Floodproofing

Protecting your home and contents against flooding

New Brunswick Department of Public Safety
New Brunswick Department of Environment and Local Government

January 2016
Revised November, 2019

About this Booklet

This booklet has been prepared in order to help you consider ways to protect your home and contents against flooding. It is not a detailed "how to" guide, or a substitute for professional advice but instead is an overview of typical floodproofing measures, intended to help you make informed decisions. References provided at the end of this booklet offer additional information about specific floodproofing methods.

“Floodproofing” means taking actions that reduce the potential for damage to your home and property caused by standing or flowing water. When properly designed and installed, floodproofing measures may reduce the likelihood that a building or its contents will be damaged during a flood, and can reduce the cost of repair if damage does occur, however **there are no floodproofing methods that are guaranteed to completely protect a building and its contents from the effects of flooding.**

The primary purpose of this booklet is to help reduce flood risk for existing buildings in locations that may be affected by flooding. **This booklet does not endorse or support new development that will create or increase risks to life, property or the natural environment in the event of flooding. When all options are available, the best method of reducing risks to people and property is to avoid locations that are susceptible to flooding.**

For additional information on how to avoid flood-prone locations see **Finding Flood Information in New Brunswick** on page 21.

Important Note: The information contained in this booklet is provided for educational purposes only. It is not intended or implied to be a substitute for professional advice. Users of the information contained in this booklet assume full responsibility for its use.

Table of Contents

This document contains internet links that are functional in the web-based version, which can be accessed by visiting www.gnb.ca and following the links to “Departments” > “Environment and Local Government” > “Environment”>”Flooding in New Brunswick”>”Flood Resilience”.

Flooding in New Brunswick

The Province of New Brunswick has a long history of flooding, with incidents of varying severity recorded as far back as 1696. The causes include snowmelt, intense or prolonged rainfall, ice jams, and coastal storm surges (high tides combined with low atmospheric pressure on on-shore winds).

Historic settlement patterns have tended to follow riverbanks and ocean shorelines, and some of the most attractive building sites are located in these areas. Unfortunately, many of these properties are located within **flood hazard areas**. Other properties throughout the province are occasionally impacted by localized flooding due to high river, stream or ditch flow, high groundwater levels, local drainage issues, and low elevation. As a result, many New Brunswickers live in areas that may be affected by flooding.

There is both anecdotal and scientific evidence that climate change is affecting the frequency and severity of New Brunswick floods and there appears to be a general upward trend in both the number of documented flood events and the cost of damage resulting from flooding in New Brunswick.

To date, the costs of flood damage to individuals and governments in New Brunswick are conservatively estimated at over half a billion dollars and this does not include indirect costs associated with disruptions to society and the provincial economy. This is a heavy financial burden to bear, and the intangible costs of human anxiety, risk and suffering add to the price New Brunswickers pay each year for flooding.

Flood hazard areas are locations adjacent to lakes, rivers or the ocean, where there is a known potential for flooding. Some, but not all of New Brunswick's flood hazard areas are shown on maps that describe the estimated location, depth and frequency of flooding. In addition, properties throughout the province, may occasionally be impacted by localized flooding even if located outside of a flood hazard area. For additional information see **Finding Flood Information in New Brunswick** on page 21.

Floodproofing offers property owners a way to reduce their vulnerability to flooding.

What is Floodproofing?

Simply put, floodproofing is any temporary or permanent feature of a building or its surroundings that reduces the potential for damage caused by flowing or standing water.

Beyond improvements to building drainage (from roofs, foundations and yards), and improvements to utility connections (back flow prevention valves, etc.), there are two basic floodproofing strategies:

Dry floodproofing is aimed at keeping surface water out of a building. This approach is preferred by most property owners because the contents of the building are kept dry and there is no need for post-flood repair or clean-up inside the building. Unfortunately, this approach is not always feasible. Deep floodwaters, even if ponded or flowing slowly, can exert great weight (hydrostatic pressure) on the outside of a building, including its foundation and external walls. Most buildings are not designed to withstand this pressure and severe structural damage may occur.

Wet floodproofing minimizes potential structural damage due to external water pressure, by allowing water into a building. Having water both inside and outside the building equalizes the water pressure on the walls and floors. Special building materials and features are used to reduce the impacts of wetting on the building's structure and contents.

Remember: When all options are available, the best protection against flood damage is to avoid locations that are susceptible to flooding.

Floodproofing measures can be further subdivided into:

Permanent floodproofing measures that are always in place and require no action by the homeowner in the event of a flood. These are most suitable for areas prone to frequent flooding, seasonal dwellings that are not always occupied and locations where there is often little advance notice of a flood,

and

Contingency floodproofing measures that are put in place temporarily before a flood occurs. They are often employed in areas where flooding takes place infrequently or where there is typically enough advance notice to take action to protect a building and its contents.

This booklet discusses these various approaches to floodproofing and provides some typical examples.

Things to Know Before You Proceed

Before proceeding with any floodproofing options, please consider:

The importance of safe access - The floodproofing techniques described in this booklet may help protect a building and contents from flood damage but they will not ensure that safe access to and from a

property is available during a flood. It is therefore important to consider how a flood will affect movement by people and vehicles (e.g. for evacuation, or access by police, fire and ambulance services). This requires consideration of the anticipated flood depth, the speed that the water will be moving and the distance to the nearest “dry land”. A good rule of thumb is to assume that for **ponded (non-flowing) water**, the maximum depth of flooding for safe access by most cars is about 0.3 metres (1 foot); the maximum depth for pedestrian access is about 1.4 metres (5 feet) for adults and 1 metre (3 feet) for children)[a] . **These safe depths decrease as water velocity increases. Even shallow water can sweep a pedestrian or a vehicle away when flowing at high velocity**. Also remember that **it may be difficult to judge the depth and speed of flood waters. Water may appear to be relatively calm even when moving at a high velocity and it may be impossible to see the bottom to determine flood depth**. **Prolonged exposure to cold water could lead to hypothermia.**

A home isolated by flooding on the St. John River

In addition to property access, building accessibility is also an important consideration. Some of the floodproofing measures described in this booklet restrict the use of doors and windows and may require the use of alternate entrances and exits.

Municipal by-laws and permits - As is the case with any construction including modifications to existing buildings, floodproofing must be carried out in accordance with all applicable building code, fire code, local by-law and building permit requirements. For example, the local planning authority (i.e., municipality, regional municipality, rural community, Regional Service Commission or the province as the case may be) may prohibit construction within a flood hazard area or impose specific conditions. For more information contact your local planning authority.

Provincial policies and permits - A *Watercourse and Wetland Alteration Permit* is required prior to fill placement or other activities such as construction, demolition, clearing land, landscaping, etc., within 30 metres of a wetland or watercourse. Additional information is available at:

http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/wetlands.html

Those considering construction in coastal areas should also consult *New Brunswick’s Coastal Areas Protection Policy*:

http://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Water-Eau/CoastalAreasProtectionPolicy.pdf

a. Ontario Ministry of Natural Resources. Technical Guide - River and Stream Systems: Flood Hazard Limit. Appendix 6 - Floodproofing. (2002)

The importance of doing it right - While some floodproofing techniques can be put in place by a knowledgeable property owner, many require the assistance of qualified people to design and install them. Members of the following associations can provide advice and assistance on floodproofing your home:

Association of Consulting Engineering Companies New Brunswick
http://www.acec-nb.ca/

Association of Professional Engineers and Geologists of New Brunswick
https://www.apegnb.com/

Association of New Brunswick Land Surveyors
http://www.anbls.nb.ca/

Canadian Homebuilder's Association NB
www.nbhomebuilders.ca

Permanent Floodproofing Measures

Permanent floodproofing measures are incorporated into the design of a building or building lot. They are permanently in place and require no additional action by property owners or occupants at the time of a flood. Examples are contained in the following sections.

Sewage Connections and Lot Drainage

The following measures will benefit any dwelling, regardless of location with respect to flooding. They focus on addressing issues associated with roof drainage, plumbing, municipal utilities, and lot grading. They include:

- Improved lot grading and channels to direct water away from buildings
- Foundation drains to direct groundwater away from the foundation
- Eaves trough downspouts that are not connected to foundation drains and are extended away from the building wall
- A basement sump pump (with appropriate capacity and stand-by electrical power) connected to a storm sewer or a free-flowing surface outlet. Avoid connecting the sump pump to the sanitary sewer
- Basement window wells (where warranted by site grading), to ensure that window sills are above the adjacent ground surface
- Valves that prevent backflow (from a municipal sewer or septic system) from entering the building. Sewer backups can cause major damage and inconvenience and occur when sewer outlets become flooded and water is forced back through the sewer line into a building. It is important to remember that buildings can be affected even if situated in areas where there is no flooding.

The above measures are described in detail in guidance prepared by the City of Moncton, called *The Homeowner's Guide to Flood Protection* available at:
http://www5.moncton.ca/docs/emergency/Flood_Protection_Manual.pdf

Additional information is also provided in **Floodproofing for Utilities** on page 15.

Dry Floodproofing

Dry floodproofing means closing off or relocating all openings in a building wall or foundation that otherwise might allow flood water to enter a building. For example, windows, doors and other openings located below the anticipated flood depth can be permanently closed in and sealed. Any water-resistant material of sufficient strength can be used (e.g. bricks, concrete blocks, glass bricks, etc.). Once closed in, the openings can no longer be used, so this measure should only be used if the windows and doors are not needed by the building occupants and are not required in order to meet the requirements of the National Building Code and National Fire Code.

Waterproof coatings or sealants can be applied to basement floors and foundation walls to reduce or eliminate seepage. Cracks or gaps can be filled in with sealants and a continuous waterproof membrane can be used to line the outside of the foundation. Membranes may be susceptible to damage when backfill is placed, so proper installation is important. Special attention is also required for any openings

used for utilities such as electricity, telephone, propane, natural gas, sewer and water, to prevent infiltration and leakage into the building.

The above measures can be used in combination with temporary flood shields and watertight doors as described under **Temporary Floodproofing Measures** on page 12.

It's important to know that although it may be technically feasible to seal the openings in external walls and foundations to create a watertight barrier, it's not always a good idea because other parts of the building wall or foundation may still fail during a flood. The structural integrity of even well-built, modern homes may be threatened if saturated ground extends above the basement floor elevation or if the flood level is higher than the top of the foundation. Therefore, **in order to reduce the potential for severe structural damage, expert advice should be obtained before installing closures, sealants and other flood barriers that are integrated into the building walls and foundation. A qualified expert can determine if the walls, foundation and basement floor are strong enough to withstand the weight of water pressing on the building from the outside** (called hydrostatic pressure).

No matter what type of foundation is used, the building should be anchored to prevent flotation or lateral movement in the event of a flood.

Wet Floodproofing

In any location where floodwater is expected to reach the outside of a building or foundation wall, the resultant water pressure can be so severe that foundations can collapse, and buildings can be heaved out of the ground, or off their foundations. Where pervious (sandy) soils allow water to move easily through the ground, this damage could happen even if no water is visible at the surface. In these circumstances, wet floodproofing (purposely allowing the water to enter the building so that the pressures on the interior and exterior of the building are balanced) may help prevent serious structural damage. While the building interior (in particular the basement) will receive some flooding, measures can still be taken to reduce the potential for damage due to wetting of the building structure or contents.

Wet floodproofing requires that openings be provided to all enclosed spaces below the anticipated flood elevation. The idea is to reduce water pressure by letting it enter the enclosed spaces at the same rate that the floodwaters rise outside. The building should also be anchored to prevent lateral movement.

Case Study: The "Spray and Wash" Basement

Last June, a homeowner's basement took in five feet of water. The fully finished basement had to be gutted. If it happens again, cleanup should be much easier. The rebuilt basement now includes metal stairs, polished concrete floors, and walls clad in foam insulation covered with mortar and steel mesh and coated in concrete and sealant.

CBC Calgary, March 20, 2014

When using wet floodproofing it is also important to ensure that any structural materials (beams, subfloors, insulation, framing etc.) and finishing materials (wall coverings, flooring, etc.) that may be exposed to flood waters are resistant to damage from wetting and drying (e.g. swelling and cracking) and can be cleaned once the flooding has subsided. Even materials that will not come into direct contact with flood waters should be capable of resisting moisture and humidity. In general, materials such as untreated wood, particle board, carpeting, corkboard, plaster, regular plywood, gypsum drywall, laminate flooring, linoleum, vinyl wall coverings, non-ceramic floor tiles, etc., should be avoided. Batt and blanket types of insulation such as mineral wool or fibreglass should also be avoided because they will retain water and

trap any floating contaminants. Alternative materials include marine grade plywood, cement board, concrete, glazed clay tile, plastic lumber (with no wood filling), non-absorbent natural or artificial stone or stone veneer with waterproof grouting, steel wall panels, ceramic or concrete tile (with mortar rather than an adhesive), metal doors, closed cell or plastic foam insulation, etc.

When wet floodproofing is employed, the dwelling owner or occupant should also prepare a plan listing vulnerable furnishings and possessions along with a predetermined strategy for removing them quickly to a location above the flood elevation. In addition, provision should be made for dewatering (pumping out and dehumidifying) the basement once the flood is over. Other measures associated with wet floodproofing, including special considerations for electrical services are described under **Floodproofing for Utilities** on page 15.

If a building may be subject to damage from waves, floating ice, or debris during a flood then wet floodproofing is not a good option. Another caution regarding wet floodproofing is that during cold weather, water that enters a building can freeze and expand, causing additional damage. Therefore, **wet floodproofing may not be the best option if other alternatives are available**.

Below Grade Living Space

Basements are the lowest part of a building and are therefore most susceptible to flooding. In early homes, basements were usually not considered as living space and were more often used as storage areas. In modern homes, basements are often finished with wall coverings and flooring and are used as recreation rooms, bedrooms or as fully-equipped apartments.

Finished basements and their contents are highly vulnerable to flood damage. **To avoid risks to life and property, wet floodproofing should not be used to accommodate below grade living space in buildings that may be affected by sudden or rapid flooding.** While dry floodproofing (employing measures to seal off a basement to keep flood water out) might seem to be the best solution, this may not be a feasible option. As previously noted, even if the water is not flowing quickly, the weight of water pressing in on a watertight building wall or foundation could result in significant structural damage.

Raising the Building

Raising a building above the flood level may reduce potential damage to a building and its contents in the event of a flood. For locations where flood hazard maps or sea level predictions are available, the appropriate elevation can be obtained by referring to the past or predicted flood elevations. (See **Finding Flood Information in New Brunswick** on page 21). Even if the flood water is higher than expected and enters the building, the flood damage will be reduced, since the depth of the water and the length of time the building's contents are exposed will be less. Including some extra height above the anticipated flood level offers an additional margin of safety.

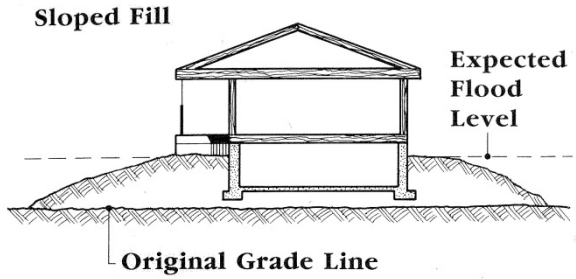
Elevation on Fill

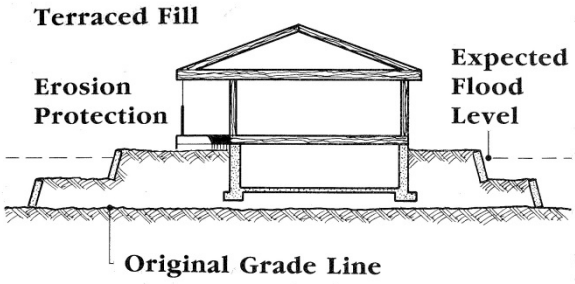
This option means constructing a mound and relocating the building on top of it. Care should be taken in the selection of the fill material Silts and very uniform sands are undesirable as they are difficult to compact. Instead the fill material should include well-graded sands and gravels since they are the most suitable for supporting the weight of buildings. Ensuring proper fill compaction is also important. This is usually addressed by placing the fill in a series of layers or “lifts” and compacting each layer before the next is added.

Placing fill overtop of organic soils can lead to instability. The existing topsoil and subsoil may have to be removed first and replaced with another material (sand, gravel, synthetic materials etc.) to provide the needed bearing capacity. The sides of the fill should be protected against erosion and sloped in such a way as to prevent slumping. The fill should not extend onto adjacent properties, so it is also important to know the location of property boundaries. Retaining a professional engineer and a land surveyor will help ensure that each of the above considerations is adequately addressed.

Elevating an existing building on fill may not be feasible in locations where flood waters flow deep and fast because: a) the required volume and depth of fill will be large; b) the fill may be subject to erosion by flowing water; c) safe access may not be available during a flood and d) the fill may block flood flow, leading to higher flood elevations on adjacent properties. Effective use of this option is therefore generally limited to buildings located near the edges of flood hazard areas. In addition, a Watercourse and Wetland Alteration Permit is required prior to fill placement or other activities such as construction, demolition, clearing land, landscaping, etc., within 30 metres (100 feet) of a wetland or watercourse. **Those considering fill placement in coastal areas should also consult New Brunswick's Coastal Areas Protection Policy.**

The foundation of a building raised on fill may still be subject to flood damage if the basement floor remains below the anticipated flood elevation. Flood water can damage the foundation by exerting pressure on it if the water is able to percolate through the fill. Special foundation design and use of anchors to prevent buoyancy may be required. Construction on a concrete slab placed on top of the fill (i.e. a foundation with no basement) may an option.





The elevation of buildings on fill is often the best protection from flooding. The above diagrams illustrate two methods of fill placement - sloped and terraced.

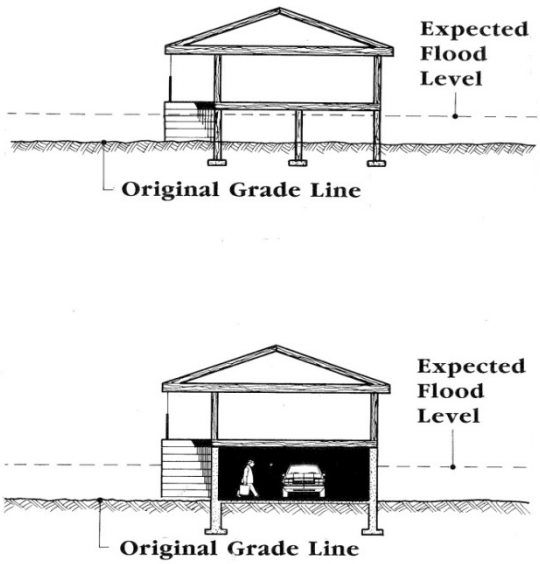
A house on fill, during a St. John River flood

Elevation on a Raised Foundation, Piers or Columns

This option means designing and reconstructing a building foundation that is high enough to ensure that the living area of a building is raised above the anticipated flood level. This requires that the building be separated from its existing foundation, raised on hydraulic jacks, and held by temporary supports while a new or vertically extended foundation is constructed below. This retrofit is typically most feasible for wood frame homes originally built on basement, crawlspace, or open foundations. Masonry homes can be more difficult to lift, primarily because of their design, construction, and weight, but raising these homes may still be possible.

The new foundation can consist either of continuous concrete walls designed to address hydrostatic pressure, or an open foundation comprised of a series of piers, posts, columns, or piles. Regardless of the foundation type, the foundation design should consider issues such as debris loading during a flood event, the position and orientation of the supports, soil conditions, and anchoring, bracing and connection details. Expert advice should be retained to design the foundation and supervise its construction.

Elevating a building on piers and columns instead of a foundation wall may be useful for coastal locations and inland locations exposed to high velocity flow or ice jams, because flowing water, waves, ice and debris may be able to pass under the building without causing impact-related damage. The supporting piers and columns and their footings should be designed to support the building weight and withstand the force of moving water as well as the impact of ice and debris. Mechanically driven piles may be the best solution where erosion is expected to be severe, such as exposed coastal locations. The open area under the building can be used for other purposes such as storage space for low value items.



During construction, buildings can be elevated on piers and columns as a method of floodproofing. The open area under the building can be used for other purposes, such as parking, outside of the flood season.

When planning an elevated foundation, it's important to determine how high the foundation should be. (See **Finding Flood Information in New Brunswick** on page 21). When selecting the appropriate elevation, it may be wise to add some extra elevation to account for uncertainties in the water level estimate.

Remember that use of this option is subject to the approval of the planning authority (municipality, regional municipality, rural community, Regional Service Commission of the province as the case may be). **This option does not provide for safe access to a property during a flood. A Watercourse and Wetland Alteration Permit is required prior to fill placement or other activities such as construction, demolition, clearing land, landscaping, etc., within 30 metres of a wetland or watercourse. Those considering elevating a building on a raised foundation in coastal areas should also consult New Brunswick's Coastal Areas Protection Policy.**

A cottage on piers during a flood on Grand Lake

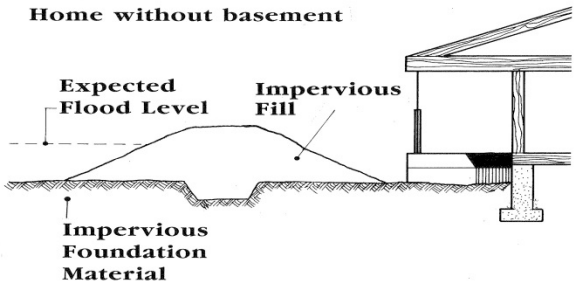
An oceanfront home on piers in Robichaud, New Brunswick

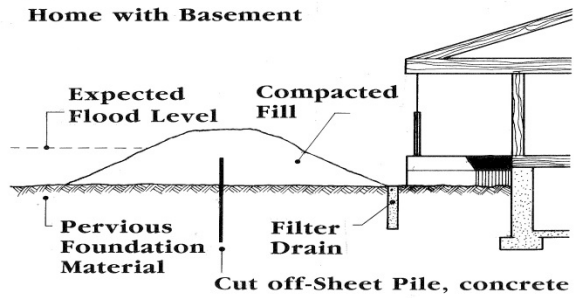
Permanent Floodwalls and Berms

Floodwalls and berms are barriers intended to keep water away from a vulnerable building or structure. This approach requires no change to the building itself and hydrostatic pressure on the building envelope is avoided.

Floodwalls can be constructed of durable, impervious materials such as masonry, concrete or earthen fill. They should be designed for the specific conditions of a particular site including the elevation of the ground relative to the anticipated flood elevation, the soil type, and the pressure that will be exerted by the depth of water outside the barrier.

Ground elevations can be established by field survey from a benchmark of known elevation, while flood elevations can be obtained using the methods described under **Finding Flood Information in New Brunswick** (page 21). The ability of a proposed wall or berm to provide an impervious barrier and resist water pressure should be verified by a professional engineer.





An important consideration in the design of a berm is the ability of the soil to permit the passage of water. If the soil is porous, seepage into the basement of the nearby home is possible. The use of cutoff walls, or blanket drains beneath the berm are one way to prevent such seepage.

Important considerations in the design of floodwalls and berms include the ability of the soil below the barrier to support its weight and resist the passage of water. If the soil is highly pervious (e.g. sandy soil), seepage underneath the berm or floodwall could be a problem and could lead to collapse. A cut-off wall buried beneath the barrier may help control seepage.

Surrounding a building with a flood barrier will be of limited benefit if sewer, water or other drainage pipes continue to allow floodwater a path of entry. If such pipes extend beyond the limits of the barrier, they will have to be equipped with backflow preventers or manually operated shut-off valves. See also **Sewage Connections and Lot Drainage** (Page 5) and **Floodproofing Utilities** (Page 15). Remember that once a valve on a sewer pipe is closed, sewage from the building will be blocked and may overflow if sinks, toilets etc. are used.

Consideration should also be given to drainage of the area within the berm. This means that snow melt and precipitation must be allowed to drain away from the building and through the barrier via pipes or channels that can be closed off during flooding. Finally, driveways or other gaps in the barrier must be blocked when a flood occurs. Sandbags or other equivalent materials can be kept on hand for this purpose (see **Temporary Dikes** on page 13).

As is the case with construction on fill, **the use of floodwalls or berms is not recommended in locations where flood waters flow fast and deep since the wall or berm will have to be high and may be subject to scour and erosion. In addition, the wall or berm may block or deflect flood flow, leading to higher flood elevations on adjacent, unprotected properties. Sudden failure of a flood wall or berm may have greater safety or damage consequences than if the wall or berm had not been constructed**. **Those intending to construct a flood wall or berm should confirm that these features are permitted by the planning authority** (municipality, regional municipality, rural community, Regional Service Commission or the province as the case may be). **A Watercourse and Wetland Alteration Permit is required prior to fill placement or other activities such as construction, demolition, clearing land, landscaping, etc., within 30 metres of a wetland or watercourse. Fill placement within a wetland will generally not be permitted. Those considering construction in coastal areas should also consult New Brunswick's Coastal Areas Protection Policy.**

Relocation

Relocation means moving an existing building that is vulnerable to flooding to a site that is above the flood elevation. If flood risk is severe and alternative locations are available, this may be the most effective floodproofing option. This option involves retaining a specialist contractor to lift an existing building from its foundation and transport it to a new foundation at the new site.

When deciding whether or not relocation is a feasible option, factors to consider include the:

- type of building (the easiest structures to relocate are single story wood frame buildings with a regular, rectangular shape);
- condition of the structure (is it structurally sound so that it can be moved?);
- route between the existing site and the new one (are there low power lines, narrow roads, weight restrictions, tight corners, etc. that will have to be addressed?);
- characteristics of the new site (elevation above flooding, safe access during flooding, ability to provide services such as well and septic system, etc.);
- permits that may be required including building permits and permits for over-size/overmass loads from the Department of Transportation and Infrastructure; and
- relative costs of relocation versus demolition and reconstruction.

Temporary Floodproofing Measures

Temporary floodproofing measures are put into place immediately before a flood and are intended to keep water out of a building for the flood's duration. Contingency measures are sometimes referred to as "active floodproofing" because they require human intervention in advance of a flood. They are therefore only useful if sufficient warning time is available to allow floodproofing measures to be deployed and the building owner or another knowledgeable person is available to put the measures in place. Where possible, floodproofing measures that are permanently in place are preferred.

Flood Shields

Flood shields are removable watertight barriers designed to prevent the passage of water through windows and doors. They consist of panels constructed of a durable, impervious material (usually metal) that can be readily installed and sealed using rubber gaskets or special sealants around the edges.

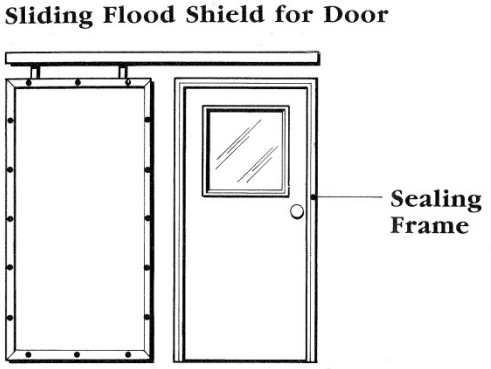
To ensure quick and easy installation during a period of immanent flood risk, flood shields should be stored close to the openings to be sealed, color-coded or numbered as to location and installation priority and held in place by simple, quick connecting fasteners and latching devices.

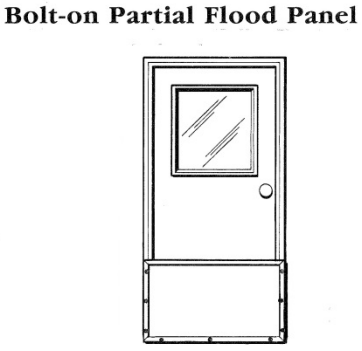
To ensure that flood shields will be effective when installed, periodic inspection and testing is advised.

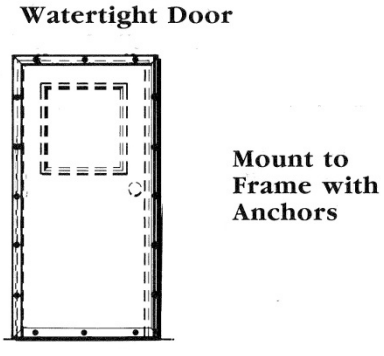
Watertight Doors and Temporary Bulkheads

Watertight doors are permanently installed but are designed to be closed and sealed only during floods. They are heavy and expensive and are generally more suited to commercial and industrial buildings than houses. If anticipated flood elevations will not greatly exceed ground level, bolt-on, partial flood panels or barriers can be installed to protect the bottom portion of a doorway.

It is important to realize that in order to be effective, flood shields and watertight doors must be well-maintained and incorporate smooth, close-fitting surfaces, waterproof gaskets and locking bolts. In







Sliding flood shields, bolt-on flood panels and watertight doors are barriers designed to prevent the passage of water through windows and doors.

general, permanent closures or sealants, or relocating doors and windows above the flood level are more effective measures.

To prevent flood waters from entering through doors and windows a temporary wall or "bulkhead" can be constructed. For example, "tongue and groove" wooden planks can be stacked on top of each other. The temporary wall can be covered by a plastic sheet and supported by a grooved concrete or steel channel attached to the sides of the door or window. A double layer of sandbags placed at the base may help to reduce seepage and provide additional stability.

As is the case for closures and sealants**, expert advice should be obtained to determine if flood shields, watertight doors and bulkheads are feasible options**, based on the anticipated depth of flooding.

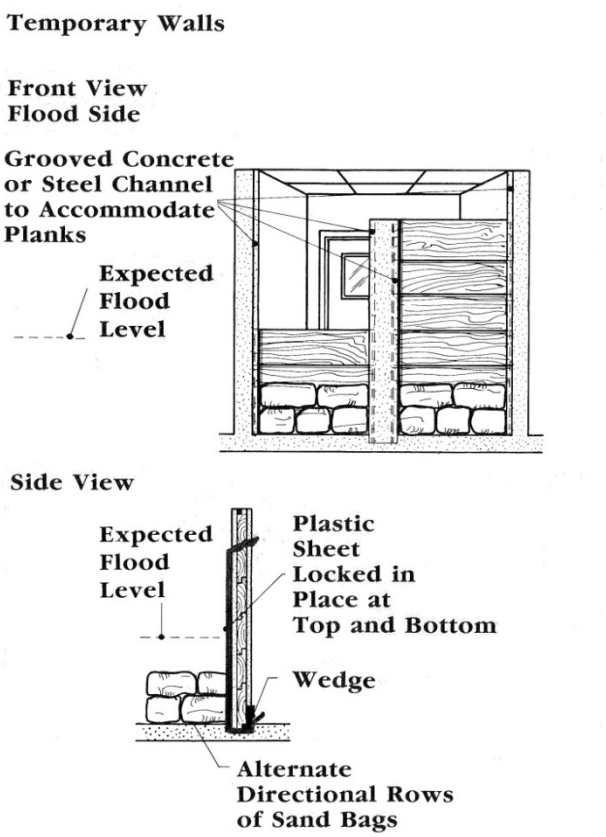
Temporary Dikes

Stacking sandbags to form a barrier against rising floodwaters is a common emergency floodproofing technique. They can be put in place to surround a vulnerable building or can be installed as needed to protect low openings such as basement windows, patio doors, etc. The bags must be strong enough to hold the sand in place and withstand prolonged contact with water. Burlap and plastic bags can be purchased that are specially made to be filled with sand.

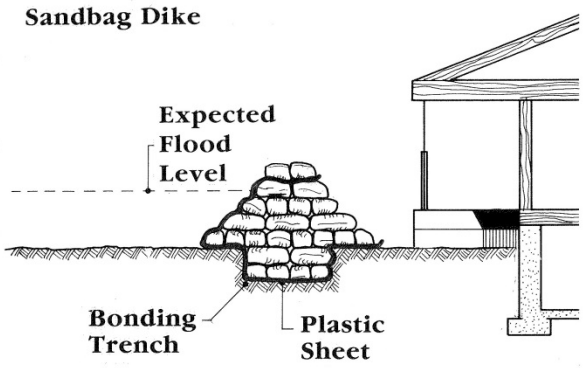
Flood water will exert pressure against the dike so if possible, a trench should be dug to anchor the dike to the ground and prevent it from moving.

Leaving some vacant space within the bags will allow the bags to overlap and mold together under their own weight, locking them in place. In addition, the orientation of the bags should alternate, so that each layer of bags is placed at right angles to the layers above and below. This adds stability to the structure. For added protection, a durable plastic sheet can be placed on the outer side of the dike to prevent the seepage of water through the barrier.

A number of alternatives to sandbags have been devised, including re-usable, anchored, rubber or



Temporary walls constructed from planks, plastic sheets and sandbags can also provide effective protection during flooding. This diagram provides a side view and front view of a temporary wall.



The diagram above illustrates how to construct a sandbag dike quickly and efficiently to form a barrier against rising floodwaters.

rubberized tubes filled with water, interlocking panels designed to hold back flood water and various other modular barriers constructed of high-density materials, anchored in place and filled with sand or water to increase their weight. These may be worthwhile options to consider and may be easier to install than sandbags. If selected, they should be installed in accordance with the manufacturer's recommendations.

Floodproofing for Utilities

If the utilities serving a building are damaged, even a structurally sound residence may be rendered uninhabitable after a flood due to unsafe or unsanitary conditions. This risk can be reduced by incorporating floodproofing features into the services contained in existing buildings. This is particularly important when furnaces and other vulnerable facilities are located in a basement and when wet floodproofing is being employed. When floodproofing building utilities, primary consideration should be given to preventing flood waters from contacting the components that are most susceptible to water damage.

Some potential measures are included in Table 1 (below) and described in more detail in references contained in **Additional Information on Floodproofing** at the end of this booklet.

Case Study: The "Upside-Down House"

When a property was badly damaged by flooding, a local builder saw an opportunity. "You have to find unique spots for the mechanical equipment that normally you would cram in a basement". The basement has no windows and contains only piping and ductwork. A small upstairs room houses one of two furnaces — designed to force air down rather than up — complete with sound insulation.

The Medicine Hat News, September 4, 2014

Remember:

- All measures and modifications must adhere to the all applicable provisions of the National Building Code and National Fire Code.
- Building, locating, relocating, demolishing or altering a building or structure typically requires a permit.
- Check with your local planning authority for specific requirements and restrictions.

Table 1: Some Common Methods of Floodproofing Utilities

Floodproofing Measure	Advantages	Disadvantages
Electrical Services Locate electrical panels, light switches, meters, service entries and electrical outlets above the anticipated flood elevation. Install separate, waterproof circuits for outlets, switches, and lighting components that must be located below the flood level and install separate circuits for emergency flood equipment (e.g. pumps and generators).	1. Elevated circuitry is completely protected from damage. 2. May avoid costly "behind the wall" failures in the event of a flood.	1. Not always easily adaptable to existing buildings.
If wiring must be located below the flood elevation, install it within a small diameter plastic pipe (conduit) to facilitate future replacement and repair of wiring.	1. May avoid costly "behind the wall" failures.	1. Not always easily adaptable to existing buildings.

Heating, Ventilating and Air Conditioning (HVAC) Systems Elevate all components (external units, internal units, thermostats, controls and ducting). For example, subject to all applicable Building Code and Fire Code requirements, major components of the heating system can be elevated on a platform, strapped to the basement ceiling or located on the main floor. Lateral or in-line furnaces are also available that fit into the ductwork. External heat pump condensers can be placed on elevated platforms or attached to the building wall above the anticipated flood elevation. If forced air ducting cannot be relocated above the flood elevation, then make sure the ducts below the flood elevation are easily accessible and can be taken apart for cleaning after the flood event. (Sediment and contaminants in the ducts can be circulated through the HVAC system if it is operated with dirty ducts).	1. No human intervention needed.	1. May be difficult and expensive to introduce into existing buildings.
Locate heating or cooling system components in waterproof utility enclosures. Depending on the anticipated flood depth, low barriers or curbs rather than complete enclosures may be sufficient.		1. May be difficult and expensive to introduce into existing buildings. 2. The requirement to access the components for servicing may limit the effectiveness of the enclosure. 3. In some applications, the enclosure is normally open and must be closed and sealed before the flood arrives.
Incorporate quick release/disconnect features into the design of the equipment to allow rapid removal of vulnerable components.	1. Potentially allows rapid shut down and relocation of vulnerable components.	1. May not be feasible for all components or may require custom-designed components. 2. Requires human intervention to remove and relocate vulnerable components in advance of a flood.
Water Supply and Sewers Install back-flow prevention valves on sewage pipes.	1. Valves function automatically to prevent sewage from backing up into the building when flooding occurs.	1. Valve requires testing and maintenance. 2. Once a valve on a sewer pipe is closed, drainage from the building will be blocked and may overflow if sinks, toilets etc. are used

Eliminate gravity drains below the anticipated flood level.	1. Prevents sewage from backing up when flooding occurs. 2. Potentially useful if flow prevention valves on sewer lines are not feasible.	1. A pump and generator are required. 2. May not be technically feasible or permitted especially for hook-ups to municipal sewers.
Install a waterproof well casing to prevent surface water from entering the well. Protect the well top from scour and impact damage.	1. Helps prevent contamination of water supply by bacteria and other pollutants during a flood.	
If possible, ensure that the septic system is located above the anticipated flood elevation. If this is not possible, install a watertight cap (e.g. bolted with neoprene gasket) to keep surface water out of the septic tank and install a valve to prevent sewage backflow during a flood.	1. May prevent sewage backflow from entering to building.	1. Sewage system may be inoperable during the flood. 2. Buoyancy forces on underground septic tanks located below the flood elevation may lead to damage and failure of the septic system.
Fuel Supply Install shutoff valves, waterproof fill caps, and make sure tank vents extend above the anticipated flood level. If evacuation is necessary, close fuel valves before leaving the site.	1. Reduces risk of fire and explosion. 2. Prevents building damage and pollution due to fuel leaks. 3. Adaptable to most buildings.	1. Minor post-flood maintenance may be required.
If oil and propane storage tanks cannot be located above the flood elevation, brace and anchor them to prevent flotation, separation of fuel lines/pipes, and damage to tanks and fuel lines (due to scour, erosion, and impact from floating debris).	1. Reduces risk of fire and explosion. 2. Prevents building damage and pollution due to fuel leaks. 3. Adaptable to most buildings.	1. Minor post-flood maintenance may be required.

Note: The information contained in the above table was obtained from: 1) United States Federal Emergency Management Agency. Protecting Building Utilities from Flood Damage, (Chapters 3 and 4) (1999); and 2) Canada-New Brunswick Flood Damage Reduction Program. Floodproofing - Protect Your Home Against Flooding (1989).

Household Hazardous Materials

Some household materials are potentially hazardous to the environment and human health. These products should therefore be securely stored to prevent their release during a flood. To reduce the risk of contamination:

- Clearly identify and label contents of, drums, or other containers, especially when materials are placed in other than their original containers;
- Place your name and address on larger fuel and propane tanks to facilitate identification of their contents and their return if they become displaced;
- Store drums and containers in areas that are least susceptible to flood waters. When possible, keep them in fenced enclosures, cabinets, or storerooms;
- Minimize the amounts and types of materials kept on site. Purchase only what you need;
- If time permits dispose of household hazardous waste materials prior to a flood, at a household hazardous waste collection centre. For more information on how to dispose of household hazardous waste materials, contact your local Solid Waste Commission.

How to Proceed

1. Learn as much as you can about flooding in your community and at your property location. (See **Finding Flood Information in New Brunswick** on page 21). The depth and velocity of flooding are major factors in choosing floodproofing measures; some methods may be inappropriate if the depth and velocity of flooding are excessive. Other important factors to consider include the expected duration of the flooding.

2. Learn more about floodproofing options. This booklet provides a general overview of available options. Additional information can be obtained from the references provided at the end of this booklet. Experts from the Associations listed on page 4 can also provide information and advice.

3. Investigate the physical condition of the building and the property. The function, condition and use of a building have a direct bearing on the need for floodproofing, and whether it is technically and economically practical. Four characteristics of your home that are particularly important in floodproofing are:
1) construction type (wood frame, brick etc.);
2) foundation type (slab on grade, poured concrete foundation, concrete block, etc.)
3) lowest floor elevation and foundation height; and
4) the building's age and state of repair.

4. **Consider any site conditions that may limit the feasibility of certain floodproofing measures.** These include the size slope and drainage of the property. Other factors to consider include: the type and location of sewer, water, gas and other piped services, the location of the electrical entry, the location of property boundaries, and any applicable by-laws that may affect the types of work that can be carried out on a property. Consideration must also be given to the safety of people in the building and to the structure should floodproofing measures fail.

5. Evaluate the costs and benefits of floodproofing. Determine the cost of floodproofing your property and weigh it against the cost of flood damage. You should also consider the personal danger and hardship you and your family may face if you do not floodproof. When making this evaluation bear in mind that **while flood insurance is available for some commercial customers in Canada, most residential insurance policies do not cover damage caused by flooding**. Damage caused by sewer backup, maybe be available but only as an extra endorsement that typically must be specifically requested by the homeowner.

The Province may make disaster financial assistance available following a flood, but this decision is based on the severity of the flood and is not a guaranteed source of funding for homeowners. If assistance is offered, not all types of damage are eligible.

6. Consult with your local planning authority and provincial officials. Remember that the proposed work must comply with all applicable building code, fire code, by-law and building permit requirements. Some planning authorities may prohibit construction within a flood hazard area. In addition, any applicable provincial permits must be obtained. For example, a Watercourse and Wetland Alteration Permit is required prior to fill placement or other activities such as construction, demolition, clearing land, landscaping, etc., within 30 metres (100 feet) of a wetland or watercourse. Those considering construction in coastal areas should also consult New Brunswick's Coastal Areas Protection Policy.

7. Select an appropriate method of floodproofing. Always seek expert advice about the best way to floodproof your home because improper floodproofing selection and design can put people and property at risk.

8. Plan your floodproofing project and hire experts to do the work. Use a licensed, bonded, and insured contractor. Before hiring a contractor, be sure to check references.

9. Know the extent of the remaining flood risk, because it can't be eliminated entirely.

Finding Flood Information in New Brunswick

Flood Hazard Maps and Flood Level Predictions

In New Brunswick, flood hazard maps have been prepared for a number of areas that are known to be at risk of flooding. The maps describe the extent and anticipated frequency of flooding and can be used to obtain flood depths at specific locations. New Brunswick's flood hazard maps can be viewed at:

Flooding in New Brunswick (arcgis.com)

Some communities have prepared their own flood hazard maps. Check with your local planning authority.

Other Sources of Information

Not all of New Brunswick's flood-prone locations have been identified on flood hazard maps and properties throughout the province may occasionally be impacted by localized flooding due to high water levels in rivers, streams and ditches, high groundwater levels, local drainage issues, and low elevation. Other potential sources of flood information include local planning authorities, media reports, historical records contained in public libraries and your own personal experience. Long-term residents can also be excellent sources of information on the history of flooding in your area. Predictions based on site-specific calculations performed by an engineering consultant can also be used as a guide.

Flood Warnings and Forecasts

For flood warnings and forecasts along the Saint John River, visit:
http://www2.gnb.ca/content/gnb/en/news/public_alerts/river_watch.html

Real time water level elevations are available from Environment Canada for selected rivers throughout New Brunswick at:
https://wateroffice.ec.gc.ca/google_map/google_map_e.html?search_type=province&province=NB

Public Alerts are issued by Environment Canada for abnormally high water levels and high waves (storm surge or storm tide) caused by storms, which have the potential to cause coastal flooding:
http://weather.gc.ca/warnings/index_e.html?prov=nb

Contact Information

For additional assistance contact:

Emergency Assistance - Police, Fire, Ambulance
Call 911

NB Emergency Measures Organization
1-800-561-4034

River Watch Flood Advisories (St John River and major tributaries)
1-888-561-4048 or
http://www2.gnb.ca/content/gnb/en/news/public_alerts/river_watch.html

Road Conditions, Traffic Advisories
511 or 1-800-561-4063 or
http://www2.gnb.ca/content/gnb/en/departments/dti/highways_roads/content/511.html

To Report Spills or Environmental Emergencies
1-800-565-1633

Additional Information on Floodproofing

More information about floodproofing options is available from the following sources. The internet links contained in this list are subject to change, as websites are typically revised from time to time. These references are provided for information only and have not been endorsed or evaluated by the Government of New Brunswick.

Canada Mortgage and Housing Corporation. Practical Measures for the Prevention of Basement Flooding Due to Municipal Sewer Surcharge [English]

Centre Européen de Prévention du Risque d'Inondation. Le bâtiment face à l'inondation - Diagnostiquer et réduire sa vulnérabilité - Guide méthodologique [French]

Centre Européen de Prévention du Risque d'Inondation. Le bâtiment face à l'inondation - Vulnérabilité des ouvrages [French]

City of Moncton. The Homeowner's Guide to Flood Protection [English]

Credit Valley Conservation. Technical Guidelines for Floodproofing [English]

Institute for Catastrophic Loss Reduction. Handbook for Reducing Basement flooding [English]

Institute for Catastrophic Loss Reduction. Best Practices for Reducing the Risk of Future Damage to Homes From Riverine and Urban Flooding : A Report on Recovery and Rebuilding in Southern Alberta [English]

Mission des sociétés d'assurances pour la connaissance et la prévention des risques naturels. Mémento pratique du particulier Risque « inondations » [French]

Ontario Ministry of Natural Resources . Technical Guide - River and Stream Systems : Flood Hazard Limit. Appendix 6 - Floodproofing [English]

République Français. Ministère de l'égalité des Territoires et du Logement. Référentiel de travaux de prévention du risque d'inondation dans l'habitat existant. [French]

République Français. Direction régionale de l'Équipement de Bretagne. Rendre son habitation moins vulnérable aux inondations - Guide à l'usage des propriétaires. [French]

République Français. Inondations: Guide d'évaluation de la Vulnérabilité des Bâtiments Vis-A-Vis de L'inondation. [French]

United States Federal Emergency Management Agency. Homeowner's Guide to Retrofitting. Chapter 7 - Floodproofing. [English]

United States Federal Emergency Management Agency. Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas. [English]

United States Federal Emergency Management Agency. Home Builder's Guide to Coastal Construction.[English]

United States Federal Emergency Management Agency. Technical Bulletin 7-93, Wet Floodproofing Requirements.[English]

United States Federal Emergency Management Agency. Protecting Building Utility Systems from Flood Damage, [English]

United States Federal Emergency Management Agency. Elevated Residential Structures.[English]