 10% and 30% of the roof or drained land area, according to a rough estimate.

#### **Depth** (cm) : calculated using the soil infiltration rate

- Identify the depth at which you want to install the rain garden, with a factor (+10%) that takes into account lost space due to slopes and depressions.

#### **Precipitation quantity**

- Check your geographical area to find out the extreme reference precipitation level



### 3 Determine its **composition**.

- Drainage system at the bottom of the basin to the sewer and geotextile.
- Gravel (3/4 net) with geotextile.
- Planting substrate (soil + sand + gravel).
  - Promotes water infiltration while supporting plant growth.
  - Filters pollutants contained in the water.
- Vegetation adapted to local conditions and tolerant to immersion should be favoured.
  - Plantings help stabilize the soil, absorb water, and improve water and air quality.
- Ground cover, levelled border.
- Overflow in case of spillage.

- ⚠️ Do not allow water to run off onto your neighbor's property.
- ⚠️ Perform regular maintenance.
- ⚠️ Manage debris collected during heavy rainfall events.

# B3C

## Types of buildings



## Expertise required

**Civil engineering:** if the basin is above ground.

**MEP:** if the basin is underground.

**Landscape architecture:** plantings.



## Financial assistance program

Possible subsidies from municipalities.



## Small buildings

Alternative rainwater management in the form of an open basin (dry or wet).

## Multi-residential, commercial, institutional

Buried basin.

## Municipal basin

Permanent presence of water with a maximum threshold.

## LANDSCAPING

# RETENTION AND INFILTRATION BASINS

**Retention basins** and **infiltration basins** are designed to **temporarily store water** and drain it more slowly into the municipal system in order to reduce the volume of water in drainage systems, limit the risk of overflow, and thus reduce runoff.

## ADVANTAGES

- Reduction and slowing down of the flow of water entering the network.
- Increase in **plant** and **aquatic biodiversity**.
- Improvement in **water quality** thanks to phytoremediation.

## RECOMMENDATIONS

Optimize plantings:

- Choose vegetation that is suited to local conditions and tolerant to immersion.
- They help stabilize the soil, absorb and improve water and air quality.
- Trees and shrubs intercept and retain water better than grass.

## INSTALLATION SCENARIOS

Suggestions for better understanding the issues to be discussed with qualified individuals.

Determine the **location, size, and depth of the pond.** → B3b

Determine its **composition** based on the specific characteristics of the site.

Determine whether you want an **open-air basin (A)** or an **underground basin (B)**.

- Connect a drainage system that directs water to municipal networks and an overflow that drains to a pit, secondary basin, or other suitable area.
  - Test the pump during periods of inactivity: at least once every three months.
  - Starting and stopping the pumps damages them: 4 times/hour max.
- Provide a waterproof membrane or **geomembrane** (retention basin) or a **permeable membrane** (infiltration basin).

**(A) If it is an open-air basin :**

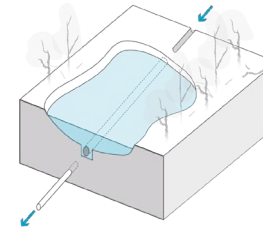
- Provide **finishing layers** that respect the slope, depth, and density of the soil.
  - Safety fences must be provided at a depth of 600 mm (24 in.) or more to prevent drowning.
- Incorporate **vegetation** as appropriate.
- Incorporate an **aerator** to keep the water oxygenated if water is present.

## (A) OPEN-AIR BASIN (WET OR DRY)

- Less expensive and less environmental impact.
- Contributes to cooling the ambient air and urban biodiversity.
- Maintenance after use, and risk of discomfort (likely odours).

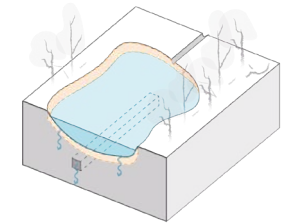
### RETENTION BASIN

Temporarily retain water



### INFILTRATION BASIN

Promote water infiltration into the soil

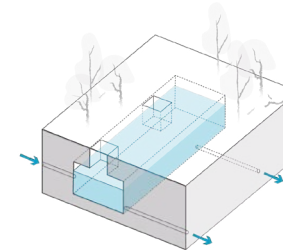


## (B) UNDERGROUND BASIN

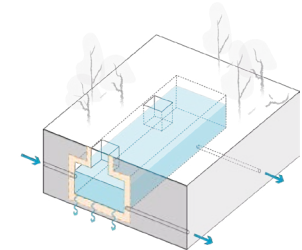
If the soil has infiltration potential.

- Offers visual discretion and does not take up floor space.
- Opportunity to collect rainwater for cleaning/watering.
- Opportunity to reuse rainwater to reduce drinking water consumption in the building.
- High cost and environmental impact (GHG emissions: concrete/plastic construction).
- Difficult to access and maintain.

### RETENTION BASIN



### INFILTRATION BASIN



- ▲ Do not discharge water on your neighbour's property.
- ▲ Perform regular maintenance.
- ▲ Manage debris collected during heavy rainfall events.

# B3d

## Types of buildings



## Expertise required

**Landscape architecture, biology, geotechnical engineering:** to identify the types of plantings suited to the environment and soil structure, and to select measures appropriate to the site conditions.

**Ecologist:** if certain species are protected.



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

\*\*See Article 73:

<https://cdn-contenu.quebec.ca/cdn-contenu/adm/min/environnement/gestion-rives-littoral-zones-inondables/guide-reference-rmun.pdf>

## LANDSCAPING

# SHORE DEVELOPMENT

**Shore development** refers to the riparian zone adjacent to a body of water (marsh, lake, stream, river, sea, etc.) that has been altered by human activity and is being restored to its natural state.

Key objectives of this measure:

- Keep water away from the building to prevent damage.
- Maximize the sponge effect by preparing the soil and planting vegetation to absorb as much water as possible, block rising water, and reduce the force of water (waves, currents).

## ADVANTAGES

- Rainwater interception and infiltration, floodwater absorption and retention, better control of water levels.
- Soil erosion control, water cooling and filtration, creation of wildlife and plant habitats, increased biodiversity, aesthetic enhancement.

## PRELIMINARY STEPS

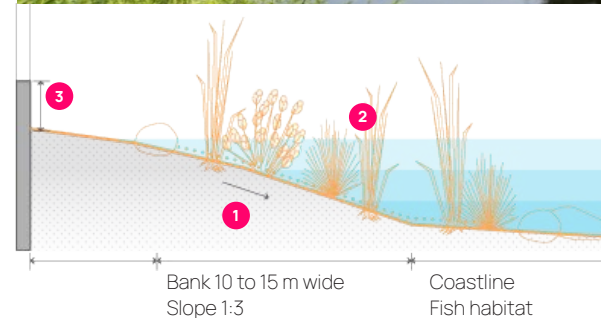
- Check restrictions in flood zones\*, as well as regulations along riverbanks and coastlines.
- If the riverbank is an ecosystem that may contain protected species, consult an **ecologist** and review the following laws:
  - Act respecting the conservation and development of wildlife (RLRQ, c. C-611)
  - Act respecting threatened or vulnerable species, CAN
  - Species at risk Act
  - Fisheries Act
- Understand the terrain: soil type, topography, flood history, intended use, etc.
- Identify riparian zones in coastal areas.
- Identify ecological habitats (fauna, flora).
- Identify problematic species (invasive, vulnerable, endangered).

▲ Seek guidance to select measures suited to the site conditions (location of slopes, soil type, drainage, sun and wind exposure, etc.).

Use plants that are well-suited to the environment based on site conditions (hardiness, slope) and that do not require fertilizers or permanent irrigation systems.



©Aquaberge



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Stabilize the bank using phytotechnologies (fascines, brush piles, etc.) or mechanical methods (riprap), if necessary.
  - Ensure a slope of 2% to 10% to direct water away from the building.
- Select plants suited to the natural environment.
  - Frost-resistant, non-invasive, and resilient in the event of prolonged submersion.
  - Include access and maintenance paths with the least possible ground impact (stilted paths)\*\*.
  - Plan for growth time and long-term maintenance needs.
- Raise the foundations above ground level. → C10b

# OUTDOOR PARKING

### Types of buildings



### Expertise required

**Landscape architecture:** for outdoor parking facilities of any size.



### Regulations

See the eco-friendly parking certification.

### Key objectives of resilient outdoor parking lots:

- Divert water away from the building.
- Prevent rainwater from flowing into the parking lot and maximize surface and subsurface retention before water runs off into the street.
- Increase permeable surfaces and « depressed » areas to allow for localized water retention.

## CONSIDERATIONS

- Consider a possible reduction in the number of parking spaces.
- Provide designated spaces for alternative mobility measures.
- Ensure that vehicles can coexist with water accumulation (e.g., electric charging stations).
- Adapt the pavement to freeze-thaw cycles and de-icing and snow removal methods.

## ADVANTAGES

- Reduction of heat islands.
- Increased urban biodiversity.
- Increased user comfort of the facilities.
- Rainwater interception and infiltration, absorption and retention of runoff, better control of water presence and accumulation.

## PRELIMINARY STEP

- Understand the site: soil type, topography, flood history, intended use, etc

- ▲ Maintaining resilient parking lots is essential to their longevity:**
- Clean the joints regularly, as permeable pavers can become clogged over time.
  - Protect electrical components from water buildup.
  - Clear drains and gutters of plants and debris.
  - Monitor plantings to remove invasive exotic species and replace dead or infected plants.



Parking lot Pierre-Laporte, Victoriaville, Certified as an Eco-Friendly Parking Facility by CRE-Montréal.

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Plan the layout (paths, open spaces, planting).
  - Choose plants that are suited to the natural environment and can tolerate de-icing salt.
  - Choose light-colored, permeable flooring to reduce heat islands and to maximize water infiltration.
  - Incorporate rainwater management measures (drains, pipes, tanks, etc.).
- 2 Incorporate lighting and electrical components in a way that is compatible with the presence of vegetation and potential water accumulation.
- 3 Plan for long-term maintenance needs, including snow removal.

# B3f

## Types of buildings



## Expertise required

**Architect, structural engineer, mechanical engineer:** to determine the structure, roof composition, and drainage system best suited to the environment and water accumulation conditions.



## Regulations

Comply with the Quebec Construction Code if a flow-controlled roof drain (FCRD) is installed:

Limit water accumulation on the roof to a maximum depth of **150 mm (6 in.)** at the lowest point of the slope.

## LANDSCAPING

# UNDERGROUND DEVELOPMENT

While **underground developments** may appear similar to ground-level developments, they actually cover the roof of a building.

Often consisting of a waterproof, insulated concrete structure, they house a parking garage or underground facilities.

These developments face significant technical limitations due to the lack of available ground-level space.

### Objectives of a resilient underground development:

- Find alternatives to water infiltration techniques.
- Develop a drainage system that respects ground level and drain capacity.
- Limit the amount of water accumulated on the underground area relative to the structure's load-bearing capacity.

## CONSIDERATION

- Treat the subsurface as a building roof.

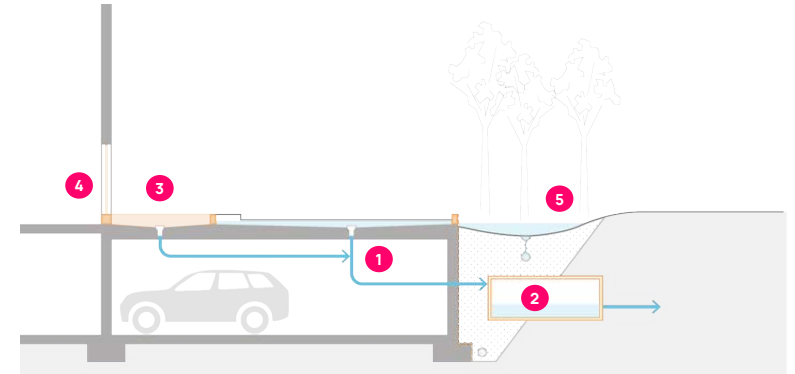
## ADVANTAGE

- Landscape integration of an underground structure with ground-level use.

## PRELIMINARY STEPS

- Understand the condition of the structure**, including its load-bearing capacity, load resistance, drainage capacity, and waterproofing.
- Identify vulnerabilities.** Water can penetrate through structural weaknesses and openings. Since these spaces are at the lowest point of the site, this is where all the water accumulates.

⚠ Each property has a specified volume of rainwater that must be retained within its boundaries and must not exceed the discharge capacity of the municipal drainage system. Below these limits, it is **generally prohibited to discharge water into public areas, and it is always prohibited to discharge water onto a neighboring property.**



Cross-section of an underground development

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Managing water accumulation:

Above the underground level:

- Adjust drainage in a controlled manner. → B2a
- If required, connect to an underground retention basin.

Disconnect the lower-level drain from the building's sanitary system so that rainwater flows into the storm sewer system.

- Raise the level of decks and walkways to divert water from the building, and prioritize flooring and paving that minimizes water accumulation. → B2b B2c
- Install waterproof doors and windows as needed. → B4

Around the underground level:

- Create depressions to maximize temporary surface retention.
- ⚠ Increase vegetation cover to enhance water absorption.

- Protect electrical and mechanical systems from water exposure.

Remove storage areas that expose property to the risk of flooding.

## Types of buildings



## Expertise required

**Architecture:** to verify that exit routes comply with the Quebec Construction Code.



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## LANDSCAPING

# LANDSCAPING OF ENTRANCES

Building entrances are particularly vulnerable to water damage, yet they are critical to ensuring the safety of occupants.

The characteristics of **resilient exterior design** are:

- Diverting water away from entrances or blocking water to keep entrances dry.
- Designing spaces that remain safe and accessible to everyone, even under extreme conditions.

## CONSIDERATIONS

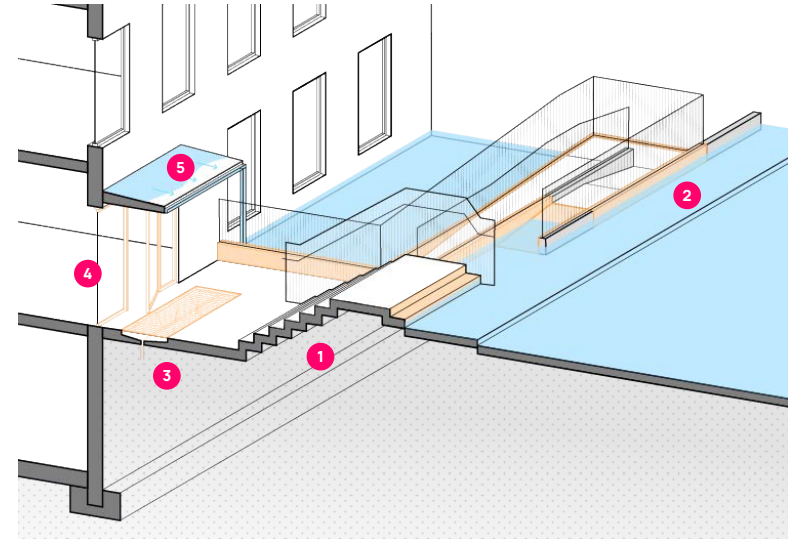
- ⚠ Check for restrictions in flood-prone areas\*.
  - Low walls must be continuous and in contact with the building's foundation or a waterproof surface.
  - Requires sufficient land and clearance between the building and the property line to accommodate the installations.
  - Consolidate building entrances as much as possible to reduce exposure.

## ADVANTAGES

- Ensures that entrances remain functional under all conditions, without special interventions.
- Preserves universal access and emergency access.

⚠ Provide the most direct and barrier-free access possible between the door and the sidewalk or a safe outdoor area.

It may be necessary to replace a door or its hardware to ensure that emergency exits remain functional even in the event of a flood.



E.g., Landscaping of an entrance that is lower than street level on a multi-unit residential building.

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Build stairs or ramps that rise above water level and descend toward the entrance.
  - ⚠ Verify that the evacuation routes comply with regulations.
- 2 Construct low walls and solid, waterproof railings to prevent water from entering the entrance access area.
  - The low walls can serve as supports for automatic or manual barrier systems to temporarily block water.
  - ⚠ Do not block the access ramp, which serves as a universal evacuation route, even in the event of flooding.
- 3 Install a drainage system at the lowest point of the access route with an emergency pumping system and a backflow prevention system.
- 4 Install a waterproof door at the building entrance. → B4
- 5 Install a canopy above the door and over part of the exit route to collect rainwater and direct it away from the secure circulation area.



### Types of buildings



### Regulations

Many municipalities prohibit the blocking of drainage ditches.

Coordinate work with municipal development projects.

Apply for the necessary permits from the municipality. The RMUN requires a permit for the construction of a ditch in a water-related area.

#### For more information:

Municipal How-to Guide for CSA Community Water Standards. (2024).

## LANDSCAPING

# DRAINAGE DITCH

A **drainage ditch** plays an important role in collecting runoff water. It is therefore recommended to maintain them, or even increase their capacity.

Key objectives of a drainage ditch:

- Collect runoff water.
- Reduce the burden on the municipal sewer system.

## CONSIDERATION

- If an existing ditch has been backfilled without adding a drainage system, its restoration should be considered.
- Not suitable in potentially contaminated areas (e.g., industrial zones).

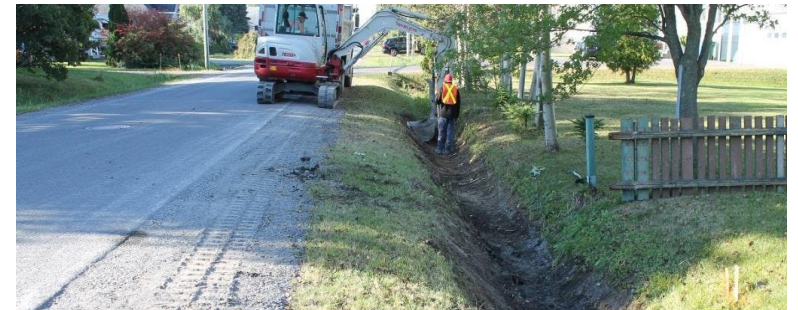
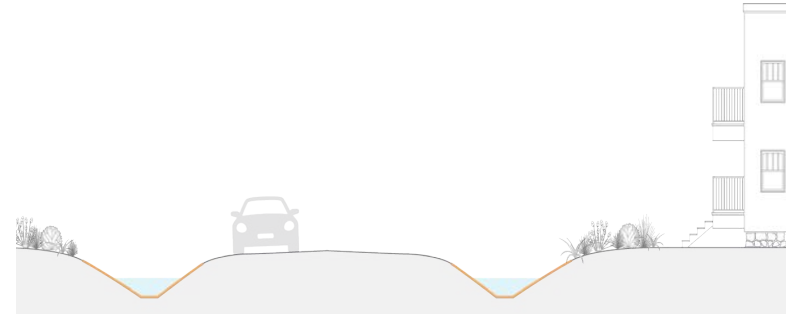
## ADVANTAGES

- Natural filtration of water that will be conveyed into the system.
- Increased biodiversity.
- Improved road safety (less water on the roads).
- Reduction of heat islands when accompanied by vegetation.

## PRELIMINARY STEP

- If the original ditch has been blocked, its original drainage function must be restored.

**▲ To ensure they function properly, drainage ditches must be inspected regularly and properly maintained: this includes clearing them of debris, snow, or ice.**



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Design**
  - Ensure the soil is stable to prevent heaving.
  - Maintain the correct slope gradient for water drainage.
  - Provide permeable soil around the drainage ditch to promote infiltration.
  - Direct water toward an outlet, a retention basin, or the sewer system.
- 2 Safety and signage**
  - Ensure safe access around drainage ditches: install protective railings if necessary based on depth and width, and add walkways over infrastructure requiring crossings.
  - Install clear signage indicating their location.
- 3 Option**
  - Install a membrane along the building walls down to the ground to slow the infiltration of water into the drainage ditch.

# SEALING OF OPENINGS

## WHAT IS IT FOR?

There are **permanent** and **temporary devices** available to seal openings.

Key objectives of **devices for sealing openings** against the risk of flooding:

- Reduce the risk of infiltration through openings.

### PERMANENT DEVICE

**Waterproof door:** unlike a standard door, a waterproof door has a frame with a compressible seal and a very sturdy stainless steel structure.

**Waterproof window:** there are waterproof patio doors for access to courtyards or small basement windows.

**Flood-proof window shutters** (permanent and openable): window protection consisting of a frame and a solid acrylic glass shutter. This is glued to the outside of the window frame and then sealed. The shutter is tiltable or removable so that it can be opened from the inside.

- Improves thermal insulation and allows ventilation.
- Maintains the amount of outside light.

### TEMPORARY DEVICE

**Flood barrier** or **cofferdam:** temporary and removable flood protection devices; system of temporary panels and permanent boxes for doors and windows.

- **Log type:** stacked logs that create a barrier to water.
- **Adjustable rigid plastic:** flood barrier where waterproofness is ensured by an inflatable seal.
- **Inflatable:** with a manual pump and adjustable according to the width of the opening.

**Waterproof flood barriers:** panel on stainless steel fasteners. It protects vents, windows, and basement windows of various sizes up to 250 cm wide by 150 cm high (e.g., basement air intakes).

## ADVANTAGES

- Reduces repair costs.
- Reduces the amount of materials discarded after a flood.
- Reduces the health effects of flooding.

## WHERE TO START?

**Understand the risk** → 

- Suitable for surface flooding.


**Know the characteristics of the building**

- What is the composition of the exterior wall? Porosity, structure, etc.
- What type of exterior cladding is used?
- What is the composition and condition of the window and door frames?

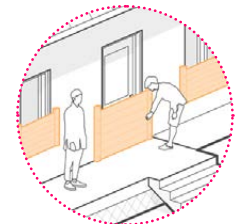
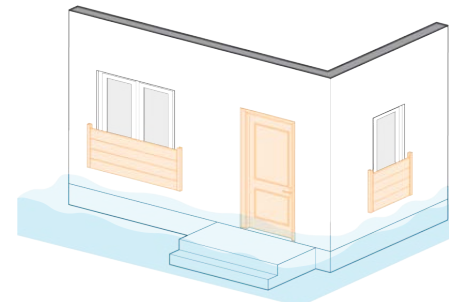
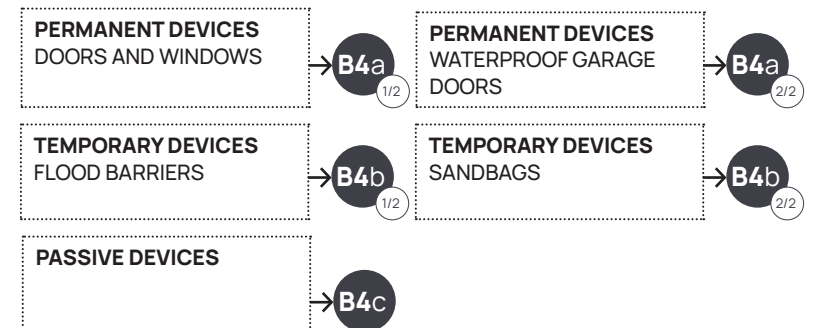
**Knowing the occupants' abilities**

- Understand your risk tolerance. For example, how to install temporary devices in case of absence.

**Identify the regulations and standards in force**

**Seek professional assistance** → 

**Choose one or more adaptation measures:**



## STUDY ON THE EFFECTIVENESS OF OPENING PROTECTIONS IN PARTNERSHIP WITH THE NATIONAL RESEARCH COUNCIL OF CANADA (NRC)

### Objectives:

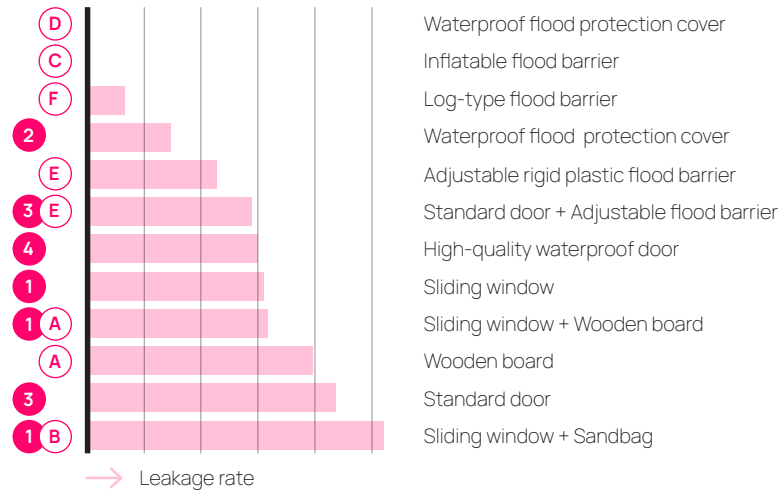
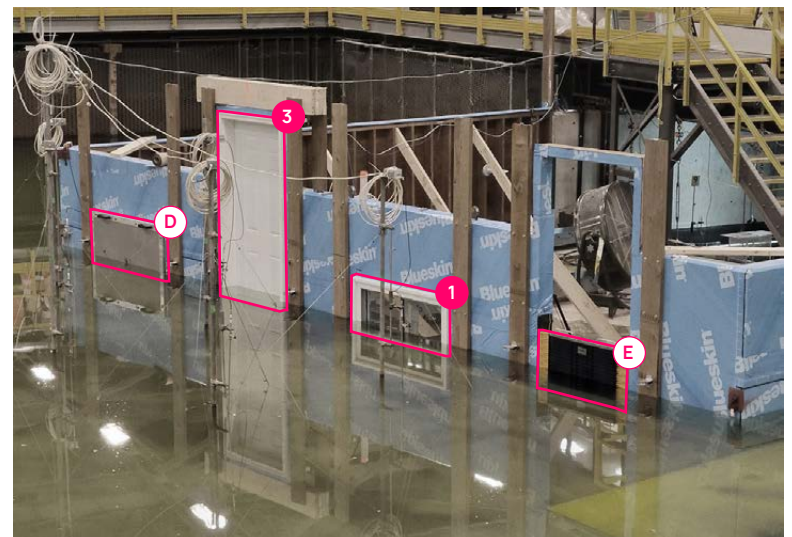
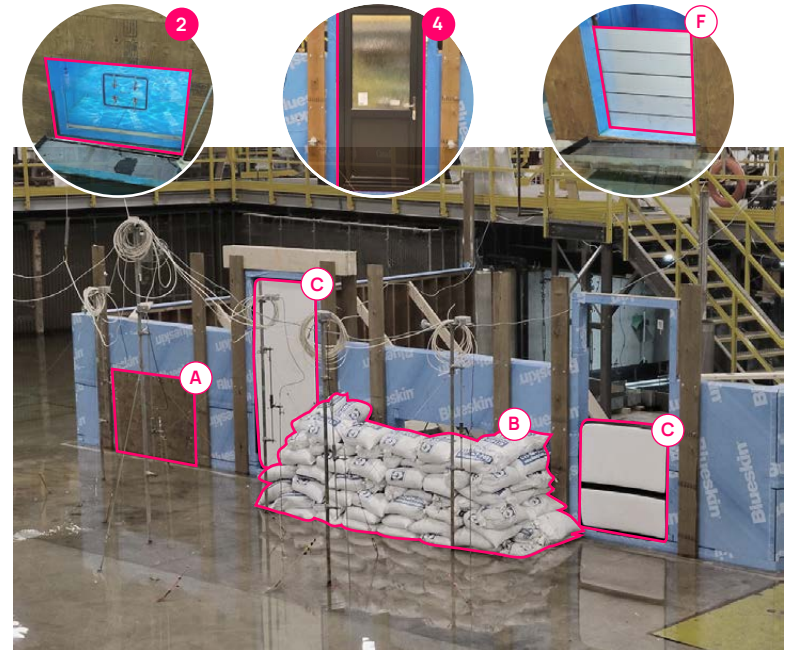
- Verify the effectiveness of Canadian standards in protecting buildings from flooding.
- Evaluate various temporary means of protection for homes in a variety of situations.
- Develop experimental protocols in accordance with existing international standards.

### Procedure

- Phase 1** : aimed to evaluate the performance (infiltration rate) of common residential buildings in Canada.
- Phase 2**: aimed to establish the effectiveness of various temporary protective structures for openings in two experimental developments.

### Results

- The table below lists permanent and temporary devices tested for their **sealing effectiveness**. The higher the leakage rate, the lower the relative sealing performance.



### Link to the study

View the full report (2025) :  
<https://doi.org/10.4224/40003530>

Types of buildings



Source



Difficulty of installation

Ease of instruction and technical expertise



Recommended number of people

Few: 1-2  
Medium: ~3  
Many: 4-5



Installation time

Low: 1-2 h  
Medium: ~3 h  
High: 4-5 h



Comparative cost between devices



Waterproofing effectiveness

Assessment combining indicators and the final result of the device in terms of its waterproofing effectiveness.

Low: significant water ingress.

Medium: moderate water ingress.

High: no or minimal water ingress.

SEALING OF OPENINGS

PERMANENT DEVICES  
DOORS AND WINDOWS

A **permanent device** is an element integrated into the architectural design. It can be deployed manually or automatically and seals doors and windows.

Flood-resistant doors and windows are designed to **withstand floodwater runoff**, but not necessarily the strong impact of waves or debris.

**!** The permanent devices tested are not produced locally and did not perform significantly better than a properly installed standard door or window.

RECOMMENDATIONS

- If a standard door is chosen, a **sturdy structure** (steel), **frame**, and **proper installation** are required. A **flood threshold** must be added.
- Have flood-resistant doors and windows and permanent barrier systems installed by a **qualified professional**.
- Connect automatic systems to an **independent, autonomous power source**.



WINDOWS

**1** High-quality standard sliding window

**2** Window protection hatch

**!** Requires an adhesive surface around the opening.

DOORS

**3** High-quality standard door

**4** Waterproof door

- Flood resistance.
- !** Choose non-glazed doors.
- !** Poor impact resistance (waves, flood debris), therefore more suitable for urban runoff.

INDICATORS

CA 	
UE 	
UE 	

- !** Perform annual maintenance:
- Check the seals on doors and windows and verify their waterproofness.
  - Check automatic systems and clear them to allow for deployment.
  - Check the independent and autonomous power source.

## Types of buildings



## Expertise required

**Mason:** to repair cracks in the wall if required.

**CMMTQ-certified professional plumber:** drainage, installation certified by the door manufacturer.



## Regulations

Check with your municipality for required permits and to find out if subsidy programs are available and their eligibility requirements. E.g., RénoPlex (Montreal).

Plumbing code: Chapter III of the QCC (Plumbing).



E.g. of a vulnerable situation

## SEALING OF OPENINGS

# WATERPROOF GARAGE DOORS

A **waterproof garage door** is a **permanent device** integrated into the architectural design.

It has an automatic mechanism and is suitable for highly exposed areas: flood zones, basins, or entrances with a reverse slope. It is designed to withstand a certain water level (check with the manufacturer). Its performance is directly related to the quality of its installation and drainage system.

## RECOMMENDATIONS

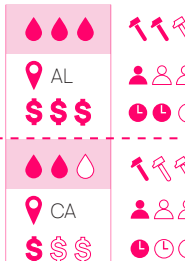
- Take delivery times and costs into account (e.g., international products).
- For less exposed areas, a reinforced traditional garage door is more accessible (local and less expensive), with the addition of a flood barrier.
- For large buildings. → **B8b**
- Combine with other measures for greater success. → **C9a**
- For an alternative, see filling the entrance with a counter-slope. → **B5c**

## PRELIMINARY STEPS

- Understand the risk.
- Check the regulations with your local municipality.
- Before installing a waterproof garage door:
  - Check that the exterior wall is not porous and does not have any cracks.
  - Have the condition of the foundations and basement slab inspected.
  - Have the existing plumbing inspected.
  - Check the maximum height that can be retained in front of the door.
- Repair cracks in the slab and walls, waterproof the foundations if required.
- Perform plumbing work, connect the retention tank, and install valves.
- Ensure there is an additional access door at the rear of the building.

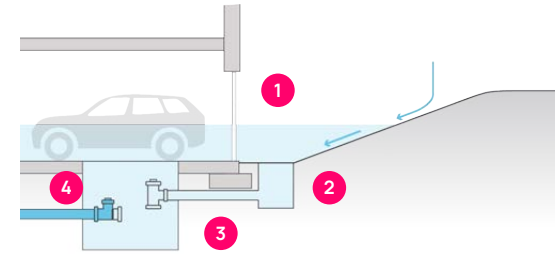
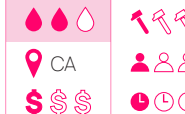
## GARAGE DOORS

Waterproof garage door < \$15,000 with delivery



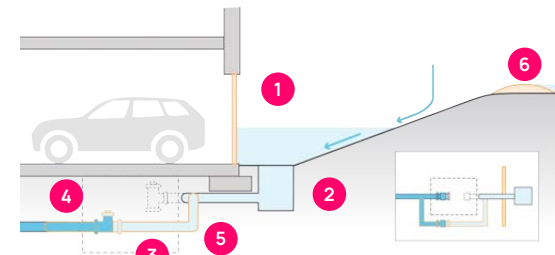
Reinforced traditional garage door < \$10,000

Steel bar reinforcement system with flood protection threshold



- 1 Standard garage door
- 2 Drain
- 3 Retention pit
- 4 Closed valve and sewer backflow

Flood scenario



- 1 Waterproof garage door
- 2 Drain
- 3 Retention pit
- 4 Closed valve
- 5 Separate valve connected to the drain
- 6 Speed bump

Adaptation scenario



Tests conducted by the City of Montreal in partnership with Écohabitation.

⚠ Do not install wooden door frames; install the door directly onto the concrete foundation wall.

## Types of buildings



### Source



### Difficulty of installation

Ease of instruction and technical expertise



### Recommended number of people

Few: 1-2  
Medium: ~3  
Many: 4-5



### Installation time

Low: 1-2 h  
Medium: ~3 h  
High: 4-5 h



### Comparative cost between devices



### Waterproofing effectiveness

Assessment combining indicators and the final result of the device in terms of its waterproofing effectiveness.

**Low:** significant water ingress.  
**Medium:** moderate water ingress.  
**High:** no or minimal water ingress.

# SEALING OF OPENINGS

## TEMPORARY DEVICES

### FLOOD BARRIERS

A **temporary device** is equipment added to the facade and installed temporarily when there is a risk of flooding. However, some devices require the installation of a permanent support frame.

## RECOMMENDATIONS

- Have permanent window and door frames installed by a professional.
- Store temporary covers, boards, or plates in an accessible location.

⚠ Before flooding, remove the wooden frame (regardless of its condition) to secure the device to the concrete and install temporary covers, boards, or plates in the boxes.

⚠ After flooding, if temporary waterproofing devices are not removed, the building may suffer damage due to lack of ventilation, such as mould growth.



## WINDOWS

### A Wooden boards

- ⚠ Requires a surface to place nails around the opening.
- Dry storage
- Can be recycled with use

### B Sandbags

- ⚠ Non-recyclable, significant environmental impact.

### C Inflatable window flood barrier

### D Waterproof flood protection cover

- Protects ventilation openings, windows, and basement windows of various sizes.
- ⚠ Requires a permanent steel frame around the stainless steel opening.

## DOORS

### E Adjustable rigid plastic flood barrier

- ⚠ Requires the creation of a space inside or in front of the opening to place the barrier.
- ⚠ Bulky to store (non-retractable).

### C Inflatable door flood barrier

- ⚠ Requires space inside or in front of the opening to place the barrier.

### F Log-type flood barrier

- ⚠ Requires the addition of a steel frame around three sides of the opening.
- ⚠ Bulky to store (non-retractable).

## INDICATORS

Waterproofing effectiveness: 3 drops	Difficulty of installation: 2 wrenches
Source: CA	Recommended number of people: 3 people
Comparative cost: \$\$\$	Installation time: 3 clocks
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Source: UE	Recommended number of people: 3 people
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## INDICATORS

Waterproofing effectiveness: 3 drops	Difficulty of installation: 2 wrenches
Source: UE	Recommended number of people: 3 people
Comparative cost: \$\$\$	Installation time: 3 clocks
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Source: CA, UE	Recommended number of people: 3 people
Comparative cost: \$\$\$	Installation time: 3 clocks
Waterproofing effectiveness: 3 drops	Difficulty of installation: 2 wrenches
Source: UE	Recommended number of people: 3 people
Comparative cost: \$\$\$	Installation time: 3 clocks

# B4b

2/2

## Types of buildings



### Source



### Difficulty of installation

Ease of instruction and technical expertise



### Recommended number of people

Few: 1-2  
Medium: ~3  
Many: 4-5



### Installation time

Low: 1-2 h  
Medium: ~3 h  
High: 4-5 h



### Comparative cost between devices



### Waterproofing effectiveness

Assessment combining indicators and the final result of the device in terms of its waterproofing effectiveness.

**Low:** significant water ingress.

**Medium:** moderate water ingress.

**High:** no or minimal water ingress.

## SEALING OF OPENINGS

# SANDBAGS

**Sandbags** are not very effective as a means of protecting openings: they provide poor waterproofing and prevent the installation of a portable pump to remove any water that seeps in.

However, they can be useful when placed **away from the building**, forming a small dike that **slows or diverts the flow of water** before it reaches the walls or openings. In this case, it is recommended to install a pump between the sandbag dike and the building.

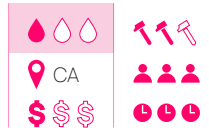


## BUILDING OR SITE

## INDICATORS

**B** Sandbag

**!** Not recyclable, significant environmental impact.



Shutterstock

# B4C

## Types of buildings



## Expertise required

Structure, hydrology, architecture: to verify the feasibility and the system's ability to integrate into its environment.



## Regulations

Comply with current regulations.

Respect restrictions in flood zones (prohibition on permanent retaining walls in Quebec).

Verify the Canadian/Quebec equivalencies of technical standards when devices originate from the United States.

Consult applicable financial assistance programs to promote the integration of adaptation measures.

## SEALING OF OPENINGS

# PASSIVE DEVICES

Passive flood barriers are gravity-operated. They rise quickly and automatically using the hydraulic force of rising water to create a waterproof barrier against flooding.

Key objectives of this type of system:

- Keep water away from the building.

## CONSIDERATION

- Consolidate building entrances as much as possible to reduce exposure.
- In cold climates: provide frost protection (heating elements, proper drainage).

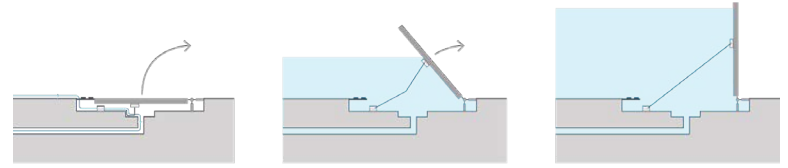
## ADVANTAGES

- Sustainable device integrated into the urban environment that preserves the building's aesthetic appeal.
- Activates without human intervention, eliminating risks associated with oversight or the absence of operators.
- Requires no power source.
- Reduced response time during flash floods.
- Discreet integration into the building's design, preserving the building's aesthetics.
- Potential reduction in insurable losses and easier access to certain financial assistance programs.

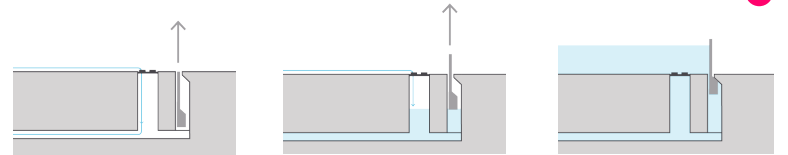
## PRELIMINARY STEPS

- Understand the system's characteristics:
  - Verify the deployment mechanism: buoyancy, hydraulic pressure, counterweights.
- Identify the permissible water height and pressure limits.
- Confirm compatibility with existing materials and foundations.
- Identify potential vulnerabilities: possible obstructions (debris, snow, ice).
- Choose the right type: lateral or vertical.

▲ Establish a regular maintenance schedule to ensure the device's performance.



1



2

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Ensure the ground is stable, that there is adequate drainage in the surrounding area, and that there are no obstacles to deployment.
- Select the system:
  - Passive lateral barriers** that deploy via tilting, buoyancy, or hydraulic pressure.
  - Passive vertical barriers** that rise under water pressure.
- Install the barrier around the perimeter of the building or integrated into the structure of the building (recessed into a threshold, wall, or garage entrance). It is possible to integrate it into an existing structure, but the integration may be less seamless.

# FOUNDATION

## WATER MANAGEMENT

### B5 SURFACE WATER DIVERSION

**B5a** Low wall / speed bump

**B5b** Window well

**B5c** Filling

### B6 GROUNDWATER MANAGEMENT

**B6a** Foundation drains

1/2

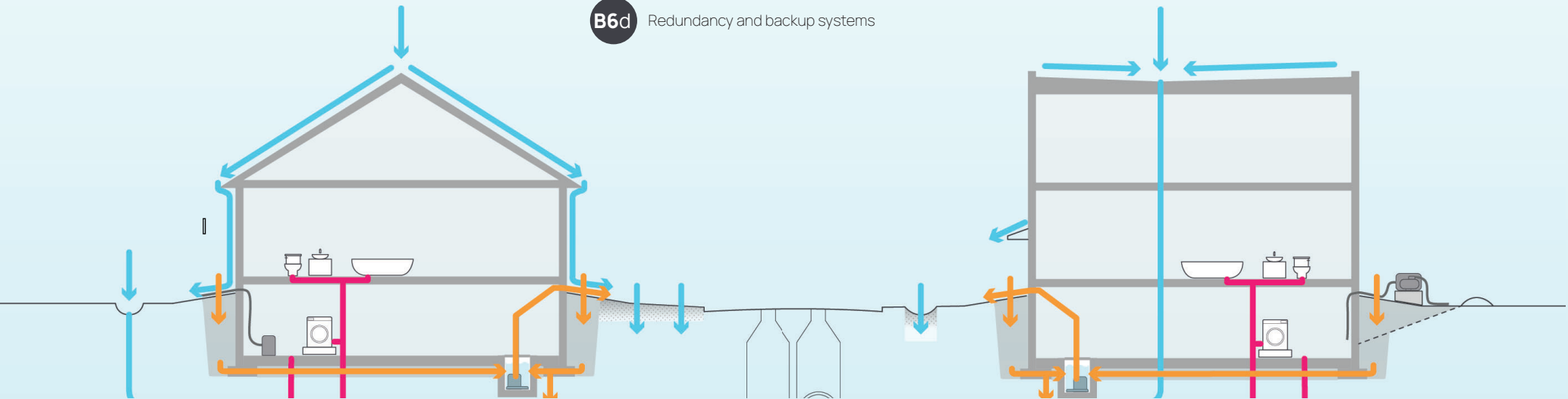
**B6a** Old foundation drains

2/2

**B6b** Gravity drainage

**B6c** Sump pump drainage

**B6d** Redundancy and backup systems



# B5

# SURFACE WATER DIVERSION

## WHAT IS IT FOR?

Several measures can be taken to **divert running or standing water from the foundation**, regardless of its source.

Key objective:

- Reduce the amount of water reaching the foundation.

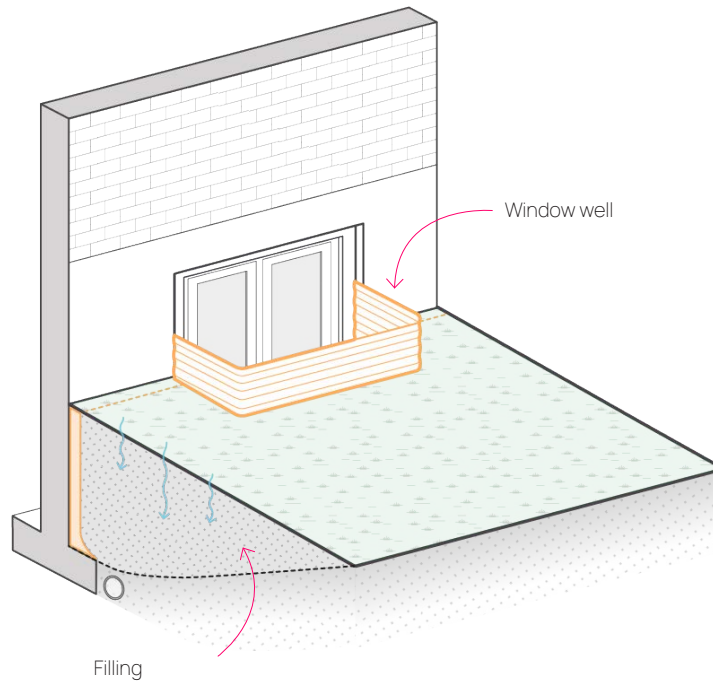


### Regulations

Chapter I of the QCC (Building).

Validate the number of exits with the building code.

Comply with universal accessibility standards if entrances are modified.



## WHERE TO START?

Understand the risk →

### Know the characteristics of the site

- What is the topography of the site?
  - Location of slopes and water flow in case of flooding.
- What is the drainage system of the street and neighbourhood?
- What is the soil composition?
  - Sand, soil, clay, rock height, etc.
- Where are the underground network pipes located?
  - Water and gas inlets.
- Are there any areas prone to overflowing in the event of heavy rain?

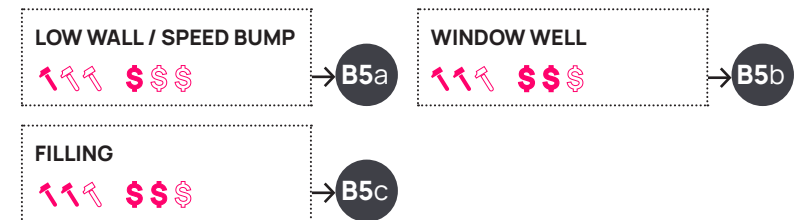
### Identify the regulations and standards in force

- Municipality
  - Does the water need to be directed to specific areas?
  - Can the directed water be blocked by certain structures?

Seek professional assistance →

- Ensure that water is directed to the right place and prevent it from causing problems elsewhere.

### Choose an appropriate strategy (one or more combined measures)



# B5a

## Types of buildings



## Expertise required

Landscape architecture or civil engineering: structure.

MEP: drainage.

Architecture: continuity of waterproofing systems.



## Regulations

Under the **modernized regulatory framework for aquatic environments**, the construction of low walls is prohibited in flood zones (see Article 35, Rmun).

Some municipalities require the addition of a speed bump when repairing a counter-slope driveway.

## SURFACE WATER DIVERSION

# LOW WALL / SPEED BUMP

**Low walls and speed bumps are exterior features on the site or adjacent to the building. They are physical barriers that are resistant to water and prevent or delay the arrival of water in a building.**

⚠️ The construction of a low wall is prohibited in a flood zone.

## ADVANTAGES

- Helps to **solidify and structure the soil** (anti-erosion) and thus redirect water flow.
- Blocks water coming from public areas.
- Protects the most vulnerable elements.

## RECOMMENDATIONS

- ⚠️ Do not discharge water on your neighbour's property.
- Modify stairs (or ramps) to create a barrier against water.
- Isolate traffic areas (pedestrian / car) with low walls connected to the building.
- ⚠️ Respect universal access. → B3g
  - E.g., modify the layout of the ramp so that its entrance connects to a dry part of the sidewalk, above the estimated water level, if possible.
- ⚠️ Do not affect the stability of existing adjacent structures.
  - Ensure that low walls are firmly anchored so that they can withstand water pressure (lateral and underground).
- Modify openings (doors and windows) to reduce the risk of infiltration in the event of water accumulation.
  - Openings of reduced size or height.
  - Waterproof window that does not open.
  - Window with partial opening at the top.
  - Waterproof door. → B4a 2/2
  - Can be completed with cofferdam systems → B4a 1/2
- Align the concrete foundation wall and the top of the low walls. → C9a C10b

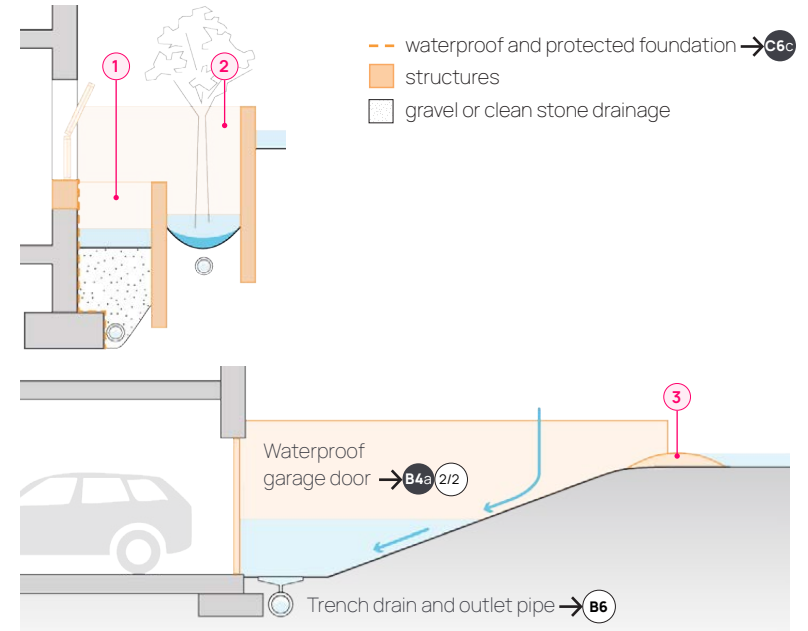


Before intervention  
entry into counter-slope



Post-intervention  
low wall and access stairs  
installation

Notre-Dame-de-Grâce,  
Montréal, Cam Construction ©:  
[www.entreprisescam.com/realisations/beton/construction-dune-descente-sous-sol-beton-projet-43](http://www.entreprisescam.com/realisations/beton/construction-dune-descente-sous-sol-beton-projet-43)



## INSTALLATION SCENARIOS

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 WATERPROOF WALL TO AID WATER DRAINAGE AT FOUNDATION LEVEL

- Ensure the continuity, waterproofing, and structural integrity of the system, from the retaining wall to the sidewalk or foundation.
- Check the condition of the foundation walls.
- Use waterproof materials and assemblies (e.g., mortar between wall blocks).
- Raise the waterproofing level of the foundation wall and window.
- Provide foundation drainage to remove accumulated water and permeable soil (gravel) to temporarily retain excess water. → B5b

### 2 WATERPROOF WALL TO HELP WATER ACCUMULATION IN LANDSCAPING

- Create a good connection between the building and landscape elements.
- Add a drainage system under the landscaping. → B3b

### 3 SPEED BUMP

- Build a speed bump at the entrance to a vehicle ramp or adjacent sloped terrain to block water at street level.

# B5b

## Types of buildings



## Expertise required

**Architecture:** location and dimensions of the opening and interior layout.

**MEP:** connection of drainage to foundation drain.



## Regulations

Section 9 of Chapter I of the QCC.

Check property lines and exit routes (Construction Code).

## SURFACE WATER DIVERSION

# WINDOW WELL

A **window well** is an **exterior feature** positioned at a distance from an exterior wall and in front of a recessed opening. It is a **water-resistant physical barrier** that prevents or delays water from entering a building.

Key objectives of a **window well**:

- Block or delay the entry of water into the building.
- Facilitate the drainage of water collected in the basin.
- Allow for the evacuation of people (emergency exit).

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### SOLIDITY

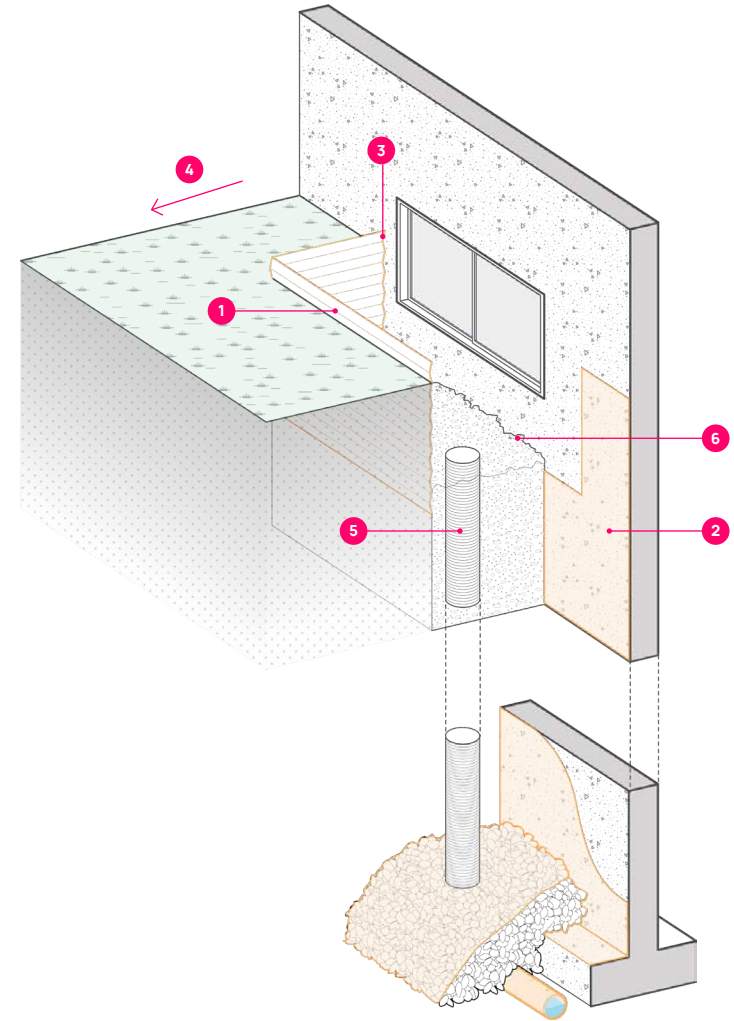
- 1 Dig the opening for the window well and install a **protective ledge** at least 150 mm (6 in.) above ground level.
  - **Anchor** the window well to the foundation wall, usually with **galvanized steel** or **precast concrete pieces**.
    - If using a steel curb, use stainless steel or galvanized anchors or studs.

### WATERPROOFING

- 2 Install a **waterproofing membrane** to waterproof the foundation wall in contact with the backfill.
- 3 Apply a **waterproofing strip** or **sealant** to protect the fasteners, limit damage to the anchors, and prevent water infiltration.

### DRAINAGE

- 4 Maintain a **slope in the ground** to divert water away from the foundation.
  - 2% minimum, 10% recommended. → B3
- 5 Install a **vertical, rigid drainage pipe** with a minimum diameter of 100 mm (4 in.) and a mesh cap at the bottom of the tank up to the level of the foundation drain geotextile.
  - ⚠ Do not connect the vertical pipe to the foundation drain. Doing so could overload the foundation drain or introduce debris that could potentially block it.
- 6 Install a **drainage backfill** (¾ clean stone, crushed gravel) to facilitate drainage to the foundation drain.
  - ⚠ Maintain a minimum distance of 150 mm (6 in.) between the bottom of the window and the crushed stone layer.



⚠ Ensure that curbs and vertical drains are cleaned regularly.

⚠ Clear snow from curbs in winter/as it melts.

⚠ Check the seals around windows and curbs.

# B5c

## Types of buildings



## Expertise required

Landscape architecture or civil engineering: structure.

MEP: drainage.



## Regulations

In flood zones: see Article 35 of the Rmun, within the modernized regulatory framework for aquatic environments.

## SURFACE WATER DIVERSION

# FILLING

**Filling** is a process that involves **filling a depression** or terrain and **stabilizing the soil** in order to create a flat surface with a slight slope away from the building. This **reduces the possibility of flooding in the basement** by filling in the counter-slope entrances.

## ADVANTAGES

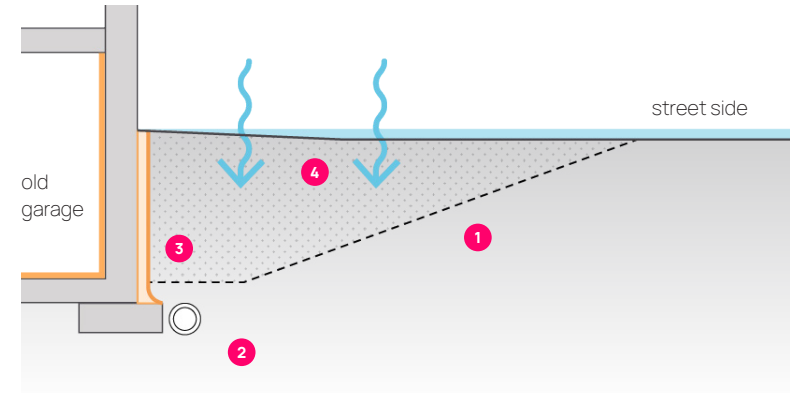
- Increased site permeability if filled with soil.
- Increased thermal insulation of the basement.

## RECOMMENDATIONS

- Check the **ventilation requirements** of the basement according to its new use.
- Add **check valves** to the drain pipes of all plumbing fixtures installed in the basement.
- To add light / ventilation to the basement, a **window** can be added below ground level above the potential water level
  - See option for adding a window well. → **B5b**
- Alternative to backfilling with soil: this space can also contain an underground or semi-buried retention basin.
  - See option for adding a retention basin. → **B3c**

### In accordance with regulations:

- Check with the municipality to confirm the applicable standards for filling and parking in front yards.
  - ▲ Filling may result in the loss of an acquired parking right.
- Validate with the permanent regulatory framework clause.
- Ensure that the evacuation route is safe and complies with the Construction Code.
  - Example: if the garage is converted into a bedroom, ensure that an adequate exit is added in accordance with the QCC in force.



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Break the **access ramp** of the old garage ramp in the case of a counter-slope entrance.
- 2 Extend the **French drain** to cover the new foundation wall.
- 3 Build a **new foundation wall** and waterproof it with a continuous **waterproofing membrane**.
  - Consider adding **rigid insulation** to the waterproofed foundation. → **C6c**
- 4 **Fill** the empty space in the garage ramp with crushed stone and cover with compacted soil (minimum 2% slope from the foundation wall).
  - ⚠ Do not waterproof the surface of the filled area, but cover it with a permeable surface to facilitate water drainage.
  - If vegetation is included, be careful of the proximity of the root system to the foundation wall.

For alternative measures to filling a counter-slope driveway: → **C9a**

# B6

# GROUNDWATER MANAGEMENT



## Financial assistance program

Check the municipality's website.

⚠ There are assistance programs for disconnecting foundation drains.



## Regulations

Chapter I of the QCC (Building).  
Chapter III of the QCC (Plumbing).  
Chapter V of the QCC (Electrical).

Check municipal regulations: installation and excavation.

The Quebec Construction Code in force requires a waterproof sump with an outside vent when a French drain is connected to it.

- 1 External foundation drains
- 2 Pump and sump
- 3 Gravity drainage pipe to the municipal system
- 4 Electrical connections
- 5 Emergency power supply
- 6 Emergency discharge pipe
- 7 Valves if required

## WHAT IS IT FOR?

A **groundwater management** system collects water that accumulates around the foundation and directs it away from it.

Key objectives in the face of flood risk:

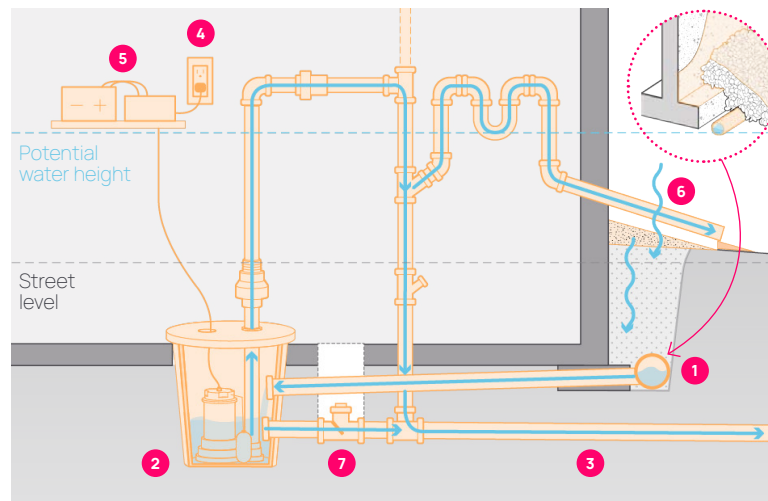
- ⦿ Drain water around the foundation to reduce the risk of cracks and infiltration under normal conditions and during snowmelt.
  - ⦿ Be functional, even in the event of a power failure.
  - ⦿ Be able to drain water to a suitable location in the event of system overload.
  - ⦿ Reduce pressure on the foundation and the risk of cracks and infiltration.
- ⚠ A groundwater management system is not used to drain water that accumulates on the floor (except sometimes cleaning water when the cover is unsealed): it manages the water present in the soil around the foundation.

## COMPOSITION OF A GROUNDWATER MANAGEMENT SYSTEM

Several configurations are possible:

- With exterior or interior **foundation drains** (under the slab).
- With or without an interior **sump**.
- With or without a **pump** (gravity system).
- Connected or not connected to the **municipal system**.

**Typical scenario with gravity drainage and sump pump:** the pump drains water to an exterior ditch when the municipal system is saturated.



## WHERE TO START?

**Understand the risk** → 🏠

- ⚠ An interior sump pit can be a pathway for water to enter during flooding caused by runoff or rising groundwater.
- ⚠ A blocked outlet can cause the slab to lift or the foundation to crack.

**Know the characteristics of the building**

- Year of construction: buildings constructed after 1955 are often equipped with a foundation drain, but the maximum lifespan of a foundation drain is 20 to 30 years.
- Know the condition and characteristics of the foundation: for example, whether or not there are cracks.

**Know the characteristics of the existing system**

- Condition, position, and connections of foundation drains and gutters.
- ⚠ A gutter should not be connected to the foundation drain. → B1a
- Drainage method: connected or not connected to a sump, with or without a pump
- Drainage point for collected water: combined system, separate system, or a ditch.

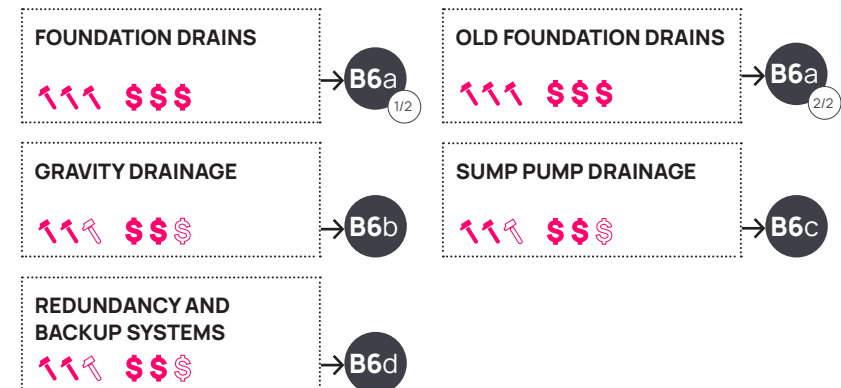
**Seek professional assistance** → 🧑‍🔧

- Determine the type of system required and ensure that water is directed to the right place and does not cause problems elsewhere.
- Have a professional assess the risk of radon infiltration.

**Know the characteristics and installation regulations**

- Soil drainage capacity: certain types of soil promote better natural drainage
- Groundwater level: a drainage system that is too close to the groundwater table may pump water continuously and lose efficiency during a flood.
- Regulations in force: in your municipality, must the drained water be directed to specific areas?

**Choose an appropriate strategy (one or more combined measures)**



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The information presented in this report is of a general and generic nature, and its applicability to a specific situation must be verified by qualified professionals.

# FOUNDATION DRAINS

## Types of buildings



## Expertise required

Contractor specializing in foundation drains.

⚠ Make sure to keep the warranty if the installation is done by a professional.



## Regulations

Section 9 of Chapter I of the QCC.



## Existing single-family homes

Most often around the exterior of the building, with or without a pump and sump system.

For larger projects (>800 m<sup>2</sup>), it is possible to have two foundation drains (interior and exterior).

A **foundation drain** is a pipe with a minimum diameter of 100 mm (4 in.), perforated at the top and bottom, and installed near the base of the foundation.

### Key objectives of a foundation drain:

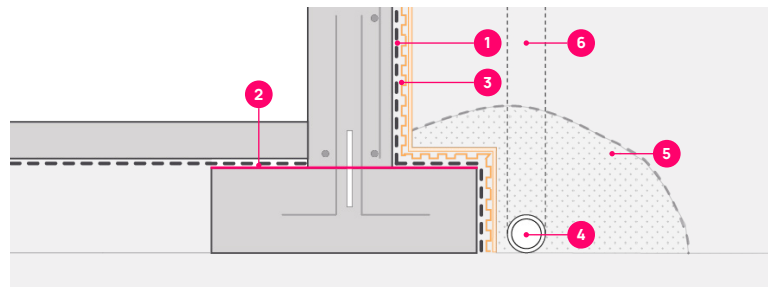
- ⦿ Redirect water around and under the building to the sewer or other suitable area.
- ⦿ Reduce hydrostatic pressure from water against foundation walls, which can cause cracks and leaks.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 EXTERIOR INSTALLATION

Conventional installation and preferred in most cases.



- Excavate to **frost-protected soil**. This depth depends on the nature of the soil and the geographical region. For example, in Quebec, the depth is at least 1.4 m (4.6 ft.) below the finished ground level.

#### 1 Install a **waterproofing membrane** against the foundation.

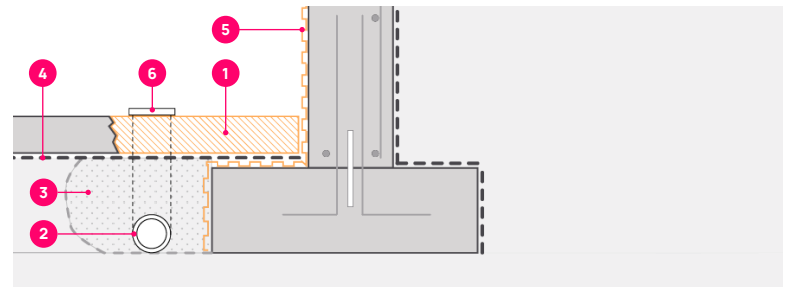
*For interior insulation:* attach the membrane to the outside of the wall up to the footing and foundation drain and cover with a drainage mat.

*For exterior insulation and if the foundation walls are rebuilt:* add a **capillary break** (2) between the footings and foundation walls.

- 3 Cover with a **drainage mat** protected by a **protective covering**. The mat will direct water to the foundation drain.
- 4 Place the **drain** at the base of the foundation footing at a minimum distance of 150 mm (6 in.).
- 5 Cover the drain with **crushed gravel** of uniform grain size, a **geotextile filter membrane**, and then **sand** up to the finished ground level.
- 6 Provide a **cleaning access panel** from the surface or from the sump.

### 2 INTERIOR INSTALLATION

Consider this option when excavation is not possible outside and the foundation wall is too porous or cracked.



#### 1 If there is an existing slab, demolish a **portion around the perimeter** of the existing slab.

⚠ Hire a radon professional to assess the risk of radon infiltration.

#### 2 Lay the **drain** at the base of the foundation footing at a minimum distance of 150 mm (6 in.).

#### 3 Cover the drain with **crushed gravel** of uniform grain size and a **geotextile filter membrane**.

#### 4 If installing a **new slab**: install a **waterproofing membrane** underneath it.

#### 5 Install a **drainage mat** covered with a sealant on the inside of the foundation wall, from ground level to the drain, to collect any water that may seep through the walls.

⚠ Avoid using bitumen-based sealant paint.

⚠ Check the thickness if using a polyurethane-based sealing or spray membrane.

#### 6 Rebuild or construct the slab, incorporating a **cleaning access panel**.

## Types of buildings



## Expertise required

Mason specializing in traditional stone masonry.

**Specialized contractor:** to coordinate excavation near old foundations.

**Structural engineer:** for consultation if the foundations are fragile or if the excavation is deep.



## Regulations

Check municipal regulations: some cities do not allow interior drains or require specific permits.

In some areas, preliminary archaeological surveys may be required.

If archaeological material is discovered by chance, it must be reported to the MCC (a requirement under the Cultural Heritage Act).

## GROUNDWATER MANAGEMENT

## OLD FOUNDATION DRAINS

Buildings constructed before 1900 often lack **foundation drains**. Even if a foundation drain is present, it may not be in good condition (maximum lifespan of approximately 40 years).

Key objectives of a retrofitted foundation drain:

- ① Redirect water around and beneath the building to the municipal sewer system or another suitable area.
- ② Reduce the hydrostatic pressure of water against the foundation walls, which can cause cracks and water infiltration.
- ③ Prevent water infiltration through joints, cracks, or the porosity of older materials, such as rubble stone.

## ADVANTAGES

- Keeping foundations dry, preventing chronic water infiltration, mold, and musty odors in basements or crawl spaces.
- Protecting the structural integrity of walls by reducing freeze-thaw cycles in porous materials.

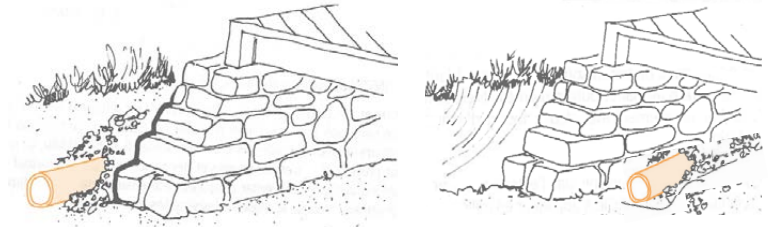
## PRELIMINARY STEPS

Before excavation:

- Check the soil composition and discuss the feasibility of the work with a qualified professional. For example, this is even more important for an older building. Assess the risks of removing moisture from a foundation built with lime mortar that has been in place for several decades on clay soil.
- Conduct a thorough inspection of the foundation to identify and seal active cracks using epoxy or polyurethane injection products suitable for old masonry.
- Plan for the drainage of collected water: to a municipal storm sewer (if permitted), a sump pit, or an infiltration area away from the building.
- Ensure the ground has a proper slope to direct surface water away from the foundation.
- If excavation to install an exterior drain is not possible (due to shared property lines or specific site conditions), install an interior foundation drain.

⚠ If iron-rich clay is present in the soil, the installation of a suitable foundation drain and sump pits is required.

⚠ Regular maintenance is required to ensure the foundation drain functions properly. Consult a specialist.



1

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## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

## 1 External drain

- Excavate down to the base of the footing (often consisting of large foundation stones beneath the rubble-stone wall).
- Clean the wall and apply a waterproofing coating if the wall is very porous. A bituminous membrane can be applied up to the lintel, or a non-adhesive membrane with an air gap.
  - ⚠ Sprayed membranes or dense polyurethane membranes, without bitumen, are possible, but irreversible.
  - ⚠ Applying a lime plaster to the exterior of the foundation requires significant maintenance and deteriorates in the underground section.
- Install a rigid, perforated PVC drain of the BNQ type (100 or 150 mm diameter - 4 or 6 inches) all around the building, with a minimum slope of 1%.
- Backfill with clean ¾ crushed gravel up to 30 cm above the drain, wrapping the entire assembly in geotextile to prevent clogging by fine soil particles.
- Backfill with compacted soil in layers, finishing with a drainage strip of river rock or a sloped permeable surface to divert surface water.

## 2 Interior drain

- Dig along the interior wall down to the footing.
  - ⚠ As with an exterior drain: do not install the interior drain lower than the bottom of the footings or the exterior wall.
- Install the drain connected to a collection pit or a sump pump leading to the outside.
- Pour a new concrete slab with a slope toward the sump. This is an opportunity to install a vapor barrier under the slab.
  - ⚠ When installing an interior drain, do not insulate the interior of the rubble-stone wall, as this would trap moisture in the masonry and could accelerate its deterioration due to freezing.

# B6b

## GROUNDWATER MANAGEMENT

# GRAVITY DRAINAGE

### Types of buildings



### Expertise required

**Plumbing contractor:**  
installation, inspection, or repair.

**French drain contractor:**  
installation, inspection, or repair.

⚠️ Make sure to keep the warranty if the installation is done by a professional.



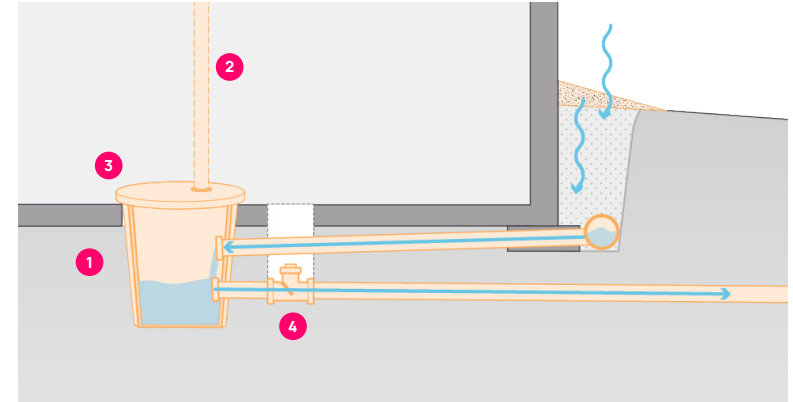
### Regulations

Chapter III of the QCC (Plumbing).  
PL-31 CMMTQ (RBQ).  
PL-60 CMMTQ (RBQ).

Groundwater intercepted by **foundation drains** → B6a is conveyed to an outlet by means of a **gravity drainage system** (passive) or a **sump pump** → B6c (active).

The gravity drainage system is **passive**, relying on the slope of the drain and the principle of gravity to ensure that water flows from the foundation drain to a lower outlet (ditch, infiltration well, or main pipe). It may or may not be connected to a sump, depending on the site configuration and terrain topography. This system works even in the event of a power failure.

For an interior sump that directs water to the municipal system by gravity : adding a **sump pump** will allow water to be drained into an exterior ditch when the municipal system is saturated.



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Drill the **slab** to install the sump.  
⚠️ Hire a radon professional to assess the risk of radon infiltration.
- 2 Connect the sump to a **vent** to allow ventilation of the sump and gravity drain to the municipal system.
- 3 Check that the **sump cover** is sealed to ensure safety, prevent debris accumulation, avoid odors, and prevent overflow onto the floor.
- 4 Install the required **valves** with **cleaning ports**. → B7  
⚠️ Avoid exposing yourself to self-flooding : → B6c

- ⚠️ A malfunctioning drainage system (insufficient slope, drain obstruction) can cause water to accumulate near the foundation, increasing the risk of infiltration, capillary rise, or water backup in the building.
- ⚠️ An improperly installed drain, an outlet clogged with debris, or a faulty connection (to a drain with a valve, for example) can prevent water from draining properly.
- ⚠️ Maintain your drainage system regularly. Check :
  - Every year that the outlet is clear.
  - Every five years, using a plug or camera, that the drains are not blocked.



Example of a blocked gravity drain outlet due to poor maintenance, causing significant structural damage (lifting and breaking of the slab, cracking, etc.) and flooding.

# B6c

## GROUNDWATER MANAGEMENT

# SUMP PUMP DRAINAGE

Groundwater intercepted by **foundation drains** → **B6a** is conveyed to an outlet via a **gravity drainage system** → **B6b** (passive) or a **sump pump** (active).

When gravity drainage is not possible due to insufficient slope, an outlet that is too far away or located at a higher elevation the system must include a **sump**, which is a pit usually located inside the building, in which a **lift pump** is installed.

The pump allows drainage water to be discharged to the designated outlet and activates automatically when the water level reaches a predetermined threshold. It is not designed to handle large amounts of water during extreme events.

### Types of buildings



### Expertise required

**Plumbing:** installation, inspection, repair



### Regulations

Chapter III of the QCC (Plumbing).  
Chapter V of the QCC (Electricity).  
PL-31, PL-55, PL-60 CMMTQ (RBC).

**Small residential, commercial, industrial, or buildings at high risk of flooding**

Common in basements, rare on the ground floor, often connected to a drain.

**Interior parking lower than city pipes**

To be installed at the lowest level and in elevator pits.

**Exterior installation**

Permitted by code if accessible for inspection and maintenance. Alternative if interior integration is difficult. In general: not recommended due to high maintenance and risk of freezing.



**Discount to be negotiated with your insurance**

Auxiliary sump pump equipped with an independent power source (e.g., battery).

⚠️ A malfunction in the drainage system (insufficient slope, drain obstruction, pump failure, or lack of backup power) can cause water to accumulate near the foundation, increasing the risk of infiltration, capillary rise, or water backflow into the building.

⚠️ An improperly installed drain, an outlet blocked by debris, or a faulty connection (to a drain with a valve, for example) can prevent water from draining properly.

⚠️ **Maintain your drainage system regularly. Check :**

- Every year that the outlet is clear.
- Every five years, using a plug or camera, that the drains are not blocked.

⚠️ **Test the pump regularly to ensure it is working properly by adding water to the sump to check that it activates, and consult the PL-55 (CMMTQ) self-inspection sheet for more details on best maintenance practices.**

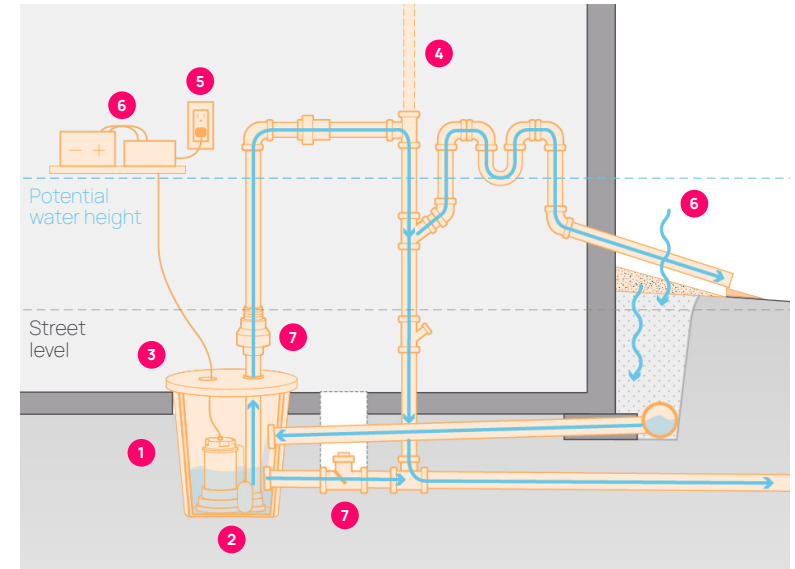
⚠️ **The pump not working, here are some possible causes:**

**Electrical problem :** power failure, power supply or amperage problem.

**Mechanical problem :** device malfunction, e.g., deformed rotor, damaged seal, punctured float, debris.

**Installation problem :** e.g., float assembly, seal installed upside down.

⚠️ **Activating the pump at a higher frequency of 10 times per hour can cause premature wear of the system. The system design must be validated by a qualified person.**



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Drill the **slab** to install the sump.
  - ⚠️ Hire a radon professional to assess the risk of radon infiltration.
- 2 Size the **system** so that the pump can run continuously for a few minutes (approximately 5 to 15 minutes) to reduce the frequency of starts and premature wear.
  - It must be sized and oriented to prevent backflow into the basement and directed to a safe drainage point.
- 3 Ensure that the **sump cover** is sealed to ensure safety, prevent debris accumulation, avoid odors, and prevent overflow onto the floor.
- 4 Connect the sump to a **vent** to allow ventilation of the sump and the gravity drain to the municipal system.
- 5 Make **electrical connections** according to standards, using a three-prong (grounded) outlet without an extension cord, and place the outlet above the potential water level.
- 6 Provide **backup systems**, as in the event of a power failure or overload, the sump can become a major source of water ingress. → **B6d**
- 7 Install the required **valves** with **cleaning ports**. → **B7**

# REDUNDANCY AND BACKUP SYSTEMS

### Types of buildings



### Regulations

Chapter V of the QCC (Electricity).

The installation of **backup systems**, whether for pump capacity or power supply, helps to keep the groundwater drainage system functional in the event of overload or power failure.

⚠ The systems presented offer good redundancy, but do not guarantee that the drainage capacity will be sufficient during an exceptional event.

#### 1 BACKUP DISCHARGE PIPE

Installed on the sump, it is used to evacuate water sent by the pump if the municipal network is saturated. Aim for an outlet (or deflector) 1.8 m (6 ft) away from the foundation, with a minimum slope of 2% (however, 10% is recommended). It must be sized and oriented to prevent backflow into the basement and directed to a compliant drainage point. → B6

#### 2 DUPLEX PUMP

Permanently installed in the sump, this system includes two pumps. Under normal conditions, they can operate alternately, which extends their service life. If a higher flow rate is required, the second pump starts automatically to assist the first.

⚠ Requires a power supply or battery backup system.

#### 3 EMERGENCY PUMP ACTIVATED BY CITY WATER

Permanently installed in the sump, this type of pump automatically starts when the water level in the sump exceeds a certain threshold, usually in the event of a power failure or main pump failure. Without electricity or a battery, it uses municipal water pressure to suck up and discharge accumulated water.

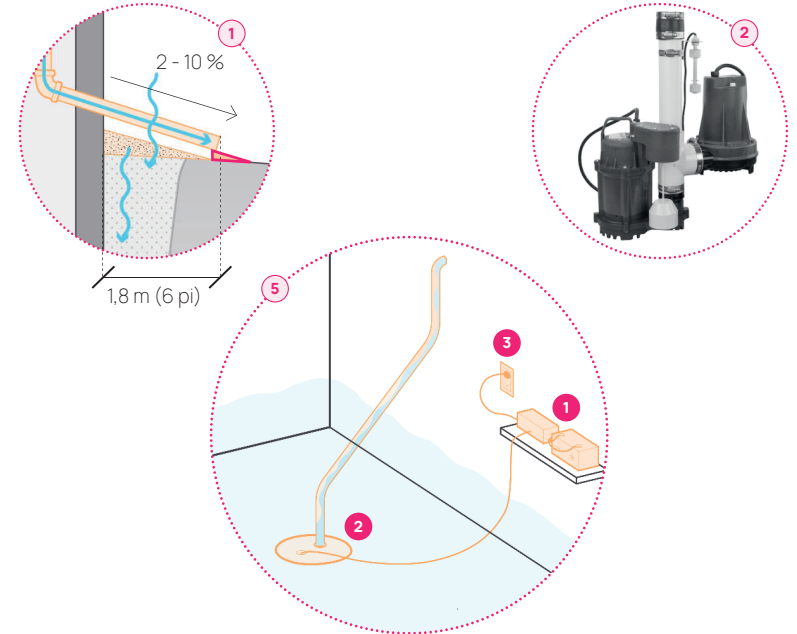
⚠ Consumes a lot of drinking water and does not work if the municipal water pressure is cut off or if the building is supplied by a well.

⚠ Some municipalities have required that they be removed because they create potable water system backflow hazard.

#### 4 BATTERY BACKUP FOR PUMPS

Backup batteries must be available and charged at all times to keep the pumps running during a power failure.

⚠ The power must be adapted to the starting current of the main or backup pump,



as a pump may require a much higher starting current than that required during normal operation.

#### 5 AUTOMATIC TRANSFER SWITCH

A transfer switch automatically switches the pump's power supply to the battery in the event of a power failure. It ensures that the drainage system remains operational without manual intervention.

- 1 Place the **battery** and **switch** above the potential water level.
- 2 Connect the **pump** and **battery** to the switch.
- 3 Connect the **switch** to a **power outlet** that is also above the potential water level.
  - A water leak detector can be added to warn of imminent flooding or a power failure.

⚠ Check that all connections comply with electrical standards.

⚠ Ensure that the positioning above the potential water level is respected to avoid any risk of contact with water.

# INTERIOR

## WATER MANAGEMENT

### B7 CHECK VALVES

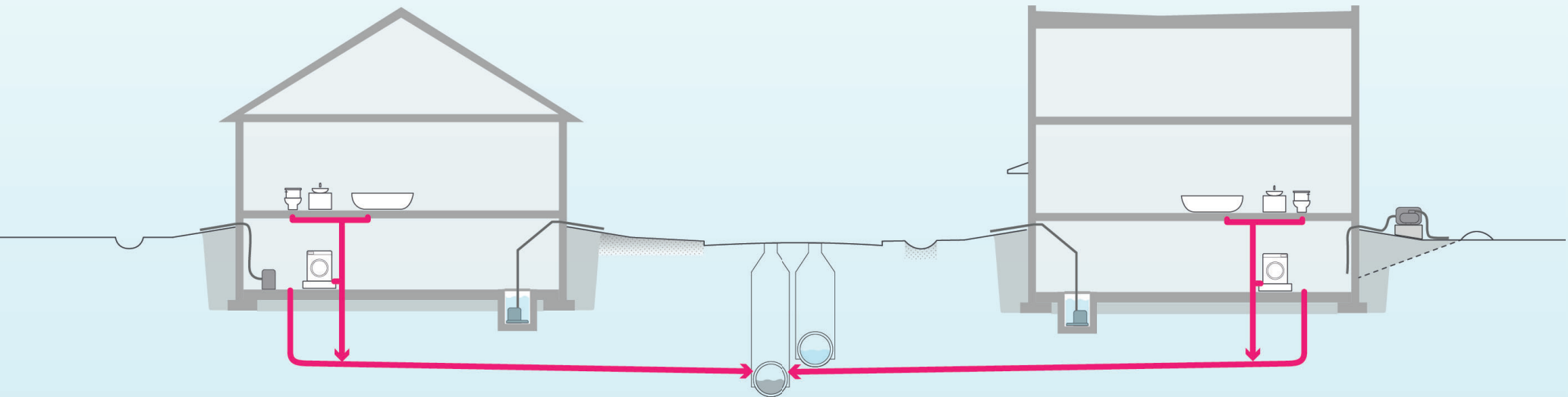
**B7a** Normally closed/open valves

**B7b** Insertable backwater valve in a floor drain

### B8 SURFACE WATER COLLECTION

**B8a** Drainage pumps

**B8b** Parking and elevator sumps



# B7

# CHECK VALVES



## Regulations

Chapter III of the QCC (Plumbing),  
PL-12 CMMTQ (RBQ),  
PL-58 CMMTQ (RBQ).

Some municipalities prohibit normally open or insert check valves.



## Residential

Positioned below the overflow level of sewer outlets.

## Commercial, industrial, and multi-unit dwellings

Floor drains in bathrooms, toilets, janitor's rooms, pump rooms, mechanical rooms, garbage rooms.

## New constructions

NC valves mandatory on secondary pipes.

## Existing buildings

NC valves recommended if connected to the municipal network.

## WHAT IS IT FOR?

The **check valve** protects against backflow.

Installed on drainage pipes inside or under the building, these valves prevent sewage or rainwater from flowing back up through sanitary appliances or drainage systems.

### 1 NORMALLY CLOSED VALVE (NC) -----

It prevents sewer backflow through sanitary equipment by remaining closed by default. It is installed :

- on a secondary pipe, before it joins the sewer lateral ;
- on the return pipe of sanitary equipment located below the level of the public sewer ;
- on the connection of equipment to the sewer lateral.

⚠ Must not be installed on a rainwater drainage pipe.

⚠ This measure applies to buildings that have already been flooded by backflow, or that are at risk of flooding.

### 2 NORMALLY OPEN VALVE (NO) -----

It protects the entire sanitary installation of a building by closing automatically in the event of backflow. It is installed :

- on a sewer lateral serving only one dwelling

⚠ Some municipalities prohibit it.

There are new systems of automatic, inflatable, and smart normally open valves (innovations to be evaluated).

### 3 INSERTION VALVE -----

It protects against backflow by blocking the return of sewage. Normally closed, it opens only to allow water to flow to the drain. It is installed :

- on an existing vertical pipe (e.g., in a floor drain in the basement).

⚠ Less durable than other types of valves.

⚠ May limit drainage flow and become blocked (not recommended in showers).

⚠ Some municipalities prohibit its use.

## WHERE TO START?

Understand the risk → 🏠

### Know the characteristics of the system

- Find out how sanitary appliances, floor drains, and storm drains are connected to the drainage system, if present on the network.
- Assess the height of potential backups in relation to the municipal network.  
Where are they located in relation to the level of the manholes in the street?
- Determine whether more than one dwelling is served by the sewer lateral.

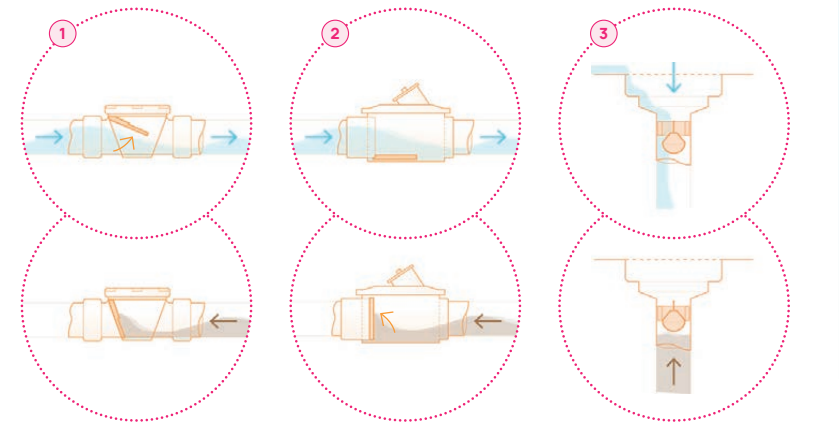
### Identify the regulations and standards in force

- Some municipalities prohibit normally open or insert valves.

Seek professional assistance → 🧑‍🔧

- Ensure that water is directed to the right place and prevent it from causing problems elsewhere.

### Choose one or more appropriate measures



→ Water flow under normal conditions.

→ Blocking during periods of overload.

# B7a

## Types of buildings



## Expertise required

**Plumbing:** advice and installation of appliances.

**Architecture and structure:** excavation and closure of walls and slabs.



## Regulations

Chapter III of the QCC (Plumbing).  
PL-58 CMMTQ (RBQ).



## Financial assistance program

Check with municipalities for possible subsidies.

## Discount to be negotiated with your insurance

A backflow prevention device for sewers or septic tanks (if the home is connected to the municipal sewer system, access to the cleaning manhole is also required).

## CHECK VALVES

# NORMALLY CLOSED / OPEN VALVES

A **normally closed** or **open valve** has the advantage of reducing the need for active mechanical components (motors, pumps) by remaining functional without external action, making the system less prone to failure.

### ① NORMALLY CLOSED VALVE

Installed on a **secondary pipe**, on the return pipe from **sanitary equipment** and/or on the connection of equipment to the collector in the basement of the ground floor.

### ② NORMALLY OPEN VALVE

Single-family residential building:

Installed on a **main pipe**, this type of normally open valve allows air to flow freely.

Other buildings:

Check the installation requirements in the relevant regulations.

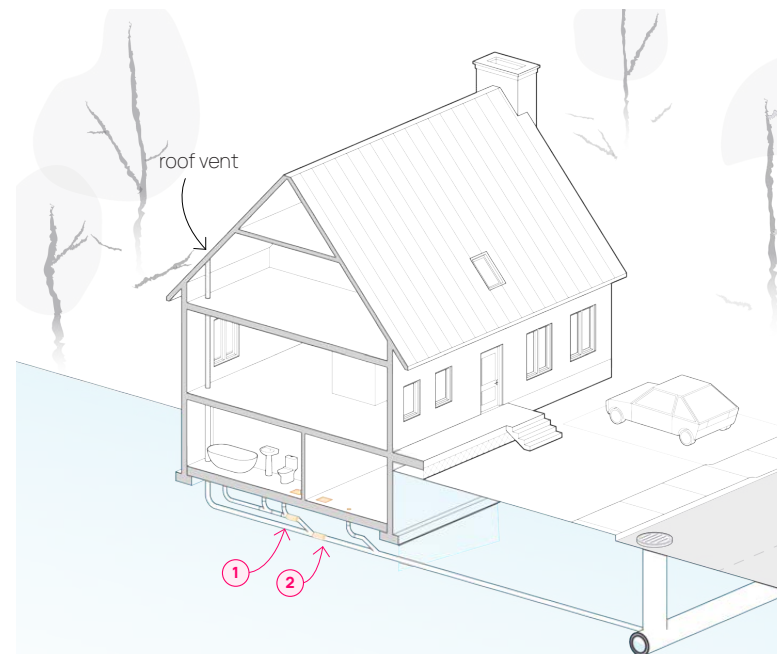
## CONSIDERATION

- Possible self-flooding and weakening of foundation walls if the valve on the sewage pipe connected to the foundation drain is closed.

▲ Never open the valve during a backflow.

▲ Regular maintenance and annual inspection of valves, as well as before and after extreme events, help to ensure their proper functioning :

- Wear protective equipment (gloves and goggles) to avoid the risk of contamination by sewage.
- Clear and open the access hatch.
- Check the seal of the valve cap and the general condition of the pipe.
- Open the valve and check that the flap or ball is in place (depending on the model: open or closed).
- Make sure that no debris, cooking grease, or residue is obstructing the mechanism.
- Operate the valve to test that it is working properly.
- If necessary, rinse lightly with clean water to prevent residue build-up.
- Close the cap and hatch securely.
- Repeat maintenance at least once a year.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Locate the **domestic water pipes**.
- Break part of the **floor slab**.  
⚠ Hire a radon professional to assess the risk of radon infiltration.
- Install a visible and accessible **inspection hatch** or **access hatch** for each valve.
- Install the **valve** in accordance with current regulations and standards.

If you have a **flat roof**, the interior roof drain empties into the main pipe. It is recommended that you disconnect it to avoid overloading the municipal network. → B2d

# B7b

## Types of buildings



## Expertise required

**Plumbing:** advice and installation of appliances.

**Architect and structure:** excavation and closure of walls and slabs.



## Regulations

If the pit serves as a floor drain → C9a

**QCC, Article 9.35.2.2:** The floor of an interior garage or garage attached to a dwelling must drain into a sump or retention pit serving as a floor drain.

**QCC, Chapter III Plumbing:** pits must have a smooth interior, with the following minimum dimensions: length 600 mm (24 in.), width 450 mm (18 in.), surface area 0.25 m<sup>2</sup> (2.7 ft<sup>2</sup>).

Check with your insurance company and the municipality to see if this device is recognized.



## Commercial and industrial

Floor drains in bathrooms, toilets, janitor's rooms, pump rooms, mechanical rooms, and garbage rooms.

## CHECK VALVES

# INSERTABLE BACKWATER VALVE IN A FLOOR DRAIN

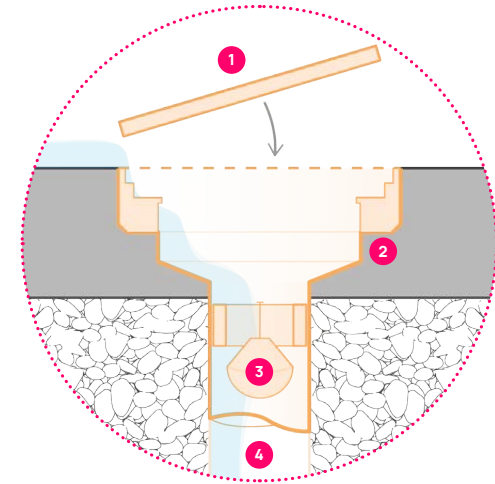
The **squeeze-in valve** allows water to flow out under pressure using a spring. It can only be installed in a **floor drain**.

A **floor drain** is a device for collecting and draining water from a floor connected to a sewage drainage system.

This overall system is used to **drain water** from sanitary (or heating) appliances during backflow or cleaning.

The grate prevents objects on the floor from entering the drain and ending up in a pipe.

- ⚠ Never open the valve during a backflow.
- ⚠ Regular maintenance and annual inspection of valves, as well as before and after extreme events, help to ensure their proper functioning:
  - Wear protective equipment (gloves and goggles) to avoid the risk of contamination by sewage.
  - Clear the access area and remove any debris or other obstructions.
  - Lift the valve cover and check that the flap or ball is in place (raised position).
  - Check the condition of the valve (wear, corrosion, seal integrity, etc.) and the overall condition of the pipe.
  - Ensure that no debris, cooking grease, or residue is obstructing the mechanism.
  - Operate the valve to test that it is working properly.
  - If necessary, rinse lightly with clean water to prevent residue buildup.
  - Close the grate securely.
  - Repeat maintenance at least once a year.



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

The drain is the hole in the floor closed by a **grate** 1 into which the **valve** 2 is inserted.

- The valve is held in place by the compression of an elastomer ring using two brass plates connected by bolts.

When the network is saturated, to prevent backflow, the **ball** 3 rises, pushed by the water coming up the **drain pipe** 4, and thus blocks the passage of water.

# B8

# SURFACE WATER COLLECTION



## Regulations

Chapter III of the QCC (Plumbing).  
 PL-31 CMMTQ (RBQ).  
 PL-47 CMMTQ (RBQ).  
 PL-48 CMMTQ (RBQ).  
 PL-50 CMMTQ (RBQ).  
 PL-60 CMMTQ (RBQ).

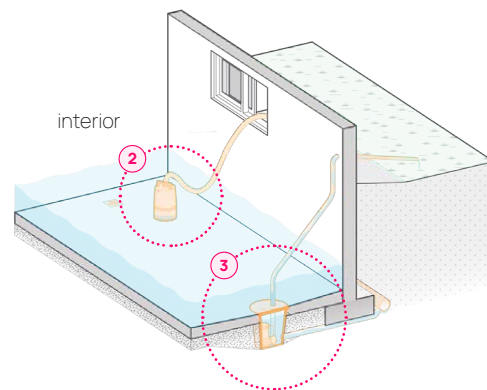
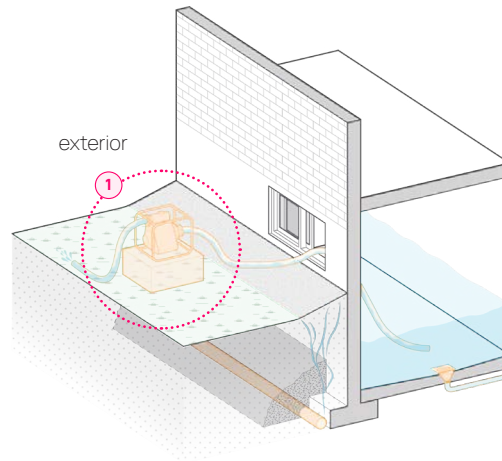
## WHAT IS IT FOR?

A **surface water collection system**, usually consisting of a pump and a power source, allows water that has managed to enter the building to be quickly removed to prevent damage, including mold that is harmful to health.

**⚠** Choose the type based on the characteristics of the flood.

### Key objectives:

- ⦿ Reduce water accumulation.
- ⦿ Slow down mold growth to protect health.



- 1 Gasoline pump
- 2 Electric pump
- 3 Sump pump → B6c

## WHERE TO START?

### Understand the risk → 🏠

- What are the characteristics of the flooding?
  - Flooding due to runoff, overflowing rivers, etc.
  - Regular/occasional flooding, minor/severe flooding.

### Identify the regulations and standards in force

- Municipality
  - Should water be directed to specific areas?
  - Can directed water be blocked by certain structures?

### Identify the characteristics and vulnerabilities of the building → A3a

- Presence or absence of a foundation drain.
- Sanitary fixtures, floor drains, and storm drains connected to the drainage system.
- Height of potential backups in relation to the municipal system and the level of street storm drains.
- The pumping capacity of a portable pump depends on the distance the water must travel to be evacuated: the further the water must be transported, the more powerful the portable pump must be.

### Seek professional assistance → 🚧

- Ensure that water is directed to the right place and prevent it from causing problems elsewhere.
- Ensure that the selected pump is correctly sized.

### Choose an appropriate strategy



# B8a

## SURFACE WATER COLLECTION

# DRAINAGE PUMPS

### Types of buildings



### Expertise required

**Mechanical or plumbing (certified):** identification of the problem, appropriate recommendations, installation (if required).

**Structure:** if drilling into the slab (sump).

① < \$500

② < \$1,000

Temporary pumps can be rented, but are often in short supply during periods of flooding.

③ < \$5,000

Prefabricated pump with sump installation.

A **water drainage pump** is a protective system installed to pump out and discharge accumulated water before it causes damage.

It must be sized to drain water from a very heavy 15-minute downpour, which has about a 4% chance of occurring each year.

There are different types of water drainage pumps (non-exhaustive list):

- **Portable pumps** (temporary equipment)

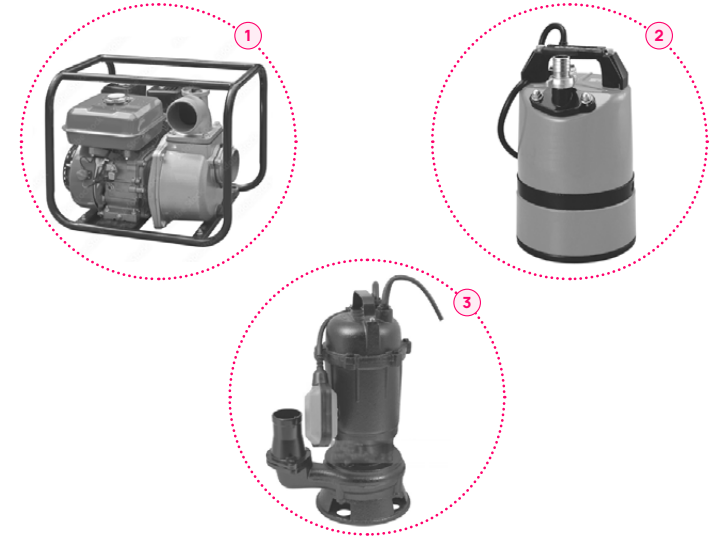
- ① **The gasoline pump** is installed high up outside the building (it cannot be submerged). It works even in the event of a power failure and can drain large quantities of water at a high flow rate.
  - ② **The electric pump** can be installed indoors. It has a lower flow rate but can drain water to a very low level (1 mm). It can be submersible or non-submersible, allowing water to be drained safely.
- **Fixed pump** (permanent equipment)
- ③ **The sump pump** is mainly used to remove water collected by foundation drains to reduce hydrostatic pressure on foundation walls. In certain cases only, this system could help remove flood water. → B8c

#### ▲ Examples of potential hazards:

- **Temporary gasoline pump** ① poses potential carbon monoxide poisoning hazards: it must be located outdoors and elevated.
- **Temporary electric pump** ② may present a risk of **electric shock**.

#### ▲ Warning system

- Install water detectors in vulnerable areas, such as near sump pits, lift pumps, or in basements.
- Test detectors regularly and replace batteries according to the manufacturer's recommendations.



## CONSIDERATIONS

- ▲ The pumping capacity of a portable pump depends on the distance the water must travel to be evacuated: the further the water must be transported, the more powerful the portable pump must be.

The hydrostatic pressure exerted on foundation walls is determined by the difference between the interior and exterior water levels.

- A weakened foundation can fail if the difference between the interior and exterior water levels is too great. To avoid overloading the structure, **pump 2 feet of water at a time**, checking to see if water continues to accumulate. If so, **wait 12 hours** before pumping again.

Requirements and capabilities:

- **Maintenance:** unlike a sump pump ③, which requires simple and accessible periodic maintenance, a gas-powered pump ① requires a specific shelter and recurring engine maintenance.
- **Accessibility:** a tenant can install a portable pump ②, but the owner must be asked to carry out the installation work for a sump pump ③.
- **Nuisances:** all types of pumps can cause noise pollution. It is recommended to avoid gasoline pumps ① and not to install a living space near a sump pump ③.

# B8b

## Types of buildings



## Expertise required

**Mechanical or Plumbing:** identification of water sources, storm and sanitary drainage, and installation of pumping equipment.

**Electrical:** power supply for pumping systems.

**Civil:** site condition assessment and water retention outside the building.

**Structural:** installation of a concrete sump pit or other device.



## Regulations

Chapter III of the QCC (Plumbing):  
PL-31 CMMTQ (RBQ).  
PL-47 CMMTQ (RBQ).  
PL-48 CMMTQ (RBQ).  
PL-50 CMMTQ (RBQ).  
PL-60 CMMTQ (RBQ).

## SURFACE WATER COLLECTION

# PARKING AND ELEVATOR SUMPS

**Pumping systems** with a sump tank and pumps →B8c are required to remove sewage and rainwater collected in the basement areas of large buildings, since this water cannot drain by gravity to the municipal sewer system, which is generally located at a higher elevation.

These systems accumulate a certain amount of water in the sump to minimize pump runtime, then convey the water outside the building using float-activated pumps.

## CONSIDERATIONS

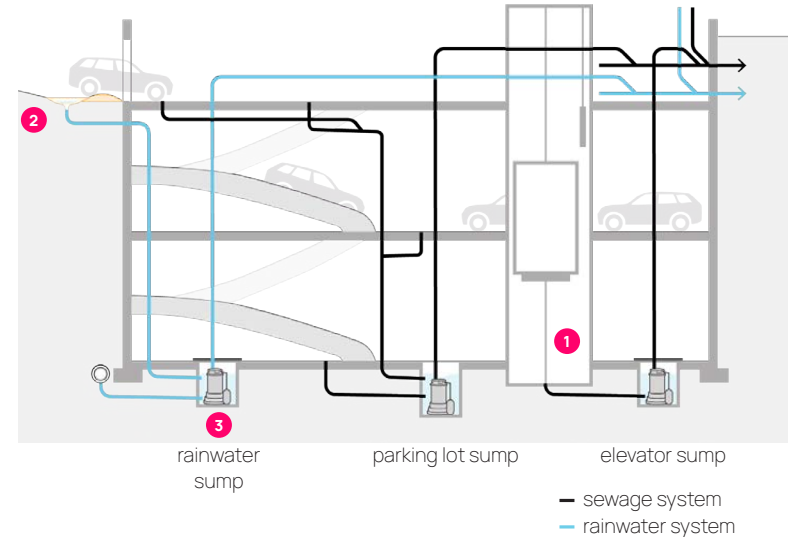
- Prioritize gravity-fed drainage to municipal systems whenever possible.
- ⚠ A power outage or pump malfunction can cause sump pits to overflow, leading to water damage or basement flooding.

## PRELIMINARY STEPS

- **Identify vulnerabilities and potential water entry points.**  
Elevator shafts are vulnerabilities because they carry water down to lower levels.  
Parking ramps facilitate the drainage of water to a low point inside the building.
- **Identify the various sources of water (see glossary) to ensure the successful design of these systems.**  
Water from indoor parking lots and elevator shafts is considered sewage due to the presence of oils and gasoline.
- **Conduct a site condition study to assess the volume of water to be managed.**  
Evaluate the proper sizing of the sump pit; consider oversizing it to account for specific flood events.

⚠ **Power outage:** when a building is equipped with an emergency generator, it is good practice to connect the pumping system's power supply to it.

⚠ **Pump malfunction:** installing a duplex pumping system - that is, two pumps in a redundant configuration - is standard practice, although not required by current codes.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 **Elevator shafts**  
Provide a dedicated sump for elevator shafts equipped with a floor drain.
- 2 **Parking ramps**  
Install a trench drain at the bottom of outdoor parking ramps to collect rainwater and prevent contamination with sewage from the parking lot.
- 3 **Rainwater sump** (typically connected to the main storm sewer)  
⚠ Consider direct discharge to the outside in cases of recurring municipal sewer overflows.

### General

- Consider installing a sand or oil separator depending on the water source.
- Design a sump and pumping system for each potential water source in the basement and separate the water until it is conveyed to its respective municipal network.
- For a more resilient installation, consider control devices:
  - control panel (separate power supply for the pump, float control audible and visual alarm);
  - connectivity to the building management system to monitor alarms remotely.

# BUILD [BACK] BETTER

The ***Build [Back] Better*** booklet presents measures to reduce the exposure of sensitive elements in a building and, in addition, to reduce the vulnerability of exposed elements. These measures relate, for example, to the resistance of architectural components and equipment, their drying capacity, and their relocation.



# BUILD [BACK] BETTER

This booklet presents measures that complement those detailed in the **Water Pathways** booklet →  aimed at reducing the intensity of flooding.

To better understand flood risk and assess the specific vulnerabilities of a building, refer to the **Flood Risk** booklet. → 

The **Build [Back] Better** booklet proposes measures to reduce the exposure of sensitive elements in a building and, in addition, to reduce the vulnerability of exposed elements. It is structured in three parts:

## 1 INTERIOR SYSTEMS

Presents works carried out from the **inside**. The measures relate to the **layout** and **design** of living spaces and mechanical, electrical, and plumbing (MEP) systems, as well as resilient materials and assemblies.

## 2 EXTERIOR SYSTEMS

Presents works carried out from the **outside**. The measures are related to the **strength, impermeability, and drainage capacity** of the building envelope (roof, exterior walls, and foundation) to prevent infiltration and manage moisture.

## 3 FOUNDATIONS AT RISK OF FLOODING

Presents **strategies** that involve underpinning or structural modification of the foundation. The foundation can be adapted to cope with flooding: either by accommodating or resisting it, or by avoiding it by moving living spaces above the potential water level.

### C1 INTERIOR [RE]DESIGN

### C2 MECHANICAL, ELECTRICAL, PLUMBING

### C3 RESILIENT INTERIOR WALLS

### C4 RESILIENT FLOORING

### C5 RESILIENT ROOFS

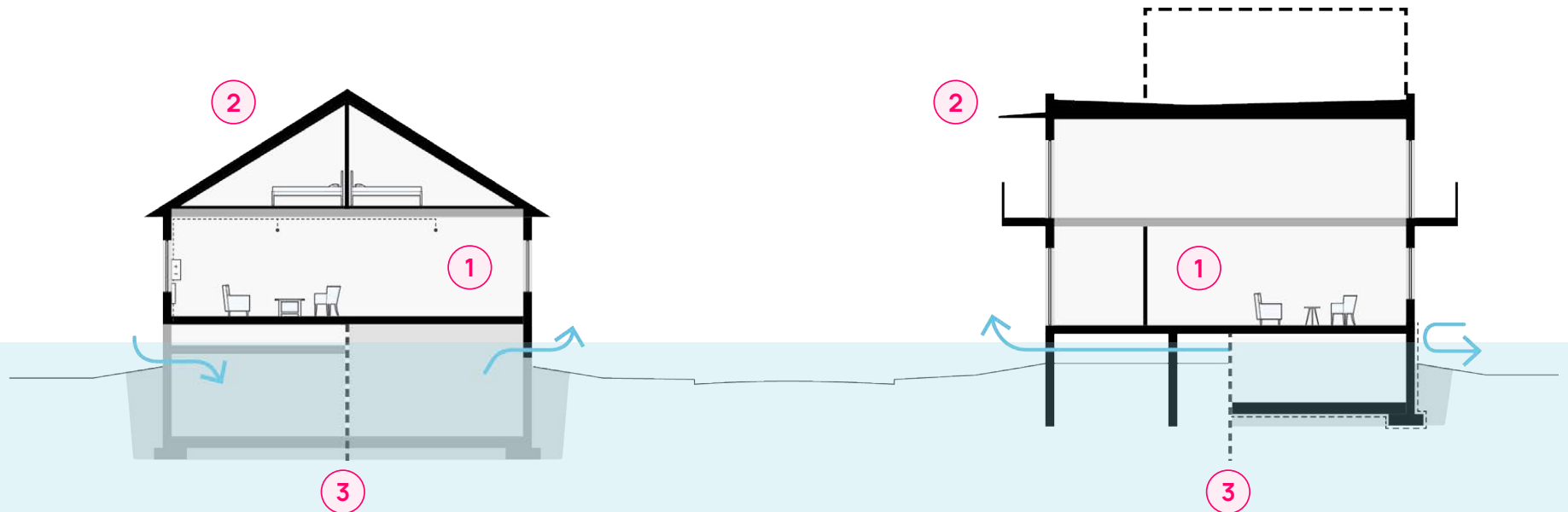
### C6 RESILIENT EXTERIOR WALLS

### C7 RESILIENT JOINTS AND PENETRATIONS

### C8 WET-PROOFING

### C9 DRY-PROOFING

### C10 FLOOD AVOIDANCE



# INTERIOR SYSTEMS

## C1 INTERIOR [RE]DESIGN

- C1a** Relocation of living spaces
- C1b** Carpentry
- C1c** Refuge area
- C1d** Addition of a floor
- C1e** Resilient commercial development
- C1f** Storage elevation

## C2 MECHANICAL, ELECTRICAL, PLUMBING

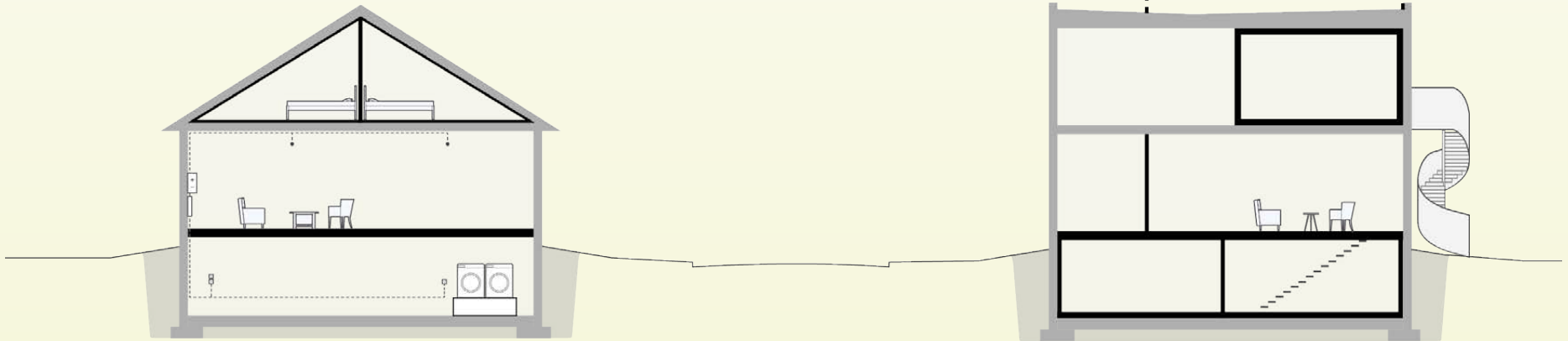
- C2a** Equipment protection <sup>1/2</sup>
- C2a** Protection of technical rooms <sup>2/2</sup>
- C2b** Electrical redistribution <sup>1/2</sup>
- C2b** Relocation of technical rooms <sup>2/2</sup>
- C2c** Independent energy <sup>1/2</sup>
- C2c** Independent energy People's safety <sup>2/2</sup>

## C3 RESILIENT INTERIOR WALLS

- C3a** Basement wall insulated from the inside
- C3b** Light-frame partition wall
- C3c** Interior finishes
- C3d** Old interior partitions

## C4 RESILIENT FLOORING

- C4a** Existing slab
- C4b** New slab
- C4c** Floor above a crawl space <sup>1/2</sup>
- C4c** Humidity management in a crawl space <sup>2/2</sup>



# C1

# INTERIOR [RE]DESIGN



## Regulations

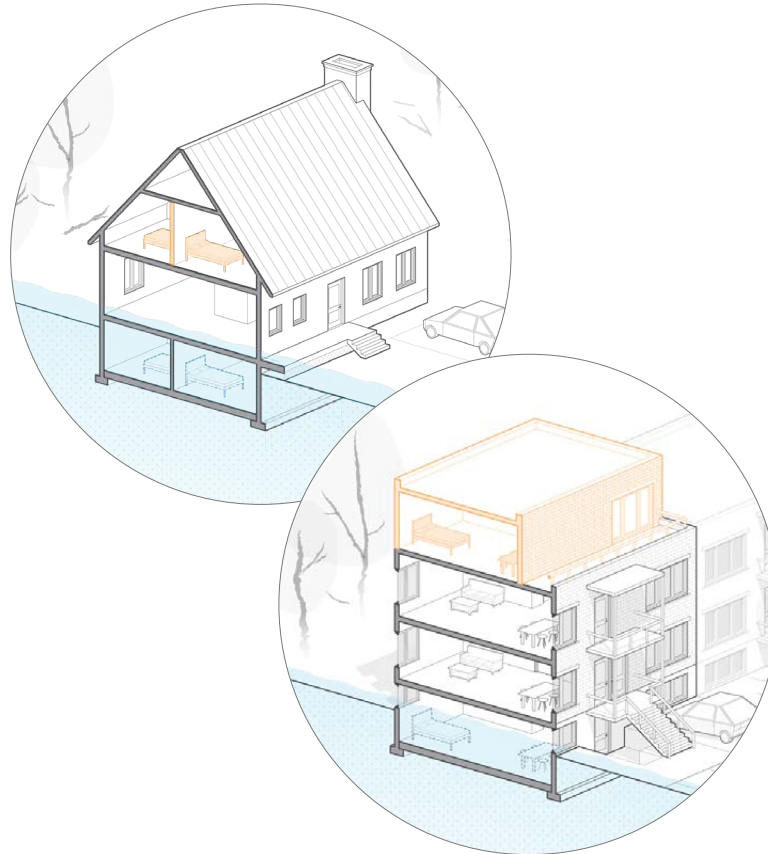
\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

### Key objectives of flood-resilient interior [re]design:

- Reduced vulnerability and/or exposure of property and materials.
- Preserved health and increased safety of occupants.
- Reduced recovery and reoccupation time.

## ADVANTAGES

- Decreased amount of materials discarded after a flood.
- Lower disaster repair costs.
- Better insurability to obtain new building insurance.



## WHERE TO START?

Understand the risk → A1 A2

### Know the characteristics of the building

Determine whether the living space allows for redevelopment. Know:

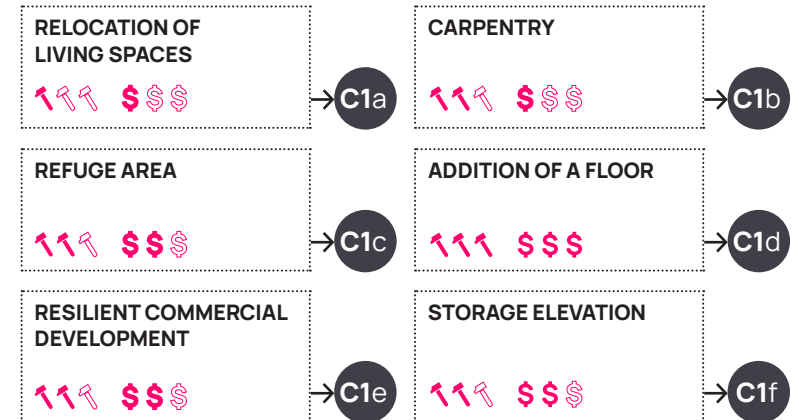
- The characteristics of the existing structure.
- The regulations related to expansion and maximum height.

Seek professional assistance → A3

Identify potential vulnerabilities → A3a

- Building's predisposition to damage:
  - Living areas and valuable property below the potential water level (or protection objective\*).
  - Secondary or emergency windows and doors located below the potential water level (or protection objective\*).
  - Non-resilient or non-resistant materials and assemblies.

Choose one or more measures appropriate to the context



# C1a

## Types of buildings



## Expertise required

Interior design or architecture: optional.

MEP: if relocating wet rooms and/or changing electrical and mechanical systems.

Structure: if a floor is added.



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## INTERIOR [RE]DESIGN

# RELOCATION OF LIVING SPACES

### Relocating living spaces involves:

- Relocating or raising living spaces used for sleeping or preparing meals, which were originally located below the potential water level (or protection objective\*).

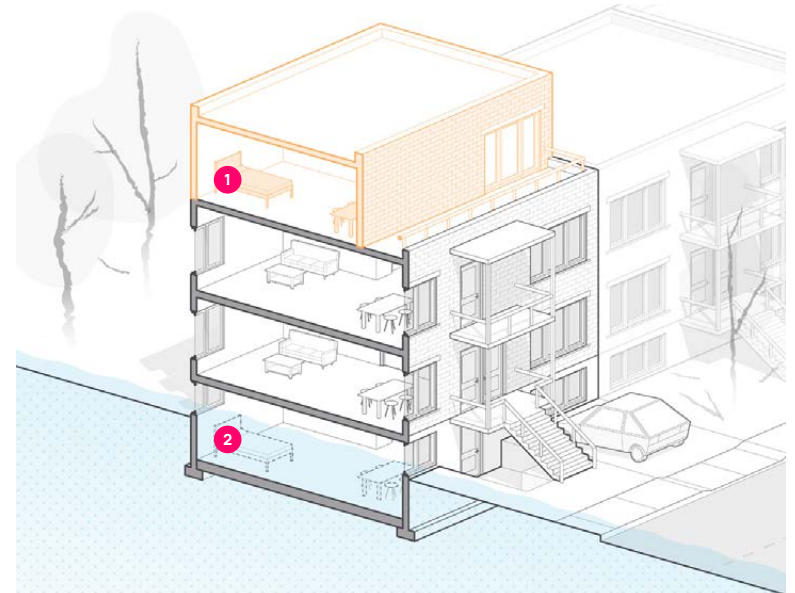
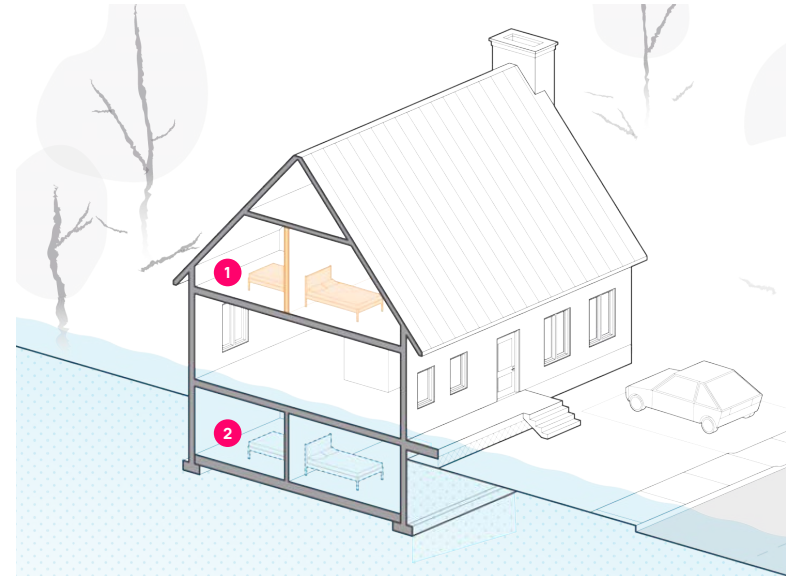
## CONSIDERATION

- Involves abandoning a basement or using it for low-risk purposes (parking, access, storage, etc.) and therefore the potential loss of living space.

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Move **bedrooms, kitchens, and bathrooms** to a level above the potential water level (or protection objectives\*) as a priority.
  - ⚠ Furniture made of textiles or water-sensitive materials must be moved to an area not exposed to the hazard or must be adapted.
- 2 Adapt areas located below the potential water level (or protection objectives). → C1 C2 C3 C4



## SPECIAL CASE

- Building exposed to a water level higher than the first habitable floor.
- Building whose existing volume does not allow for the relocation of rooms:
  - If it is not possible to relocate living spaces, it is strongly recommended that a **refuge area** be provided. → C1c
  - Homes that are entirely exposed to the risk of flooding can be relocated by **adding a floor** → C1d under certain conditions (financial and urban planning and government regulations).
- Buildings exposed to high winds or tornadoes:
  - Access to the basement must be maintained.

# C1b

## Types of buildings



## Expertise required

**Interior design:** who has references in resilient carpentry.



## Regulations

### Commercial and institutional:

Quebec Construction Code: Comply with fire resistance and universal accessibility requirements for doors (materials and dimensions) and comply with recognized Canadian standards (CAN, CSACAN, ULC, etc.). Metal, composite, or fire-retardant wood doors and frames that meet mechanical and fire resistance standards is often preferred.

- ✓ Strong
- Average
- Weak
- ♻️ Recyclable
- 🍃 Recoverable
- ✗ Sacrificial (temporary role)

# INTERIOR [RE]DESIGN CARPENTRY

**Carpentry** includes cabinets and cupboards, stairs, doors and windows, and ornamental components. These can suffer significant damage in the event of flooding.

### Resilient carpentry aims to:

- Limit material losses in the event of contact with water.
- Reduce the risk of damage to structures in contact with water (walls, floors, etc.).
- Prevent conditions conducive to mould growth.

### Characteristics:

- Made of materials with good overall resilience (or designed to be easily removable/replaceable).
- Allows for rapid drainage and effective drying after temporary immersion.
- Does not trap moisture or promote mould growth.

⚠️ The installation of resilient carpentry elements does not guarantee total protection of the components.

## MATERIALS

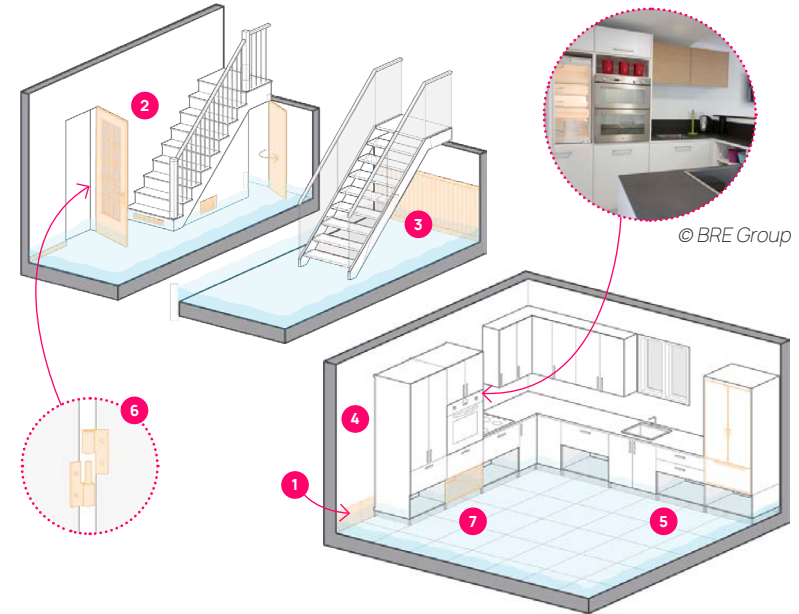
### Doors

TYPE	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Hollow core ✗	○	○	○	○
Solid core ✗	○	○	○	○

### Moldings

TYPE	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
MDF ✗♻️	○	○	○	○
Pine ✗🍃	○	○	○	○
Jointed pine ✗🍃	○	○	○	○

Material resistance capacity testing  
in partnership with the University of Sherbrooke



© BRE Group

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Install **removable mouldings** and trim (e.g., baseboards → C3c).
- 2 Install **interior hinged doors** rather than sliding doors to limit the effects of water pressure or mechanism deformation.
- 3 Prevent water accumulation with an open **staircase** configuration (without risers).  
⚠️ Otherwise, provide access under the stairs or a ventilation hatch.
- 4 Incorporate **free space** behind built-in furniture for ventilation.
- 5 Raise **cabinets** and **cupboards** on legs to facilitate cleaning, or add removable **kick plates**.
- 6 Install doors with **quick-release hinges** (hinged) to facilitate their removal in the event of flooding.
- 7 Use **removable drawers** to facilitate their removal with their contents in an emergency.

⚠️ Immediately after flooding (if the water is not contaminated): clean and dry the woodwork to reduce the risk of mold growth.

# C1c

## Types of buildings



## Expertise required

**Architecture and/or structure:** if modifying access points and/or adding a floor.

**For a large building:** consult an architect to establish safety strategies and validate evacuation routes.



## Regulations

Check with your local municipality to find out the conditions that apply to the construction of a refuge area and to changes in the appearance and height of the building.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

# INTERIOR [RE]DESIGN REFUGE AREA

A **refuge area** is a space above the potential water level (or protection objective\*) designated as a place of refuge. It must be accessible from inside the building and to the outside for evacuation purposes.

## CONSIDERATIONS

- The refuge area can be a designated space located high up in the building or an exterior or interior space on a roof.
- In the case of a multi-unit building, the owner must define an area designated as a refuge for the most vulnerable occupants (e.g., basement dwellings) or all occupants, secure access, and install clear signage.

## ADVANTAGES

- If converting an existing interior space: preservation or minor modification of the building's exterior appearance.
- If expanding on the roof: increase in living space, if the lower dwelling communicates with the designated refuge area.

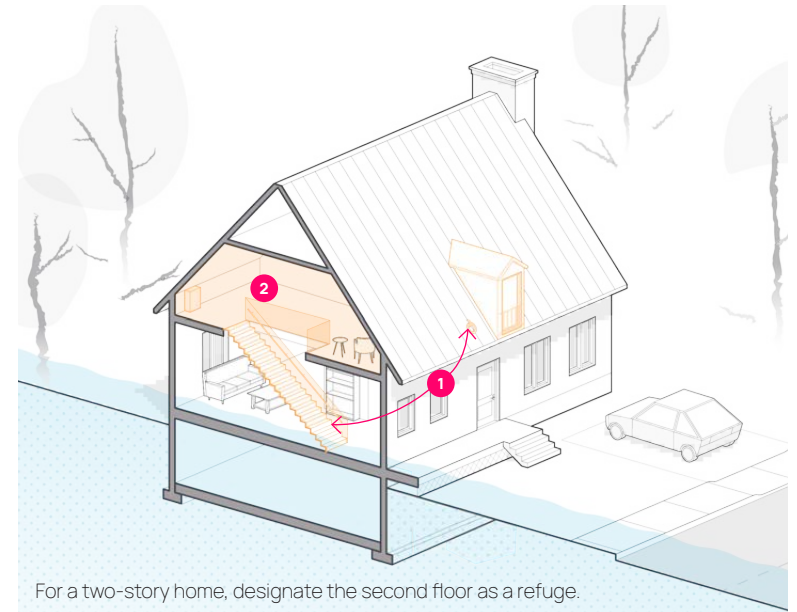
## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

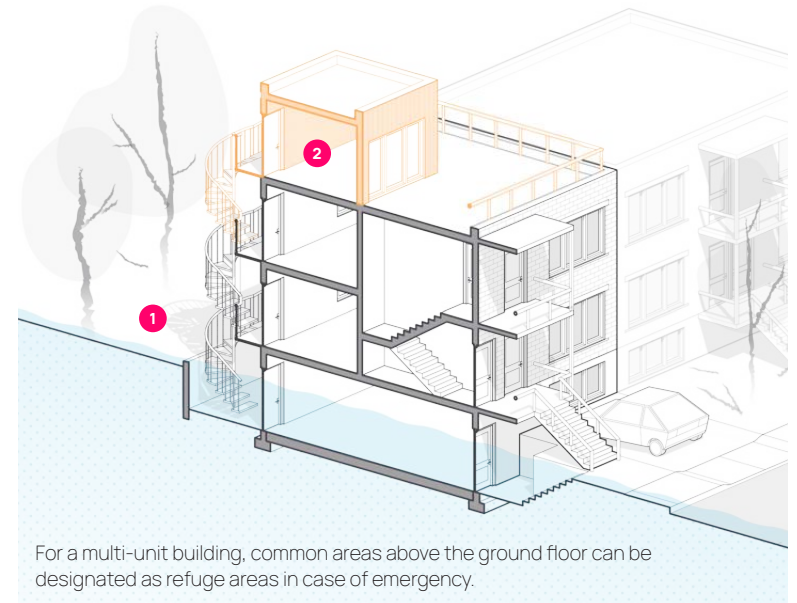
- 1 **Requires access from inside the building and access to the outside for evacuation:**
  - Access from the inside via a fixed staircase with handrails, a ladder or a retractable staircase, and visible and clear signage to facilitate movement to the refuge area.
  - Emergency exit to the outside (door or window), dimensions 1m x 1m min.
  - ⚠ If the potential water level is high, provide a mooring ring on the outside to facilitate access by water or helicopter.
- 2 **Design the spaces:**
  - Dimensions: minimum area of 1 m<sup>2</sup> per person; if indoors: minimum ceiling height of 2.20 m.
  - Structure and floor: minimum capacity of 125 kg/m<sup>2</sup>, water and wind resistance
  - Non-slip flooring.

## SPECIAL CASE

- **Building or dwelling where all floors are below the potential water level (or protection objective\*):**
  - Creation of an ideal covered space on the roof or on the roof of a well-anchored annex building.
  - Creation of access from inside the main building to a suitably designed refuge area.



For a two-story home, designate the second floor as a refuge.



For a multi-unit building, common areas above the ground floor can be designated as refuge areas in case of emergency.

⚠ Equip the refuge area with a 72-hour emergency kit.

For more information: [www.quebec.ca/securite-situations-urgence/urgences-sinistres-risques-naturels/comment-se-preparer-a-la-maison](http://www.quebec.ca/securite-situations-urgence/urgences-sinistres-risques-naturels/comment-se-preparer-a-la-maison)

# C1d

## Types of buildings



## Expertise required

**Structure:** assessment of additional loads.

**Architecture:** design and layout.



## Regulations

The municipality may have requirements regarding the height and architectural integration of a building. Modifications must be subject to a permit application and may have to go through a special committee such as an Urban Planning Advisory Committee (UPAC).

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## INTERIOR [RE]DESIGN

# ADDITION OF A FLOOR

Adding a floor allows you to:

- Relocate living spaces that were originally located below the potential water level (or protection objective\*).
- Create a refuge area → C1d in a building whose foundations cannot be raised.

## CONSIDERATIONS

- Involves abandoning a basement or using it for low-risk purposes (parking, access, storage, etc.), thus potentially losing living space.
- Requires a structure that can support an additional floor and flood loads (\$\$\$).
- Ability to carry out the work depending on the type of building (e.g., terraced house).

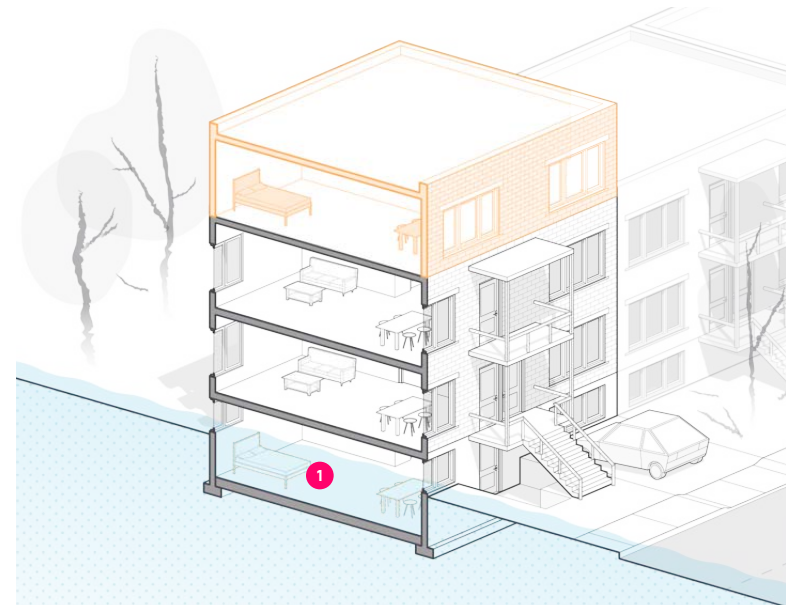
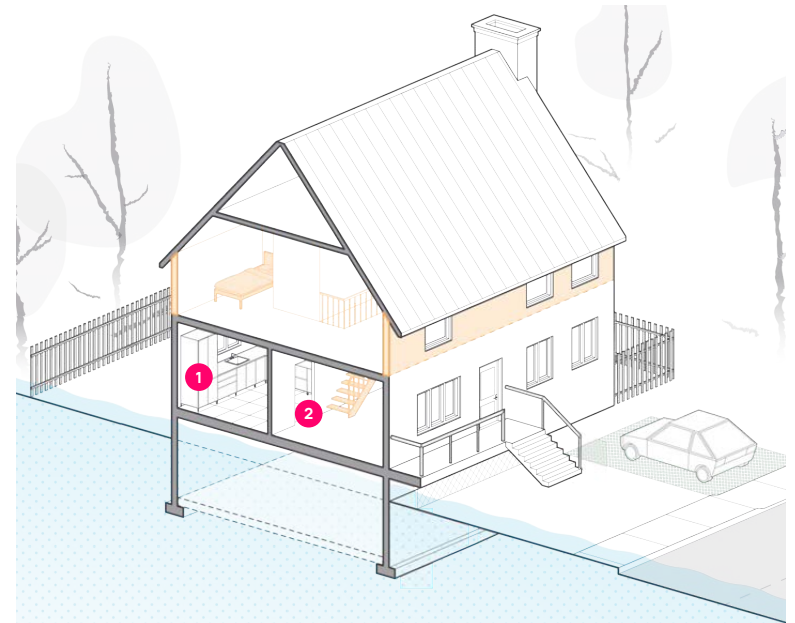
## ADVANTAGE

- Provision of natural light in the relocated rooms.

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Adapt spaces located below the potential water level (or protection objective\*).** → C1 C2 C3 C4
- Create access points.**
  - ⚠ Adapting to flooding should not hinder universal accessibility.
- Single-family home expansion option:**
  - Prioritize an upward expansion (setback or mezzanine) rather than excavating the basement, if regulations allow.
- Basement dwelling replacement option:**
  - Convert the basement dwelling into a crawl space, with the possibility of building a dwelling above ground on a new floor (\$\$\$), if regulations allow.
- Transformation of an existing dwelling located entirely below street level:**
  - Possible division into two vertical dwellings (with the upper floor) \$\$\$ to reduce their exposure.



## Types of buildings



## Regulations

Ensure that any work on the floor, electrical systems, or walls complies with local codes. Check accessibility regulations if steps or ramps are added in the Quebec Construction Code.

Confirm with the owner that the necessary permits have been obtained.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## INTERIOR [RE]DESIGN

# RESILIENT COMMERCIAL DEVELOPMENT

Street-level commercial spaces are at risk during flooding events. Direct, threshold-free entrances are particularly vulnerable to water infiltration.

**Resilient commercial development** involves:

- Elevating or protecting critical equipment.
- Reducing the risk of damage to fixtures and fittings (walls and floors) that come into contact with water.
- Preventing conditions conducive to mold growth.

## CONSIDERATIONS

- Leasing context: minor adaptations are preferred to limit structural work.
- Space constraints: need to optimize the layout without reducing retail space.
- Universal accessibility: any floor elevation requires transition solutions (ramps and handrails).

## ADVANTAGES

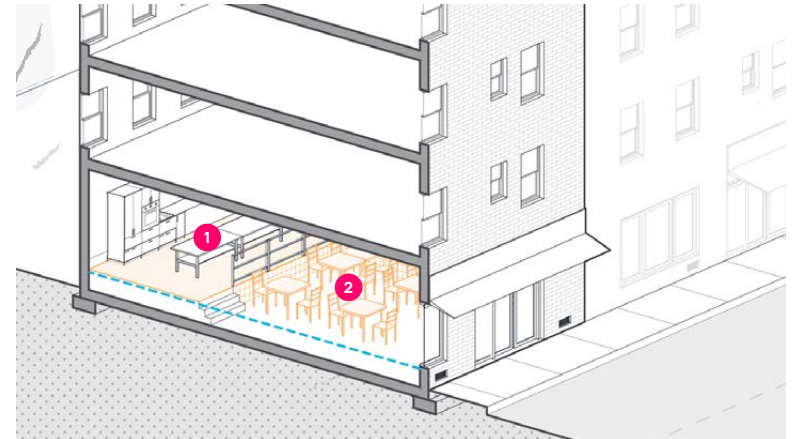
- Optimization of interior layout (more clearance, smoother traffic flow).
- Improved durability of materials and furnishings.
- Potential for reduced insurance premiums.
- In some cases, this can prevent business closures and revenue loss.

## PRELIMINARY STEPS

- **Understand the risk.**  
Identify the potential water level (or protection objective\*).
- **Understand the characteristics of the building and its systems.**  
Check the capacity and location of drains.  
Assess the structural limitations of the premises (walls, floors, utility access).
- **Check the impact on the basement** of potential water infiltration through the ground floor fixtures.

▲ Any presence of water can pose a serious risk to health and the building (dry rot).

It is essential to inspect the condition of the fixtures and the building after a flood.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 Flood avoidance zone

- Position storage areas for goods, rooms such as kitchens, and equipment above the potential water level (or the protection objective\*).

### 2 Wet-proofing zone

#### Simple Actions (\$)

- Clear the floor as much as possible.
- Elevate goods and use pallets, shelves, or pedestals.
- Install water-resistant and easily movable furniture.

#### Intermediate Actions (\$\$)

- Raise wiring and electrical outlets.
- Add coverings or panels to protect the bottom of walls.
- Waterproof sensitive areas: joints, lower parts of walls, thresholds.

#### Major work (\$\$\$)

- Adjust floor slopes toward floor drains.
- Install or improve an interior drainage system.
- Raise the areas containing technical equipment slightly and, if space and structure allow, raise the entire floor.
- Install resilient materials.
- Use waterproof wall and floor coverings.



# INTERIOR [RE]DESIGN STORAGE ELEVATION

## Types of buildings



## Expertise required

**Architecture / interior design:** optimizing the layout and selecting resilient materials.

**Engineering (mechanical, electrical):** relocating systems, pumps, drainage, check valves, and emergency power supply.

**Structural:** if major modifications are planned.

**Insurance company:** verifying eligibility for flood coverage.



## Regulations

Provide drainage or pumping systems.

Verify the requirements and compatibility (load, anchoring, strength) of removable barriers. Verify insurance coverage and compliance with industry standards.

In flood-prone areas, certain fixed components may require ministerial approval for special measures (e.g., permanent retaining walls), which underscores the importance of removable or passive systems.

Storage areas, basement equipment, and ground-level loading docks are at risk during flooding events.

## Key objectives of storage elevation:

- Maintain a safe space for people and property in the event of an emergency.
- Limit water intrusion through doors, windows, floors, and mechanical systems.
- Reduce the number of vulnerable items located at ground level.
- Protect critical equipment: servers, electrical appliances, inventory.
- Ensure rapid restoration of operations.

## CONSIDERATIONS

- Potential loss of space due to raising the floor.
- Possible challenges with universal accessibility.
- Different needs depending on the type of business (inventory, cold storage operations, kitchen, etc.).

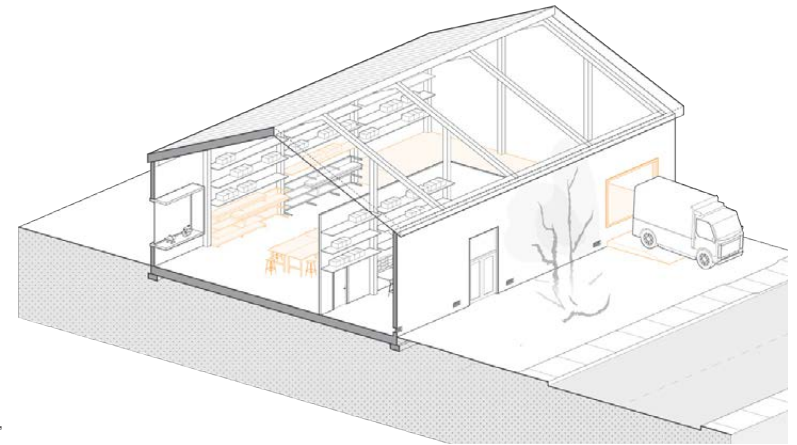
## ADVANTAGES

- Overall improvement in occupant safety.
- Protection and accessibility of inventory at all times during a flood.
- Rapid recovery, limiting renovation or cleanup costs.
- Better eligibility for flood insurance.
- In some cases, it can simplify the management of critical inventory and equipment.

## PRELIMINARY STEPS

- **Understand the risk.**
- **Identify potential vulnerabilities.**
  - Height of servers, outlets, cabling, etc.
  - Identify existing porous or high-risk materials (plaster, untreated wood).
  - Check the stability of furnishings (carpets, fixed or unstable furniture).
  - Locate potential water entry points (doors, floor drains, cracks).
  - Locate hazardous materials.
  - Check the drainage system: pumps, drains, check valves.

- ▲ **Protect digital data.**
- ▲ **Develop an evacuation plan for staff and inventory based on the type of flood and flood levels.**



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### Layout Options

- 1 **Redesign the physical layout of the premises, if the landlord and the facility allow it.**
  - Elevate servers, electrical outlets, and IT equipment.
  - Install a system for raising inventory (hydraulic lift).
  - Use resilient flooring and walls. → C3 C4
  - Prioritize stainless steel and washable surfaces.
  - Install lightweight, modular, and easily movable furniture. → C1b
  - Plan to install flood-protection equipment in front of openings (e.g., cofferdams).
  - Allow for the evacuation of vehicles to higher ground.
- 2 **Compartmentalize the layout during the design phase**
  - Provide higher-level spaces dedicated to materials or goods at risk of submersion. Provide a raised loading dock.
- 3 **Relocate storage and elevate inventory to an upper floor.**

# C2

# MECHANICAL, ELECTRICAL, PLUMBING



## Financial assistance program

Examples in Montreal:

Grant for buildings with 1 to 5 units.  
Financial assistance for owners (private and public).



## Regulations

Comply with the performance objectives of building, plumbing, and electrical codes.

For **multi-residential** buildings, check whether there are any areas where living spaces are prohibited, requirements to raise technical equipment, or authorized drainage systems on the land and buildings.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

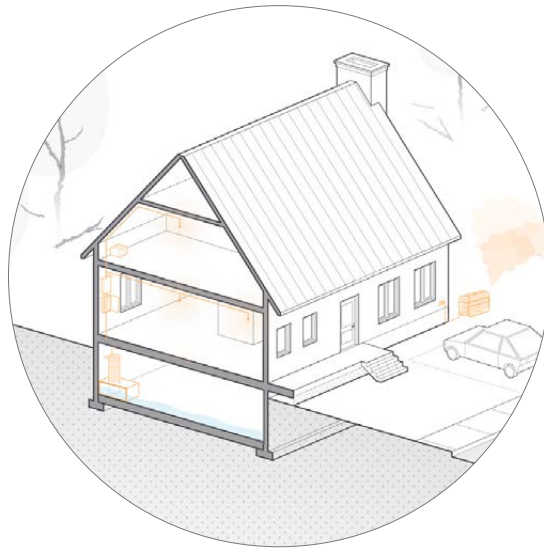
**Mechanical, electrical, and plumbing (MEP)** systems include electrical, air conditioning, and ventilation networks and equipment.

Key objectives of **resilient adaptation of MEP systems**:

- Reduce the vulnerability and/or exposure of systems and appliances.
- Preserve the health and increase the safety of occupants.
- Reduce recovery and reoccupation time.

## ADVANTAGES

- Reduce post-disaster repair costs.
- Preserve healthy interior occupancy conditions in an emergency: ability to keep equipment running during flooding.



▲ It is not recommended to use any device or system that has been in contact with water. These must be replaced or cleaned and inspected by a professional.

## WHERE TO START?

Understand the risk → A1 A2

Know the characteristics of the building

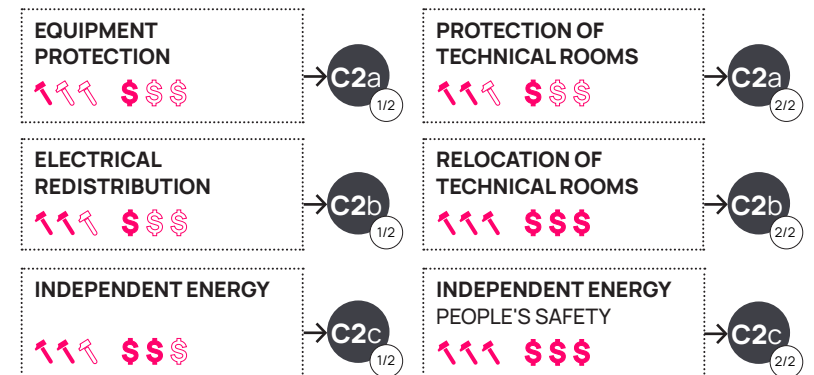
- Identify:
  - Type of electrical distribution (rising or descending).
  - Type of heating: electric resistance, water, or air.  
Heating source: electricity or natural gas.
  - Location and operation of ventilation and air conditioning systems.
- Estimate the electrical power (in watts) required to power essential appliances:
  - Water evacuation devices.
  - Heating and lighting systems for the refuge area (recommended).

Seek professional assistance → A3

Identify potential vulnerabilities → A3a

- Building's susceptibility to damage:
  - Location of equipment below potential water level (or protection objective\*).
  - Absence of non-return valve.
  - Combined drainage system (storm and sanitary drainage).
  - General power supply that cuts out automatically (for safety reasons or due to an accident).

Choose one or more measures appropriate to the context



Types of buildings



Expertise required

Electrical and/or plumbing: electrical connections and checks on submerged appliances.



Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

MECHANICAL, ELECTRICAL, PLUMBING

EQUIPMENT PROTECTION

Key objectives for **protecting Mechanical, Electrical, Plumbing (MEP)** equipment, including appliances, water heaters, air conditioners, heat pumps, ducts, etc.:

- ⦿ Raise them above the potential water level.
- ⦿ Relocate them to the upper floors.
- ⦿ Secure them in place with fasteners.

IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

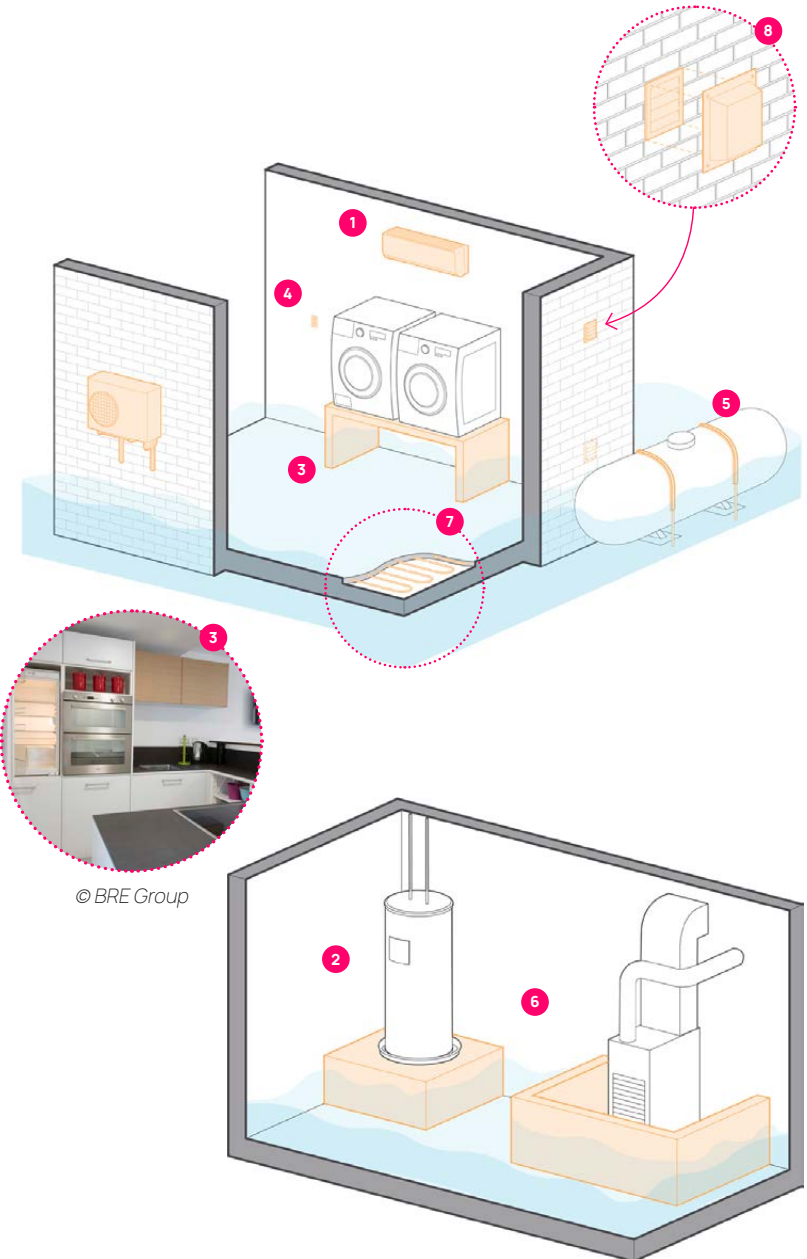
ELEVATION AND RELOCATION

- 1 Relocate **heating and air conditioning equipment** to a minimum height of 60 cm (24 in.): heat pumps, baseboard heaters, convectors, radiators, ventilation ducts located below the potential water level (or protection objective\*).
- ⚠ Consider potential noise pollution when choosing the new location for the equipment.
- 2 Raise the equipment on a **platform** or slab above the potential water level (or protection objective\*) or move it to a higher floor.
- 3 Raise or embed **appliances** that cannot be moved to a higher floor using furniture with good flood resistance. → C1b
- 4 Raise all wall openings: electrical outlets, pipes, ventilation or dryer outlets, etc.

ON-SITE PROTECTION

- 5 Securely **anchor** hydrocarbon tanks to the ground.
- 6 Protect appliances with **flood barriers** or **cofferdams**.
- ⚠ Combine this measure with a water evacuation system (submersible pump) to prevent infiltration.
- ⚠ The higher the potential water level, the greater the hydrostatic pressure. The barrier must be built accordingly.
- 7 If **heated floors**: protect them with a **water-resistant assembly** (concrete screed or ceramic coating). → C4
- 8 Temporarily protect small equipment that cannot be raised with **waterproof covers/hatches**.
- ⚠ Covers/hatches must be removed after the flood.

⚠ Protecting equipment and appliances in place does not eliminate the risk of damage caused by moisture. It is recommended that vulnerable equipment be raised or relocated.



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### Types of buildings



### Expertise required

**Certified mechanics, electricians, and plumbers:** determine the location of equipment (basement vs. lean-to), identify the potential water level, and assess whether the equipment will remain operational underwater (e.g., some systems will continue to function if the potential water level is low).



### Regulations

Chapter I and Chapter V of the Quebec Construction Code.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## MECHANICAL, ELECTRICAL, PLUMBING

# PROTECTION OF TECHNICAL ROOMS

The **protection of technical rooms** involves the design and location of the spaces where this equipment is housed. When protection is not possible, relocation must be considered. → C2b

### Objectives:

- Maintain the integrity of the equipment necessary to ensure the building's operation.
- Ensure the operation of essential equipment in the event of an emergency evacuation.

## CONSIDERATIONS

- When designing a new building, it is necessary to consider the size and quantity of the equipment, as well as its location, in order to determine the most appropriate adaptation measures.
- The size of the equipment **1** and the complexity of the electromechanical systems **2** do not always allow them to be raised above the potential water level (or the protection objective\*).
- The limited space in electromechanical rooms **3** also makes it impossible to provide on-site protection around individual equipment at all times.

## ADVANTAGES

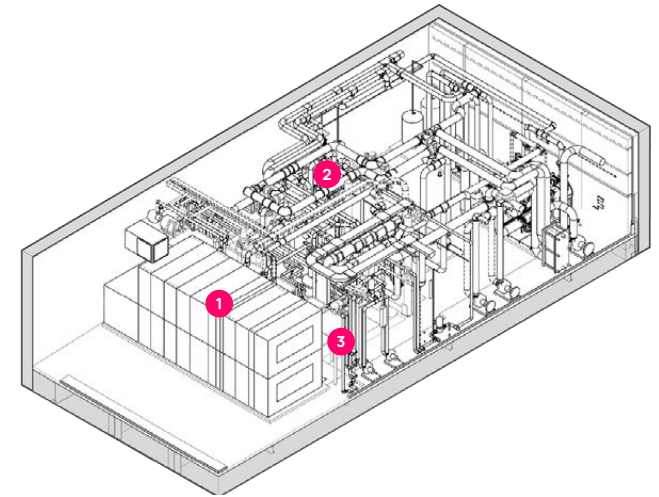
- Extended equipment lifespan.
- Increased occupant's safety level.

## PRELIMINARY STEP

- Have a qualified person verify that the equipment remains operational in the event of water ingress or contact, regardless of the water level.

▲ Annex rooms, which are typically located on the ground floor or in the basement, must comply with certain design criteria outlined in Hydro-Québec's Green Book. Check these criteria before making any design changes.

▲ Without proper protection for equipment, insurance coverage and warranties may be voided. Check and adapt the building accordingly.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

Combine different implementation options depending on the type and extent of the flooding.

- Install a **water sensor** to trigger an alert at the first sign of flooding, enabling the emergency plan to be activated.
- Install **floor drains** connected to the drainage system to facilitate drainage in all areas susceptible to flooding.
- Ensure the **electrical wires are waterproofed** using wiring types resistant to extreme conditions, as specified in Table 19 of Chapter V of the Quebec Construction Code. For electrical enclosures, select the appropriate NEMA rating based on the risk level.
- If the potential water level is low, centralize the equipment in a single room with **waterproofing around the room** rather than around the equipment.
- Design a **modular mechanical/electrical room**, factory-assembled and installed on-site before the equipment.

If none of these options is feasible and the risk of flooding remains, consider relocating the utility rooms. → C2b 2/2

Types of buildings



Expertise required

**Electricity:** electrical connections and checks of submerged appliances.



Regulations

For multi-residential buildings, Hydro-Québec requires the installation of an access ramp to the auxiliary chamber.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

MECHANICAL, ELECTRICAL, PLUMBING

ELECTRICAL REDISTRIBUTION

Key objectives of **redistributing the electrical network** in the event of flooding:

- ⦿ Protect electrical components.
- ⦿ Create a separate network that allows power to be cut off in exposed areas while maintaining power in circuits located above the potential water level (or protection objective\*).

IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

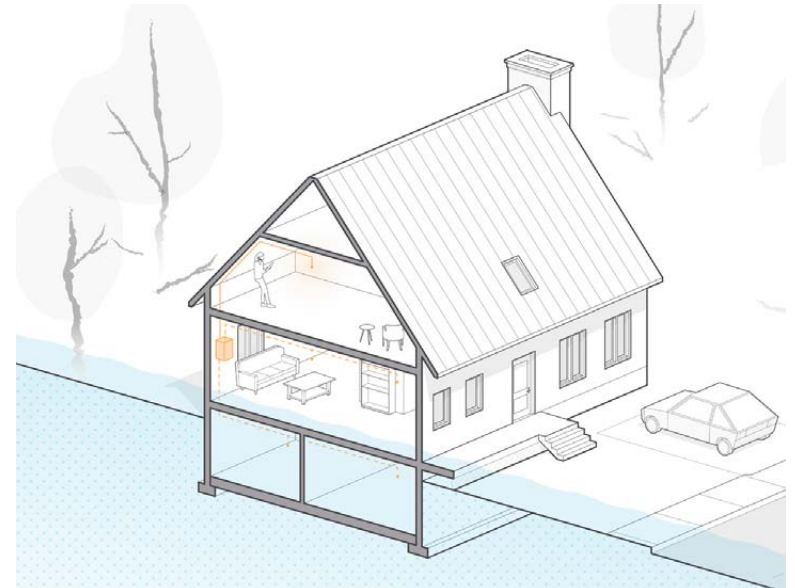
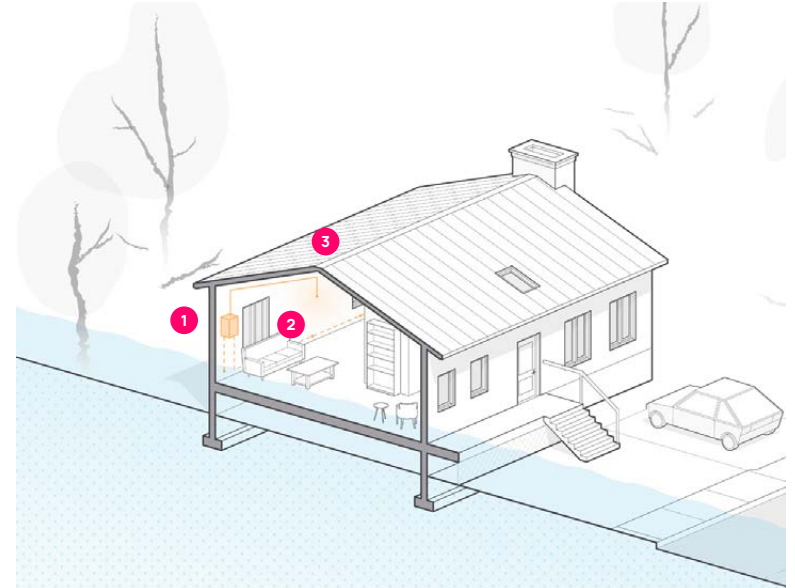
COMPONENT PROTECTION

- 1 Raise the **electrical panel** and **circuit breaker** to 0.5 m (20 in.) above the potential water level (or protection objective\*), or, ideally, to a higher floor.
- 2 Raise all other **electrical components** in the network above the potential water level (or protection objective\*).
  - ⚠ Use specialized outlets and waterproof boxes in areas exposed to flooding.
  - ⚠ Be careful to maintain universal accessibility to switches and outlets.
- 3 Install **distribution** that descends from the ceiling if possible: wiring at ceiling level and along walls rather than at floor level.
  - Wiring located below the potential water level (or protection objective\*) must be equipped with a water-resistant sheath.

CREATE A SEPARATE ELECTRICAL NETWORK

- Separate **electrical circuits** that are susceptible to flooding from other circuits on upper floors.
- Install a highly sensitive ground fault **circuit interrupter** that automatically shuts off circuits affected by flooding.

- ⚠ Cut power to at-risk floors before flooding occurs.
- ⚠ Clearly indicate instructions for cutting off the lower circuit with appropriate signage.



### Types of buildings



### Expertise required

Mechanical, Electrical,  
Architectural, Structural



### Regulations

Chapter I and Chapter V of the  
Quebec Construction Code.

Utility rooms and utility  
compartments, typically  
located on the ground floor or  
in the basement, must comply  
with certain design criteria set  
forth in Hydro-Québec's Green,  
Red, or Blue Books.

**⚠** Consult these applicable  
requirements before making  
any design changes.

\* Consult your municipality  
to find out the conditions  
applicable in flood zones under  
the modernized regulatory  
framework for aquatic  
environments, based on the  
intensity level of the hazard.

## MECHANICAL, ELECTRICAL, PLUMBING

# RELOCATION OF TECHNICAL ROOMS

The **relocation of electromechanical equipment** helps reduce the risk of  
building or industrial equipment shutdown in the event of a flood.

This measure involves:

- Moving the equipment above the potential water level (or the protection objective\*).
- Adapting the associated networks and connections (electrical, mechanical, etc.).

## CONSIDERATIONS

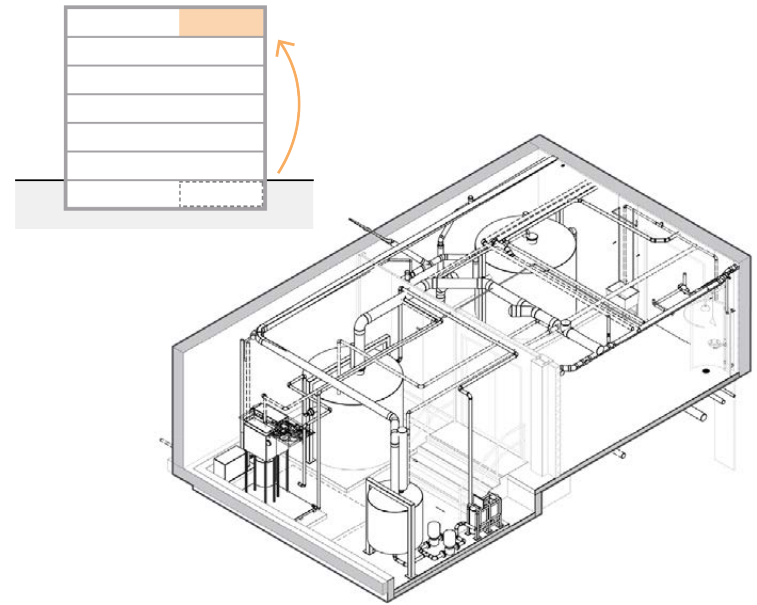
- In existing structures, the complexity of the connections between different equipment (piping, ventilation ducts, control wiring, and electrical networks) can make relocation complex, or even impossible, if the design was not originally planned above the potential water level (or the protection objective\*).
- A reconfiguration of the electrical system is possible as long as the equipment on that system is not essential to the building's operation in emergency mode.

## ADVANTAGE

- Reduction damage to equipment that are relocated above the potential water level (or the protection objective\*).

## PRELIMINARY STEPS

- Understand the operation and characteristics of heating, ventilation, and air conditioning systems to determine if space is available and if regulations permit relocation.
- Consult professionals to verify whether it is possible to relocate the equipment.
- If relocation to a higher level within the existing building is not possible, and if exterior space and regulations permit, an expansion may be considered.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Verify the structural load-bearing capacity to ensure that it can support such loads, as electromechanical equipment can be very heavy.
- 2 Relocate electromechanical rooms above the potential water level or the protection objective\*.
  - ⚠** **Noise emissions** from equipment that are audible in adjacent rooms must remain below an acceptable level.
  - ⚠** **Vibrations** emitted by equipment propagate differently depending on the type of surface on which they are installed.

**⚠** It is not recommended to locate a **server room** or **generator room** below the potential water level (or the protection objective\*). Regardless of the protective measures taken, none can guarantee that flooding that could damage equipment will not occur.

### Types of buildings



### Expertise required

**Electricity:** electrical connections and checks on submerged appliances.



### Regulations

Requirements may vary depending on the classification of the building in the Quebec Construction Code, including: small buildings (part 9), large buildings, and high-rise buildings (part 3).

See: Alimentation électrique de secours on [rbq.gouv.qc.ca](http://rbq.gouv.qc.ca)

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## MECHANICAL, ELECTRICAL, PLUMBING INDEPENDENT ENERGY

Key objective of an **independent power source** (batteries, generator, solar panels, etc.) in the event of flooding:

- ☉ Power equipment necessary for the safety of occupants or for water evacuation if the main power grid is shut down or affected by flooding.

### IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Locate the main components of the electrical system (electrical panel, connections to independent power sources) above the potential water level (or protection objective\*). → C2b
- 1 Connect a **transfer switch** with the backup power source to the central distribution panel or to the necessary equipment.

⚠ Consult your supplier for advice on choosing the right equipment.

#### GENERATORS

- 2 **Locate the device outside** the residence, away from openings and air intakes, and protected from flood water (e.g., raised on a base).

⚠ Provide a voltage regulator to reduce the risk of damage to certain appliances.

⚠ Provide a sufficient quantity of gasoline, propane, and/or natural gas to ensure the appliances will function (approximate operating time: 5 to 11 hours).

#### BATTERIES

- 3 Choose a **battery suited to your needs:** uninterruptible power supply, rechargeable from the grid or solar panels.

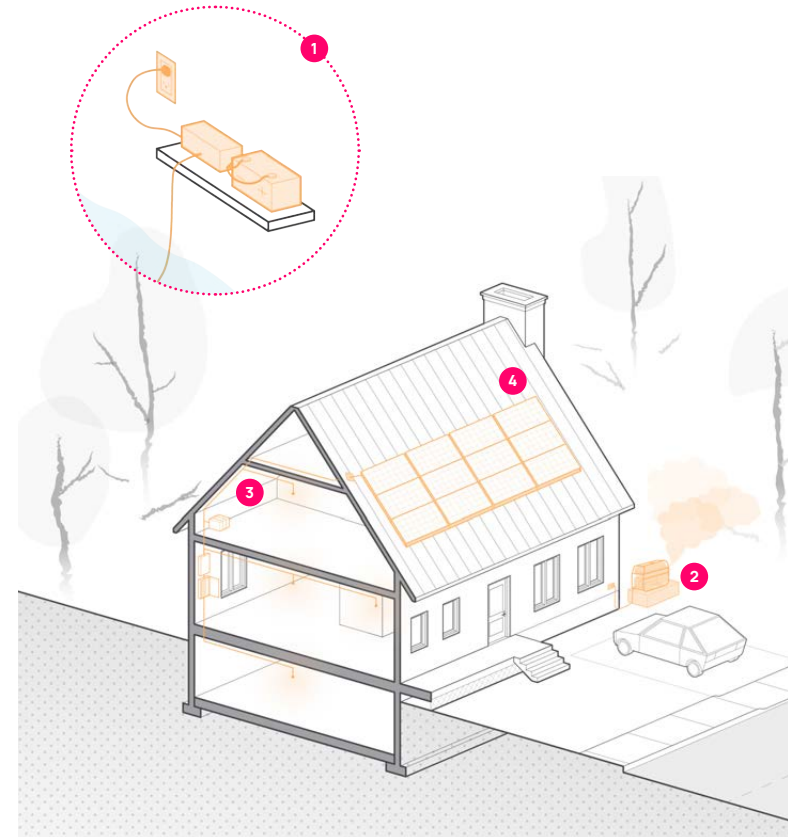
- Locate the battery above the potential water level (or protection objective\*) or on a floor protected from flood water.

⚠ The capacity of the battery or batteries should be sufficient to power the appliances for approximately 5 to 11 hours.

#### SOLAR PANELS

- 4 Choose a **system suited to your needs:** grid-connected or stand-alone, presence of an inverter, number of batteries, etc.

⚠ This independent energy source depends on sunlight conditions. The system chosen must be able to store enough electricity in a battery to be self-sufficient in the event of a power failure.



### Types of buildings



### Expertise required

Mechanical, Electrical



### Regulations

Chapter I of the Quebec Construction Code  
CSA C282; CSA Z32; CSA B139  
and CSA B149

If the building or a section of the building is designated as a refuge area by government authorities, the regulations regarding electromechanical systems differ.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## MECHANICAL, ELECTRICAL, PLUMBING

# INDEPENDENT ENERGY PEOPLE'S SAFETY

An **independent power source** ensures the safe evacuation of building occupants and the continued operation of essential equipment in the event of a power outage.

This measure involves:

- Installing batteries and generators.
- Regularly verifying that they are functioning properly.

## CONSIDERATION

- Equipment sensitive to power outages must be protected by an uninterruptible power supply system to prevent any interruption.

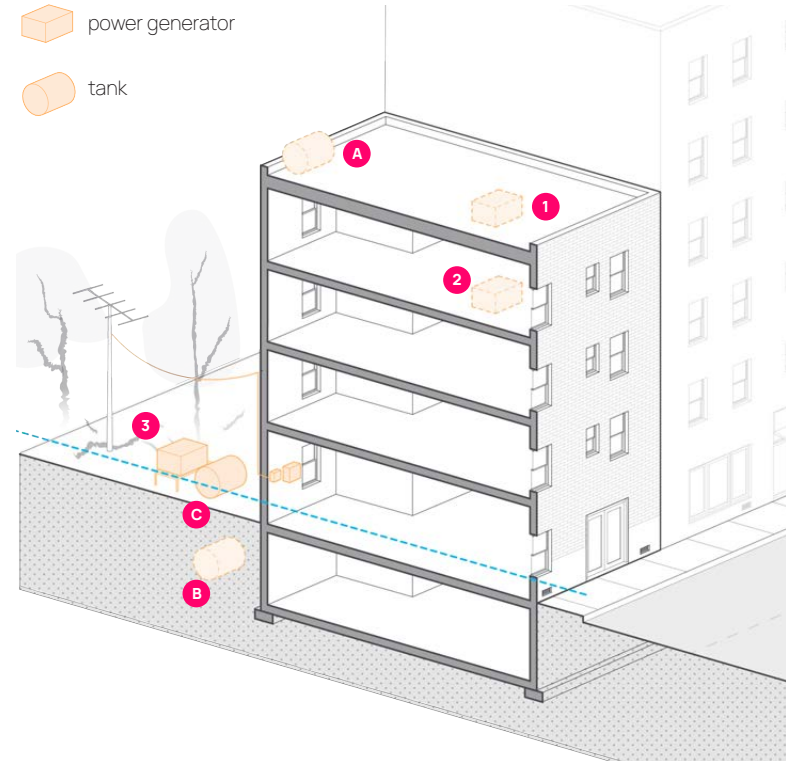
## PRELIMINARY STEP

- Determine the required autonomy of the emergency power system based on the building type and the connected equipment.

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- ⚠ The equipment of the emergency power supply system must be installed above the potential water level (or the protection objective\*) to ensure they will function properly in the event of a flood.
- Verify that the loads can be supplied by a generator or batteries.
- If a generator is required, determine the type of fuel to be used (diesel or natural gas).
- Size the fuel tank (if the generator runs on diesel) and select its location (A-B-C).
- Select the generator's location (1-2-3) - consider exhaust venting, fuel supply, and the level of the protection objective\*.
- Provide a separate electrical system for emergency equipment, with a dedicated panel and a transfer switch ensuring automatic switchover to the generator in the event of a power failure.



- ⚠ Without an emergency power system, insurance coverage and guarantees may be voided. Check and adapt the building accordingly.
- ⚠ The capacity of emergency power sources is generally insufficient to power all building equipment; they must be focused on essential functions and comply with relevant CSA standards.
- ⚠ In the event of a power outage, connecting mechanical water drainage equipment to an independent power source helps limit the impact of flooding.

# C3

1/3

# RESILIENT INTERIOR WALLS

Wood-frame walls are composed of assemblies of materials that retain their properties even when in contact with water.

1. The **frame** is the structure that supports the insulation and interior finishing materials, whether for a partition or an insulated exterior wall.
2. The **insulation** limits heat loss, improves thermal and acoustic comfort, and protects the interior of the building from moisture.
3. The **finish** includes all the visible elements that complete a wall: finish panels, baseboards and mouldings, finish plates for electrical outlets and switches, finishing materials such as paint, etc.

The assemblies of a resilient wall are designed to:

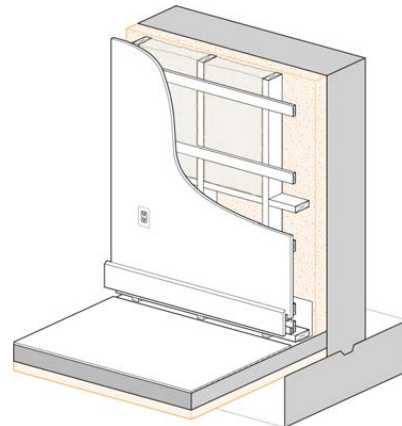
- ☉ Promote water drainage and drying.
- ☉ Allow for the mobility and/or temporary removal of elements whose condition changes after wetting (e.g., ability to remove insulation, baseboards).
- ☉ Reduce the risk of mould growth.

The materials used in a resilient wall are capable of:

- ☉ Absorbing little or no water.
- ☉ Clean and dry easily after getting wet.
- ☉ Retain their original dimensions and integrity after getting wet. - Lower repair costs after a disaster.

## ADVANTAGES

- Reduced repair costs after a disaster.
- Less material to throw away after a flood.
- Possible improvements in energy efficiency, thermal comfort, and acoustics.



© AWBQ + ÉcoHabitation

## WHERE TO START?

Understand the risk → A1 A2

Know the characteristics of the building

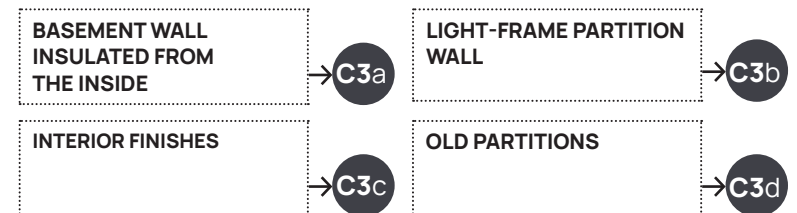
- Assess the composition and condition of the foundation walls and slab, date of construction, potential major renovations, ceiling height, etc.
  - Check the radon content (a natural, odourless, and toxic radioactive gas); above a certain level, this could increase the scope of the work.
- ⚠ If the result is positive: contact a professional to carry out the appropriate work.

Seek professional assistance →

Identify potential vulnerabilities → A3a

- Building's predisposition to damage:
  - Materials that are not or only slightly resilient/water-resistant.
- Water entry points:
  - Cracks in exterior walls and foundations.
- Specific visible problems:
  - Deformation of materials, swelling.
  - Moisture or mould stains on finishes or interior woodwork even after drying.

Choose one or more measures appropriate to the context



### Regulations

Municipalities may prohibit certain materials or require adaptation measures in the event of flooding (e.g., installation of removable walls or antifungal or water-repellent treatments).

The Quebec Construction Code does not require walls to be built with materials that are impervious to water and moisture, but rather to be designed with moisture and infiltration risks in mind: use "suitable" materials, allow for quick replacement of lower wall sections after damage, comply with fire resistance requirements, and prevent health risks (mold, bacteria).



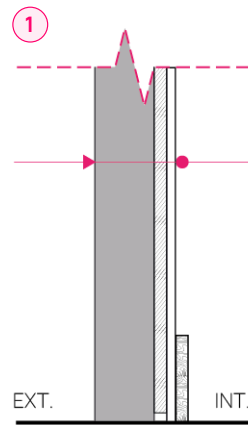
Multi-residential: for technical rooms, it is recommended to install PVC casings, water-repellent coatings, and removable panels (note that fire resistance requirements may make installation complex).

# RESILIENT INTERIOR WALLS

## PROBLEMATIC PRACTICES

Examples of residential building assemblies that are **not flood-resistant** and must be completely dismantled and rebuilt after a disaster.

A **recurring problem**: the presence of glass wool insulation which, when in contact with water, deforms, compacts, and does not return to its original shape when dry, leaving uninsulated air spaces in the assembly. The large amount of water absorbed by the wool takes a long time to dry.

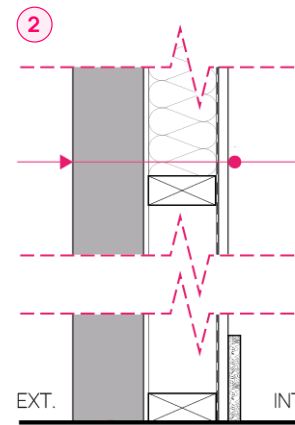


**Construction period:** 1940 - 1960

**Composition:** gypsum board (or asphalt-coated kraft paper) on vertical wood framing, nailed to the uninsulated concrete foundation wall, with pine baseboards.

**Problem:** lack of insulation, materials that deteriorate when exposed to water.

**Risk:** condensation problems.



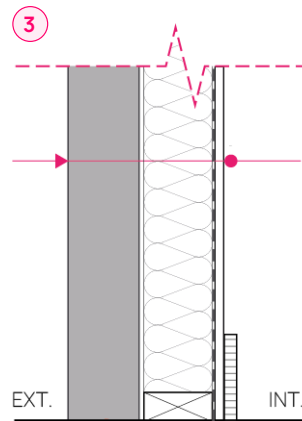
**Construction period:** 1960 - 1970

**Composition:** assembly with fiberglass wool insulation in the upper part of the wall with MDF baseboard.

**Advantage:** limits damage in the event of water infiltration, since the wool should not come into contact with water.

**Problem:** lack of water drainage, materials that deteriorate in the presence of water.

**Risk:** water stagnation in the assembly and deterioration of the gypsum, preventing the water from drying and evaporating.

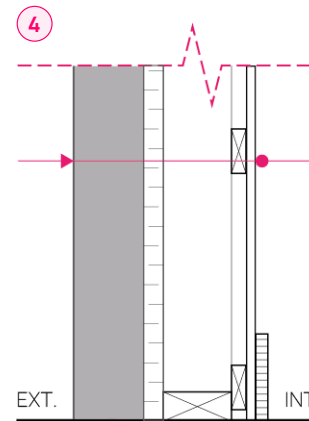


**Construction period:** 1980 - 2010

**Composition:** assembly with fiberglass insulation over the entire height, vapour barrier behind the gypsum board with MDF baseboard.

**Problem:** wood studs enclosed with fiberglass insulation between the concrete and the vapour barrier, materials that deteriorate in the presence of water.

**Risk:** in the event of flooding, water cannot dry, moisture remains trapped, leading to mould and rot.






**Construction period:** 2010 - present


**Composition:** assemblies with or without a vapour barrier with MDF baseboard.

**Problem:** lack of insulation; the vapour barrier on the warm side prevents the assembly from drying by trapping water and blocking evaporation after a period of wetness; materials deteriorate in the presence of water.





**Risk:** in the event of flooding, water cannot be completely drained away, moisture remains trapped, leading to mould and rot.

## RESILIENT INTERIOR WALLS MATERIALS

TYPE OF INSULATION	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Glass wool <del>X</del> \$	○	○	○	○
Rock wool insulation <del>X</del> \$	○	○	○	○
Semi-rigid rock wool <del>X</del>	○	○	○	○
Expanded polystyrene + wood 	○	○	✓	○
Expanded polystyrene (R5) + integrated reflective vapor barrier	○	○	✓	✓
Extruded polystyrene <del>X</del> \$	✓	✓	✓	✓
Sprayed urethane foam  <del>X</del> 	✓	✓	✓	✓
Molded expanded polystyrene <del>X</del>	•	✓	✓	✓

TYPE OF FRAME	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Wood stud (SPF) 	✓	○	○	✓
Metal post	✓	✓	✓	✓

TYPE OF FINISH	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Cardboard gypsum board (or plasterboard with cardboard finish) <del>X</del>	○	○	✓	○
Fiberglass gypsum board (or fiberglass plasterboard) <del>X</del>	○	○	✓	○
Lightweight concrete panel	✓	○	✓	✓

-  Strong
-  Moderate
-  Weak
-  Not evaluated
-  Valuable
-  High environmental impact
-  Work carried out by a professional
-  Low cost
-  Sacrificial (temporary role)
-  Only for walls without any cracks, not to be used on old buildings, and do not apply yourself.

Material resistance capacity testing in partnership with the University of Sherbrooke

# C3a

## Types of buildings



## Expertise required

Architecture or company specialized in flood adaptation.

## RESILIENT INTERIOR WALLS

# BASEMENT WALL INSULATED FROM THE INSIDE

For greater resilience of interior spaces, basement walls against a concrete foundation should be **insulated from the outside**. This reduces the risk of mould growth and the amount of materials discarded after flooding. →C6c

However, when insulation from the outside is not possible, **insulation from the inside** may be a solution. This fact sheet presents the guidelines.

### Characteristics of a resilient basement wall insulated from the inside:

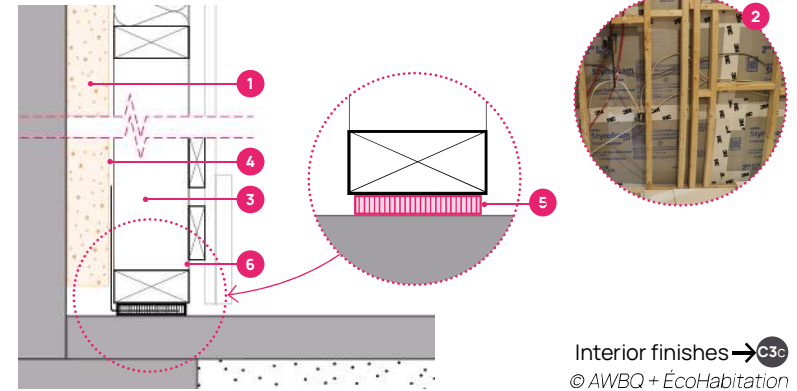
- ☉ The hydrophobic insulation retains its original dimensions after contact with water.
- ☉ The insulation at the bottom of the frame (if present) is removable and/or retains its original dimensions and properties after wetting.
- ☉ The assemblies promote water drainage and are able to reduce potential moisture thanks to air spaces that allow drying and, when properly positioned, do not affect the integrity of the vapor barrier.

## CONSIDERATIONS

- Prioritize insulating the foundation wall from the outside. If this is not possible, insulation from the inside should only be used for foundation walls that are in good condition.
- ⚠ If a foundation wall that is not waterproof or shows signs of deterioration is insulated from the inside, potential interior moisture could rise through capillary action and cracks could worsen.
- ⚠ Sprayed urethane should not be used in older buildings and is only suitable for foundations that do not have any cracks at the time of installation. Bear in mind that this installation is not reversible; if the wall cracks after installation, the foundation will no longer be visible for inspection.

⚠ Immediately after flooding: remove materials that can be dried and follow government recommendations for cleaning (see *Nettoyage sa maison* on [quebec.ca](http://quebec.ca)).

⚠ If acoustic insulation: rock wool insulation can be removed from the lower part of the wall or partition frame to prevent it from getting wet or to allow it to dry, then replaced after drying. →C3c



Interior finishes →C3c  
© AWBQ + ÉcoHabitation

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Before insulating, if interior drain: →B6a
  - 1 Install **insulation** with good overall resilience performance:
    - R15 min. extruded polystyrene boards, at a distance of 50 mm to 100 mm from the floor, or
    - Sprayed urethane, provided there are no cracks in the foundation wall.

⚠ Do not do this yourself, as there is a risk of ignition. →C3c
  - 2 Place a **wooden frame** on top of the rigid insulation.
    - Design removable wall sections that allow access to the insulation at a minimum height of 1.20 m (48 in.). →C3c
  - Option to insulate the bottom of the frame with **removable or hydrophobic** insulation.
    - Another option: do not install insulation on the first 50 to 100 mm (2 to 4 in.).
- Allow for substantial air spaces in the assemblies to prevent water from being trapped, allow for good drainage and quick drying:**
- 4 Between **rigid insulation** and **framing**: 6 mm (1/4 in.) min.
  - 5 Between the **bottom plate** and the **concrete slab**, using a lateral anchor or a **waterproof strip**: 50 to 100 mm (2 to 4 in.). The space can also be created using a **ventilated strip** or small 25 mm (1 in.) wide sections of:
    - 20 mm (3/4 in.) thick non-slip stair tread;
    - 25 mm (1 in.) thick extruded polystyrene panel.
  - 6 Between the lowest **horizontal furring strip** and the **framing**: 12.5 mm (1/2 in.) min.

# LIGHT-FRAME PARTITION WALL

## Types of buildings



## Expertise required

Architecture or company specialized in flood adaptation.



## Regulations

If a specific degree of fire resistance is required, consult a specialist to determine the necessary assembly, in accordance with CAN/ULC-S101 as required by the Quebec Construction Code.

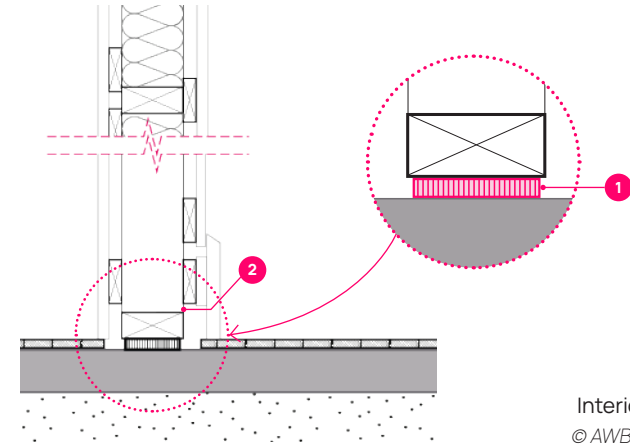
A **light-frame partition** is an interior wall that is not against an exterior wall or foundation. It can be located in the basement or on the ground floor.

The **framing** is the structure that supports the interior finishing materials. It can be made of wood or metal.

### Characteristics of a resilient light-frame partition:

- ☉ The layout of the frame and its elevation above the floor promotes water drainage and drying.
- ☉ The sound insulation at the bottom of the frame (if present) is removable and/or retains its original dimensions and properties after getting wet.

- ⚠ Before a flood, remove materials that may be damaged by water, or
- ⚠ Immediately after a flood, remove materials that can be dried after contact with water, such as insulation located at the bottom of the frame and follow government recommendations for cleaning (see *Nettoyer sa maison on quebec.ca*).



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

Design **removable wall sections** that allow access to the insulation at a minimum height of 1 m 20 (48 in.). → C3c

- To make the junction between the fixed section and the removable section less visible, cover it with a transition strip.

**Provide air spaces in the assemblies to prevent water from being trapped, allow for good drainage and quick drying:**

- 1 Between the **bottom plate** and the **concrete slab**, create a space by adding a **waterproof strip** or establish a space using small sections of:
  - 20 mm (3/4 in.) thick non-slip stair treads cut into small sections 25 mm (1 in.) wide.
  - 25 mm (1 in.) thick extruded polystyrene panel cut into small sections 25 mm (1 in.) wide.
  - 17.5 mm (11/16 in.) thick ventilated plastic strip (recycled plastic possible).
- 2 Between the lowest **horizontal furring strip** and the **ventilated strip**: 12.5 mm (1/2 in.) min.

⚠ By incorporating horizontal furring strips, the partition will be wider than the standard size. It is therefore necessary to take into account adjustments to all door frames, the width of which is standardized for a 38 x 89 mm frame with two gypsum boards.



# RESILIENT INTERIOR WALLS

## INTERIOR FINISHES

### Types of buildings



### Expertise required

Architecture or company specialized in flood adaptation.

**Finishes** include all visible elements that complete a wall: finish panels, baseboards, finish plates for electrical outlets and switches, etc.

### Key characteristics of a resilient interior finish:

- ☉ Elements whose condition changes after wetting are removable.
- ☉ Materials absorb little or no water, are easy to clean and dry, and retain their original dimensions and integrity after getting wet.

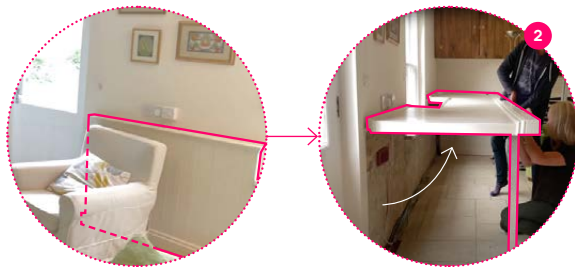
### CONSIDERATION

- If it is not possible to use resilient assemblies and materials, **easily replaceable finishing materials** can be used strategically.

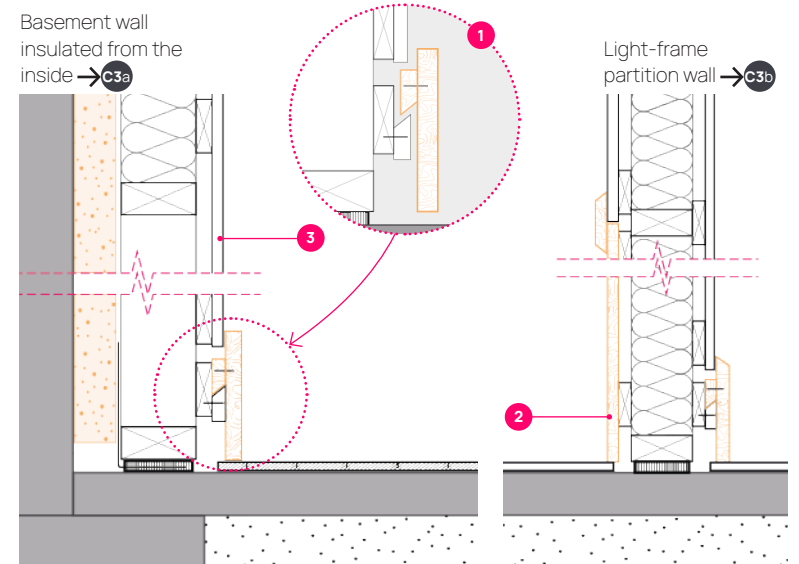
- ▲ Before a flood, remove materials that may be damaged by water, or
- ▲ Immediately after a flood, remove materials that can be dried after contact with water, such as insulation located at the bottom of the frame and follow government recommendations for cleaning (see Nettoyer sa maison on quebec.ca).



Example of removable baseboard © ÉcoHabitation



Our Flood Resilient Home, episode 6 © The Environmental Design Studio



© AWBQ + ÉcoHabitation

### INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

#### Removable finish on light framing:

- 1 Attach a **removable baseboard** (6 in. min.) to the bottom furring strip using two 45° angled battens with grooves for water drainage.
- 2 Secure **plywood** with visible screws so that the panel and wool (if present) on the lower part of the partition can be removed after flooding.
  - The plywood wall can be converted into a table using integrated legs to serve as a support for objects during flooding and facilitate drying after flooding (example opposite).
- 3 Attach moisture-resistant, fiberglass-reinforced **gypsum boards** or lightweight concrete panels to the top of the plywood or removable baseboard.

#### Raw finish on concrete foundation wall:

- Adding a water-resistant finish such as **vapor barrier paint** or **masonry sealant** does not produce satisfactory long-term results (flaking, spalling, etc.).



## Types of buildings



## Expertise required

**Plasterer-decorator:** specializing in traditional techniques for conservation projects.

**Architect:** to identify appropriate recommendations.



## Regulations

See Part 10, Division B of Chapter I – Building of the Quebec Construction Code.

## RESILIENT INTERIOR WALLS

# OLD PARTITIONS

**Old interior partitions** (plaster on wooden laths, paneling, renders) are susceptible to moisture and water infiltration. These traditional systems consist of multiple layers of coating, each composed of lime, sand, fibers, and plaster. Permeable to water vapor, they contribute to the building's thermal and hygrometric balance when applied continuously. Preserving them requires an understanding of these hygrothermal properties to ensure the building's resilience against flooding and water damage.

Objectives to be achieved during maintenance or restoration:

- Maintain or restore the condition of the walls and the continuity of the finish
- Preserve the historical authenticity and character of the site.
- Prevent deterioration of the wood and plaster.

## CONSIDERATIONS

- Following water damage, the use of standard gypsum boards should only be considered as a last resort.
- The wooden laths used as a substrate can be retained if they show no major warping and are thoroughly dried.

## ADVANTAGES

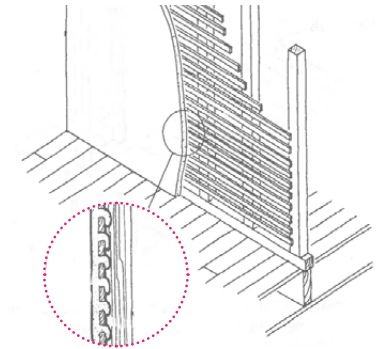
- Preserve the historical authenticity and character of the site.
- Coating: provides good thermal inertia and humidity regulations. Exceptional longevity when protected from contact with water.

**▲ Most old paints contain lead; some plaster and coating finishes may contain asbestos. Do not strip or sand. Scrape by hand while vacuuming with a HEPA filter before painting or treating the surface.**

**▲ For corrective work:** before starting any work, remove a few floorboards to check for hidden mold.

**▲ In case of damage (including mold):**

- Document the damage for restoration or insurance purposes (photos, videos).
- Identify the source of moisture before any repairs.
- If possible, remove baseboards (molding) to facilitate drying.
- Clean up sludge (deposits of water and fine sediment particles) quickly before it dries.
- Ventilate the area promptly, particularly by moving furniture away from the walls.
- If necessary, seal leaks and cracks (e.g., on balconies or overhangs).
- Have a qualified professional inspect sections of plaster that are affected or damaged.



© Jules Auger

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### Preventive (routine maintenance of plaster on lath) \$\$\$:

- Repair cracks using the same finish as the existing surface: lime-sand or plaster.
- Clean gently without using abrasive or acidic products.
- Avoid vapor-impermeable paints (vinyl or elastomeric) that trap moisture.

### Corrective (repair and replacement of lath after damage) \$\$\$:

- Remove the baseboard before working on a damaged wall. Keep it to put back in place if its condition allows; otherwise, replace it with an identical one made of the same material.
- Remove damaged materials (plaster, lath).
- Replace the rotten lath with lath of the same type and size.
- Apply one or more coats of lime- or plaster-based coating, depending on the original technique, to restore the original appearance.
- Repaint.
  - ▲ If lead-based: repaint to encapsulate the lead.
  - ▲ If oil or alkyd: follow the « fat over lean » rule; do not apply acrylic (or latex) directly over oil paint without a suitable primer, as this could cause significant, widespread peeling that is difficult to correct. Some acrylic primers have low vapor permeability and can even be used as vapor barriers.
- Alternative: Modify the lower sections of the walls without compromising the heritage value. → C3c

# C4

1/3



## Regulations

Quebec Construction Code requirements / Implication for flood zones:

**Materials:** the floor must be constructed with water-resistant or easily replaceable materials.

**Structure:** structural elements must retain their integrity after immersion or be accessible for inspection/replacement.

**Insulation:** never use absorbent insulation in crawl spaces or under slabs.

# RESILIENT FLOORING

Floors (basement, ground floor, or intermediate floors) consist of a structure, sometimes insulation, and a finish:

1. The floor **structure** supports the interior finishing materials, whether for a floor between two levels or on a foundation slab.
2. The **insulation** limits heat loss, improves thermal and acoustic comfort, and protects the interior of the building from moisture.
3. The **finish** refers to the visible surface of the floor, i.e., the covering (wood, linoleum, etc.) and/or the surface finish (varnish, epoxy, etc.).

**Resilient flooring** is made up of assemblies and materials that retain their properties even when in contact with water.

**Floor assemblies** are designed to:

- ☉ Promote water drainage and drying.
- ☉ Allow for the mobility of elements whose condition changes after wetting.
- ☉ Reduce the risk of mould growth.

**Floor materials** are capable of:

- ☉ Absorbing little or no water.
- ☉ Cleaning and drying easily after getting wet.
- ☉ Retaining their original dimensions and integrity after getting wet.

## ADVANTAGES

- Reduced repair costs after a disaster.
- Reduction in the amount of materials discarded following flooding.

## CONSIDERATIONS

- Ventilation and cleaning of components exposed to flooding to ensure good drying conditions and prevent mould growth.
- Effectiveness of the measure depends on the quality of execution.

## WHERE TO START?

Understand the risk → A1 A2

Know the characteristics of the building

- Assess the composition and condition of the floors.
- Check the radon content (a naturally occurring, odourless, toxic radioactive gas); above a certain level, this could increase the scope of the work.  
⚠ If the result is positive: contact a professional to carry out the appropriate work.

Seek professional assistance →

Identify potential vulnerabilities → A3a

- Building's susceptibility to damage:
  - Materials that are not or only slightly resilient/water-resistant.
- Water entry points:
  - Cracks in the floor slab.
- Specific visible problems:
  - Deformation of materials, swelling.
  - Moisture or mould stains on finishes or interior woodwork even after drying.

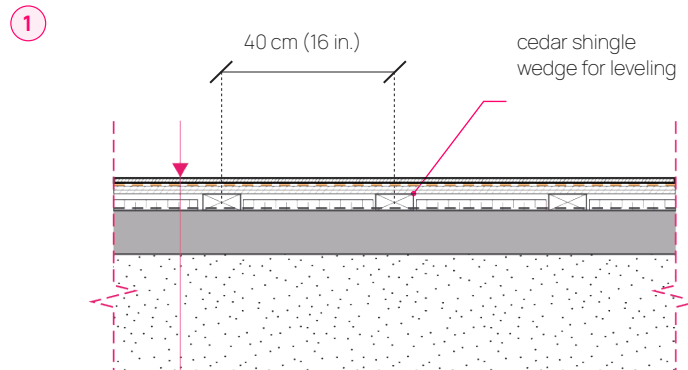
Choose one or more measures appropriate to the context



# RESILIENT FLOORING

## PROBLEMATIC PRACTICES

Examples of assemblies with **non-flood-resistant flooring**.

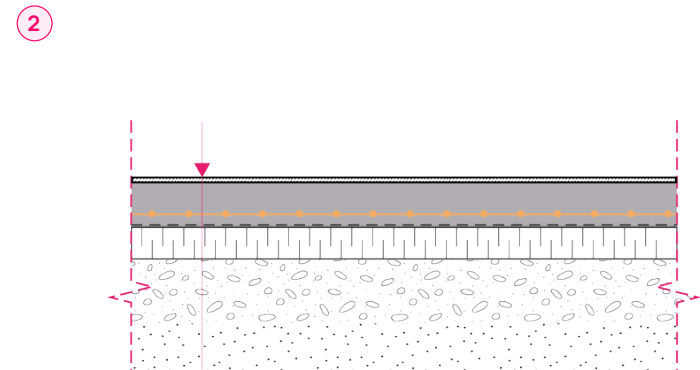


### Subfloor and floating floor laid on existing slab

**Composition:** existing uninsulated and non-waterproof slab, polyethylene membrane, rigid expanded polystyrene insulation, subfloor system with plywood and ethafoam membrane, flooring with floating floor.

**Variations:** sprayed polyurethane, without insulation or with vertical 2x4s

**Problem:** 2x4 joists are susceptible to rot, configuration makes drying difficult, choice of laminate flooring.



### Floating floor with rigid insulation built after 2013

**Composition:** basement floor with heated floor and rigid EPS or sprayed urethane insulation.

**Problem:** choice of laminate flooring, which is susceptible to rot and will not withstand water infiltration.

## RESILIENT FLOORING MATERIALS

- ✔ Strong
- Moderate
- Weak
- Not evaluated
- ♻️ Fully recoverable
- ♻️ Partially recoverable
- ✘ High environmental impact
- \$ High cost
- ✘ Sacrificial (temporary role)

TYPE OF FLOOR INSULATION	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Expanded polystyrene with wood fasteners <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">✔</span>	<span style="color: red;">○</span>
Expanded polystyrene + integrated reflective vapor barrier (R5)	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>
Extruded polystyrene <span style="color: red;">✘</span> <span style="color: red;">\$</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>
Molded expanded polystyrene	<span style="color: red;">•</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>

TYPE OF FLOOR FRAMING SYSTEM	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Chipboard panel glued onto a raised plastic base <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Chipboard panel laminated to grooved extruded polystyrene panel <span style="color: red;">✘</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Chipboard panel laminated to grooved expanded polystyrene panel <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>

TYPE OF FLOOR FINISH	OVERALL PERFORMANCE	WATER-PROOFING	DRYING CAPACITY	STABILITY
Floating laminate <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Click vinyl	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>	<span style="color: red;">✔</span>
Linoleum <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">•</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Cork tile <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">•</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Varnished hardwood <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Oiled hardwood <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>
Engineered wood <span style="color: red;">✘</span> <span style="color: red;">♻️</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>	<span style="color: red;">○</span>

Material resistance capacity testing  
in partnership with the University of Sherbrooke

# C4a

## Types of buildings



## Expertise required

Company specialized in **floor adaptation** for the replacement of finishing materials with more resilient materials.

**MEP:** verification and recommendation of the drainage system.

Company specialized in **radon**: calculation of the level and adaptation of the work according to the result.



## Regulations

The Quebec Construction Code requires designs that allow surface water to flow away.

The APCHQ recommends slopes of 2% from the foundation wall.

## RESILIENT FLOORING

# EXISTING SLAB

The renovation of a **floor on an existing slab** depends on the date of construction → **C8** and the condition of the slab. If the space is habitable, the floor on the slab and the rest of the basement must be adapted in accordance with the adaptation recommendations. → **C8** **C9**

### Characteristics of a resilient floor on an existing concrete slab:

- The assemblies promote drainage and drying.
- The type of insulation allows for proper humidity management.
- The materials retain their integrity after getting wet.

If the use of resilient materials and assemblies is not possible, materials that can be easily replaced after wetting may be used.

## ADVANTAGES

- Improved thermal comfort.
- Reduced health risks.
- ⚠ Before starting work, check the radon level and contact a professional to adapt the work accordingly.

## INSTALLATION SCENARIOS

Suggestions for better understanding the issues to be discussed with qualified individuals.

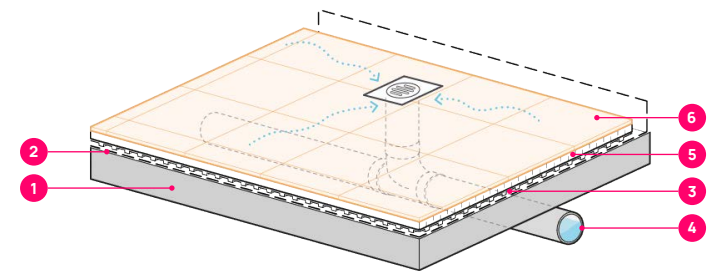
### 1 KEEP AN ALREADY INSULATED SLAB (built after 2013)

- **Drainage:** check the external drainage conditions around the foundation. If there is no drain or it cannot be repaired, it is possible to add an internal drain → **B6a** by partially demolishing the perimeter of the slab. Consult a professional to determine whether this is necessary. → **C8**
- **Finish:** leave the concrete exposed on the floor or install a subfloor with finish coverings:
  - Linoleum, vinyl, or cork tiles, VOC-free, with a vapour barrier adhesive.
  - Waterproof finish such as ceramic or epoxy.
- ⚠ In the case of ceramic, the subfloor must be ultra-rigid.
- ⚠ Wood or floating floor coverings are not recommended. A full-thickness hardwood floor could be considered as it will return to its original shape after drying. In this case, provide expansion joints to allow the slats to swell after flooding, and add a waterproof spacer under the wood joist.
- **Humidity management:** → **C4c** **2/2**



Example of waterproof composite floor finish with floor drain.

Flood Resilient Repair Home, Watford, Building Research Establish © BRE Group



### 2 RETAIN AND INSULATE THE EXISTING SLAB currently not insulated and not waterproof

- 1 Clean the **existing concrete slab**.
- 2 Install a **vapor barrier** on the slab that extends up the foundation wall.
- 3 Attach a **drainage mat** to the vapour barrier affixed to the slab, following the slight slope of the original slab to an **existing floor drain** 4.
  - ⚠ Ensure that a check valve is present. → **B7**
- 5 Add **rigid insulation** and cover it with a **finish**: 6
  - Urea-formaldehyde-free click vinyl planks.
  - ⚠ Wood or floating floor coverings are not recommended.

### 3 KEEP AND DO NOT INSULATE THE EXISTING SLAB

- **Finish:** leave the concrete floor exposed.
- **Humidity management:** → **C4c** **2/2**
- **Option:** insulate the basement or crawl space walls. → **C3a**

### 4 REBUILD A NEW SLAB INSULATED FROM BELOW → **C4d**

- **Drainage:** add an interior foundation drain. → **B6a**

# C4b

## Types of buildings



## Expertise required

**Mechanical and plumbing:** inspection and recommendation of the drainage system building's capacity and other structural elements.

**Structure:** if required.

# RESILIENT FLOORING NEW SLAB

The construction of a **floor on a new slab** depends on the intended use (e.g., if you want the space to be habitable, you will prioritize, for example, the integration of insulation and underfloor heating):

The slab floor and the rest of the basement must be adapted in accordance with the adaptation recommendations. → C8 C9

### Characteristics of a floor on a new slab:

- The concrete and the slopes promote drainage and drying.
- The external insulation promotes better humidity management.
- The materials (structure, insulation, and finish) retain their integrity after getting wet.

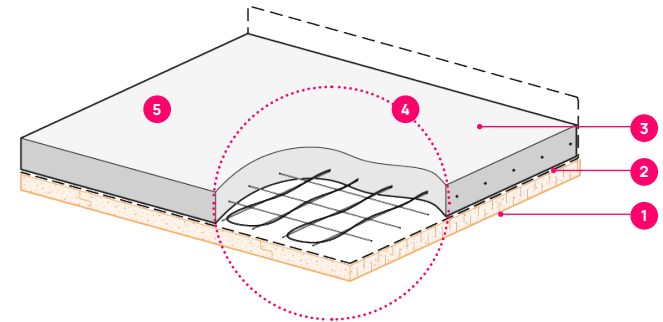
## ADVANTAGES

- Improved thermal comfort.
- Reduced health risks.
- ⚠ Before starting work, check the radon level and contact a professional to adapt the work accordingly.



Example of installing a heated floor.

© ÉcoHabitation



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Demolish the **existing slab**.
  - ⚠ Do not dig lower than the bottom of the foundation footing.
- Level the plumbing with **floor drain, check valves, interior foundation drain, etc.**
- Level the floor according to the available ceiling height to add the thickness of the **insulation**.
- 1 Install the **insulation** on a level bed of crushed stone.
- 2 Install a **vapor barrier** over the rigid insulation and seal it to the foundation wall.
- 3 Pour the **new concrete slab**, incorporating a slope and drainage → B6a and pumping system to facilitate water drainage. → B6b
  - ⚠ The expansion joint around the perimeter of the slab, resulting from the presence of the vapour barrier, is important as it allows for differential movement between the slab and the foundation, which helps reduce the risk of cracking in the slab.
  - ⚠ Provide for a slight slope towards a sump / floor drain.
- 4 **Integration of heating:**
  - Floor heating poured directly onto the slab (recommended).
  - Baseboard above the potential water level.
- 5 Cover the slab with a **concrete densifier** and then a **sealant** to prevent stains.
  - **Finish:** leave the concrete floor unfinished.
  - ⚠ Avoid installing flooring directly on the slab, as this could lead to mould growth on both the top and bottom surfaces after flooding.
- **Humidity management** : → C4C 2/2

### Types of buildings



### Expertise required

Company specializing in flood-proofing.

MEP: inspection and recommendations for the drainage system.

Structural work: if required. General renovation contractor or energy efficiency specialist.

Drainage specialist: if required in advance for very damp or flood-prone crawl spaces.



### Regulations

Some municipalities prohibit wooden living-area floors in certain zones.

See Part 9, Section 9.18 of Chapter 1 – Building of the Quebec Construction Code.

## RESILIENT FLOORING

# FLOOR ABOVE A CRAWL SPACE

An old wooden-framed floor located above a crawl space, which is often unheated and made of compacted earth, is particularly vulnerable to moisture and air infiltration. Its durability depends on a construction method that limits the exchange of air and moisture with the crawl space, while allowing the wood to dry.

Objectives to be achieved during maintenance or restoration:

- ☉ Reduce relative humidity in the crawl space.
- ☉ Promote drainage and drying of components after an episode of moisture or flooding.

## CONSIDERATIONS

- Insulation can trap moisture in the joists and decking, promote condensation, accelerate wood rot, and weaken the structure.
- ⚠ Do not insulate the floor above a crawl space.

## ADVANTAGES

- Reduction of humidity in the crawl space and on the ground floor.
- Reduced risk of mold and wood deterioration.
- Improved thermal comfort without creating hidden risks.
- Potential reduction in heating costs associated with cold air infiltration.

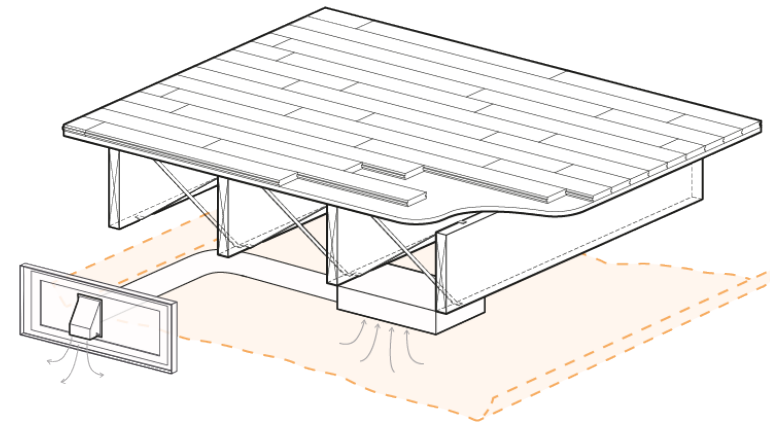
## PRELIMINARY STEPS

Assess current conditions by monitoring temperature and relative humidity.

Identify potential vulnerabilities.

- Remove unnecessary covering layers (carpet, vinyl tiles, etc.) to expose the original floor (while preserving layers of interest).
- Inspect the crawl space: moisture, standing water, condition of joists, columns, and other wooden components.
  - Any presence of water under the floor increases the risk of various types of rot, including dry rot, which is often invisible in the short term and highly damaging to the structure.
- Identify points of entry for outside air (drafts, cracks, openings in the foundation).
- Check that surface water is not draining into the crawl space.

⚠ **After a flood or water damage:** If the floor shows signs of warping due to flooding, replace only the sections that are beyond repair; some original components can be kept if they return to their original shape after drying.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 Waterproof the crawl space floor

- Do not open crawl space vents or windows in the summer, when the outdoor air has a high moisture content.
- Install a sturdy polyethylene vapor barrier (min. 6 mil, ideally 10–20 mil for better puncture resistance) on the floor, extending the sheets up the foundation walls by at least 15 cm to limit the evaporation of this water into the crawl space.
- Overlap the seams by at least 30 cm and seal them.
- Seal the membrane against the concrete base of the pillars using an appropriate sealant.

### 2 Seal air leaks

- Seal major air leaks coming from the outside (critical areas: edge joists, penetrations).
- Preferably use Ethafoam tubes of the required diameter or use weatherstripping in localized cracks and openings.
- Do not use reversible polyurethane unless it is applied with a very fine nozzle to target only the crack.
- Avoid completely filling the joint between joists and masonry to prevent creating a moisture bridge.

### 3 Managing residual moisture

- Install a dehumidifier to remove residual moisture and maintain a relative humidity level below 50–60%.
- Leave the floor joists exposed to the air in the crawl space. They must be able to dry upward (toward the floor) and downward (toward the dry crawl space). → C4C

Types of buildings



Expertise required

**General contractor or indoor air quality specialist:** for the installation of the vapor barrier and sealing

**Electrician:** for the safe installation of electrical outlets and, if applicable, heating.



Regulations

See the BNQ standard on Mold Contamination in homes.

See Part 9, Section 9.18 of Chapter I – Building in the Quebec Construction Code.

For more information:

See Post-flooding action to be taken on quebec.ca.

RESILIENT FLOORING

# HUMIDITY MANAGEMENT IN A CRAWL SPACE

Water may temporarily enter a **crawl space** or **basement at risk of flooding**: this space should be designed to accommodate water and drain it quickly to minimize damage.

Key objectives of **humidity management** in crawl spaces and basements:

- Reduce damage to property, the building, and the structure.
- Prevent water infiltration and control relative humidity.
- Increase drying capacity to reduce the risk of mold.

## CONSIDERATIONS

- ⚠️ A consistently high relative humidity level (above 60–70%) promotes the growth of wood-destroying fungi and mold that contaminate the air rising into the house through floor infiltration.
- During the cold season, for a crawl space or unoccupied basement, heating can be controlled using a humidistat rather than a thermostat (heating is adjusted to the exact amount needed). A dehumidifier is often used in the summer and can also be used in the winter; its operation will provide minimal space heating.

## ADVANTAGES

- Protecting joists and flooring from dry or wet rot.
- Creating a healthier environment for mechanical systems.

## PRELIMINARY STEPS

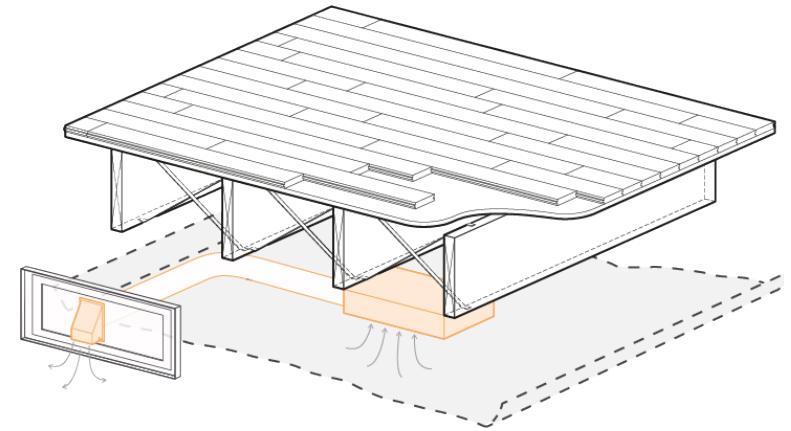
Understand current conditions by monitoring temperature and relative humidity.

⚠️ Do not rely on perceptions, but on facts.

Evaluate installation scenarios:

- ① Check for condensation issues.
    - If so, assess whether openings allow for passive ventilation.
    - If not, install openings or reopen those that have been sealed off.
  - ② If passive ventilation is insufficient, use mechanical ventilation.
- ⚠️ Keep windows closed during hot and humid periods to limit the entry of hot, humid air.

⚠️ **After a flood:** Remove the water, as mold can appear in less than 72 hours. Thoroughly clean the floors and dry them quickly to prevent warping of materials and mold growth. If a plastic sheet has been laid on the floor, remove it to allow the area to dry.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

If the previous step ① does not work, here is a description of scenario ②:

- ① Waterproof the crawl space floor. → C4C 1/2
- ② Seal off any openings to the outside to create a controllable, enclosed space and prevent the influx of humid outside air.
- ③ Actively dehumidify.
  - Install a household **dehumidifier** with adequate capacity (often 23–33 L/day – 50–70 pints/day) in the crawl space, on a stable platform.
  - Set the unit to a target **relative humidity of 40–50%**.
- ④ Drain the water continuously.
  - To avoid having to manually empty large amounts of water from the dehumidifier or having it stop working because it is full, connect the drain hose directly to a sewer drain.
  - Install a **check valve** to prevent water from entering the building.
- ⑤ Heat and circulate the air continuously as a supplement (optional).
  - ⚠️ Always ensure the **temperature remains between 4 and 15 °C**.
  - ⚠️ Heat the crawl space if the mechanical ducts are not insulated.
  - Add supplemental heat if necessary to help the dehumidifier operate more efficiently in winter and improve comfort.
    - Electric baseboard heaters: install them above the potential water level to prevent electric shock; ensure they have an independent power supply.
    - Small-capacity wall-mounted heat pump: more energy-efficient.
  - Install floor fans to circulate air and prevent stagnant air from coming into contact with colder surfaces, thereby preventing condensation.

# EXTERIOR SYSTEMS

## C5 RESILIENT ROOFS

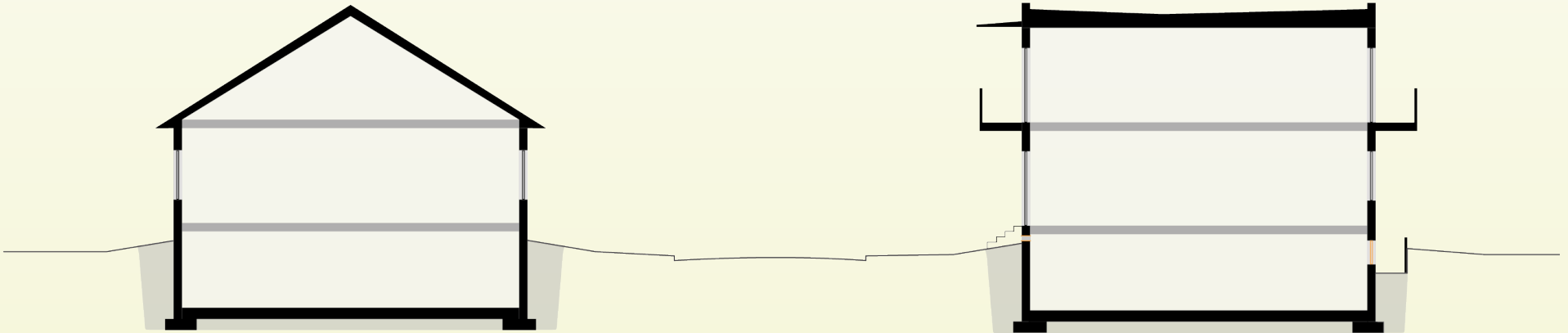
- C5a<sup>1/2</sup> Sloped roof
- C5a<sup>2/2</sup> Ventilated roof
- C5b Flat roof
- C5c Parapets
- C5d Chimneys and dormers

## C6 RESILIENT EXTERIOR WALLS

- C6a<sup>1/2</sup> Masonry cladding
- C6a<sup>2/2</sup> Old masonry
- C6b Lightweight cladding
- C6c<sup>1/2</sup> Exterior-insulated foundation wall
- C6c<sup>2/2</sup> Exterior-insulated rubble stone foundation
- C6d Commercial facade and curtain wall

## C7 RESILIENT JOINTS AND PENETRATIONS

- C7a<sup>1/2</sup> Openings
- C7a<sup>2/2</sup> Old doors and windows
- C7b Flood vents
- C7c<sup>1/2</sup> Balconies and canopies
- C7c<sup>2/2</sup> Balconies with wood cantilevers
- C7d Sill plate



# C5

# RESILIENT ROOFS

A **roof** (sloped or flat) protects the building from the elements. It must be waterproof against outside water and manage inside humidity.

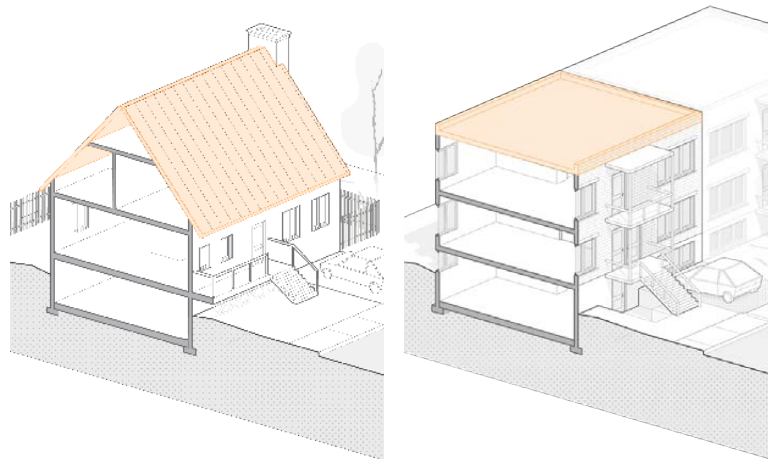
A **resilient roof** plays an important role in managing rainwater by directing and/or accumulating it in a controlled manner. → **B1 B2**

Key objectives of a **resilient roof**:

- Ensure waterproofing (assembly and choice of materials).
- Prevent infiltration and overload of the network.
- Ensure good ventilation of the roof, especially in older buildings.
- Ensure that roof joints (chimneys, skylights, parapets, etc.) are waterproof.
- Direct water to the right place.
- Exceed the minimum requirements specified in the Construction Code to withstand extreme weather conditions (high winds with the risk of damage, heavy rain with excessive water accumulation that damages waterproofing and drainage systems).

## ADVANTAGES

- Increased roof durability.
- Improved energy efficiency of the building.
- Opportunity to reuse rainwater and reduce drinking water consumption.



## WHERE TO START?

Understand the risk → **A1 A2**

Know the characteristics of the building

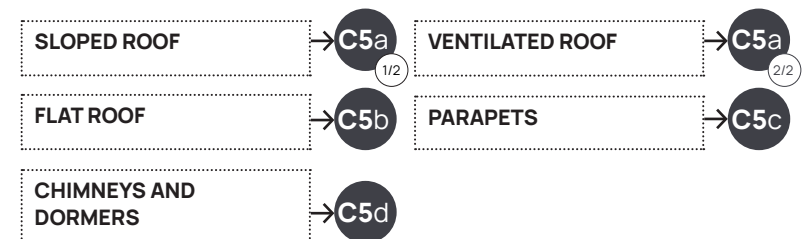
- Understand the composition of the roof: date of construction, potential major renovations, etc.
- Observe the condition of your roof.
- ⚠ Slope, drainage systems, quality and resistance of materials.

Seek professional assistance →

Identify potential vulnerabilities → **A3a**

- ⚠ Roof vulnerability can be exacerbated by the weight of snow or weather fluctuations (freezing and thawing, solar radiation).
- Building's predisposition to damage:
  - Poor slope management.
  - Sagging or deformation of the frame/support.
- Water entry points into the building:
  - Tearing / lifting of the covering (tiles, shingles, etc.).
  - Degradation or absence of the waterproofing membrane.
  - Poor sealing of openings (windows, mullions).
  - Cracks in roofing or parapets.
  - Degradation, loose joints or absence of gutters.
  - Damage to drains: blockages and risk of overflow (flat roofs).
  - Damaged joints and membranes around penetrations and other junctions.
- Specific visible problems:
  - Moisture or mould stains on interior finishes and roof trusses of ventilated roofs.
  - Signs of water accumulation (flat roof or between multiple roof slopes): differences in roof colour.

Consult the recommendations according to the type of roof



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The information presented in this report is of a general and generic nature, and its applicability to a specific situation must be verified by qualified professionals.



### Financial assistance program

City of Montreal: subsidies available (for roofing work).



### Regulations

⚠ Avoid doing the work yourself to maintain your warranties.

According to the RBQ (Régie du Bâtiment du Québec), GCR (Residential Construction Guarantee) protection only applies if a contract is signed with a general contractor for part of the work. In the case of complete self-build projects, there is no mandatory RBQ guarantee.

### Types of buildings



### Expertise required

**Roofing (specialized company):** for installation and inspection in case of damage.

Services of an **architect** are mandatory if the building has a floor area of more than 600 m<sup>2</sup>.

Poorly designed roof can cause serious damage.

**Structure:** for structural reinforcement work if additional load-bearing supports are required (green roof or terrace).

**Insurance:** in case of damage.

## RESILIENT ROOFS

# SLOPED ROOF

A **sloped roof** is a roof that naturally drains and carries water away from the building. → B1

In addition to directing water to the right place, a **resilient sloped roof** must:

- ☉ Be waterproof, especially at the joints.
- ☉ Be well ventilated to facilitate drying.
- ☉ Be securely fastened and have a water-resistant coating.
- ☉ Ensure a uniform roof temperature.
- ☉ Direct water naturally toward the roof edges.
- ☉ Facilitate drying and reduce heat transfer to the outside (in winter) and inside (in summer).

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### WATERPROOFING

- 1 **Structural cladding.**
  - **Weatherproof** (or waterproof) **membrane.**
  - **Underlayment** under the roof covering. Seal air leaks and install an elastomeric bitumen membrane covering the entire roof.
  - **Air barrier** between the interior of the building and the ventilated space to prevent ice dams: when melting, water can rise under the shingles and cause damage.
  - Galvanized steel **valley flashings** or bituminous strips to prevent infiltration.
  - Continue **flashing** (e.g., under the underside of dormer window frames).

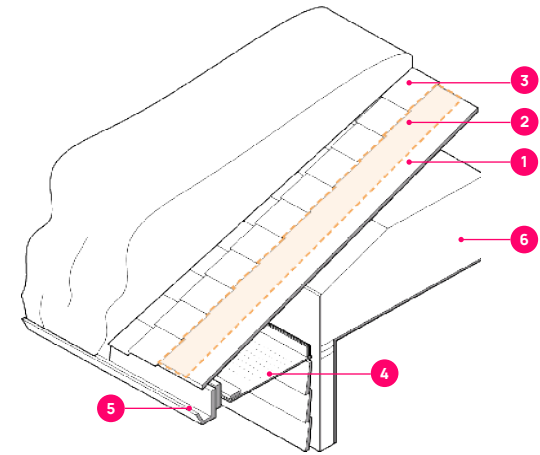
### SOLIDITY

Prevent tearing

- 3 Waterproof and resistant **roof covering** (rain screen): asphalt shingles, galvanized, painted, or stainless steel sheet metal, etc.
  - **Strong fasteners:** nails, hooks, special screws, etc.

Prepare for extreme conditions:

- **Reinforcements** on the edges (e.g., windbreaks, cover plates, etc.) that strengthen the roof's resistance to strong winds and water infiltration from below.
- **Buffer zone** around the house : gravel, drains, infiltration wells, with underground piping systems to divert water away from walls and foundations.



### DRAINAGE AND DRYING

- 4 Use **soffits** that allow ventilation.
- 5 Securely install wide, durable **gutters** (zinc, aluminum, PVC) suited to local rainfall levels, with free-flowing downspouts to ensure proper drainage, equipped with leaf guards.
  - **Large roof overhang** to protect facades: 40 to 60 cm (15 to 25 in).
  - **Smooth decking** to promote water runoff.
  - **Air spaces** in assemblies and joints to promote drying.
- 6 Install **insulation** away from the roof decking to allow for ventilation and eliminate heat loss.

### MATERIALS

⚠ Pay attention to the **quality** of materials, their **installation**, and regular **maintenance**.

- **Asphalt shingles** \$ lifespan: 15-25 years (installation: from bottom to top).
- **Metal roofing** \$\$\$ lifespan: between 50 and 70 years (galvanized steel, aluminum, etc.).
- **Slate** \$\$\$ lifespan: 75 to 100 years.

⚠ **Gutters:** perform regular maintenance each season to prevent clogging from leaves or debris and the accumulation of moss on the roof, which retains moisture and can damage the tiles.

### Types of buildings



### Expertise required

**Roofing contractor or energy performance consultant:** to calculate ventilation requirements, inspect the condition of the insulation and airtightness, and recommend suitable products.

**Roofing contractor:** if required for vents.

**Insulation specialist:** if required.



### Regulations

See Part 9, Section 9.19 of Chapter 1 – Building of the Quebec Construction Code.



## RESILIENT ROOFS

# VENTILATED ROOF

**Attic or loft ventilation** is a simple, passive measure that helps reduce the risks associated with water infiltration and heat loss.

Objectives of ventilation:

- ☉ Create and maintain a flow of cool, dry air in the space beneath the roof sheathing to ensure a uniform temperature across the roof.
- ☉ Evacuate heat in the summer and increase drying capacity to reduce the risk of rot, mold, and warping.
- ☉ Eliminate problems with ice dams and condensation.

## CONSIDERATION

- ⚠ Do not change any existing settings if the attic of an existing building does not have any water infiltration issues.

## ADVANTAGE

- Increased roof durability.

## PRELIMINARY STEPS

Assess the condition of the roof and identify potential vulnerabilities.

- The combination of a poorly ventilated attic and a defective air barrier can lead to a risk of condensation caused by indoor moisture (cooking vapors, showers, breathing). In winter, this condensation freezes, forming frost that, as it melts, can soak into the insulation, rot the wood, and damage the ceiling finish.
- Snow dams often form where insulation touches the roof deck, keeping that area slightly warmer than the rest of the roof, which causes localized melting.

Before improving ventilation, ensure that the interior ceiling is properly airtight:

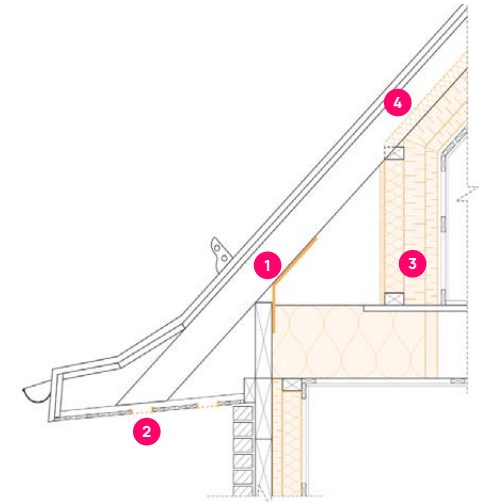
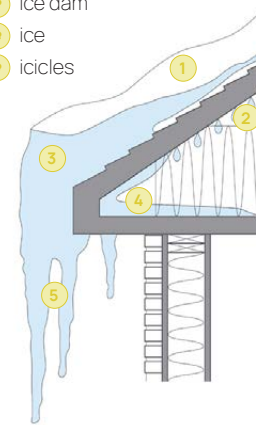
- Seal all leaks of warm, humid air into the attic: poorly sealed access hatches, recessed light fixtures, ventilation ducts, cable penetrations, and wall/ceiling junctions.
- Ensure that bathroom and kitchen exhaust fans vent to the outside via a wall or roof duct, and never directly into the attic. If this is not possible, insulate and seal all ducts.

Calculate the required net free ventilation area according to standards.

- Generally, a ratio of 1/300 of the attic area for slopes greater than 3/12, and 1/150 for shallower slopes and cathedral ceilings.

Possible causes of leaks

- 1 snow buildup
- 2 melted snow seeping into the attic
- 3 ice dam
- 4 ice
- 5 icicles



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 Install **rigid baffles** (made of plastic or foam) in the attic between each truss or rafter, at the soffit level, to prevent loose or mat insulation (mineral wool, cellulose) from falling, blocking air inlets, or coming into contact with the roof deck. Create and maintain a 2.5-inch air gap.
- 2 Install **soffit and ridge vents** according to the net free ventilation area and ensure they are clear of any obstructions.
- 3 If required, **insulate the roof**.
  - ⚠ Maintain the continuity of the air seal with the new insulation.
  - 4 If the roof is insulated, **leave space between the rafters and the joists**.
    - ⚠ Do not fill the open cavities with insulation.
    - ⚠ Do not obstruct the ventilation space above the insulation.
      - Install a heating cable if required.

**Ventilated flat roofs on rafters** (similar principle).

- Maintain a continuous 2.5-inch ventilation space above the insulation, from the underside of the deck to the gable or ridge vent.
- If required, install « goosenecks » between each rafter that extend outward, or install static anti-gust vents.

# C5b

## Types of buildings



## Expertise required

**Roofing (specialized company):** for installation or for inspection of the roof in case of damage.

If required: seek the assistance of a master roofer for maintenance.

## RESILIENT ROOFS

# FLAT ROOF

A **flat roof** is resilient and durable because it is better protected against extreme weather conditions.

### Characteristics of a **resilient flat roof**:

- ☉ Be waterproof, especially at joints and penetrations. The shape of the roof is conducive to water accumulation, which can be harmful to the building.
- ☉ Be highly resistant to extreme temperature and wind conditions.
- ☉ Promote controlled temporary water retention.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### SOLIDITY

#### Install a new membrane and ensure that:

- the structure and support panels are in good condition and solid ;
- the waterproofing system adequately covers the flashings and all elements in contact with the roof ;
- the quality of the membrane is adequate for the needs and/or vulnerabilities of the roof.

- 1 Properly overlap the different membranes used to ensure waterproofing between the roof and its components (flashings, drain, gooseneck, skylight, etc.).

Choose a green roof to promote absorption and slow down water runoff. → **B2b**

Reduce the risk of tearing for roofs that are particularly exposed to wind.

- Limit surface equipment.
- Add reinforcement systems.

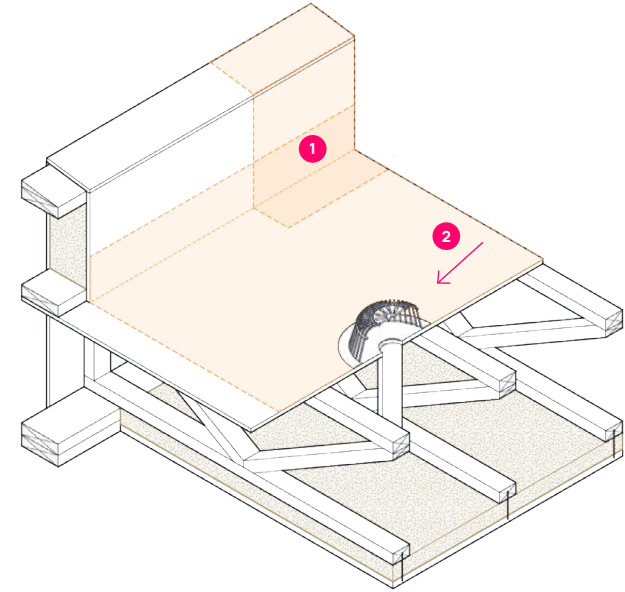
### DRAINAGE AND DRYING

Managing abnormal rainfall volumes.

- Install overflows, controlled-flow roof drains, controlled overflow areas, or gargoyles.
- Provide a second means of water drainage.
- Divide the roof into several drainage basins to reduce the scope of work in the event of failure.

- 2 Provide a slope of at least 2% toward the drain to reduce risks.

⚠ Seek professional assistance to properly size roof drains and downspouts. → **B2a**



### MATERIALS

⚠ Pay attention to the quality of materials, their installation, and regular maintenance.

- **Multilayer (asphalt and gravel)** \$ lifespan: 15 to 20 years.
- **Elastomeric membrane** \$\$ lifespan: 20 to 30 years.
- **TPO membrane (most common use)** \$\$\$ lifespan: 20 to 35 years.
- **EPDM membrane** \$\$\$ lifespan: 20 to 35 years.

⚠ **Roof drains and downspouts:** perform regular maintenance (at least twice a year) to prevent clogging by leaves or debris, prevent the accumulation of moss on the roof that retains moisture, and check for cracks and other possible damage to the membrane and flashing.

# C5c

## Types of buildings



## Expertise required

**Master roofer:** specializing in flat roofs and metal flashing work. Precision and expertise in bending and installing flashings are essential.

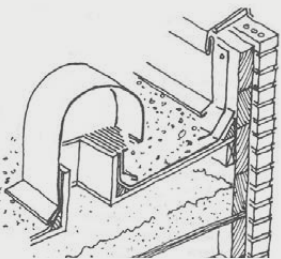
**Have the condition of the materials assessed:** (with warranty), waterproofing membrane, slope on top of the parapet.

**Structural engineer:** if there is a problem with significant sagging or water infiltration.



## Regulations

The regulatory height of the parapet is often dictated by the building code based on the number of stories.



@JulesAuger

## RESILIENT ROOFS

# PARAPETS

**Flashings** protect the junction between the building wall and the flat roof membrane. This junction, at the parapet, is highly exposed to the elements. The parapet, a low wall extending above the roof, serves both as protection and as a support for the waterproofing and roof equipment.

Objectives to be achieved during maintenance or restoration:

- ☉ Ensure the roof is watertight.
- ☉ Direct water to the correct location.

## CONSIDERATION

- Flashings on older parapets are often inconspicuous yet vulnerable points. Their maintenance is frequently inseparable from the replacement of the flat roof membrane, as it requires removing and redoing the upper finishes while preserving the integrity of the historic materials.

## ADVANTAGES

- Helps maintain the membrane's lifespan (20–30 years).
- Prevents damage to the roof, the most exposed part of the building.
- Reduces long-term repair costs by limiting damage to walls and the membrane.

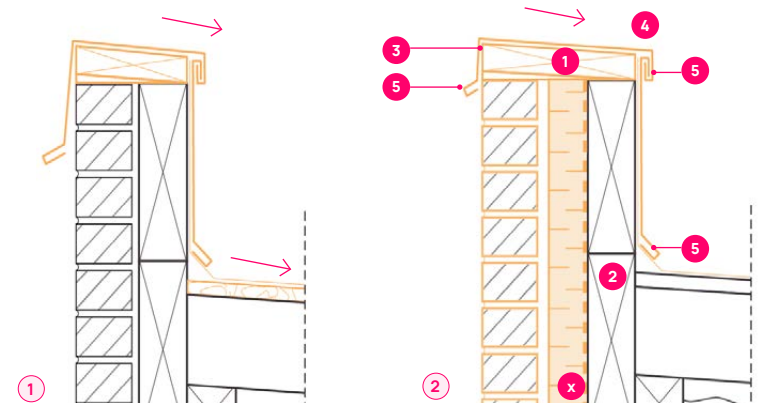
## PRELIMINARY STEPS

Identify potential vulnerabilities:

Water can penetrate and run down the wall structure, sometimes reappearing well below it on the inside, giving the impression of a window or wall problem. Water infiltration can damage the top of the wall, adjacent interior walls, and the roof structure.

- Check for any rot in the structural wood, signs of moisture, damage to interior finishes, gaps, cracks, protrusions, peeling, etc.
- Check the condition of the mortar, as the flashings are installed there.

▲ Importance of maintenance: check the flashing annually.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### Types of repairs

- Repairing the parapet's waterproofing: remove the old metal flashing, the joint cover, and any rotten or loose material, then reinstall the flashing.
- Repairing the wall with insulation installation: remove the brick, install the insulation x, then replace the brick, ensuring that a structural support is in place.

### Preparation of the substrate

- Securely fasten the «nailing strip» (treated board) to the parapet structure.
- ⚠ To ensure that water seeping behind the flashing is redirected toward the roof surface and not into the wall, the nailing strip must have a **slope of at least 10%** (to ensure an effective minimum of 5%) toward the interior of the roof.
- Structurally, the parapet must include a timber frame capable of supporting lateral loads and holding the top rows of bricks, which cannot rest solely on an unsupported timber frame

### Weatherproofing membrane

- Apply a **self-adhesive, vapor-permeable membrane** to the nailing strip and the adjacent portion of the flat roof. It should extend the full height of the nailing strip and be turned outward over the front face of the parapet.
- ⚠ At the point where it meets the roof, follow the AMCQ specifications: the flashing must consist of three layers (underlayment, reinforcement, and finishing membrane).

### Flashing

- Install the **flashing apron** (made of aluminum, galvanized steel, or copper), which forms the angle of the parapet. Its upper drip edge extends inward toward the roof to direct water droplets onto the roof. A clip is recommended to mechanically secure the apron to the nail-down edge.
  - Cover the apron with a two-part **cover** to allow for differential movement.
- Secure the joint finishes with a **drip edge**. On the cover, at the longitudinal joints and at the ends of the counter-flanges, create a double fold (or use cover caps) to ensure the joints are completely watertight and prevent water from seeping in from above.

# C5d

## Types of buildings



## Expertise required

**Roofing contractor:** for water infiltration issues related to flashing.

**Carpenter specializing in woodwork** (dormers, windows)

**Insulation contractor:** specializing in complex details and airtightness for condensation issues.



## For more information:

Quirion, P., & Brulotte, M. (2016). Toit. Bois. Bardeau - Guide technique. Centre de conservation du Québec.

## RESILIENT ROOFS

# CHIMNEYS AND DORMERS

The junctions where the roof meets **chimneys, dormers or other elements** that penetrate the roof slope are vulnerable to water infiltration because they disrupt the continuity of the roof covering.

Objectives for the maintenance of historic buildings:

- Ensure proper waterproofing.
- Ensure proper roof runoff capacity.

## CONSIDERATION

- **Respect for the characteristics of the historic building:** maintain the originality of the roofing where possible and restore existing elements (e.g., ice guards).

## ADVANTAGES

- Reduction of moisture problems.
- Protection of the structure and the integrity of the building envelope.
- Increased durability and improved thermal comfort (e.g., by insulating a dormer window).

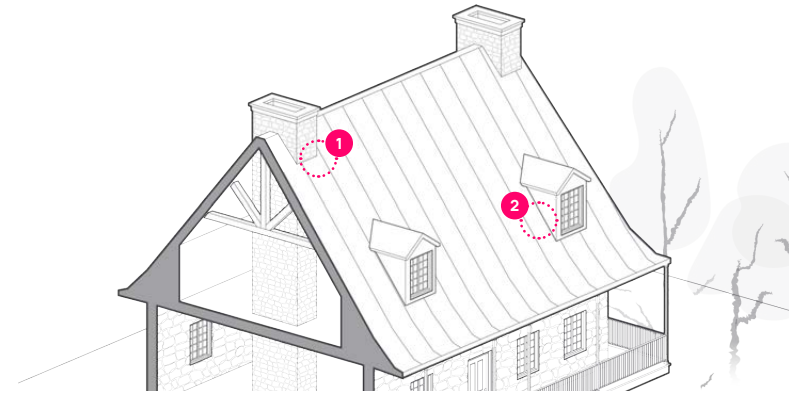
## PRELIMINARY STEPS

Identify the **source of moisture:** water infiltration or condensation.

- **Liquid water infiltration:** generally results from a lack of waterproofing in flashings, counter-flashings, or the cladding. Water follows gravity and may appear far from the point of entry.
- **Condensation:** around dormers, it often results from warm indoor air coming into contact with a cold surface.
- Check the **condition of the joints:** flashings, counter-flashings, cladding, brickwork, mortar, and support wood.

### ▲ Best practices:

- Add or restore ice guards to protect the joints.
- If possible, relocate vents and plumbing risers toward the roof ridge to minimize the risk of water infiltration.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 Rainwater leakage

- Temporarily remove the roofing material in the affected area to inspect and repair the wood if necessary.
- Install a self-adhesive waterproofing membrane over the deck and extend it up the vertical face.
- Install bent and, if necessary, welded metal flashings covering the membrane, and install counter-flashings over the flashings and under the dormer cladding (or within the chimney masonry).
- ▲ Custom work performed by a specialized sheet metal worker.
- Ventilate the roof and replace the original sheathing on top or replace it with an identical one.

### 2 Condensation (typical of dormers)

- Remove the interior sheathing (plaster, gypsum) to expose the structure.
- Seal air leaks between the warm interior and the cold cavity with tow or Ethafoam tubes of the required diameter around windows and where the structure meets the roof.
- ▲ The use of spray foam is not recommended because it is difficult to control during installation; it can hide problems, and its impermeability can contribute to wood deterioration.
- Apply a continuous rigid insulation (polyisocyanurate, XPS, or rock wool) to all interior surfaces without allowing the insulation to touch the roof deck.
- Install a moisture-variable membrane that allows moisture to escape when humidity levels are too high in the absence of a vapor barrier.
- Install furring strips and secure the interior sheathing.
- Finish with new cladding (drywall, boards).

# C6

# RESILIENT EXTERIOR WALLS

**Exterior walls** play an important role in managing rainwater, humidity, airtightness, and temperature variations. They help protect against the elements while ensuring comfort and energy efficiency.

The design of a **resilient exterior wall** must also take into account the junctions of the elements attached to it (openings, balconies, awnings, etc.) and the type of cladding (masonry and lightweight). → C6b

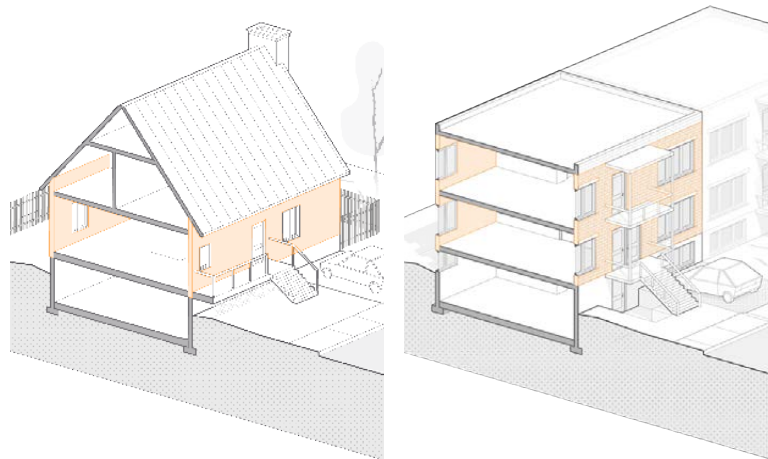
⚠️ If poorly installed or maintained, they can become a route for water to enter the building and cause damage.

**Objectives of a resilient exterior wall:**

- ⊙ Effectively manage rainwater and humidity.
- ⊙ Increase airtightness.
- ⊙ Balance pressures.
- ⊙ Ensure the durability of materials, even when exposed to water.
- ⊙ Choose materials with good absorption and retention capacity.

## ADVANTAGES

- Increased building lifespan.
- Improved building energy efficiency.



## WHERE TO START?

**Understand the risk** → A1 A2

**Know the characteristics of the building**

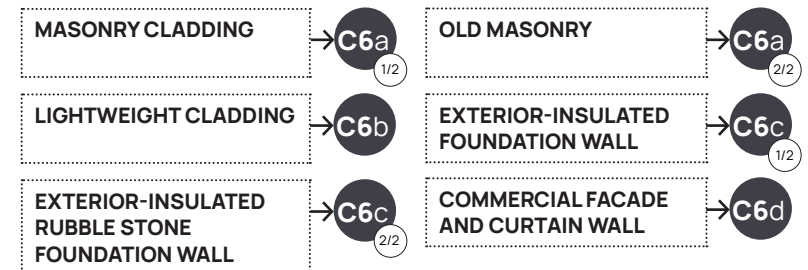
- Understand the composition of the walls: date of construction, potential major renovations, etc.
- Observe the condition of the exterior walls.

**Seek professional assistance** →

**Identify potential vulnerabilities** → A3a

- Building's predisposition to damage:
  - Openings located below the potential water level.
  - Flow direction from balconies/terraces/windowsills towards the building.
  - Porous materials (e.g., wood, brick, and/or mortar).
- Water entry points into the building:
  - Cracks or damage to exterior walls, dislocation (deformation).
  - Moisture or mold problems, damage due to condensation.
  - Defective or missing waterproofing membrane.
  - Deterioration of materials due to poor drainage and flashing, leading to water accumulation.
  - Holes in the masonry (weep holes, vents, etc.).
- Malfunctions / installation problems requiring expert assessment:
  - Poor joints between walls and foundations, walls and roofs, walls and balconies, etc.

**Consult the recommendations according to the type of wall**



Types of buildings



Regulations

Some municipalities have PIAs that require building modifications to be approved by the municipality's CCU.

Mortar spatter and splashes vs. weep holes:

See AEMQ, section 12.3, standard A371-04, note e).

See ACQ technical data sheet FT-9.20.1310.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

RESILIENT EXTERIOR WALLS

# MASONRY CLADDING

**Masonry cladding** on an exterior wall can be made of stone, brick, concrete blocks, etc. Masonry does not play a load-bearing role (unlike traditional solid walls) but acts as a primary barrier against the elements.

Characteristics of a **resilient masonry cladding**:

- ☉ Does not deteriorate (spalling, swelling, rotting) when in prolonged contact with water and does not develop mould.
- ☉ Resists pressure, debris impact, weathering, and temperature variations.
- ☉ Prevents moisture migration inside the wall.
- ☉ Allows for effective drainage behind the cladding and ventilation.
- ☉ Provides a good balance of pressure on each side of the cladding to prevent water infiltration.

## ADVANTAGES

- Increases the life of the building, durability against freeze/thaw cycles.
- Limits the amount of debris after a disaster.
- Suitable for buildings located in very windy geographical areas.

## CONSIDERATION

- Masonry has high water retention and dries slowly.

## INSTALLATION SCENARIO

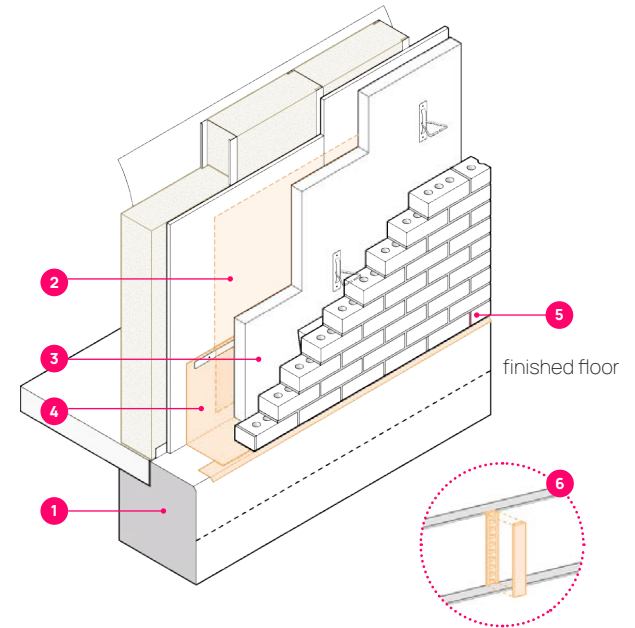
Suggestions for better understanding the issues to be discussed with qualified individuals.

### SOLIDITY

- 1 Use a concrete foundation wall that is high enough to ensure clearance above the ground and the potential water level (or protection objectives\*). → C10b

### WATERPROOFING

- 2 Install a **waterproofing membrane** in critical areas (wall bases, buried walls), glued or heat-welded to the wall.
  - ⚠ Risk of water absorption in the event of prolonged flooding: combine this protection with a surface treatment.
- When required, treat the surface with a **water-repellent coating** to prevent or slow down water infiltration while remaining vapour-permeable and without altering the appearance of the wall.
  - ⚠ Favor non-film-forming or beading water-repellent products that allow the wall to breathe, such as natural hydraulic lime-based coatings.



### DRAINAGE AND DRYING

- 3 Ensure that the cavity behind the wall is reasonably **free of mortar**, with **cleaning holes** installed. → C10b
- 4 Install **flashing** with a **waterproof membrane** underneath the brick facing to reduce the risk of corrosion.
- 5 Keep **weep holes** and upper vents clear at all times and cover lower **vents**, but ensure good ventilation.
  - Balance the pressure on both sides of the facing for large wall assemblies (see EPPE concept).

### MATERIALS

- Pay attention to the **quality** of the materials, their **installation**, and regular **maintenance**, such as repointing the mortar joints every 40-50 years.
- **Brick \$\$\$** and **stone \$\$\$\$** lifespan: 50 to 150 years. Natural, fire-resistant, durable, but requires minimal maintenance.

- ⚠ Before a flood: cover the weep holes with **caps** 5 as they become a route for water to enter. → C2a
- ⚠ Immediately after the flood: remove them to promote ventilation.

### Types of buildings



### Expertise required

Mason specializing in historic preservation.

**Architect or conservation consultant:** for projects involving listed buildings or structures of historical significance.

**Specialized contractor** for paint removal from brick or stone, as cleaning masonry is a highly complex process.

For major projects, request references (NRC, 2008).

### For more information:

Maurenbrecher, A. H. P., Trischuk, K., Rousseau, M. Z., & Subercaseaux, M. I. (2008). Les mortiers de rejointoiement pour les bâtiments de maçonnerie ancienne: considérations pour l'exécution. Archives des publications du CNRC.

## RESILIENT EXTERIOR WALLS

# OLD MASONRY

**Mortar joints** in older buildings play an essential role in water management. They bind the masonry together, protect it, and allow moisture to escape. Inappropriate or deteriorated joints can promote water infiltration, trap water, and accelerate the deterioration of the structure, particularly in the context of flooding, rain, and increased humidity.

Objectives for the maintenance of historic buildings:

- Intercept the bulk of rainwater on the exterior surface and ensure its drainage.
- Preserve the structural integrity and durability of the masonry.
- Protect masonry elements (stone, brick) from damage caused by moisture and freeze-thaw cycles.

## CONSIDERATIONS

- Mortars and renderings are what are known as sacrificial materials: they must be able to degrade preferentially, thereby protecting the stone and brick from deterioration.
- The mortar's properties must be compatible (composition, hardness, vapor permeability) with the stone masonry it bonds to, allowing it to fulfill its protective role without causing damage.
- The choice of mortar may vary depending on its location within the building. For example, below ground level where humidity is high, a more hydraulic mortar is preferred.
- There are various binders used to make mortar. These, when mixed with sand, can be used alone or in combination (e.g., lime-cement): hydrated lime, hydraulic lime, Portland cement. Mortars can be purchased pre-bagged or prepared on-site by the mason.

## PRELIMINARY STEPS

- Check the condition of the stones, mortar, and joints that ensure the wall is waterproof. Identify potential vulnerabilities:
  - Crumbling / missing joints, cracks around openings, chipping bricks (due to freeze-thaw cycles), signs of moisture or white efflorescence (salts).

If visible deformations are present, consult a qualified professional.

- Identify and correct issues related to poor water management (gutters, flashings, ground slope) before repointing.
- Research the properties of different binders and mortars.
- Check the condition of the finish before removing paint if necessary and repairing the plaster if needed.

▲ Avoid painting or treating masonry with waterproof coatings, which can cause damage to the bricks / stones.



© Alexandra Michaud (Action Patrimoine)

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### Integrity of masonry walls

- Check the condition of the inner part of the wall (core): delamination, large voids, or deformation, and verify the compatibility of any added materials (replacement stone and mortar) to assess the wall's integrity before proceeding with repointing.
- Consult the mortar's technical data sheets (e.g., <https://www.daubois.com>)
  - ▲ Consult an architect or a specialized mason.

### Choice of mortar (laying and repointing)

Rule: mortar / plaster = sacrificial (softer and more permeable than stone / brick).

In solid masonry walls, prioritize more flexible mortars that are compatible with the substrate, rather than stronger mortars.

- **Type O** (e.g., 1:2:9): limestone / porous brick, jointing mortar.
  - ▲ Weaker and more permeable, acts as a sacrificial layer, so avoid using it in basements.
- **Type N** (e.g., 1:1:6 or 1:2:6): can be used with dense brick / granite.
  - ▲ Use caution with softer or already deteriorated materials, as a mortar that is too strong can accelerate deterioration. Option to be evaluated based on the context.
- **Type S** (e.g., 2:1:9): avoid (too high in cement).
  - ▲ Ratios (cement: lime: sand). These ratios are for reference only and must be adjusted based on the existing masonry (brick / stone) and exposure.

### Curing (final stage of mortar hardening)

- Ensure optimal curing conditions necessary for mortar carbonation:
  - Wet curing (hydraulic lime and cement: lime mix, types N and O): 3 days.
  - Curing before exposure to freezing temperatures:
    - Hydrated lime: 3 months.
    - Cement-lime mixture (types O and N): 3 to 7 days.
    - Hydraulic lime: 28 days.
- Protect the joints from direct sunlight and wind.

# C6b

## Types of buildings



## Regulations

Some municipalities have PIAs that require building modifications to be approved by the municipality's CCU.

Membrane flashings at the foundation wall junction are also required for walls with light cladding.

### For more information:

AERMQ. (2024). *Manuel technique 2024*. (V.25.06.30). <https://aermq.qc.ca/services/manuel-technique/>

## RESILIENT EXTERIOR WALLS

# LIGHTWEIGHT CLADDING

**Lightweight cladding** on an exterior wall is a thin, non-load-bearing covering attached to the wall structure. It is mainly used to protect the facade from the elements and to provide an aesthetic finish. It can be made of PVC, wood, fibre cement, aluminum, certain composites, or metal.

### Characteristics of resilient lightweight cladding:

- Does not deteriorate (flaking, swelling, rotting) when in prolonged contact with water and does not develop mould.
- Prevents moisture migration inside the wall.
- Allows for effective drainage behind the wall and ventilation of the structure.
- Must be securely fastened to prevent tearing or peeling.

## ADVANTAGES

- Easy to remove, clean, or replace after flooding.
- Economical

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### SOLIDITY

- Prioritize a **raised foundation wall** made of concrete or non-porous stone.

⚠️ High risk of lightweight cladding being torn off during bad weather if the building is located in a very windy area.

⚠️ Low resistance to water pressure and debris impact.

### WATERPROOFING

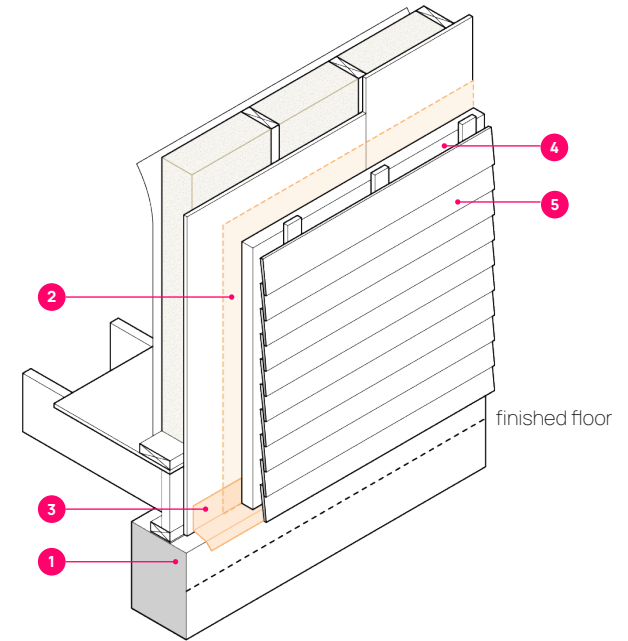
- Install a **waterproof membrane** 2 that extends above the **flashing** 3 at the foundation wall and protects the foundation wall.

### DRAINAGE AND DRYING

- 4 Ventilate **air spaces** with **furring strips** (vertical or diagonal, depending on the cladding chosen) to optimize water drainage and drying of components, as well as to facilitate the replacement of components damaged by water.

Considerations when choosing the layout of slatted cladding:

- **vertical** (\$\$): more effective at directing rainwater to the ground, minimizing the risk of water infiltration and premature deterioration.
- **horizontal** (\$): easier to install and replace when damaged (only the bottom slats need to be replaced).



## MATERIALS

- 5 Apply a **water-resistant coating**.

⚠️ Pay attention to the **quality** of the materials, their **installation**, and the regularity of their **maintenance**.

- **Wood** \$\$\$ lifespan: 40 to over 100 years.

Natural, eco-friendly, impact-resistant, and low-maintenance. Choose a wood species that is resistant to biological degradation (e.g., sapwood-free cedar) and prioritize an installation method that takes movement and drying into account.

- If wood: finishes on all sides to prevent warping.

- **Vinyl** \$ lifespan: 15 to 35 years.

Waterproof, low maintenance but relatively fragile when exposed to the elements.

- **Metal** \$ to \$\$\$ lifespan: 40 to 75 years (steel and aluminium).

Durable, weather-resistant, low maintenance, can be expensive.

- **Fiber cement** \$\$ lifespan: 15 to 30 years.

Non-combustible, resistant to mold and insects, but limited in terms of impact resistance.

Perform regular **maintenance** to reduce the risk of water infiltration:  
⚠️ Avoid aggressive detergents, high-pressure jets, and hard brushes.  
⚠️ Perform a visual inspection every year to identify any rot, cracks, missing nails, or peeling paint.

Types of buildings



Expertise required

Structural engineer: feasibility assessment.



Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.



Financial assistance program

See available 0% interest loans to help homeowners improve the energy efficiency of their buildings (e.g., Canada Greener Homes Loan).

For more information:

Bourassa, A., Trempe, R., & Méthé, L. (2024). Valoriser les bâtiments existants. Écobâtiment.

RESILIENT EXTERIOR WALLS

# EXTERIOR-INSULATED FOUNDATION WALL

Existing or new **concrete foundations** should ideally be **insulated from the outside** when excavation is possible.

Repairing damaged, cracked, or porous foundations and then insulating them from the outside increases the resilience of a basement by limiting the amount of materials inside that are exposed to flooding.

A basement wall can be **insulated from the inside** → C3a, but it will be less resilient: more materials will be affected in the event of a basement flood.

Features of resilient exterior foundation wall insulation:

- Protects the structure against freezing/thawing and ground moisture.
- Stabilizes the temperature and humidity around the foundation.
- Preserves the integrity of repaired or newly poured concrete.

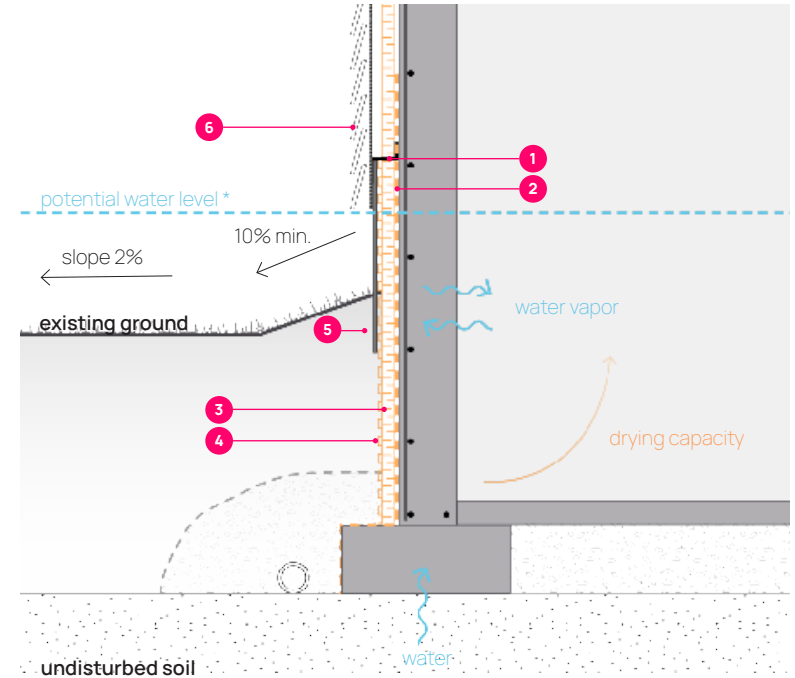
## CONSIDERATIONS

- Applicable to concrete walls in good condition, cracked and repaired concrete foundation walls, porous walls (blocks, rubble, stone, etc.) → C6b
- Requires excavation work.
- This measure does not prevent water from entering the building. Exterior foundation insulation can be combined with waterproofing → C9b on a new concrete foundation to reduce the risk.
- The space below the potential water level (or protection objective\*) remains exposed and must be adapted to accommodate water temporarily: interior redesign → C1, mechanical, electrical, plumbing → C2, interior walls → C3 and resilient flooring. → C4



Example of exterior insulation of foundation walls.

© ÉcoHabitation



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Repair damaged walls.
- Position the **flashing** against the wall and the **cladding fastening system** at the insulation break, above the potential water level (or protection objective\*), to contain and secure the elements covering the foundation walls.
- Lay the **waterproofing membrane** starting from the footing → B6a and working up to the cladding fastening system.
- Incorporate **rigid water-repellent insulation** with good compression capacity and a waterproof internal structure.
- Place the **drainage mat** on top of the insulation.
- Protect the insulation with a **water-resistant and water-repellent panel** installed on the surface and cover 15-20 cm below ground level.
- Secure the **cladding** starting from the fastening system of the cladding.

## Types of buildings



## Expertise required

**Excavation and masonry contractor:** to determine the appropriate insulation materials, their compatibility with the soil, and the types of existing masonry.



## Regulations

Check with the municipality to see if there are any regulations regarding the preservation of the appearance of masonry walls for heritage buildings.

In some areas, preliminary archaeological surveys may be required.

If archaeological material is discovered by chance, it must be reported to the MCC (a requirement under the Cultural Heritage Act).

## For more information\*:

Hartwig M. Kiinzel. (1998). Effect of interior and exterior insulation on the hygrothermal behaviour of exposed walls. Materials and Structures / Matériaux et Constructions. Vol. 31, pp. 99-103. Ville de Québec. L'isolation. Les Guides Techniques.

## RESILIENT EXTERIOR WALLS

## EXTERIOR-INSULATED RUBBLE STONE FOUNDATION

The foundation of an old stone or rubble-stone building is designed to manage moisture in a sustainable manner. Liquid water can be drawn into porous materials through capillary action. It is therefore recommended to protect them by **insulating them from the outside**.

Key features of a rubble stone foundation insulated from the outside:

- Preserve structural integrity by facilitating the drying of the wall.
- Provide long-term protection for masonry elements (stone, brick, mortar) against damage caused by moisture and freeze-thaw cycles.

## CONSIDERATIONS

- Insulation and drainage work requires excavation around the perimeter of the building. If excavation is not possible, prioritize measures to divert water away from the surface. → **B3**
- ⚠ It is not recommended to insulate a rubble stone foundation exposed to high moisture levels from the inside. The heat emitted by the building in winter no longer warms the masonry, which can cause new freeze-thaw problems and surface cracking in the foundation stones\*.

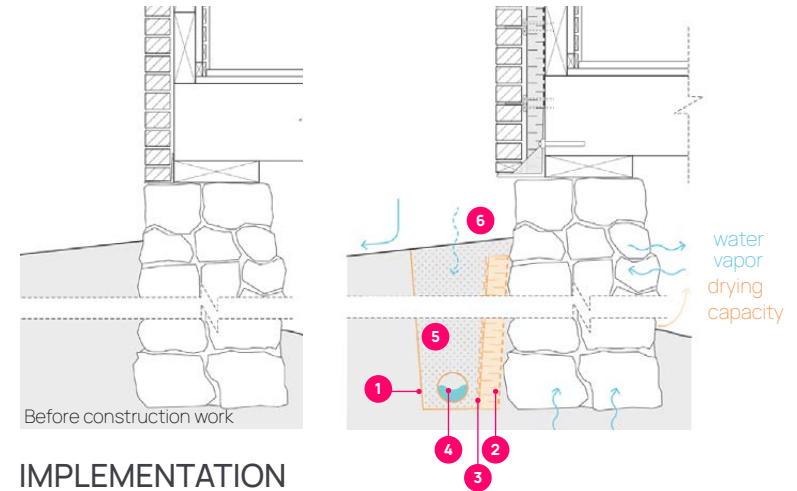
## ADVANTAGES

- Significant reduction in heat loss through the foundations.
- Preservation of the wall's thermal inertia and reduction of thermal bridges.
- Limitation of moisture loads in the crawl space.

## PRELIMINARY STEPS

- Consult a qualified professional to assess the feasibility of the work. Identify the characteristics of the site (adjacent properties, stability, slopes, soil composition). For example, drainage issues in clay soil can have serious consequences for the building.
- Identify the composition and condition of the foundation wall and the presence of plaster. Examples of potential vulnerabilities: traces of efflorescence and/or cracks on the foundation stones, signs of water infiltration inside, cracking of mortar joints, separation of mortar from masonry elements, etc.
- Identify the drainage system: presence and condition.
  - Prior to 1955, buildings were rarely equipped with a foundation drain, and the maximum lifespan of a French drain under stress is 20 to 30 years.
- Assess the height of the foundations.

⚠ Any water infiltration can lead to the risk of dry rot, which can cause significant damage to the building.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

## Excavation

- 1 Dig a trench around the foundation, 60 to 90 cm wide.
  - ⚠ Do not dig deeper than the base of the foundation.

## Cleaning and repair

- Clean the rubble stone joints, replace damaged stones, repoint with a suitable mortar → **C6a** (2/2) and cover with plaster.

## Installation of insulation

- 2 Apply rigid, closed-cell insulation panels that are water-resistant and compression-resistant. Examples: extruded polystyrene (XPS), high-density semi-rigid rock wool (vapor-permeable).
  - ⚠ Avoid irreversible methods such as the use of adhesive.
  - ⚠ Extend the insulation down to the bottom of the wall and up to 5 cm below the final finished floor level.
- Add a drainage panel to reduce hydrostatic pressure.
- Add a water-repellent membrane to the rubble stone wall, which has been previously repaired with a sacrificial coating, making the addition of the membrane potentially reversible.
- Add a horizontal insulation panel at the bottom of the trench to protect against freeze-thaw cycles, if the foundation is no deeper than 1.20 m (4 ft.).

## Protection and backfilling

- 4 Install a foundation drain at the base of the footing. → **B6a**
- 5 Backfill the trench with crushed gravel to a minimum depth of 30 cm (12 in.) above the drain, followed by compacted soil to hold the insulation in place.

## Surface finish

- 6 Create a sloped drip edge (approx. 10% slope) against the foundation using crushed stone to prevent splashing and erosion and to keep the top of the insulation hidden but accessible.

# COMMERCIAL FACADE AND CURTAIN WALL

## Types of buildings



## Expertise required

**Architecture:** analysis of joint details, material selection, increasing the height of glazing.

**Structure:** raising the foundation wall, adapting the curtain wall, resistance to hydraulic pressure.

**Curtain wall specialist:** waterproofing, sealants, membranes, air barriers.

**Landscaping:** integration of rainwater management measures.



## Regulations

See the recommendations of the AVFQ (Association de vitrerie et fenestration du Québec).

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

Commercial facades (curtain walls, storefronts, large openings) are major points of water ingress during flooding. Their resilience depends on the height of the glazing, the sealing of the frames, the strength of the materials, and the management of exposure conditions (slopes, drainage, sensors, and appropriate parapets).

Improving the resilience of a **curtain wall** involves:

- ⦿ Improving the waterproofing.
- ⦿ Delaying or preventing frame submersion.
- ⦿ Reinforcing the structure of the frame and materials in contact with water.
- ⦿ Increasing the strength and durability of materials, the frame (weatherstripping, sealants), and the opening (in contact with the frame): wood protection membrane, water-repellent concrete coating, etc.

## CONSIDERATIONS

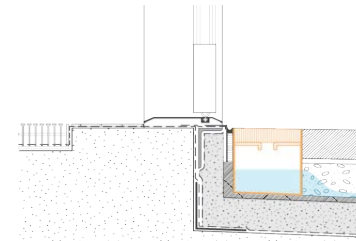
- Maintaining consistency between: glazing height, door level, interior floor height, and low wall or threshold level.
- Combine interventions with landscaping and drainage strategies: gutters, permeable areas, sponge zones, slope management.
- Even a high-performance curtain wall can allow a small amount of water to infiltrate under pressure.
- Aging or poorly maintained joints are sources of infiltration.
- Exterior features (permeable areas, cavities, grates) must be maintained to remain effective.

## ADVANTAGES

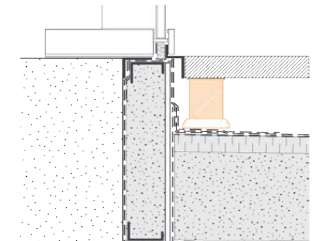
- Enhanced protection of the frame, materials, and facade components.
- Extended service life of the curtain wall.
- Reduced maintenance costs.
- Improved indoor comfort (reduced water infiltration).
- Ease of replacing parts when damaged by water.

## PRELIMINARY STEPS

- **Identify potential vulnerabilities:** frame / wall joints, door thresholds, flashings, sealant thickness, facade drainage, etc.
- **Ensure the quality of the installation.** Improperly installed sealants cannot be easily adjusted after installation, which can lead to the risk of leaks and significant damage.



Permeable door threshold



Paving on pedestals

- 1 Mineral drainage system to divert water away from the base of the curtain wall



- 2 E.g., raising a curtain wall



- 3 E.g., waterproof curtain wall

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

- 1 **Prevent water from reaching the building (\$)**
  - Divert water away from the building using permeable systems:
    - An air cavity beneath the slab supported on pedestals.
    - A permeable substrate beneath the exterior slab.
    - A temporary basin beneath the grate in front of the facade.
    - Regular maintenance: draining the cavity, cleaning the grates.
- 2 **Raise the curtain wall and glazing (\$\$)**
  - Position the glazing and the joint above the potential water level (or the protection objective\*):
    - Build a new low wall or raise the foundation wall.
    - Adapt facade details during renovation or interior remodeling.
    - Coordinate eventually the raised window level with a raised interior floor, including steps and a ramp
- 3 **Water resistance with a waterproof curtain wall (\$\$\$+)**
  - Ensure maximum performance when water reaches the facade:
    - Frames and glazing must be designed to be submerged and to withstand water pressure and debris impacts during a flood. They must be installed in a wall that has, at a minimum, the same strength and must be inspected regularly and properly maintained.

# C7

# RESILIENT JOINTS AND PENETRATIONS



## Regulations

The Quebec Construction Code requires designs that comply with water infiltration requirements.

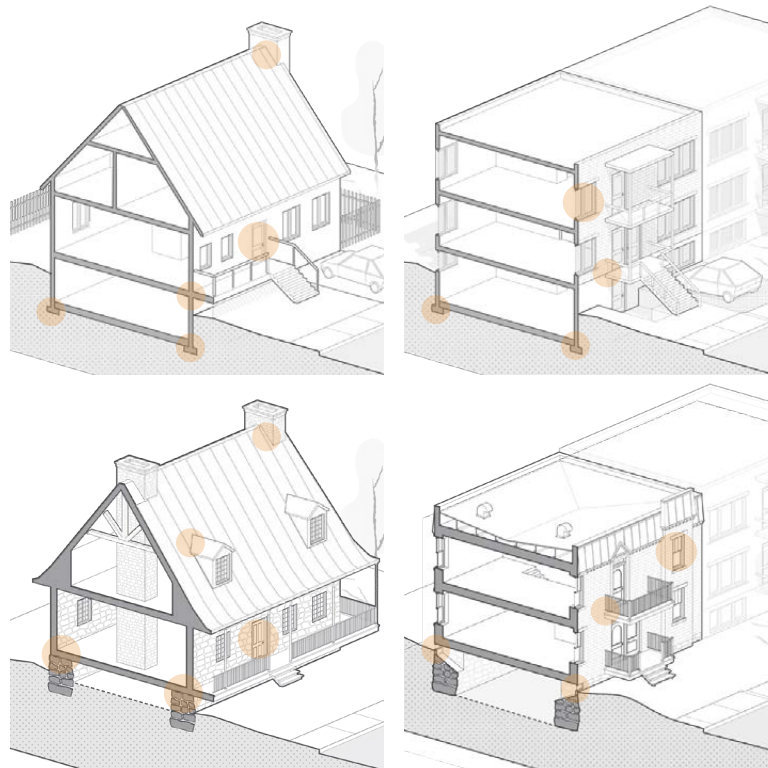
Most products used to control water infiltration at various joints, walls, openings, roofs, and penetrations are also high-performance products that must comply with air and water vapor infiltration requirements.

**Joints** are connection points between two elements of a building and typical / sensitive points of water entry during flooding: sill plates (connection between exterior walls and foundation), door and window frames, balcony or awning attachments, etc.

**Penetrations** are potential entry points for water into a building. These include doors, windows, basement windows, mechanical openings (ventilation ducts, equipment outlets), service entrances (water supply pipes, electrical and telephone cables), skylights and dormer windows, etc.

### Objectives of a resilient joint or penetration:

- ☉ Promote water drainage to the outside.
- ☉ Prevent water from penetrating the frame, insulation, or interior finish.
- ☉ Maintain air and water tightness, even in cases of prolonged exposure.
- ☉ Accommodate differential movements of materials.
- ☉ Prevent cracking due to mechanical, hydric, or thermal variations.



## WHERE TO START?

Understand the risk → A1 A2

### Know the characteristics of the building

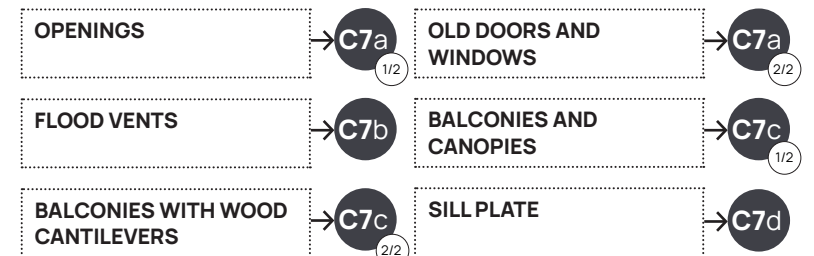
- Understand the composition of joints and penetrations: date of construction, potential major renovations, etc.
- Observe the condition of joints and penetrations.

Seek professional assistance →

Identify potential vulnerabilities → A3a

- Water entry points into the building:
  - Penetrations in walls or openings (structure, mechanical, electrical, and plumbing equipment passages).
  - Waterproofing problems at the joints of openings, mullions, fittings (joints, membranes, damaged flashings) and at the joints of elements attached to the facade (balconies, awnings).
- Malfunctions / installation problems requiring expert assessment:
  - Poor connection between foundation walls, footings, and slabs.
  - Poor installation of openings (e.g., poor closure).

### Consult the recommendations according to the type of joint or penetration



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The information presented in this report is of a general and generic nature, and its applicability to a specific situation must be verified by qualified professionals.

## Types of buildings



## Regulations

Perimeter membranes around openings are explained in several publications referring to AAMA/WDMA/CSA 101/I.S.2/A440, CAN/CSA-A440/A440.1

### For more information:

AVFQ & APCHQ. (2016). *Guide chantier - Isolation et étanchéité des fenêtres #7: Étanchéité à l'eau.*

AERMQ. (2024). *Manuel technique 2024.* (V.25.06.30). <https://aermq.qc.ca/services/manuel-technique/>

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## RESILIENT JOINTS AND PENETRATIONS

# OPENINGS

**Joints around openings**, including assemblies around door and window frames, hatches, or ventilation openings, are common routes of infiltration. During flooding, they are a major route for water to enter.

### Characteristics of a resilient opening joint:

- ⦿ Waterproof, airtight, and moisture-proof.
- ⦿ Directs water outside, away from woodwork and the interior of the wall.
- ⦿ Maintains the integrity of sealants in contact with water, their elasticity and their volume after drying.
- ⦿ Ensures the solidity of mechanical connection anchors, including window frames.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

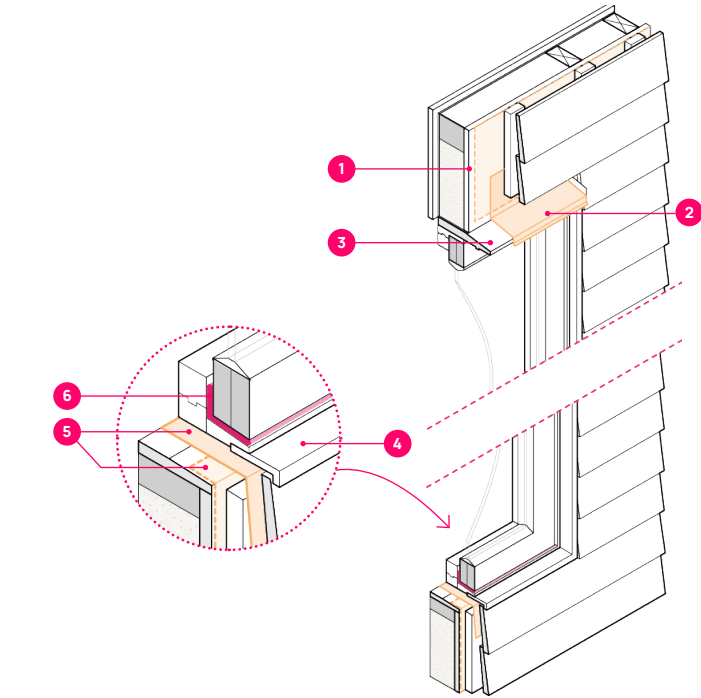
- **Protect openings** located below the potential water level (or protection objective\*) or in an area exposed to flooding:
  - Add window wells. → **B5b**
  - Add sealing devices to openings. → **B4**
- ⚠ Improve the quality of the installation of openings.

## SOLIDITY

- Reinforce the **structure** to withstand water pressure and debris, prevent glass breakage or window frame dislodgement.
  - Prioritize a garage door with a steel frame (\$) or a waterproof door (\$\$\$) → **B4a** 2/2
  - ⚠ If PVC is used, check its quality, strength, and lifespan.
  - ⚠ Avoid glass doors or choose reinforced glazing.
- Secure the **frame** to the wall by adding waterproof compression seals, especially in exterior door thresholds to prevent water from rising.
- Use **water-resistant hardware** (anti-infiltration).
  - Install anti-pressure bars if necessary.

⚠ Always check the condition of materials and maintain them properly. Some water-repellent materials can deteriorate and allow water to seep in. Wood moves over time and requires regular maintenance.

⚠ Immediately after flooding: **remove the water** → **BB** then **ventilate** through the windows and/or activate other drying systems (fan, dehumidifier, heating, etc.).



## WATERPROOFING AND DRAINAGE

- 1 Install a **weatherproof membrane** that overlaps the front of the flashing
- 2 Add a **drip edge** or **flashing**, if needed, to protect the window from runoff water.
- 3 Extend the **lintel** and **windowsill** beyond the cladding to keep water away.
- 4 Slope the sill of the opening **outward**.
- 5 Add a **self-adhesive waterproof membrane** raised or attached to the interior vapor barrier to prevent contamination in the wall cavity.
- 6 Add a **waterproof compression seal** around the window frame.

## MATERIALS

- ⚠ Pay attention to the **quality** of materials, their **installation**, and regular **maintenance**.
  - **Sensitive materials**: wood, plaster, insulation.
  - **Water-repellent or water-resistant materials**: aluminum, PVC, treated wood, silicone-based sealant, neoprene gasket, etc.
  - **Washable** and **easily replaceable finishes**.

### Types of buildings



### Expertise required

**Carpenter / joiner** to identify damage and restore using appropriate techniques.

**Weatherstripping specialist**, if required.



### Regulations

The restoration of openings, respecting the original geometry, profile, materials, and color, is governed by the RBQ and must generally align with the objectives and requirements of municipal regulations.

### For more information:

Quirion, P., & Brulotte, M. (2016). Toit. Bois. Bardeau – Guide technique. Centre de conservation du Québec.

## RESILIENT JOINTS AND PENETRATIONS

# OLD DOORS AND WINDOWS

Joints between **old doors and windows** and the building envelope, exterior cladding, and structure are common points of infiltration and, in the event of flooding, a pathway for water to enter.

Objectives for the maintenance of historic buildings:

- Maintain water, air, and moisture tightness.
- Direct water outward, away from the joinery and the interior of the wall.
- Protect the structure from water damage.

## CONSIDERATIONS

- Prioritize restoring old windows and doors while respecting the original geometry, profile, materials, and color.
- Prioritize solvent-based chemical stripping when the paint layers to be removed contain lead (to limit dust production).
- Ensure that this does not lead to moisture accumulation in the wall or frame.
- Significantly increasing the airtightness of an older building will, in the absence of an air exchanger, impact indoor air quality.

## ADVANTAGES

- Well-maintained historic windows and doors offer exceptional, long-lasting durability
- The combination of windows / storm windows and doors / storm doors offers several advantages: reduced risk of water infiltration and deterioration, prevention of mold and rot, preservation of the building's heritage value, and improved thermal insulation, making them worth preserving rather than replacing.

## PRELIMINARY STEPS

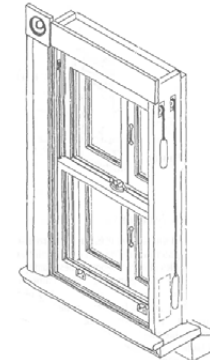
- Identify the composition and materials (e.g., wood species, dimensions, type of finish).
- Inspect the condition of the caulking. Caulking that is too dry or cracked promotes water infiltration and heat loss.
- Verify that all weatherstripping is in good condition.
- Identify potential vulnerabilities:
  - Deformations, worn rebates, rot at the bottom of the jamb and sill, missing caulking, improper slope of the sill.
  - Cracks in the glazing (promote air leakage and rot in the sills).
  - Shrinkage, swelling, cracks, and deterioration of window or door frames.

### ▲ In case of damage:

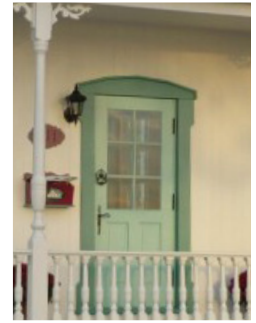
- Wooden windows and doors can be restored.
- Oxidized metal surfaces must be cleaned and protected.



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## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 General

- Ensure that the window is as airtight as possible. Install weatherstripping around the interior window frames or apply caulking for the winter.
- Ensure that the storm window is not airtight to allow residual moisture to escape and prevent condensation.
  - ▲ The gaps between the storm window and the frame must be left open, and the ventilation openings (in the center mullion) must not be blocked.
- Ensure that the window sill has sufficient slope to allow water to drain away from the building.
- Monitor indoor humidity, as excessively high levels promote condensation (e.g., visible signs: frost on windows). Ensure that the kitchen range hood and bathroom fan are present and functioning properly.
- Replace existing caulk joints.
- Prioritize regular inspection and maintenance.

### 2 Paint

- Avoid using acrylic paints outdoors.
- Prioritize alkyd or linseed oil paints to protect the wood.
- Protect all sides of the frames (top, bottom, sides).
- Choose opaque paints or stains to minimize maintenance and preserve authenticity (transparent stains and varnishes do not protect the wood from UV rays and require frequent maintenance).

### 3 Insulation (windows and doors)

- Implement strategies to prevent thermal bridging issues on jambs, especially when walls are thick: improve airtightness, use partial insulation, and seal the jambs to the masonry from the inside.

# C7b

## Types of buildings



## Expertise required

**Architecture or specialized contractors:** properly locate and size flood vents.

**Structure:** if required for wall assessment.



## Regulations

Changes to the exterior (appearance and materials) may be regulated by municipal regulations.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## RESILIENT JOINTS AND PENETRATIONS

# FLOOD VENTS

**Flood vents** consist of creating an opening in a basement or crawl space foundation wall to allow the controlled passage of flood water into a building constructed with water-resistant or quick-recovering materials. → C3 C4

### Key objectives of a flood vent:

- Equalize the internal and external pressure on the foundation wall to preserve its structural integrity. 1
- Reduce the vulnerability and/or exposure of property and materials.

## CONSIDERATIONS

- Requires a water drainage system.
- Requires a ventilation system. → C4c 2/2
- If it is a basement, it remains exposed, resulting in a loss of living space.
- For large-scale buildings. → C8c
- ⚠ In areas prone to ice jam flooding or river flooding, debris or ice could limit the effectiveness of vents.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### LAYOUT

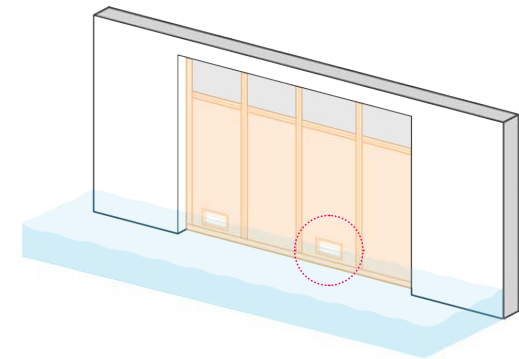
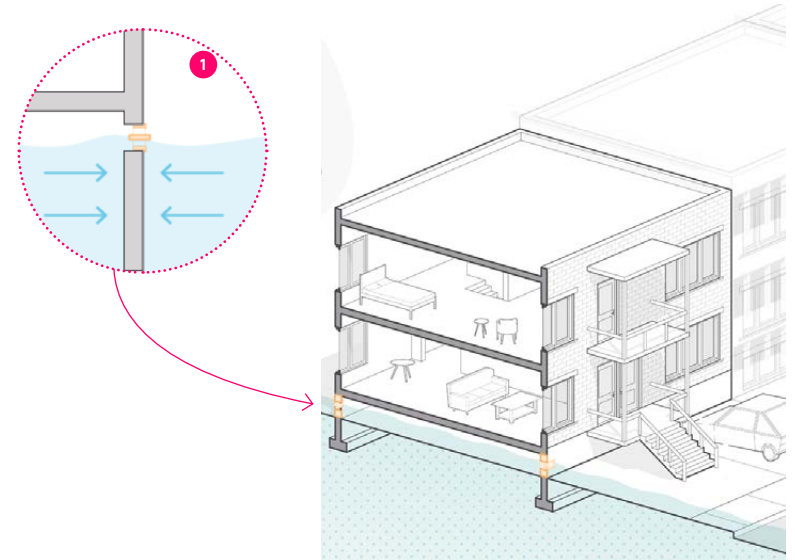
- If basement: Install at least two vents on two different walls for each enclosed room located below the potential water level (or protection objective\*) to allow water to pass through.
  - ⚠ The bottom of each vent opening must be at least 0.3 m (12 in.) above the highest exterior ground level.
  - ⚠ The fastening and size of the rough opening are specified by the manufacturer, between two studs or in the foundation.

### DRAINAGE

- Add a pump and floor drain to remove water after flooding. → B6c

### SPECIAL CASES

- A vent can be installed directly into an **existing opening**, such as a garage door.
  - ⚠ The openings in doors should only be used if there are insufficient sections of wall available for a vent.



- ⚠ Immediately after a flood: **remove flood water** → B8 and ensure that moisture in the basement is controlled and managed. → C4c 2/2
- ⚠ Post-flood health risks can be mitigated by hiring certified cleaning professionals, as flood water can carry contaminants.

### Types of buildings



### Expertise required

**Structure:** assessment of wall condition (frame, exterior joists, junction).



### Regulations

Part IX of the Quebec Construction Code  
Check condominium regulations and municipal bylaws: projections, margins, alignments, rights of way.

Intramural flashings are explained in several publications:

Drawing SBS-C1 / Division 2.62 de AMCQ. (2025). *Systèmes d'étanchéité en bitume modifié.*

GCR. (2023). *Solin de jonction - solin mur / toiture.*

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## RESILIENT JOINTS AND PENETRATIONS

# BALCONIES AND CANOPIES

**Balconies and canopies** can be used to direct water and protect sensitive areas, such as building entrances. If poorly designed, balcony and canopy joints can become entry points for water.

Characteristics of a **resilient joint with a balcony or canopy:**

- Directs water to the right place.
- Protects elements vulnerable to water.

## CONSIDERATION

- In newer balcony structures made of steel or concrete, thermal break systems can be installed between the balcony structure and the wall structure. In all cases, the joints must be covered with a suitable waterproof membrane to prevent water from migrating into the wall.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### WATERPROOFING

Install waterproof membranes with the required overlaps depending on the water flow:

- Provide a **backsplash** at least 150 mm high for waterproof balcony coverings (e.g., fiberglass).
- Cover the balcony backsplash and rear support element (e.g., brick) with a **strip of waterproofing membrane** (intramural flashing).
- Install **metal flashing** under the weatherproof covering, covering the balcony backsplash and attached to the support panel.

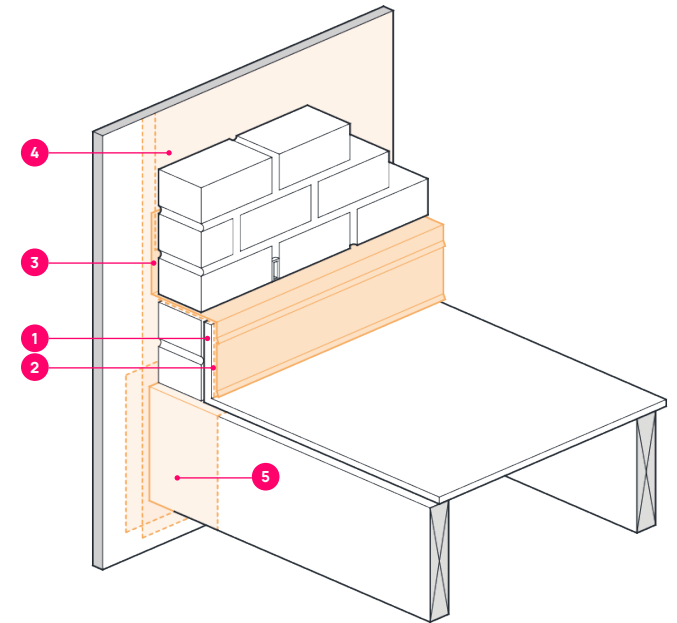
For brick cladding, incorporate weep holes above the flashing.

- Cover the top of the metal flashing with a wide **strip of waterproof membrane**.
- Cover each joist junction with the wall structure with a **waterproof membrane** that folds over the support panel.

### MATERIALS

- Avoid **materials** that are susceptible to rot, corrosion, or expansion.

Choose materials that are resistant to temporary immersion or frequent contact with water.



### DRAINAGE

- Direct water to appropriate locations, away from foundations.  
⚠️ Avoid runoff along walls and water accumulation on surfaces.

For balconies:

- Slope** greater than 1.5% towards the outside.
- Drainage holes** (vents).
- Stainless steel or perforated aluminum **railings**.

For canopies / awnings:

- Slope** towards the outside (min. 5%) to drain water away from the building.
- Overhang** of at least 60 cm (24 in.), and ideally 1 m (39 in.) or more to keep rainwater away.
- Gutters and downspouts** directed to suitable areas.

Types of buildings

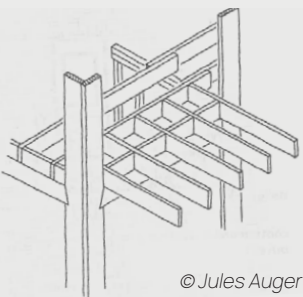


Expertise required

**Carpenter / Joiner:** experienced in the restoration of historic structures and complex waterproofing details.

**Cabinetmaker:** for the reproduction of decorative moldings.

**Contractor:** specializing in historic preservation; CMAQ-certified professional craftsman.



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RESILIENT JOINTS AND PENETRATIONS

# BALCONIES WITH WOOD CANTILEVERS

Joints between **cantilevered balconies** and the building envelope, exterior cladding, and structure of older buildings are vulnerable points. Joists that penetrate the building envelope create sensitive connections, which serve as entry points for water into the envelope and floor structure and are susceptible to air infiltration. These issues can compromise the stability of the balcony and the building.

Objectives for the maintenance of historic buildings:

- Reinforce the waterproofing of the original joint to resist water infiltration, especially during extreme cold, to prevent interstitial condensation.
- Ensure effective drainage of water away from the structure to prevent infiltration, mold, and rot.

## CONSIDERATION

- **Respect for the characteristics of the historic building:** reproduce the original fascia boards and moldings while incorporating modern, high-performance solutions.
- Do not seal the underside of a balcony to avoid trapping water, which could lead to rot and structural weakening.

## ADVANTAGES

- Reduced risk of water infiltration and damage to walls and floors.
- Prevention of mold and rot.
- Preservation of the building's property value.
- Improved energy efficiency thanks to better waterproofing.

## PRELIMINARY STEPS

Identify problems

- Water pooling at the wall junction, leaks, rot in joist ends, thermal bridges, etc.

Assess the condition of the balcony

- Remove the decking to inspect the structure. The building's insulation is often hidden by brick and difficult to assess without destructive testing.

Choose the repair strategy

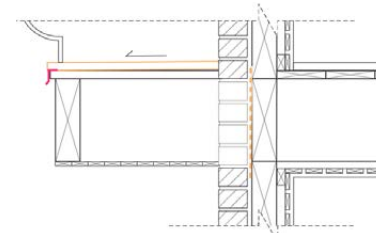
- Prioritize an approach that preserves the original cladding if possible.
- Prioritize a more sustainable scenario (Scenario 2 recommended) if the structure is compromised.

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

**Scenario 1** ↑↑↑ \$\$\$

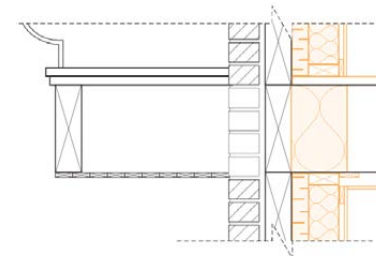
### MINOR REPAIRS TO CONTROL WATER RUNOFF



- Create a 2% to 5% slope from the wall outward by adding insulation under the new decking.
- Install metal flashing with a pronounced drip edge to facilitate runoff. During dismantling, air-seal the perimeter of the joists, even for minor work.

**Scenario 2** ↑↑↑ \$\$\$

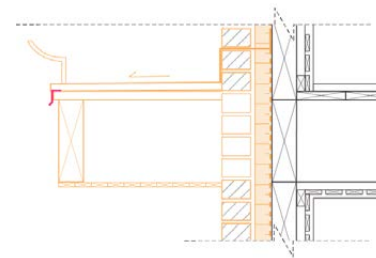
### IMPROVED AIRTIGHTNESS AND INTERIOR INSULATION



- Seal gaps around the joists with Ethafoam tubes of the required diameter (or tow) to block warm, humid air.
- Insulate the walls and ceilings from the inside and, if possible, insulate the joists on the exterior side to reduce the thermal bridge. Pay close attention to the balcony door thresholds, the most vulnerable point of the assembly.

**Scenario 3** ↑↑↑ \$\$\$

### COMPLETE RENOVATION OF THE BALCONY AND FACADE



- Remove the bricks and, if necessary, replace the joists with wood (e.g., hemlock) cut to the original dimensions and treated with linseed oil, including on-site cuts.
- Install a non-adhesive membrane over the joists.
- Install a waterproofing membrane that extends behind the insulation and brick so that it rises above the metal flashing
- Create a slope.
- Avoid tongue-and-groove boards (spaced apart) that trap moisture.
- Enclose the underside of the balcony with fascia boards, providing ventilation openings to allow condensation to escape.

# C7d

## Types of buildings



## Expertise required

Architect

Engineer / Consultant /  
Building envelope inspector

General or specialized  
foundation contractor:  
excavation.

Excavation contractor:  
foundation waterproofing and  
drainage.



## Regulations

The Quebec Construction Code requires that wood structural materials comply with certain standards:

CSA O86 - Engineering design in wood

CSA O177 - Qualification Code for Manufacturers of Structural Glued-Laminated Timber

## RESILIENT JOINTS AND PENETRATIONS

# SILL PLATE

**Joints between exterior walls and foundation walls** (the sill plate) are common points of infiltration. During a flood that reaches the ground floor, they are significant points of water entry.

Characteristics of a **resilient wall and foundation junction**:

- ☉ Prevents water from infiltrating between the two walls.
- ☉ Ensures that water flows away from the walls and toward the ground.

## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

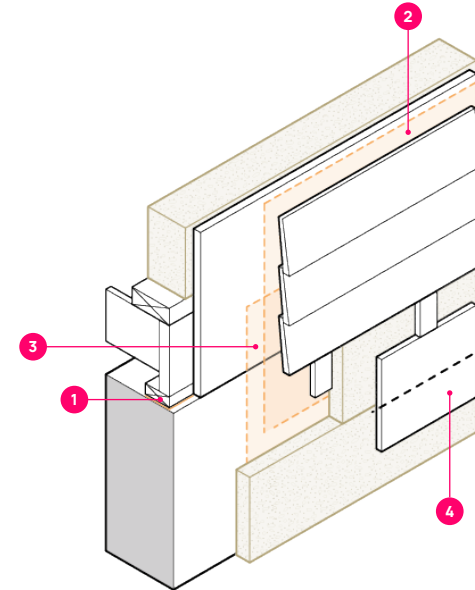
### SOLIDITY

- 1 At the junction with the foundation wall, ensure that the sill plate and support panel are sound, i.e., free of cracks, rot, or mold, and made of a material with good overall resistance to water and moisture.
- Seal the space between the sill plate and the concrete with, for example, a compressible waterproof tape.
- Cover any concrete (potentially damp) that is in contact with wood (sensitive to water) with a waterproof membrane.
- Prioritize assemblies that are protected from water but facilitate rapid drying.

⚠ Not recommended\*: Burying the edge joist in concrete can create risks of thermal bridges and condensation.

### WATERPROOFING

- Install the waterproofing membrane continuously and with adequate overlaps at joints to prevent air leaks and moisture transfer:
- 2 Lay the main waterproofing membrane on a support panel, ideally one that is rot-proof.
- 3 Overlap the main waterproofing membrane of the support panel with the foundation membrane at their junction, taking into account the risk of structural movement.
- 4 Provide a means of protecting the foundation insulation or membrane. → C6c



There are several types of exterior walls and foundation joints. E.g., concrete foundation, aligned with a light wood frame wall that presents a reduced risk of thermal bridging and simple, effective waterproofing.

⚠ Consult a qualified professional to determine the composition of the wall.

⚠ Depending on the type of wall, cladding, and insulation, it may be necessary to install metal flashing on top of the concrete foundation, with a drip edge on the outside and a strip of waterproof membrane on top, juxtaposed with the main membrane.

⚠ Mixing different materials that do not have the same physical properties could lead to differential movement and premature deterioration.

# FOUNDATION

## AT RISK OF IMMERSION

### C8 WET-PROOFING

C8a Adapting a crawl space

C8b Adapting a basement

C8c Adapting an underground parking

### C9 DRY-PROOFING

C9a Adapting an entrance with a counter-slope

C9b New waterproof foundation

### C10 FLOOD AVOIDANCE

C10a Raising a floor

C10b Raising an existing foundation

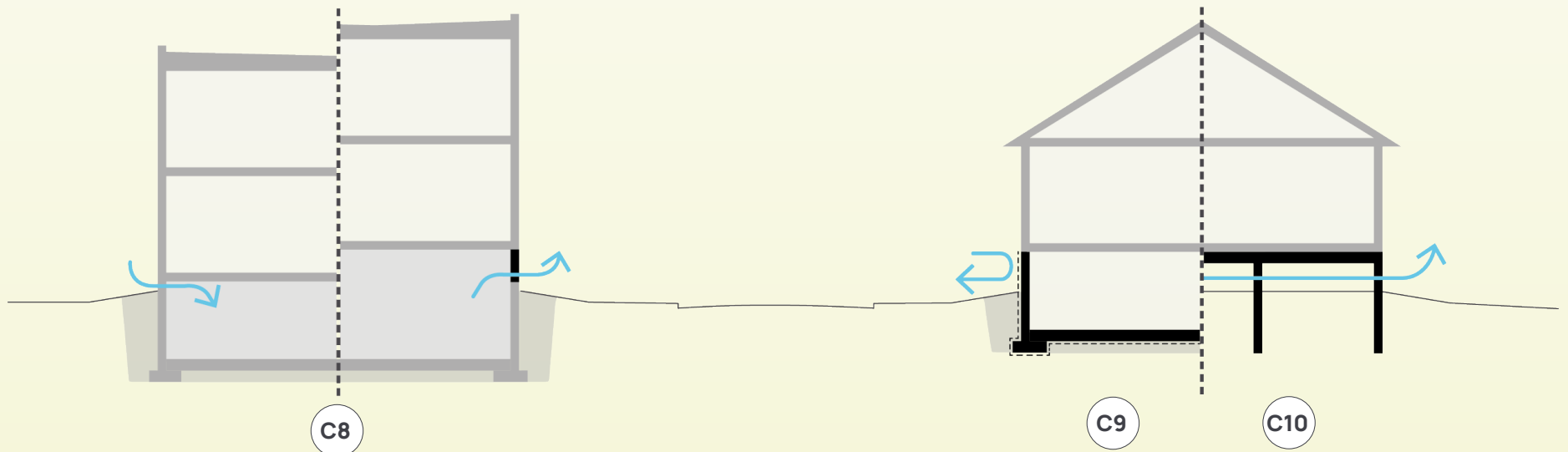
1/2

C10b Lifting an old building

2/2

C10c Elevation on pillars or columns

C10d Elevation on screw piles or stilts



# INTRODUCTION

## WHERE TO START?

### Understand the risk → A1 A2

- Potential water level
- Potential water flow (strength of the current)
- Groundwater levels (and possible fluctuations)

### Know the characteristics of the building

- Understand the composition of the walls and foundation slab: date of construction, potential major renovations, etc.
- Observe the condition of the walls and foundation slab.
- Know the type of structure: attached or detached building
- Know if there is a foundation drain (interior or exterior) and sump pump.

### Identify potential vulnerabilities → A3a

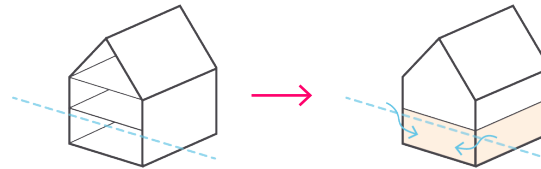
- Building's predisposition to damage:
  - Openings located below the potential water level.
  - Garage entrance on a counter-slope.
  - Drainage system missing, poorly installed, damaged, or blocked.
- Water entry points into the building:
  - Cracks or damage to the foundation, dislocations.
  - Cracks in the basement slab.
  - Interior joints (slab/column, basement slab/foundation wall).
  - Exterior joints (deck, corner, etc.).
  - Capillarity - porous wall or slab materials.
  - Capillarity - envelope materials.
  - Capillarity - interior assembly materials.
  - Holes in walls or openings (structure, equipment passages, MEP).
  - Moisture or mould problems.
  - Defective or missing waterproofing membrane.
  - Waterproofing problems at openings, mullions, and trim joints (damaged joints, membranes, flashings, inverted membrane overlap, etc.).
  - Material deterioration due to poor drainage
- Malfunctions / installation problems:
  - Poor connection between foundation walls, footings, and slabs.
  - Poor installation of openings (e.g., poor closure).

### Choose an appropriate strategy:

## POSSIBLE MEASURES

### C8 WET-PROOFING ↑↑↑ \$\$\$

Temporarily limiting the damage.



#### ADAPTING A CRAWL SPACE

- Basement: not habitable

→ C8a

#### ADAPTING A BASEMENT

- Basement: habitable - secondary use

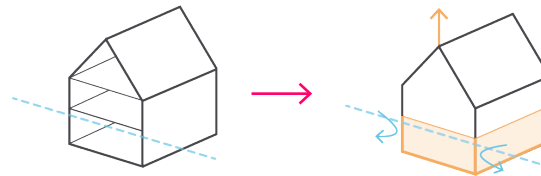
→ C8b

#### ADAPTING AN UNDERGROUND PARKING

- Basement: secondary use

→ C8c

### C9 DRY-PROOFING ↑↑↑ \$\$\$+



#### ADAPTING AN ENTRANCE WITH A COUNTER-SLOPE

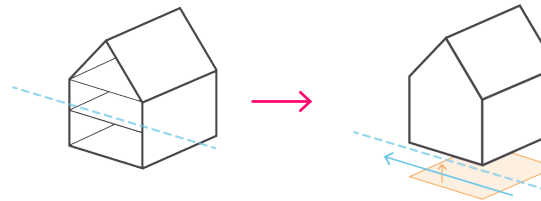
→ C9a

#### NEW WATERPROOF FOUNDATION

- Basement: habitable - main use

→ C9b

### C10 FLOOD AVOIDANCE ↑↑↑ \$\$\$



#### RAISING A FLOOR

- Basement: habitable - secondary use

→ C10a

#### RAISING AN EXISTING FOUNDATION

- Basement: habitable - secondary use

→ C10b

#### LIFTING AN OLD BUILDING

- Basement: habitable - secondary use

→ C10b

#### ELEVATION ON PILLARS OR COLUMNS

- Basement: not habitable

→ C10c

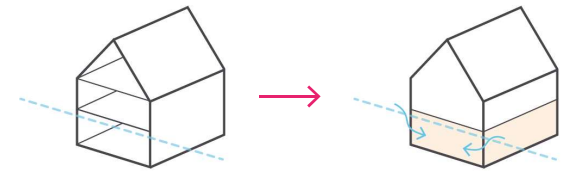
#### ELEVATION ON SCREW PILES OR STILTS

- Basement: not habitable

→ C10d

# C8

# WET-PROOFING



## Regulations

Check municipal regulations: layout (margins, alignments, shared walls) and excavation.



## Financial assistance program

City of Montreal: possible subsidies (foundation repairs).

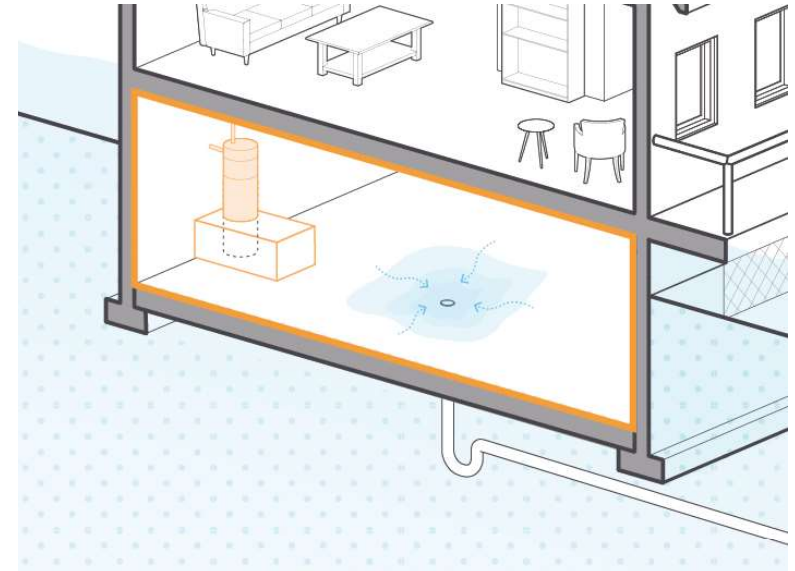
**Wet-proofing** consists of dealing with flooding by allowing controlled passage of water inside an existing foundation.

### Why choose this approach?

- To reduce hydrostatic pressure on a deteriorated or porous foundation.
- To reduce property damage in areas where infiltration flooding is common, whether caused by rising groundwater, overflowing low-flow streams, or municipal storm sewer system saturation.

### Characteristics:

- ⦿ Planned openings allow water to enter in a controlled manner.
- ⦿ Materials used in exposed areas are resistant to water and moisture.
- ⦿ Walls, floors, and other assemblies are designed to dry quickly without warping or losing their insulating capacity after flooding.
- ⦿ Equipment and appliances are elevated or protected in place.
- ⦿ Drainage and/or pumping system allows water to be removed efficiently and quickly after flooding.



## CONSIDERATIONS

- Potential loss of living space.
- The basement must be cleaned and dried after flooding to prevent mould and rot.

## STRATEGIES

ADAPTING A CRAWL SPACE

→ C8a

ADAPTING A BASEMENT

→ C8b

ADAPTING AN UNDERGROUND PARKING

→ C8c

Seek professional assistance →

# C8a

## Types of buildings



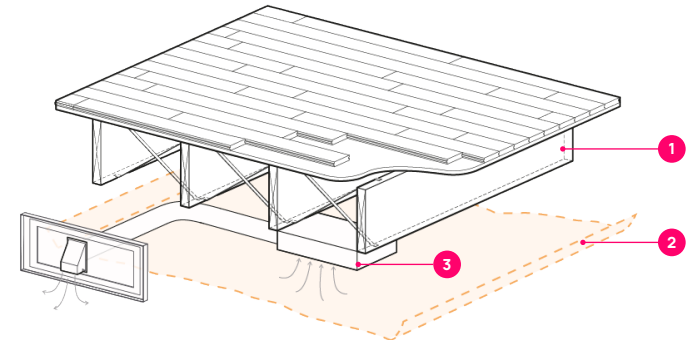
## WET-PROOFING

# ADAPTING A CRAWL SPACE

Water may temporarily enter a crawl space that is at risk of flooding: it can be **adapted** to be ready to accommodate water and drain it quickly to limit damage.

### Key objectives of **adapting a crawl space**:

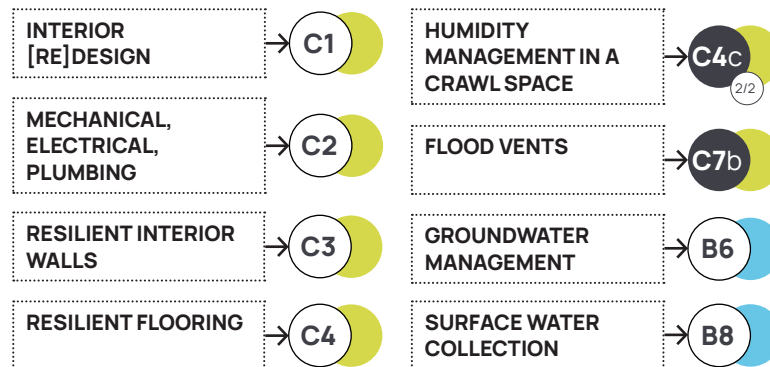
- Reduce damage to property, buildings, and structures.
- Reduce hydrostatic pressure on foundation walls.
- Prevent infiltration.
- Increase drying capacity to reduce the risk of mould.



## CONSIDERATIONS

- Possible strategy for all types of foundations.
- No habitable use is possible in this case.
- If the potential water level is above the first habitable floor, it is possible to combine this measure with Raising a floor → C10a or Raising an existing foundation → C10b in order to reduce its exposure.

## MEASURES TO COMBINE



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

### Wood or concrete ceiling and earthen floor.

#### 1 Wood ceiling:

- ⚠ It is strongly recommended not to install a vapour barrier and/or insulate the ceiling above the crawl space (or ground floor) as this can cause condensation problems on the joists and increase the risk of mould or rot.
- ⚠ Never insulate a wooden basement ceiling, especially not with sprayed urethane, as this makes inspections difficult and this method encapsulates moisture and presents a risk of mould growth.

#### 2 Earthen floor:

- Add a **sheet of polyethylene** directly on the ground to reduce moisture rising.
- Install a **dehumidifier** and make sure to control and manage humidity in the crawl space. → C4c<sup>2/2</sup>

# C8b

## Types of buildings



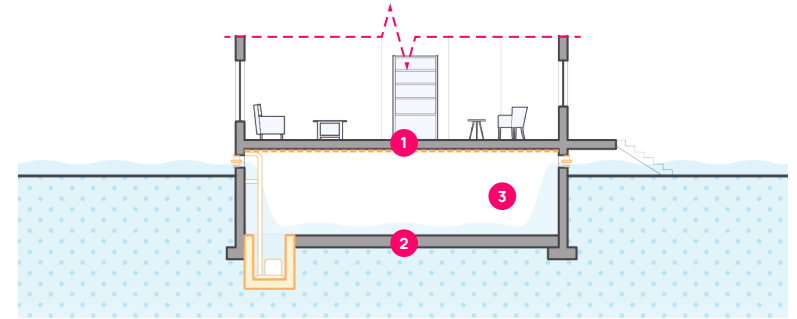
## WET-PROOFING

# ADAPTING A BASEMENT

Water may temporarily enter a basement that is at risk of flooding: it can be **adapted** to be ready to accommodate water and drain it quickly to limit damage.

### Key objectives of **adapting a basement**:

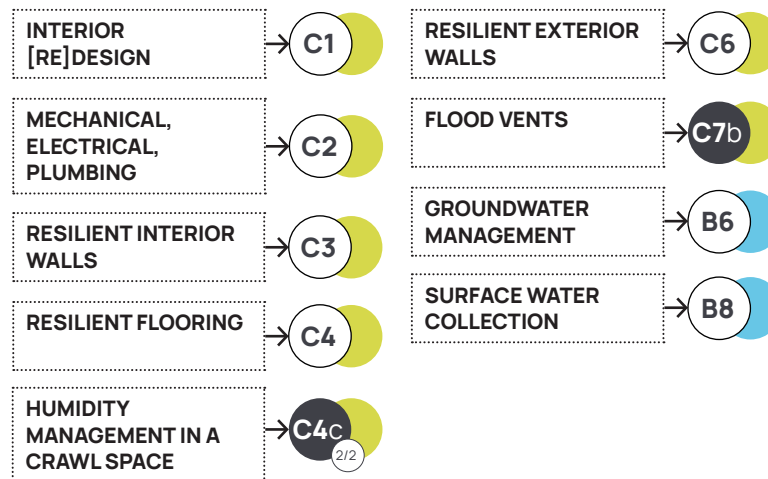
- ☉ Reduce damage to property, buildings, and structures.
- ☉ Reduce hydrostatic pressure on foundation walls.
- ☉ Prevent infiltration.
- ☉ Increase drying capacity to reduce the risk of mould.



## CONSIDERATIONS

- Possible strategy for all types of foundations.
- No habitable use is possible in this case.
- If the potential water level is above the first habitable floor, this measure can be combined with Raising a floor → C10a or Raising an existing foundation → C10b in order to reduce its exposure.

## MEASURES TO COMBINE



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

Wood or concrete ceiling and earthen floor.

- Concrete ceiling:**
  - Apply a water-repellent coating under the ground floor.
- Concrete floor:**
  - Add **floor drains**.
  - Install a **vapour barrier membrane** on the basement floor and seal it to the foundation walls.
- Make sure to control and manage moisture in the basement. → C4c<sub>2/2</sub>

## Types of buildings



## Expertise required

**Civil and/or mechanical engineer:** to ensure proper drainage of surface runoff or to manage the groundwater table and reduce water pressure on the foundation.



## Regulations

Discuss with the municipality to explore adaptation options, for example, a building height variance to minimize basement excavation while meeting parking and accessibility requirements.

## WET FLOOD-PROOFING

## ADAPTING AN UNDERGROUND PARKING

Located at the lowest point, underground spaces, including parking garages, are particularly vulnerable to flooding caused by runoff, backflow, or seepage.

Objectives of **adapting an underground space:**

- Manage water that may enter the space.
- Slow the flow of water discharged into the drainage system.
- Preserve the structural integrity of the building.

## MEASURES TO COMBINE

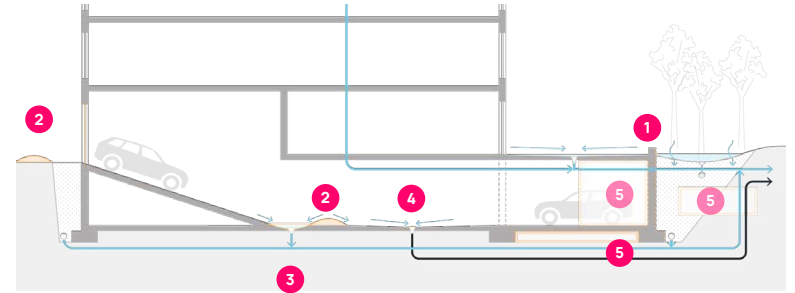
- Prioritize passive design solutions to minimize reliance on MEP systems or equip them with emergency systems. → **B6d**
- Protect or elevate storage areas → **C1f** and mechanical and electrical systems. → **C2b**
- Install MEP systems using smart segregation; consider installing an MEP room in a less vulnerable area. → **C2a** **C2b**
- Determine whether a mutualization scenario with a neighboring permeable plot is possible to serve as a water drainage area in case of emergency.
- Maximize the mutual use of building entrances to reduce exposure.

## PRELIMINARY STEPS

- **Understand the risk.**  
Determine the groundwater table (piezometer study) and bedrock elevation to assess potential water flow.
- **Identify potential vulnerabilities.**  
Identify all elements that could fail under pressure and create a pathway for water ingress. E.g., the drainage system of an underground structure → **B2**, garage doors in an indoor parking garage → **B4**.

⚠ Establish a cleaning and analysis procedure following an incident.

It is recommended that the facility be equipped with a warning system to prevent user access in the presence or risk of water, in order to avoid accidents or drowning. Emergency evacuation procedures must remain operational under all circumstances.



## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

## STRUCTURE

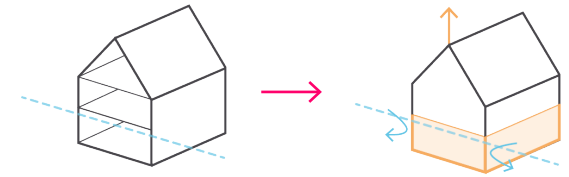
- 1 If necessary, reinforce the foundation walls and add a waterproof membrane.
    - Coat the concrete floor, columns, and walls with a waterproof, washable finish that can withstand submersion.
- ⚠ Depending on the condition of the structure, temporarily retain water in the basement during a flood to balance hydrostatic pressures.

## DRAINAGE

- 2 Install a speed bump at the top of the ramp (interior if possible) and another at the bottom, after the trench drain and a waterproof garage door.
- 3 Oversize the trench drain to handle basement overflow when the sanitary drain pits are full.
- 4 Adapt the floor slab with adequate slopes directed toward the oversized sanitary drain sump.
  - If water is running down the inner side of the foundation wall, install gutters at the junction between the slab and the foundation to collect, contain, and direct the water to the proper drain.
- 5 Install one or more retention basins to control the discharge flow to the city, but also to allow for water storage. There are several options:
  - **Retention basin under the slab** with strong exterior and interior waterproofing if the soil structure and bedrock depth allow it.
  - **Oversized retention basin**, either interior or exterior, to temporarily accommodate a larger volume of water.
  - **Sacrificial space** in the basement area to serve as an emergency overflow, allowing water to accumulate quickly and temporarily while being continuously pumped out to the street.

# C9

## DRY-PROOFING



### Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

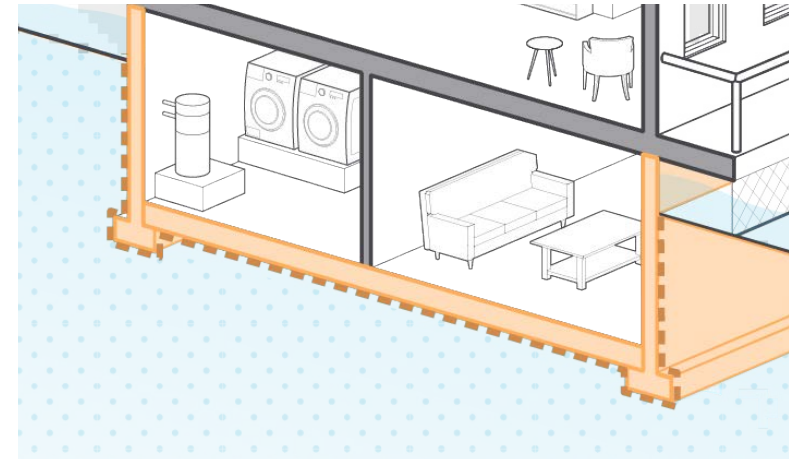
**Dry-proofing** consists of dealing with flooding by preventing water from entering the foundation.

#### Why choose this approach?

- To prevent water from reaching vulnerable parts of the building.
- To create secondary use spaces below the potential water level (or protection objective\*), particularly in areas with low-intensity flooding.

#### Characteristics:

- ☉ The building envelope is waterproof, including foundation walls, openings, joints, and mechanical systems.
- ☉ Materials are chosen for their ability to resist moisture and maintain their integrity.
- ☉ Effective drainage prevents water from accumulating around the foundation.
- ☉ Physical barriers (temporary or permanent) can be incorporated to block water from entering the building.



### CONSIDERATIONS

- This approach is generally more expensive to implement than wet-proofing, particularly in renovation projects.
- It requires a structure that is in good condition and adequately anchored to be able to withstand the hydrostatic pressure exerted by water.
  - ⚠ In the event of failure, the damage can be significant: lifting of the slab, loosening of the entire building, rapid flooding of exposed levels, etc.

### STRATEGIES

ADAPTING AN ENTRANCE WITH A COUNTER-SLOPE

→ C9a

NEW WATERPROOF FOUNDATION

→ C9b

Seek professional assistance →

**Types of buildings**



**Regulations**

**Municipality:** check specific areas where water must be redirected.

Regulations may require the preservation of a private parking space on the property.



**Financial assistance program**

**City of Montreal:** possible subsidies (for foundation repairs).

**DRY-PROOFING**

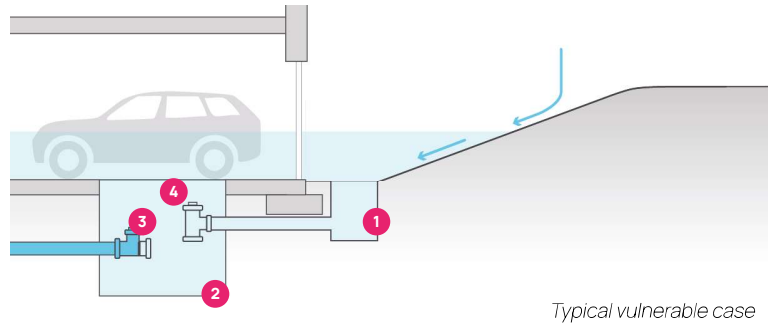
# ADAPTING AN ENTRANCE WITH A COUNTER-SLOPE

A **sunken garage entrance** is located at a lower level than the street or main road, and its access slope leads towards the building.

This situation makes the building vulnerable to flooding.

**POTENTIAL VULNERABILITIES**

- Water infiltration and mould.
- Structural damage to foundations.
- Overloading of the drainage system, backflow.
- Soil erosion around the entrance and reduced accessibility.



*Typical vulnerable case*

- 1 Exterior drain
- 2 Interior retention pit
- 3 Normally closed check valve installed after the sanitary tee
- 4 Interior drain

**STEPS TO TAKE**

**1 Prevent water from entering the building**, protect the foundations, and keep as much water as possible at street level.

- Improve landscaping.  
Soil permeability (soil composition, rock level, groundwater height, see hydraulic study, slopes, etc.).

- Low wall / speed bump
- embankment / filling
- retention basin etc.



**2 Block water by adding permanent or temporary protective equipment** to block water if necessary.

- cofferdam
- waterproof garage door etc.



**3 Drain water if it manages to enter the building** with an effective drainage system if necessary.

- valve
- pump, sump, and adequate electrical system capacity etc.



**4 Adapt the interior layout if water manages to enter** the building if necessary.

- resilient interior walls
- resilient flooring etc.



**Seek professional assistance** →

Types of buildings



Expertise required

**Landscape architecture:** speed bumps, filling, low walls.

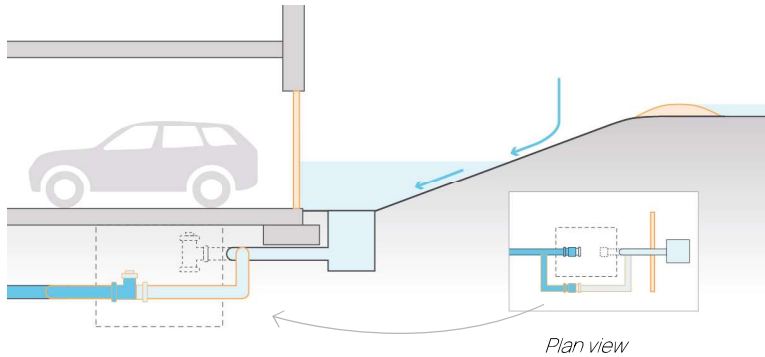
**MEP engineering:** check valves, submersible pumps, and sumps.

**Architecture:** resilient exterior walls, resilient interior walls, resilient floors.

**Company specializing in waterproofing devices for openings:** temporary equipment (e.g., cofferdams) and permanent equipment (e.g., waterproof garage doors).

**DRY-PROOFING**  
**MEASURES TO COMBINE**

1 GARAGE PRESERVATION



**RESILIENT EXTERIOR WALLS**

Repairing cracks (walls, membrane, and insulation)



**SPEED BUMP**



**PERMANENT DEVICES**

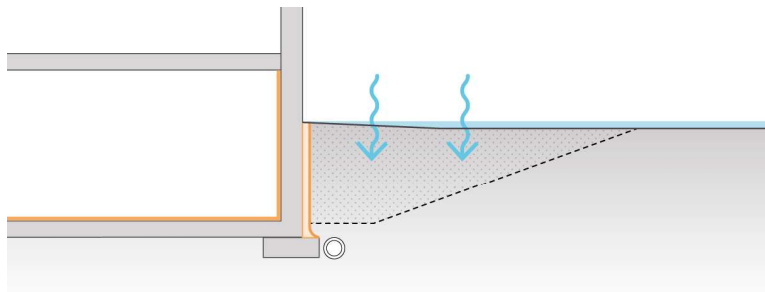
Waterproof garage door



**DRAINAGE**

Connection of the exterior drain to the municipal sewer system

2 CHANGE OF BASEMENT USE



**RESILIENT EXTERIOR WALLS**

Repairing cracks (walls, membrane, and insulation)  
Waterproof coating



**FILLING**



**GROUNDWATER MANAGEMENT**



**RESILIENT INTERIOR WALLS**

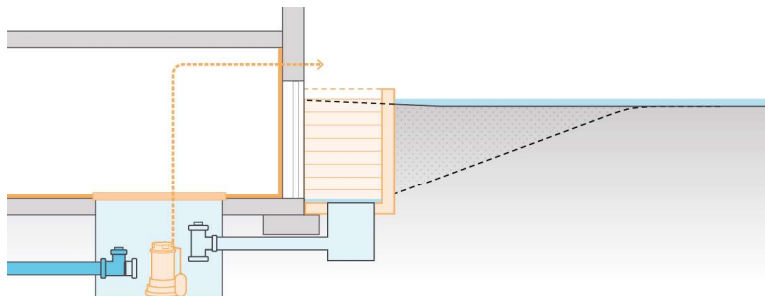


**RESILIENT FLOORING**



⚠ Consider construction work to adapt your drain (block or remove) to the filling.

3 REDESIGN OF AN ACCESS



**LOW WALL**



**FILLING**



**GROUNDWATER MANAGEMENT**



**RESILIENT INTERIOR WALLS**



**RESILIENT FLOORING**



⚠ The pump must remain accessible for maintenance.

# C9b

## Types of buildings



## Expertise required

**Structure:** feasibility assessment and plans and specifications.

**Architecture:** verification of modifications to the envelope and compliance with the Construction Code.

**Electrical and plumbing:** network adaptation.



## Regulations

Check with the Quebec Construction Code to see if two exits are required.

Ensure that basement bedroom openings comply with requirements for rapid evacuation in case of fire or comply with "egress" requirements.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

## DRY-PROOFING

# NEW WATERPROOF FOUNDATION

**Waterproofing foundations** involves constructing new waterproof and reinforced foundations to withstand flood waters and prevent the building from being lifted. For existing buildings, this is an opportunity to raise the building and the ground floor above the potential water level (or protection objective\*).

Objectives of a **new waterproof foundation** are:

- Increase the stability of the building.
- Provide better protection for the ground floor against flooding.

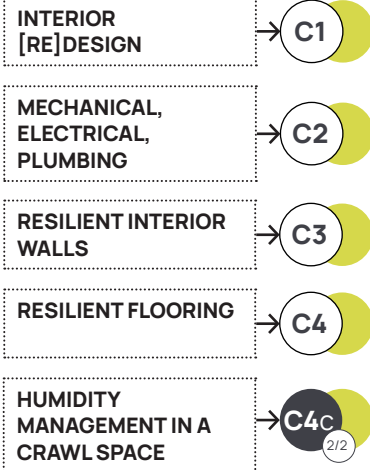
## ADVANTAGE

- The basement remains exposed, but can be used as living space (see measures to be combined) if the building is not located in a flood zone\*.

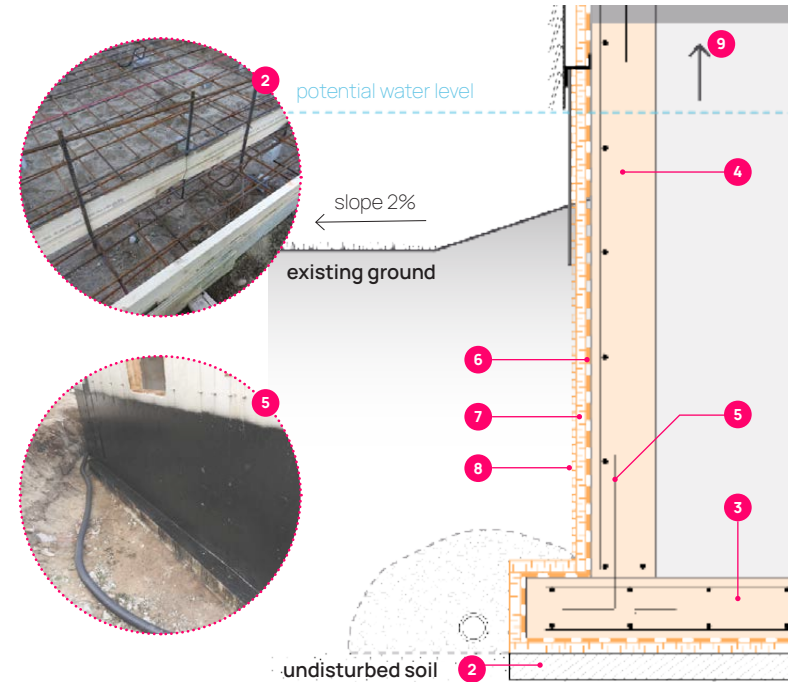
## CONSIDERATIONS

- Possible strategy for detached buildings with all types of foundations.
- If the existing building is raised, plan to adapt the exterior fittings, drainage, and connections of the various pipes.
- Incompatible with the installation of a sump and submersible pump, as it is prohibited to drill into a waterproof slab. It is recommended to drain water using a gravity drainage system that directs it to a pit (or elsewhere, as appropriate).
- Ensure good ventilation and mandatory opening in the rooms.

## MEASURES TO COMBINE



Before construction work      During construction work - Elevation



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Raise the building **1** and proceed with excavation.
- Pour a **concrete slab 2** on the ground, install a **waterproof membrane and insulation** (also called a protective panel).
- Pour a **new slab 3** and **foundation walls 4** (reinforced concrete) to at least 300 mm (12 in.) above the potential water level (or protection objective\*), connecting them with **reinforcing studs 5**.
- ⚠ Avoid poor anchoring and ensure that water pressure is calculated correctly to avoid the risk of uplift or cracking.
- Cover the new walls and slab with a **waterproof membrane 6**, ensuring that the **wall membrane overlaps** with the slab membrane.
- **Insulate from the outside 7** the foundation walls → C6c and add a drainage mat **8**.
- Take advantage of the building being lifted to **raise the foundation** above the potential water level (or protection objective\*) **9**.

# C10

# FLOOD AVOIDANCE



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity class of the hazard, as well as other regulatory conditions applicable to urban planning and architectural design.

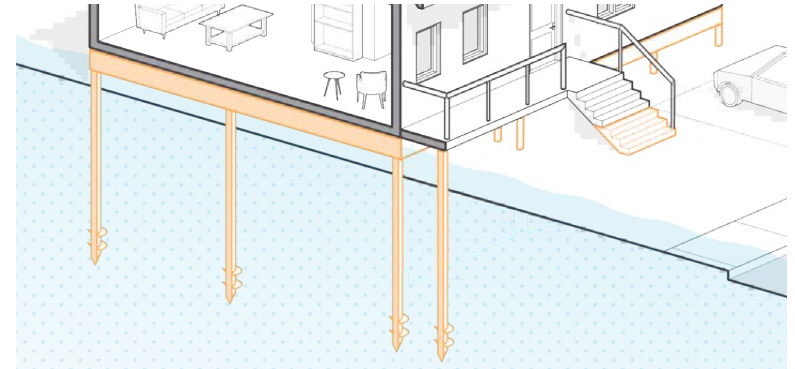
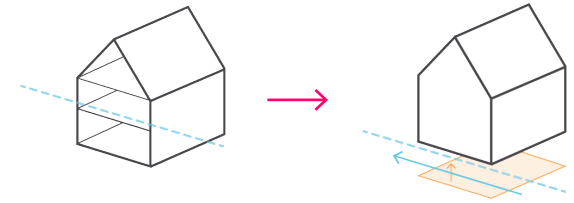
**Flood avoidance** consists of raising the living floor above the potential water level (or protection objective\*) and, as much as possible, removing vulnerable components of a submerged building.

### Why choose this approach?

- To limit property damage in an area exposed to flooding.

### Characteristics:

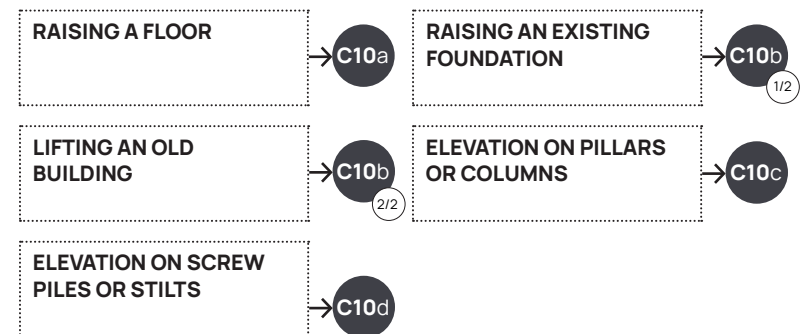
- The foundation, whether continuous or isolated (as applicable), is adequately anchored below the frost line and designed to withstand flood loads.
- The underside of the first floor is water- and moisture-resistant and adequately insulated.



## CONSIDERATIONS

- Structural studies for construction on pillars, columns, piles, and stilts.
- Redesign of access points and addition of steps (universal accessibility issues).
- Temporary lifting and/or relocation of the building (for raising it on a continuous or point foundation).
- Temporary relocation of furniture, goods, and equipment (for raising the floor).
- Modification of interior drainage systems and conduits (electricity, gas, water, etc.).

## STRATEGIES



Seek professional assistance →

# C10a

## Types of buildings



## Expertise required

**Structure:** review of loads and feasibility



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity class of the hazard.

## FLOOD AVOIDANCE

# RAISING A FLOOR

**Raising a floor** involves raising the first habitable floor above the potential water level without raising the building.

It is possible to raise most of the floor while leaving the entrance area at its original height. This means that the building's access does not have to be redesigned.

⚠ In this case, plan for the main entrance to be above the potential water level (or protection objective\*).

## ADVANTAGES

- ⚠ Creates a refuge area by default. → C1c
- No or little change to the exterior appearance of the building.

## CONSIDERATIONS

- Possible strategy for buildings with existing concrete foundations that are continuous and in good condition.
- The basement remains exposed, but secondary use may be possible (measures to be combined).
- Loss of ceiling height.
- Redesign of access points and addition of steps (universal accessibility issues).

## MEASURES TO COMBINE

INTERIOR  
[RE]DESIGN

→ C1

RESILIENT FLOORING

→ C4

MECHANICAL,  
ELECTRICAL,  
PLUMBING

→ C2

HUMIDITY  
MANAGEMENT IN A  
CRAWL SPACE

→ C4c

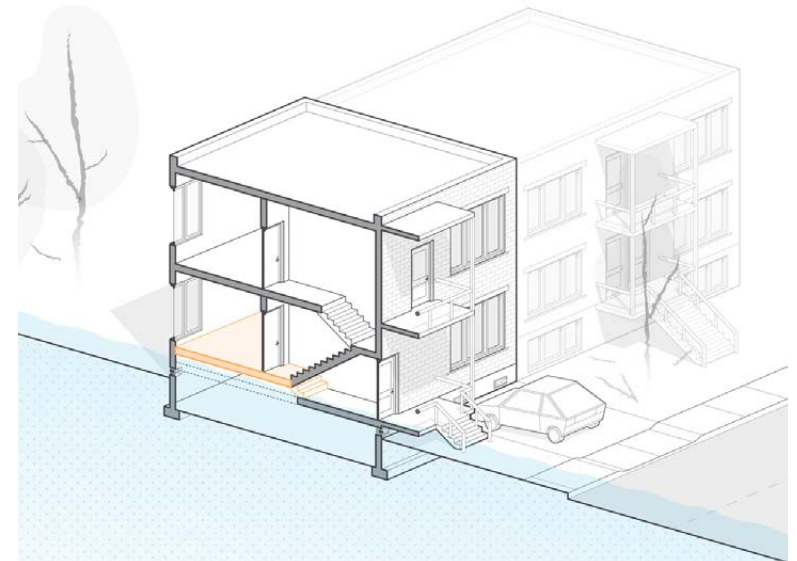
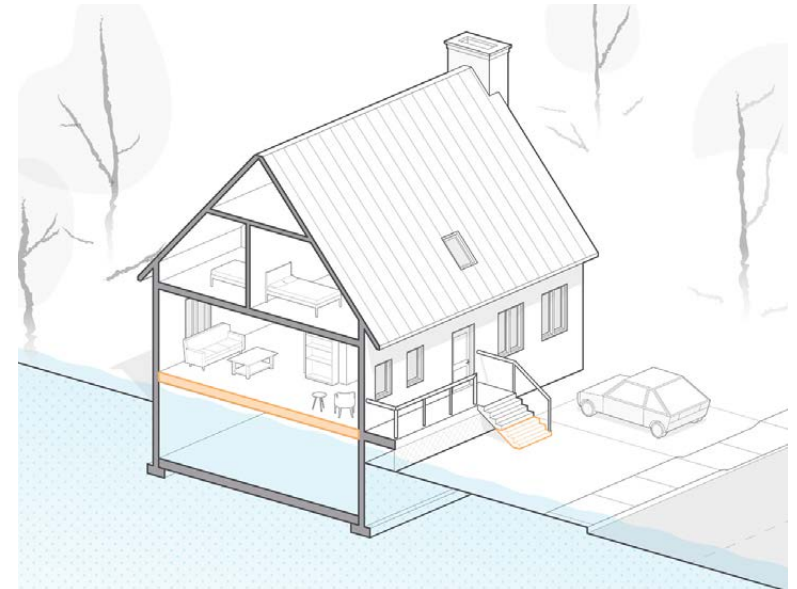
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RESILIENT INTERIOR  
WALLS

→ C3

FLOOD VENTS

→ C7b



## Types of buildings



## Expertise required

**Structure:** feasibility assessment.

**Architecture:** verification of modifications to the envelope and compliance with the Construction Code.

**Electrical and plumbing:** network adaptation.



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity class of the hazard.

## FLOOD AVOIDANCE

# RAISING AN EXISTING FOUNDATION

Raising an existing foundation involves adding height to the existing foundation wall in order to raise the first habitable floor above the potential water level (or protection objective\*), with the aim of reducing the risk of the building being exposed to flooding.

## ADVANTAGES

- Preservation of the basement as a secondary living space.
- Depending on the height of the raising: additional natural light and views in living spaces.

## CONSIDERATIONS

- Possible strategy for detached buildings with existing concrete foundations that are continuous and in good condition.
- The basement remains exposed but secondary use may be possible (measures to be combined).
- Redesign of access points and addition of steps (universal accessibility issues).
- Temporary lifting of the building.

## MEASURES TO COMBINE

INTERIOR [RE]DESIGN

→ C1

RESILIENT FLOORING

→ C4

MECHANICAL, ELECTRICAL, PLUMBING

→ C2

HUMIDITY MANAGEMENT IN A CRAWL SPACE

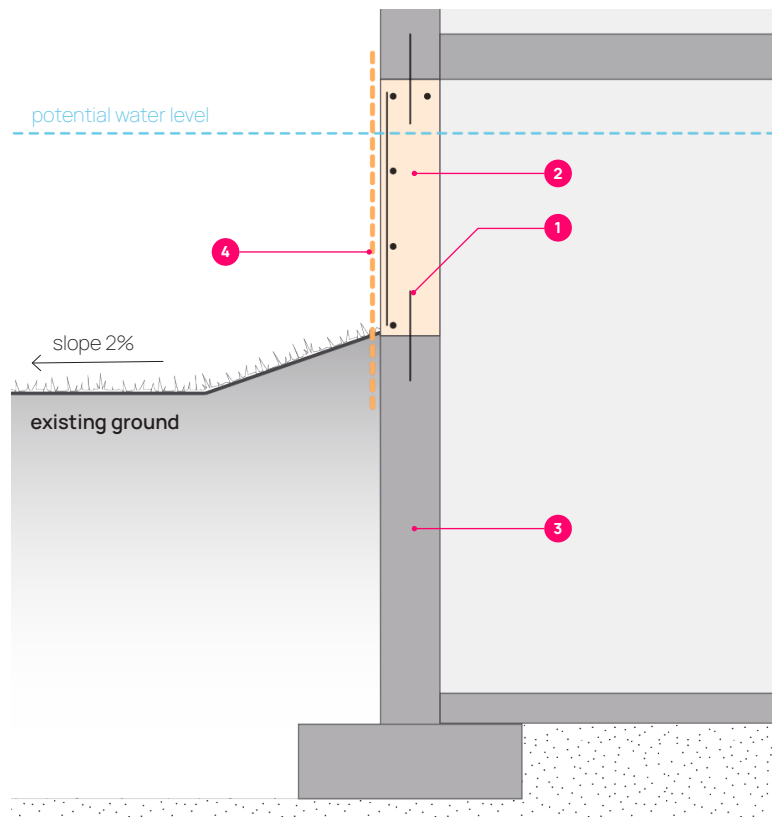
→ C4c

RESILIENT INTERIOR WALLS

→ C3

FLOOD VENTS

→ C7b



## INSTALLATION SCENARIO

Suggestions for better understanding the issues to be discussed with qualified individuals.

- Raising the building.
- 1 Integrating **reinforcement studs** into the existing structure to accommodate the new wall height.
- Form and pour **new reinforced concrete foundation walls** 2 above the **existing foundation walls** 3 in good condition.
- 4 Install a **waterproofing membrane** at the junctions of the new and existing concrete foundation walls.
- If you want to create a living space: **exterior insulation** → C6e or **interior insulation.** → C3a

Types of buildings



Expertise required

Company specializing in building lifting and relocation.

Specialized research firm: to assess the project's feasibility.

Structural engineer, foundation and civil engineering contractors, architects: to calculate the building's load-bearing capacity during lifting and design the new foundations.

Process requiring special permits and close coordination with the municipality.



Regulations

Consult the municipality's urban plan and the PIA bylaw regarding integration issues.

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity level of the hazard.

FLOOD AVOIDANCE

# RAISING AN OLD BUILDING

Raising the foundations of an old building involves lifting the entire structure above the potential water level or the protection objective\*. This approach allows the building to remain in its original location.

It is an alternative to raising the building on stilts or piles, a method prohibited for very old buildings, which involves demolishing the existing foundations to rebuild new, taller, and stronger ones in order to reduce the exposure of inhabited spaces.

## CONSIDERATIONS

- A complex and costly process, often comparable to the cost of new construction. Grants may be available for heritage buildings.
- Challenges regarding urban integration and the preservation of heritage value, e.g., through the redesign of entrances and the addition of steps (issues of universal accessibility, impact of raised foundations in a designated historic village, loss of the typical relationship to the street found in older buildings (ground floor level and its interface with public space), erosion of original architectural codes.
- Potential difficulty in maintaining insurability after adaptation work.

## ADVANTAGES

- Preservation of certain features of the historic building within its context and at its original address, and promotion of the collective memory of the site.
- Reduction in the amount of historic materials discarded as a result of flooding.

## PRELIMINARY STEPS

Verify **technical feasibility**

- Ensure the building is in good overall condition.
- Confirm that the structure can be raised, particularly based on the building's floor area and weight.

Verify **regulatory feasibility**

- Confirm restrictions with the urban planning department (e.g., maximum height).
- Research comparable elevation projects in the vicinity (to learn more about costs, constraints, etc.).

Identification of **potential vulnerabilities**

- Assess soil stability, etc.

⚠️⚠️⚠️ \$\$\$ Given the costs and scope of the work, ensure that the project is appropriate for the building and its urban context.



Before elevation work

During elevation work

After elevation work

@googlestreetview

## IMPLEMENTATION

Suggestions for better understanding the issues to be discussed with qualified individuals.

### 1 Preparation

- Detach the building from the foundation by cutting the anchors and pipes.
- Structurally reinforce the building if necessary (ring beam).

### 2 Lifting

- Install synchronized hydraulic jacks under the structure.
- Lift the building gradually and carefully, and install temporary support towers.

### 3 Foundations

- Demolish the existing foundations, then construct new reinforced concrete foundations above the potential water level: waterproofing.
- Add exterior insulation and a waterproofing membrane. → C9b
- Add a foundation drain around the perimeter. → B6a

### 4 Repositioning

- Carefully lower the building onto the new foundations.
- Reconnect all utilities (water, sewer, electricity, gas).
- Redesign the access path to reach the now-raised entrance.
- Complete finishing work to integrate the new base into the building and landscape the outdoor areas to direct water away from the building.

## ALTERNATIVES

1 Convert the ground floor to accommodate water → B3 and reinforce the building's structure to potentially add an additional story. → B6a

⚠️ Challenges related to the architectural integration of the additional story.

2 Relocate the entire building to a less exposed area.

⚠️ Loss of urban identity, urban sprawl, and the risk of neighborhood decline.

# C10c

## Types of buildings



## Expertise required

**Structure:** feasibility assessment and recommendation on the choice of structure.

**Architecture:** verification of modifications to the envelope and compliance with the Construction Code.

**Electrical and plumbing:** network adaptation.



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity class of the hazard, as well as other regulatory conditions applicable to urban planning and architectural design.

## FLOOD AVOIDANCE

# ELEVATION ON PILLARS OR COLUMNS

**Elevation on pillars or columns** consists of raising the entire building above the potential water level (or protection objective\*), while partially retaining the existing continuous foundation where possible. This approach reduces the use of materials, limits the scope of the work, and minimizes exposure of inhabited spaces.

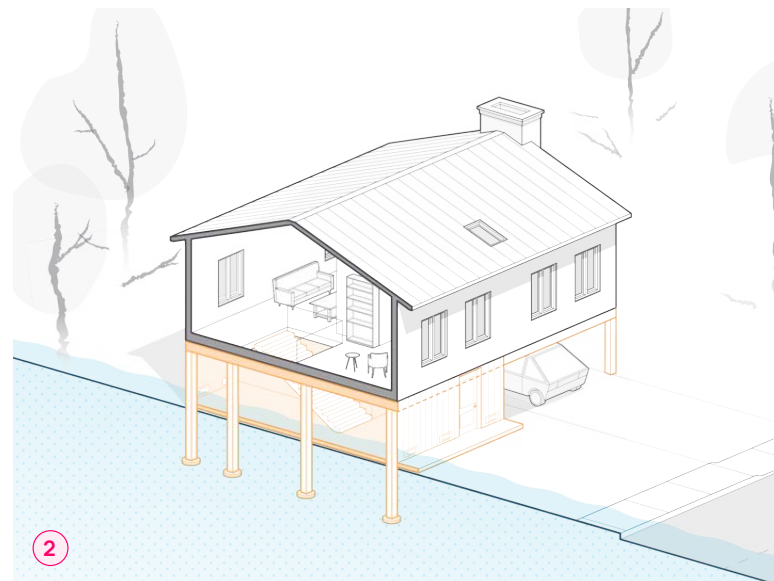
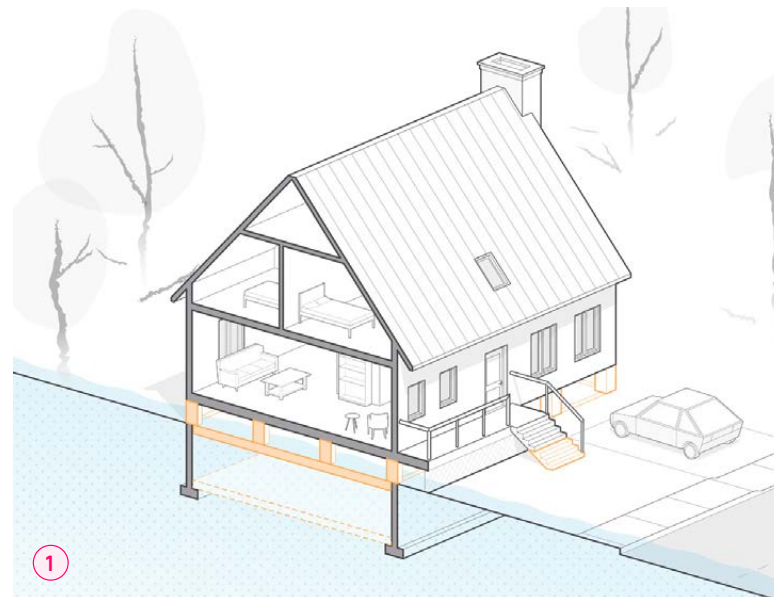
A foundation on **pillars** ① (concrete or masonry) or **columns** ② (wood or steel) consists of vertical posts resting and anchored on an existing or newly constructed footing. The space cleared under the building allows water to flow freely, reducing hydrostatic pressure and the impact of floating debris.

## ADVANTAGES

- Improved soil absorption capacity due to the reduction of impervious surface area in direct contact with the ground.
- Hydraulic transparency: does not create a major obstacle to the natural movement of water.
- Greater natural light in living spaces and possibility of developing the space under the building for low-risk use (parking, access, storage).

## CONSIDERATIONS

- Possible strategy for small detached buildings (single-family buildings up to two storeys).
- ⚠ Not suitable for old or dilapidated structures.
- Foundations may be preserved if they are continuous and in good condition.
- Redesign of access points and addition of steps (universal accessibility issues).
- Temporary lifting of the building (requires space).
- Possible loss of living space in the basement.
- Modification, insulation, and waterproofing of interior/exterior drainage systems and conduits (electricity, gas, water, etc.).
- Not recommended for old or fragile buildings that cannot withstand the movement or transfer of loads.



## Types of buildings



## Expertise required

**Structure:** feasibility assessment and recommendation on the choice of structure.

**Architecture:** verification of modifications to the envelope and compliance with the Construction Code.

**Electrical and plumbing:** network adaptation.



## Regulations

\* Consult your municipality to find out the conditions applicable in flood zones under the modernized regulatory framework for aquatic environments, based on the intensity class of the hazard, as well as other regulatory conditions applicable to urban planning and architectural design.

## FLOOD AVOIDANCE

# ELEVATION ON SCREW PILES OR STILTS

**Elevation on screw piles or stilts** consists of raising the entire building above the potential water level (or protection objective\*) on a new point foundation. This approach minimizes the exposure of living spaces.

A foundation on **piles** (1) or **stilts** (2) consists of vertical posts driven deep into the ground without prior excavation (except for prefabricated concrete stilts) and does not require footings. The space cleared under the building allows water to flow freely, reducing hydrostatic pressure and the impact of floating debris.

There are several types of **piles** and **stilts**: screw piles, wooden stilts, steel stilts, and concrete stilts. The choice must be made according to the characteristics of the building and the ground.

## ADVANTAGES

- Improved soil absorption capacity due to the reduction of the impermeable surface in direct contact with the ground.
- Hydraulic transparency: does not create a major obstacle to the natural movement of water.
- Greater natural light in living spaces and the possibility of developing the space under the building for low-risk use (parking, access, storage).

## CONSIDERATIONS

- Possible strategy for small, detached buildings (single-family buildings up to two storeys).
- More suitable for new construction.
- Redesign of access points and addition of steps (universal accessibility issues).
- Temporary lifting and relocation of the building (requires space).
- Loss of basement living space.
- Modification, insulation, and waterproofing of interior/exterior drainage systems and conduits (electricity, gas, water, etc.).
- Not recommended for older or weakened buildings that cannot withstand displacement or load transfer.

