

# FLOOD EVENTS



## Risks to Buildings, Occupant Safety & Environment

- ◆ Damage to, or destruction of buildings caused by coastal or inland flooding
- ◆ Weakened foundations and structural integrity from flooding and increase runoff
- ◆ Utility service interruption, including sewage systems
- ◆ Loss of property and personal assets due to water damage or contamination from sewage, soil and mud
- ◆ Increased coastal salt spray and salinization of soils

### Site Strategies

Strategy	Cost	Impact	Alignment
Avoid sites in projected zones of coastal, estuarine and riverine floodplains, and areas vulnerable to groundwater, stormwater/overland (aka pluvial) flood hazards	\$	***	
Review available flood hazard information available from the province or local municipality to identify relevant flood risks and develop knowledge of historical flood events for the site	\$	***	
Assess the criticality of buildings and identify infrastructure that is required (e.g. ability of building and surrounding infrastructure to accommodate a 5, 10, 50 year flood depending on building type or occupancy)	\$	***	
Include scour protection for shoreline developments, such as riprap aprons, blanket and gravel toppings, or filter fabric or floodwalls	\$\$\$	***	
Incorporate landscape features such as berms to provide natural barriers, and wetlands and swales with native plants to buffer wave energy and absorb and redirect water on-site	\$\$	***	
Use permeable paving materials and grade away from structures to improve overall rainwater infiltration capacity of the site, reducing the pressure on sewer systems	\$\$	**	
Abide by the established design flood elevation (DFE) / flood construction level based on the future floodplain extent, and limit programming uses below this level in to parking, building access and minor storage	\$\$	***	
Where necessary, infill sites to raise the land, or elevate the building using stilts, foundation walls, or other water resistant structures to ensure habitable spaces and mechanical and electrical equipment are above the established DFE	\$\$\$	***	

### Design Strategies

Strategy	Cost	Impact	Alignment
Where necessary, select higher performance, water-resistant building materials to reduce damage to building structure, envelope and interior finishes within the DFE	\$\$	**	
Install watertight shields for windows and doors, reinforce walls to withstand the pressures from floodwaters, and include removable barriers or flood proof doors or gates at all entrances below the DFE	\$\$	**	
Ensure key services (e.g. electrical rooms, back-up power) are located on higher floors at low/no risk of flooding	\$\$	***	
Ensure elevator controls are placed to avoid flooded areas and inspect elevators after a flood. Ensure hydraulic elevators' machine rooms are located above the ground floor to prevent flooding, and install locking systems (e.g. float switch systems) to prevent elevator cabs from descending below lowest floor or base flood level	\$\$	***	
Protect electrical equipment with waterproof enclosures	\$\$	***	
If necessary, include flood vents (permanent openings in foundation walls) to allow floodwater to escape	\$\$	**	
Use sealants and membranes to reduce seepage of floodwaters through walls. In high risk areas, it may be better to allow basements to flood if foundation walls are not capable of withstanding hydrostatic, buoyancy forces	\$\$	*	
Install sump pumps at the lowest point of the floor, with backup power supply and regular testing (low rise)	\$	*	
Design site storm water conveyance away from structures for increased volumes and flows	\$\$	*	
Install check valves or backwater valves in third pipe, storm and sanitary sewer lines and permanently seal any floor drains that are not in use	\$	*	
Ensure downspouts are directed to rock pits and away from backfill zones and rainwater volumes are not directly conveyed to the storm sewer systems, except where stormwater systems are designed to accommodate flows	\$	***	

Flooding events can originate from either slow or sudden inundation of water from extreme rainfall events, or seasonal snow and glacial melt. Flooding along coastal areas can also be caused by storm surges and high tides associated with sea level rise. Increased flows of water poses a challenge to infiltration and drainage infrastructure, including permeable ground and storm water sewer systems. Both slow and fast moving slood events pose threats to building, infrastructure and human health. The frequency and severity of flooding events are projected to escalate with climate change as storm events increase and sea levels continue to rise along most of BC’s coast.

## Operations Strategies

Strategy	Cost	Impact	Alignment
Procure and install temporary flood barriers at entrances to prevent flood waters from entering the building. Provide entry and exit points over barriers	\$\$	**	
Develop regular maintenance schedule for sewer valves	\$	**	
Develop emergency management plan to address potential elevator failures.	\$	*	
Implement or connect to an emergency notification system to share details about sudden flooding events, evacuation plans, and steps occupants can follow (ICI buildings)	\$	**	
Inspect and maintain sump pump systems and electrical circuit breakers, and ensure systems are labelled to indicate their zone of control.	\$	*	
Following occupancy and after major storm events, inspect hardscape and contributing drainage areas. Conduct any needed repairs or stabilization. Replace or repair any necessary pavement surface areas that are degenerating or spalling	\$	**	
Inspect and remove accumulated sediment in pre-treatment cells and inflow points (ICI buildings)	\$	**	
Check vegetation and green infrastructure for evidence of excessive ponding or concentrated flows. Take remedial action where necessary	\$	*	
Add reinforcement planting to maintain desired the vegetation density. Stabilize the contributing drainage area to prevent erosion	\$\$	*	
Check for clogging or slow-draining soil media, a crust formed on the top layer, inappropriate soil media, or other causes of insufficient filtering time, and restore proper filtration characteristics (except in backfill zone)	\$	**	
Identify the appropriate insurance package to prepare for high risk flooding events	\$\$	**	

 Severe Storms
  Seismic Events
  Chronic Stressors

Relative Cost/ Cost Premium

Low	Medium	High
\$	\$\$	\$\$\$

Relative Impact

Low	Medium	High
*	**	***

## Community Benefits

 Consider the following strategies to help improve the resilience of the community overall:

- ◆ Install native vegetation and green infrastructure (rain gardens, infiltration swales, green roofs, rainwater harvesting, daylighted streams and constructed wetlands) to improve water detention, conveyance, and ground permeability
- ◆ To mitigate the impacts of riverine flooding, use flood proofing design and elevated structures to reduce the volume of debris scattered during flooding events, reducing the chances for contamination and destruction of surrounding areas
- ◆ Coordinate efforts to establish a continuous physical barrier to floodwater inundation, such as structural barriers harmonised across multiple developments, to better protect the surrounding area
- ◆ Ensure building connection to community fire response plans (e.g. notification systems)
- ◆ Design the building so that it can act as a shelter for those displaced during flood events
- ◆ Provide occupant education on refuge areas, evacuation measures, exit locations, etc.

### Additional Resources

- ◆ FEMA Design Guide for Improving Critical Facility Safety from Flooding and High Winds
- ◆ City of Vancouver Citywide Integrated Rainwater Management Plan, Volume II - Best Management Practice Toolkit
- ◆ City of Vancouver Flood-Proofing Policies
- ◆ Credit Valley Conservation Technical Guidelines for Floodproofing
- ◆ CSA Z800-18 Basement Flood Protection Guideline