

A Public Guide to Living with Floods

**A pictorial overview of
flood management on
private property**



**Catchments
& Creeks**

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A Public Guide to Living with Floods

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Cover: Brisbane flood 2011 by Catherine Cleary

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Significant effort has been taken to ensure that this publication is sufficiently generic in its content for it to be used as a general, non-technical, public reference document. The general content, and generic nature of the document means that this publication is unlikely to address all of the flooding issues relevant to a particular property, or to provide sufficient information to allow the reader to prepare a comprehensive flood response plan for a particular residence.

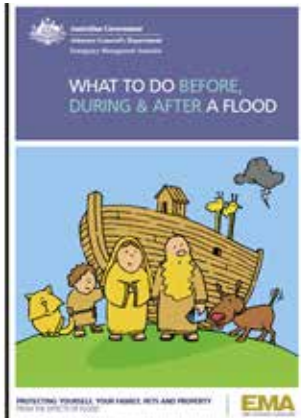
The flood and floodplain management practices presenting within this document are largely aligned with current Australian practice; however, individual states and territories may have specific recommendations that may differ from those presented within this document.

The author cannot and does not claim that the document is without error, or that the recommendations are appropriate in all circumstances and for all site conditions.

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It is strongly recommended that readers seek their own site-specific advice from trained professionals before purchasing or renting a residential property.

Principal reference documents:



What to do Before, During & After a Flood

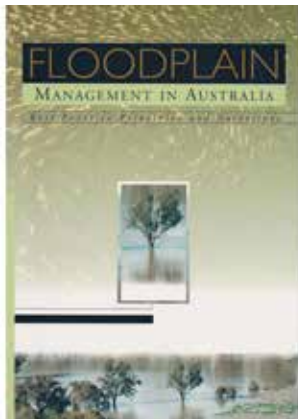
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ISBN 0-9750474-8-5

Web search:

www.ema.gov.au Ô Publications Ô “What to do Before, During and After a Flood”

or

www.ema.gov.au/www/emaweb/emaweb.nsf/Page/Publications_CommunityAwarenessPublications_WhattodoBeforeDuringandAfteraFlood

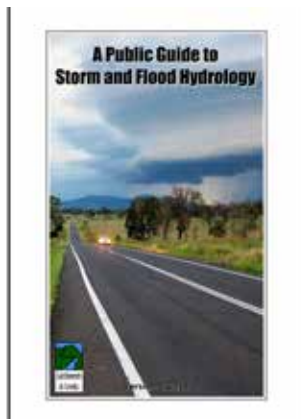


Floodplain Management in Australia

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Agricultural and Resource Management Council of Australia and New Zealand.

Standing Committee on Agriculture and Resource Management (SCARM).

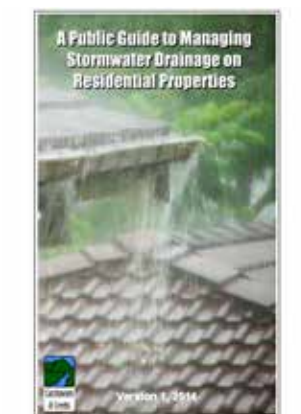


A public guide to storm & flood hydrology

A Public Guide to Storm and Flood Hydrology, Witheridge, G. 2014. Catchments and Creeks Pty Ltd, Brisbane

Available through:

www.catchmentsandcreeks.com.au



A public guide to stormwater drainage

A Public Guide to Managing Stormwater Drainage on Residential Properties, Witheridge, G. 2015. Catchments and Creeks Pty Ltd, Brisbane

Available through:

www.catchmentsandcreeks.com.au

Contents	Page
Purpose of document	5
About the author	5
Introduction	5
Impacts of floods	8
Benefits of floods	13
Types of flooding	14
Flash floods	17
Landslips and mudflows	18
The colour of floodwaters	19
Things to consider before buying or renting a home	
Natural disasters	21
Living with floods	22
Property investigations	24
Building and property inspections	25
Risks to buildings caused by waterway bank erosion	27
Flood related stormwater issues	28
Building features	31
Things to consider when building a home	32
Managing property flooding	
Controlling floods	34
Controlling different types of flooding	36
Controlling river flooding	39
Controlling creek flooding	40
Using dams to control flooding	41
Using levees to control flooding	42
Management of floodplains	43
Things to do before a flood	
Things to do before a flood	45
Learning about your flood risk	46
Critical flood heights record form	48
Preparing your property and yourself for future floods	50
Preparing a pre-flood checklist	51
Items that may need to be purchased before a flood	52
Organising flood insurance	53
Things to do during a flood	
Preparing for an imminent flood	55
Organising your pets and animals	60
Understanding flood warnings	61
Evacuating your property	62
Moving through floodwater	63
Living through a flood	64
The dangers of floodwater	66
Things to do after a flood	
Recovering after a flood	68
Cleaning up after a flood	72
Glossary of terms	75

Purpose of document

There are currently a number of government-sponsored documents available on the Internet providing guidance on preparing for floods. Rather than focus on the delivery of the same information, this document focuses on improving the knowledge base of those people living within flood-prone areas. It is hoped that through improved public awareness there will be a corresponding improvement in the public's understanding of, and response to, flood warnings.

The purpose of the document is to:

- improve the general community's knowledge of flooding issues
- improve the community's preparation for, and management of, flooding
- improve the community's understanding of, and response to, flood warnings
- assist homebuyers to make wise decisions in regards to the purchase of property
- provide a community-education tool for those professionals working within the flood control industries
- assist government officers in responding to flood inquiries.

This publication does **not** intend to represent a comprehensive engineering or technical guide to flooding. Technical issues are presented in a manner that best describes the issues from a non-technical perspective. In effect, the contents of this publication present a 'practical' perspective rather than a theoretical or academic perspective.

About the author

Grant Witheridge is a civil engineer with both Bachelor and Masters degrees from the University of NSW (UNSW). He has over 30 years experience in the fields of hydraulics, stormwater management, creek engineering and erosion & sediment control, during which time he has worked for a variety of federal, state and local governments, and private organisations.

Grant commenced his career at the UNSW Water Research Laboratory constructing and operating physical flood models of river floodplains. He later worked for Brisbane City Council on creek engineering and stormwater management issues. He currently works through his own company Catchments & Creeks Pty Ltd.

Introduction

Flooding is one form of natural disaster where communities can exercise some degree of control over both the risks and outcomes. However, in most cases the risk of flooding cannot be totally removed. Flood control dams and levees cannot prevent all floods. Even a home build on the top of a hill can still be subject to local flooding problems caused by rainwater intrusion, groundwater flooding, local stormwater run-off, or a broken water supply pipe.

Moving all people out of flood-prone land is not practical or even desirable. Many people have modified their living arrangements to allow them to live successfully on floodplains. Many people live and work within the productive agricultural lands that benefit from regular flooding. Many people accept the occasional inconvenience of floods as the price they pay for the benefits of good river views or a rural style of city living.

However, not everyone is suited to living on flood-prone land. Some people move into flood-prone areas because they cannot afford the purchase price or rental cost of flood-free homes. Unfortunately, these are usually the people that can least afford the high cost of flood insurance.

Many homes in flood-prone areas are elevated for good reason. However, if flooding is infrequent, then the lower levels of these homes are often utilised for additional living space, firstly for non-habitable activities such as laundries and games rooms, but ultimately for additional bed rooms and even rental flats. Again, it is usually the people that can least afford the cost of flooding that inhabit these flood-prone dwellings.

People often go into shock upon the onset of a flood. While in this condition, it can be difficult for people to express or receive important information, such as flood warnings. One of the most effective ways of reducing the 'shock' and increasing your 'resilience' to floods is to increase your knowledge of floods and the risks that your home and business may face. This publication has been prepared for the purpose of increasing the community's knowledge of floods, and encouraging people to better plan for future floods and the post flood recovery.

Introduction



Photo supplied by Catherine Cleary

Property flooding



Photo supplied by Catchments & Creeks Pty Ltd

A choice of building style



Photo supplied by Catchments & Creeks Pty Ltd

Flood control levee



Photo supplied by Chris Pfeiffer

Cleaning up after a flood

Introduction

- The first part of this publication looks at the various types of flooding and the impact floods can have on a community.

Things to consider before buying or renting a home

- The second section of the publication deals with the types of flood-related issues that should be considered before renting or purchasing a property.
- A short discussion is also provided on things to consider when building a home.

Managing property flooding

- This section of the publication looks at the various ways of controlling or living with each of the different types of floods.
- Discussion is provided on the pros and cons of various types of local and regional flood mitigation schemes.

Things to do before, during and after a flood

- The final three sections of this publication outline activities that may be required before, during and after a flood.

Introduction



Photo supplied by Catherine Cleary

Property flooding



Photo supplied by Catherine Cleary

River flooding



Photo supplied by Catchments & Creeks Pty Ltd

Local council



Photo supplied by Catchments & Creeks Pty Ltd

Property for sale

Flooding and drainage

- Flooding is the inundation of a building or land by water.
- Different names are given to different types of flooding based on the origin of the water prior to it entering the property.
- Drainage is the process of managing the passage of groundwater and stormwater run-off through a property.
- It is noted that poor drainage conditions can also cause property flooding.

Types of flooding

- The different types of flooding include:
 - rainwater infiltration
 - groundwater flooding
 - local flooding
 - stormwater flooding
 - watercourse flooding
 - backwater flooding
 - flash flooding
 - coastal flooding, including tidal, storm surge, wave run-up, wind-blown wave and tsunamis.

Council's responsibilities

- It is **not** the job of councils to investigate **all** the potential flooding problems associated with your home or property.
- Council's job normally involves:
 - checking that land use activities are appropriate for the given land zoning
 - checking that buildings comply with the relevant building codes (a task that may also be performed by a private certifier)
 - providing advice on creek and river flood levels where such information is known to council.

Resident's responsibilities

- When purchasing a property, it is **your** responsibility to organise the necessary building inspections and to access relevant flood information.
- When building a home it is ultimately your responsibility to ensure appropriate people are involved in its design. Knowing who to involve in the building's design usually requires the advice of experts.
- When living on a flood-prone property it is your responsibility to be aware of your flood risk and your response to flooding.

Impacts of floods



Property flooding

Property flooding

- The inundation of homes is one the most emotionally taxing aspect of flooding.
- Like any other form of home invasion, it can leave residents feeling vulnerable and powerless.
- It is this feeling of 'loss of power' or 'loss of control' that often makes people reach out in anger towards those they feel should have controlled the situation.
- This emotional pain often lasts well beyond the financial and physical impacts of floods.



Searching for a missing person

Loss of life

- Without question, the most devastating aspect of flooding is the loss of life.
- Floods can carry people from areas of relative safety to areas of extreme risk in a matter of seconds.
- Floods place people in unfamiliar situations causing panic and confusion, often resulting in people making decisions that in hindsight appear unwise or irrational.
- Floods can also result in a loss of pets and livestock.



Structural damage

Building damage

- Flood inundation of homes can damage floor coverings, wall cladding, furniture, and electrical goods.
- Structural damage to buildings is normally caused by high velocity flows; however, structural damage can also result from land subsidence that can occur either during or after a flood.
- People are often emotionally unprepared for the degree of structural damage done to their home during a flood.



Damaged furnishings

Property damage

- Often it is the loss of treasured personal items, including photos, trophies and historical records, that continues to cause grief well after the flooding has past.
- Significant water damage can occur to furniture even if the house is located in a low-velocity region of a flood.

Impacts of floods



Commercial building



Farm inundation



Problems of floodwater and mud



Flooding of mine site

Industrial and commercial buildings

- Essential businesses like food outlets, post offices, banks, newsagents and medical centres are often located within the old town centre, which is often the most flood-prone region of a town.
- While office files and light machinery can be housed within the upper floors of commercial buildings, key processing equipment often needs to be located at ground level for convenience. This can delay the re-tooling and recovery of affected businesses.

Rural communities and farming

- The flooding of rural properties may not attract the same level of media coverage as urban flooding, but the emotional and economic costs can be just as damaging.
- The flooding of farms can render crops worthless while delaying the replanting of future crops.
- Even though the introduced sediment can bring welcome nutrients, it can also introduce weeds, chemicals and diseases from upstream properties.

Loss of stock

- The loss of stock is not only an emotional loss of life, but also a loss of wealth.
- Stock can be lost during the flood by the direct actions of floodwaters, or after the flood as a result of deep mud pockets or water-borne diseases.

Mining and extractive industries

- Flood inundation of open cut mines can result in significant financial costs and production delays.
- The de-watering of large open pits can be both expensive and time consuming.
- Floodwaters pumped from these pits can be contaminated with fine particulate matter, as well as being affected by acidic waters contained in tailings dams.

Impacts of floods



Flooded roadway

Road closures

- Road closures can severely limit the movements of emergency services both during and immediately after floods, as well as preventing the safe evacuation of flood affected areas.
- Road closures also:
 - prevent the delivery of essential goods by trucks
 - interferes with the normal day-to-day movement of residents
 - isolates tourists.



Damaged railway

Damage to transport networks

- Flooding can damage road and rail corridors as well as close airports.
- Elevated roads and rail lines often act as levee banks, and thus can be subject to severe erosion as floodwaters spill over these raised embankments.
- Damaged transport networks not only cost money to repair, they also delay the overall flood recovery process.



Landslip

Landslips, bank slumping and mudslides

- Landslips are common both during and immediately after floods.
- The extent and severity of landslips usually depends on the rate at which floodwaters recede and the degree of tree clearing that has occurred on the land.
- In extreme cases, landslips can undermine homes and cause foundations to shift leaving homes uninhabitable.



Structural subsidence

Land and footing subsidence

- Flooding can cause the shifting of building foundations.
- Flooding can also cause:
 - bank slumping leading to cracking in adjacent buildings
 - swimming pools to either lift from the ground or experience severe cracking
 - land subsidence resulting in ongoing surface drainage problems.

Impacts of floods



Asphalt lifted from roadway



Photo supplied by Catherine Cleary

Damaged paperwork



Floodway rescue



Surcharging sewer

Financial cost

- The financial cost of floods can be extensive, not only for residents, but also for the community as a whole through increased government expenditure.
- It may be comforting for some people to think that governments carry the primary burden of the damage bill, but ultimately it is the community that pays these costs.
- Even the costs carried by insurance companies will ultimately be carried by future policyholders.

Loss of data, files and memorabilia

- Floods are particularly damaging towards paperwork.
- Important personal files and memorabilia can be lost, or at least badly water marked.
- Unfortunately, archived paperwork is often stored in garages and basements where its susceptibility to flood damage is increased.

Emotional stress

- Flooding can cause emotional stress and ongoing anxiety even if no property damage or personal injuries occur.
- The trauma caused by a flood rescue or being swept along a storm drain can have long-lasting impacts.
- Memories of the sound, smell and even the vibrations caused by a raging flood can last for years.

Sewer overflows and health concerns

- Floods can cause groundwater to leak into sewers, which in turn causes the sewers to overflow into urban waterways.
- Even though such overflows are heavily diluted by the floodwater, the released water is still a potential source of pollution and disease.
- Floodwaters in urban areas should always be considered a health risk.

Impacts of floods



Creek erosion

Watercourse erosion

- Some degree of creek erosion should be expected during floods, even in totally undisturbed catchments; however, urbanisation can significantly increase the extent and severity of this erosion.
- Floods can also transfer weed seed throughout a catchment.
- Invasive weed seed can also be contained within the sediments left behind by floods.



Floodwater entering ocean

Damage to marine life and habitats

- Clay-sized particles suspended by floodwaters generally only begin to settle out of the water once these waters mix with salt water, or are contained within a large water body such as a lake or dam.
- Upon entering marine waters, sediment-laden floodwaters often break free of the ocean bed and begin to spread over the surface of the ocean. Once mixed, these suspended clay particles settle to the ocean floor damaging seagrasses and corals.



Wildlife

Impact on wildlife

- The existence of property fencing can interfere with the ability of wildlife to escape from floodwaters.
- In urban areas, the movement of wildlife through suburbs is often restricted to just the waterway corridors. The flooding of these waterway corridors makes life tenuous for urban wildlife.
- Of course, flooding can have its greatest impact on burrowing animals.



Plants lost through flood inundation

Loss of floodplain vegetation

- Severe flooding can cause the loss of certain plant species.
- Some plant species die as a result of long-term inundation (even if the plant is not fully submerged) while other plants die only if they become fully submerged.
- It is important to note however, that regular flooding is essential for the survival of some riparian species.

Benefits of floods



Water supply dam

The filling of dams

- Floods can also bring many benefits, including the filling of water supply dams.
- The increased certainty of water supplies caused by regular flooding can allow greater water usage by commercial and agricultural activities.
- Not only do floods fill instream water storage dams, but floods can also allow farmers to pump water into off-stream dams that can supply irrigation water months after a flood.



Post flood clean-up

Flushing of sediments from rivers

- Soils contain particulate matter of various sizes from clays, to silts, to sands, to gravels. Over time, the gravels primarily settle in mountain streams, the sands in creeks, the silts in rivers, and the clays in bays and estuaries.
- Without regular flooding, rivers can fill with organic-rich silts, eventually causing odour and water quality problems.
- In general, flooding is as important to the long-term health of our rivers as fire is to our bushland.



Inundation of floodplain

Replenishment of floodplains

- Floods wet the soil profile within floodplains allowing deep-rooted vegetation to survive through years of drought.
- Floods also feed our floodplains with nutrient-rich sediments that replenish the lands fertility often providing farms with bountiful post-flood crop yields.
- Regular flooding is also essential for the survival of some floodplain tree species.



Salt-affected land

Flushing of salts from rivers

- Floods can help to wash damaging salts from agricultural lands.
- It is not a coincidence that salt affected lands primarily exist in regions of low rainfall, or areas where the natural wetting and drying of lands has been altered.

Types of flooding



Storm damage to roofs

Rainwater infiltration

- This type of flooding results from the direct infiltration of rainwater into a building through the roof of the building.
- Rainwater infiltration is typically associated with roof and/or building damage, whether caused by falling debris, windstorms or cyclones.
- It is noted that the absence of 'sarking' on a roof frame can increase the risk of rainwater infiltration during windstorms.



Photo supplied by Catchments & Creeks Pty Ltd

Groundwater seepage from a rock wall

Groundwater flooding

- Groundwater flooding is where water seeps from saturated ground and enters and pools on the land or within a building.
- This type of flooding typically occurs when a building is recessed into the ground and the surrounding ground becomes saturated as a result of ongoing rainfall.
- Groundwater flooding can also result from building foundations cutting through a natural groundwater spring.



Photo supplied by Catchments & Creeks Pty Ltd

Failure of a water supply pipe

Local flooding

- This type of flooding results from a locally generated source of water, such as:
 - overflowing of a washing machine, bath, or toilet
 - leaking taps
 - excessive lawn or garden watering
 - leakage from a water pipe
 - breakage of a water supply main.
- Local flooding is often random and difficult to manage.



Photo supplied by Catchments & Creeks Pty Ltd

Overland flow of stormwater run-off

Stormwater flooding

- Stormwater flooding is normally associated with the movement of overland flow through properties.
- Overland flow is stormwater run-off moving across the land surface towards a defined watercourse or receiving water.
- By definition, stormwater flooding is **not** influenced by the backing-up of waters from a downstream watercourse.
- Expert advice is usually required to distinguish between stormwater and watercourse flooding.

Types of flooding



Floodwater moving along a floodplain



Floodwater backing up into the floodplain



Flash flood – Toowoomba 2011



Property inundation during a king tide

Watercourse flooding

- Often termed creek or river flooding.
- This type of flooding is normally associated with stormwater run-off moving along a defined watercourse either within the main channel or along its floodplains.
- These floodwaters normally move with an obvious velocity, entering from one side of a property and leaving via the other side.
- It can be difficult to visually or technically separate watercourse flooding from 'backwater flooding'.

Backwater flooding

- Backwater flooding involves the spreading of floodwaters laterally into partially-isolated, low-velocity rivulets or areas of a floodplain.
- Floodplains may contain two regions; the 'floodway' where floodwaters continue to move in a downstream direction, and 'backwater regions' are where floodwaters pool with little or no forward velocity.
- Floodways are generally more dangerous than backwater regions due to the increased flow velocity within these areas.

Flash flooding

- A flash flood is where flood levels rise rapidly as a result of local rather than distant rainfall.
- Flash floods can be caused by:
 - sudden, high-intensity, local storms
 - dam or embankment failures
 - storm fronts moving in the same direction as the floodwater.
- Flash floods are more common in areas located immediately downstream of an escarpment or steep gully.

Tidal flooding

- Tidal flooding is the inundation of land by coastal or estuarial waters as a result of normal meteorological conditions.
- Tidal flooding is most commonly associated with 'king tides', which occur in mid-summer and mid-winter.
- This should **not** be confused with flooding caused by storm surge or wave set-up.
- High tides can also cause an increase in the elevation of other types of floods such as watercourse flooding and storm surge.

Types of flooding



Storm surge during a cyclone

Storm surge

- Storm surge is the temporary rise in sea level caused by the extreme surface winds and low atmospheric pressure associated with severe weather conditions, such as cyclones or hurricanes.
- Low atmospheric pressures can cause a rise in sea level additional to normal tidal movement.
- Highest sea levels occur when these storms coincide with king tides.



Wave run-up during a cyclone

Wave run-up

- Waves can cause property flooding either as a result of 'wave run-up' and/or 'wave set-up'.
- Wave run-up is the movement of wave water up a beach slope relative to the still-water level—an action commonly made more intense by an approaching cyclone.
- Wave set-up is the minor raising of sea level inside the surf zone as a result of the energy released from the breaking waves.



Wave splash during a cyclone

Wind-blown wave splash

- This type of flooding is normally associated with strong on-shore winds bouncing waves off seawalls.
- Wind-blown wave splash is most commonly associated with coastal waters, but can also occur on large lakes.
- The large volumes of water displaced by wave splash can be blown inland flooding the land before slowly finding its way back to the ocean or lake.



Tsunami inundation, Japan 2011

Tsunami

- A tsunami is a wave or series of waves generated by earthquakes or other underwater tectonic disturbances.
- It is the extremely large volumes of water associated with each wave that causes the extensive flooding of the land.
- Property damage is caused by both the depth and velocity of the flood wave passing over the land.

Flash floods



Lockyer Valley, Queensland 2011



Photo supplied by Catchments & Creeks Pty Ltd

Steep drainage catchments

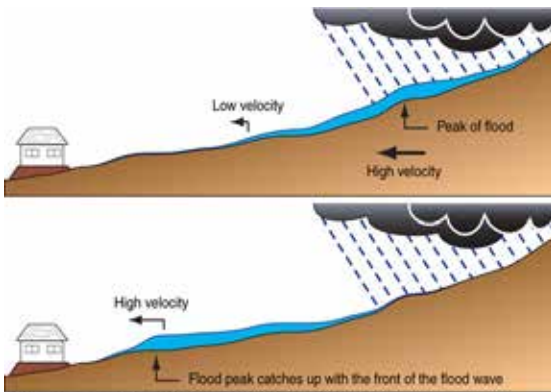


Diagram supplied by Catchments & Creeks Pty Ltd

Formation of a flash flood



Photo supplied by Catchments & Creeks Pty Ltd

Fast-flowing channelised watercourse

Definition

- The Macquarie Dictionary defines a flash flood as *'a sudden, destructive rush of water down a narrow gully or over a sloping surface in desert regions, due to heavy rains in the mountains or foothills.'*
- The term is commonly used to describe any fast rising flood where there is insufficient warning to allow evacuation or property relocation.
- The term 'inland tsunami' is inappropriate (and not recommended) though it does reflect the potential degree of damage.

Where they are likely to occur

- Flash floods can occur within any small drainage catchment, i.e. a drainage catchment where it would take less than, say, 2 hours for a person to walk to the top of the catchment.
- Flash floods mostly occur within gorges or steep hilly catchments, or in creeks located immediately downstream of gullies or steep hilly landscapes.
- However, sudden, heavy, down bursts associated with thunderstorms can cause flash flooding in any small catchment.

The cause of flash flooding

Factors that can contribute to the occurrence of flash flooding include:

- A sudden, heavy, rain burst commonly associated with a thunderstorm.
- A small, steep drainage catchment where the leading edge of the flood becomes more abrupt (like a wall of water) as the peak of the flood catches up with the leading edge of the flood wave (left).
- Dense channel vegetation folding flat during severe flooding conditions, which cause floodwaters to move faster.

Actions to reduce the risk of flash floods

The following actions can, in some cases, help to reduce the risk of flash flood damage:

- Removal of homes from high-risk areas.
- Installation of an early warning system.
- Rehabilitation of creeks and drainage lines previously channelised or concrete-lined.
- Adopting the principles of water sensitive urban design within new developments.
- Utilisation of stormwater detention systems within new developments.

Landslips and mudflows



Landslip of shallow soil profile



Landslip following soil saturation



Landslip following river flooding



Damage to homes caused by a mudflow

Landslide & landslips

- A landslide is a term commonly used to describe a mass movement of surface material, typically containing earth, rocks, vegetation and associated building materials, down the face of a slope.
- A landslip is a type of *landslide* that comprises mainly soil and underlying weathered material.
- Landslips and landslides are common during the latter stages of large floods.

Landslide triggers

Landslides are commonly triggered by:

- The saturation of shallow soil profiles established over steep rock faces (top).
- The saturation, by rainwater, groundwater or leaking pipes, of soils on steep slopes where the natural cover of deep-rooted vegetation has been depleted (left).
- The rapid lowering of floodwaters adjacent to a steep, high riverbanks after the river bank has become saturated by rainwater and/or floodwater (below).

Impact of floods on riverbanks

- Long duration river flooding can contribute to the saturation of riverbank soils (assuming the soils are not already saturated by rainwater). This infiltrated water adds significant weight to the soil, as well as weakening the soil structure.
- A rapid fall in river levels can trigger the slumping of riverbanks.
- The risk of such slumping can be increased as a result of tree clearing and dam operations.

Flooding by mudflows

- Mudflows can 'flood' the land and cause significant property damage.
- Mudflows typically occur when water is suddenly applied to poorly structured clayey soils, especially in the absence of good vegetation cover.
- **Liquefaction** is the process where certain types of clayey soils are liquefied (made fluid) usually as a result of severe vibration such as during an earthquake.

The colour of floodwaters



Flooding in rural Victoria, 2014

Clear/black floodwater

- In stable, well-vegetated catchments, rainfall and floods often cause only limited soil erosion, and as a result, floodwaters can flow relatively clear.
- However, floods can strip nutrients from the land, and the digestion of this organic matter by aquatic microbes can strip oxygen from the water leading to smelly anaerobic (low oxygen) conditions.
- Over time the floodwaters can darken, leading to the term 'blackwater'.



Flooding at Emerald, Queensland, 2011

Turbid floodwater

- Catchments with only partial vegetation cover, such as catchments that extend into arid and semi-arid regions, typically have floodwaters that take-on the colour of the local soil, in particular, the clays.
- Raindrops impacting on the exposed soil can release significant amounts of clay into the floodwater.
- The 'turbid' conditions prevent light penetration, and thus also the microbial activity leading to the smells often associated with 'cleaner' floodwater.



Lockyer Valley flooding, 2011

Dark, sediment-laden floodwater

- High velocity floodwaters can strip nutrient rich topsoils from rural and agricultural land leaving the floodwaters a dark brown colour.
- The dark colour remains for as long as the floodwaters remain turbulent; however, as the floodwaters move into low-gradient rivers and floodplains, the coarser sediments settle from the water and the floodwaters usually begin to take on a lighter brownish-redish colour.



Brisbane River flooding, 2011

Floodwaters with a hint of 'green'

- On long rivers where floodwaters take several days to pass along the waterway, sediment levels in the floodwater can reduce to a point where light penetration into the floodwater can commence algae growth resulting in a slight green colour.
- Alternatively, the combination of nutrient stripping by upland floodwaters, and the disturbance of organic-rich bed sediments by highly turbulent river flows, can also give in-channel floodwaters a greenish colour.

Things to consider before buying or renting a home

Natural disasters



Landslide and mud flows



Wind damage



Fire damage



Flood and storm damage

Earth

- The purchase of a home is a time for clear rational thinking—it is a time to ask questions about your future investment.
- Firstly, can you afford the home; secondly, can you afford the consequences of a natural disaster?
- Natural disasters include landslides, winds, fire and floods.
- Landslides can result from numerous problems including subsoil drainage problems.

Wind

- The adoption of modern building codes is the best way to prepare your home for possible windstorms.
- When buying a home, especially homes that are over ten years old, it is important to commission a professional building inspection to report on the building's compliance with current building codes.
- If the roof has been replaced with corrugated metal sheeting, then check that the roof is appropriately tied to the building foundations.

Fire

- Bushland settings are often associated with an elevated fire risk.
- Different types of bushland experience different levels of fire risk.
- The local rural fire authority and/or council should be able to provide advice on the fire risks expected to be associated with a property.

Water

- The water threat can come from many sources, including rainfall, stormwater, floods, storm surge and coastal waves.
- Most drainage problems can be solved by appropriate building repairs and/or property landscaping.
- Property flooding however, may not be so easily resolved.
- This publication aims to provide home owners and residents with assistance in living with property flooding.

Living with floods



Rural property flooding



Emergency funding



Low-level flooding

Certificate of Insurance

You have a Duty of Disclosure in revealing this insurance. Important information about your Duty of Disclosure and a number of questions in relation to it are outlined on the first page of this Certificate of Insurance. Please read this information carefully as failure to meet your Duty of Disclosure obligations could impact on your insurance.

Cover Details - Home and Contents (Classic)

Insured address: _____

Type of home: Freestanding Home on Foundations is owned and occupied by you.

Type of cover: Classic Home and Contents cover

Period of insurance: From 4pm 28 October 2010 until 4pm 28 October 2011

Sum insured:

Legal Liability	\$20 million
Home	\$248,600
Contents	\$55,100 (see table below for details of Contents cover)

Item	Where is it covered? at the home away from home *	Sum insured
General contents	✓ ✗	\$55,100
Total contents		\$55,100

* cover away from home anywhere in Australia and New Zealand

Home and contents insurance

Living with floods

- Not everyone is suited to living in flood-prone regions.
- Floodplains can be very picturesque and agriculturally fertile places to live and work, but this beauty comes at a price.
- It is important to ask yourself if you are prepared for the financial and emotional ups and downs of living on a floodplain.
- This is a time to be honest and open with your family members about the potential risks and hazards.

Financial ups and downs

- The financial impacts of flooding are not just limited to property damage, in some cases people can be laid off work for months while businesses recover from a flood and the markets return to normal.
- Living on a floodplain is a gamble, and the first rule of gambling is not to gamble anything you are not prepared to lose.
- Do you know what you could lose?
- Do you know how long you can afford to be out of work?

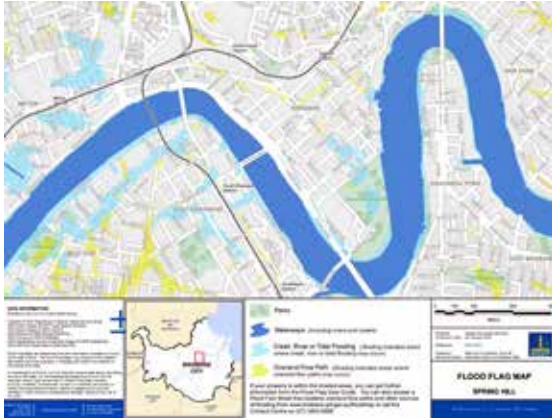
Emotional roller-coaster

- The threat of flooding can be very stressful, even if the floodwaters do not eventually reach your home.
- People often assume they can live with the flood risk given the flooding will only occur once every 50 or 100 years.
- Most people however, underestimate the emotional strain of not knowing which storm will result in the 'big flood'.
- How quickly do you think you will become tired of moving your possessions to higher ground?

Accessing flood insurance

- Comprehensive flood insurance is not always available.
- Before purchasing a home, investigate what types of flood insurance are available in the area, and whether you can afford the premiums.
- If you plan to rent a home, then investigate if you can obtain appropriate insurance for your possessions.
- Alternatively, ask yourself if you can afford not to be insured.

Living with floods



Flood map (Brisbane City Council)



Isolated property



Elevating household items



Flood-proofing home and buildings

Accessing flood risk information

- Asking questions is the best way of obtaining information about your future home or investment property.
- Useful information can be obtained from the local council or emergency services office, such as:
 - the height of historical flood levels
 - the likely frequency of flooding.
- Further guidance on where to go for information is provided in the following pages.

Speak to locals

- Learn from local residents what life is like living with the floodplain.
- Don't just consider the flood prone nature of the property, also consider the flood potential of the surrounding roads.
- Even if the property is located above expected flood levels—it could still be isolated by floodwaters.

Are you able to live with the flood risk

- Think about what possessions you would like to save in the event of a flood.
- If the home has floors elevated above the expected maximum flood level, then will you be physically capable of moving your possessions to these upper levels.
- Is the home located in an area where flood warnings will give you time to relocate your possessions.

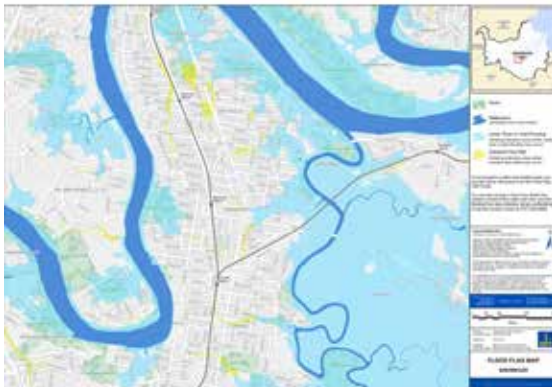
Are you self-reliant

- If you purchased a flood-prone property that will require flood proofing before each flood event, then will you be in a position to be able to purchase and install the necessary flood control measures.
- Remember; your friends or neighbours may be busy protecting their own properties, or may not even be able to access your property during a flood.
- Flood-prone properties may not be the best choice of residence for those people that need regular medical assistance.

Property investigations



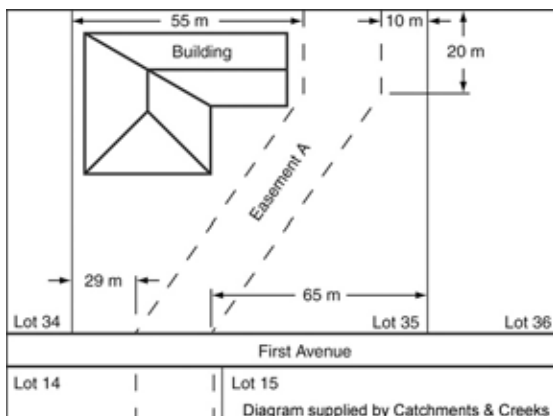
Property inspection



Flood map (Brisbane City Council)



Overland flow (red) and creek flooding



Drainage easement plan

Investigating potential problems

- The purchase of a home is likely to be one of the biggest investments you will ever make, so why not take the time to investigate the risk of flooding.
- If your initial investigations raise some concerns, then arrange for an expert to carry out a more detailed investigation.
- A consulting engineer specialising in flooding can interpret government flood data, and where necessary, carry out site specific flood modelling.

Flood maps

- State and local governments often provide flood maps to help people identify flood-prone properties.
- Flood maps usually identify only those properties directly affected by creek or river flooding.
- In coastal areas it may be necessary to download storm surge maps.
- In cyclone areas it is also important to study the flood risk of proposed evacuation routes.

Overland flow paths

- Some flood maps not only identify areas subject to creek and river flooding, but also the location of major overland flow paths (here shown in red, but may appear in another colour on other maps).
- These maps identify only those areas subjected to 'concentrated' overland flow.
- Overland flows generally only cause property flooding when a blockage occurs along the flow path, or a property has a poorly designed drainage system.

Registered drainage easements

- The existence of a drainage easement does not necessarily mean that the property has a drainage problem, but it does suggest that further investigations need to occur before purchasing such a property.
- Drainage easements may exist on a property for a number of reasons, including:
 - protection of underground pipes
 - protection of an overland flow path
 - protection of an open drain.

Building and property inspections



Building inspection report



Internet search

ENGINEERS—See	ENGINEERS (Cont'd)
Aeronautical Engineers..... 88	—See
Bio-Medical Engineers..... 227	Power Transmission Equipment & Supplies..... L-Z 1686
Chemical Engineers..... 413	Precision Engineers..... L-Z 1687
Civil Engineers..... 441	Printing Engineers..... L-Z 1696
Combustion Engineers..... 474	Radio Distributors, Parts & Service..... L-Z 1716
Designing Engineers..... 641	Refrigeration Engineers..... L-Z 1745
Diesel Engineers..... 642	Repetition Engineers..... L-Z 1753
Electrical Engineers..... 775	Sound Engineers..... L-Z 2012
Electronic Engineers..... 779	Steam Engineers..... L-Z 2029
Engineers-Consulting..... 794	Structural Engineers..... L-Z 2061
Engineers-General..... 797	ENGINEERS-AUTOMATION—See
Engineers-Installation &/or Maintenance..... 799	Automation Systems & Equipment..... 168
Engineers-Manufacturing..... 799	ENGINEERS-COMMUNICATION—See
Geotechnical Engineers & Consultants..... 996	Radio Communication Equipment & Service..... L-Z 1714
Heating, Hot Water & Ventilating Engineers..... 1060	Telephone Systems & Equipment..... L-Z 2123
Hydraulic Equipment & Supplies..... 1124	ENGINEERS-CONSULTING..... 794
Marine Engineers..... L-Z 1355	See Also
Mechanical Engineers..... L-Z 1370	Geotechnical Engineers & Consultants..... 996
Mining Engineers..... L-Z 1379	ENGINEERS-GENERAL..... 797
Motor Engineers & Repairers..... L-Z 1411	
Plastics-Toolmakers & Engineers..... L-Z 1630	

Continued Next Column

Typical Yellow Pages listing



Gully erosion up-slope of a new home

Property inspections

- There are some professional property inspections that you should be arrange whether or not a potential flood or drainage problem is expected to exist.
- These reports include:
 - a building inspection by a qualified building inspector
 - a search for any easements that may exist across the property
 - a flood risk search.

Flood investigations

- In most cases a flood search conducted through the local council will provide all the necessary flood information in regards to potential creek and river flooding.
- However, this type of flood search will not necessarily provide all the information you need; for example, it may not include information on the flood risks associated with overland flows.
- In some cases, additional property inspections will be required, which will involve searching for the right consultant.

Consulting engineers

- Civil engineering is the branch of engineering that normally deals with flood and drainage investigations.
- However, an Internet/Yellow Pages search for a civil engineer is likely to list mainly those engineers that focus on structural design and/or civil construction.
- Engineers that specialise in stormwater management and flood investigations are more likely to be listed under the heading '*Engineers – Consulting*'.

Soil investigations

- If your building proposal involves cutting into the side of a steep slope to form building foundations, then a geotechnical investigation is recommended.
- If the soil tests identify dispersive, sodic or slaking soils, then advice from a 'soil scientist' may be required.
- If the soils are chemically unstable, then cutting into the hill-slope may initiate major gully erosion problems, or worse, landslips.

Building and property inspections



Roof drainage

Roof drainage

- A report on the drainage system of existing buildings is usually included in the 'building inspection' conducted by a registered building inspector.
- A plumber can be engaged to further investigate specific issues identified within the building inspection report.
- Specialist roofing contractors can also identify and rectify roof drainage problems.



Property drainage

Property drainage

- Investigations into potential overland flow problems, including the management of stormwater run-off entering your property from adjacent properties, normally requires a drainage engineer.
- The drainage engineer may also be able to advise if legal advice is required to resolve the matter.
- Remember; poor drainage can cause property flooding even if the house is located on the top of a hill.



Failed rock retaining wall

Retaining walls

- The weather conditions that can cause creek and river flooding, can also cause local soil saturation leading to the shifting or failure of retaining walls.
- Most of the problems associated with retaining walls relate to either subsoil drainage or land instability issues.
- Drainage issues should be investigated by a stormwater or geotechnical consultant.
- Land stability issues should only be investigated by a geotechnical consultant.



Creek bank failure

Creek and riverbank erosion

- If a home is located on a steep slope or close to the banks of a watercourse, then landslips or bank erosion could threaten to undermine the home.
- Always ask yourself: why is the home up for sale?
- A civil engineer or river morphologist will be required to investigate the risk of watercourse erosion.
- A geotechnical engineer may be required to investigate the potential for the bank erosion to cause a landslide.

Risks to buildings caused by waterway bank erosion



Meandering waterway

Most waterways move over time

- Most people retain the expectation that creeks and rivers are 'static' structures that only erode or move if something is 'wrong' within the catchment.
- The truth is that most waterways move laterally or slowly change their shape as a part of their natural processes.
- Some waterways move slowly year by year, while others may rest quietly for decades only to move violently during a severe flood.



Bank erosion on outside of channel bend

The risks presented by channel bends

- In general, bank erosion can occur anywhere along a waterway, but the most active and mobile regions of waterways are the outsides of channel bends.
- Channel beds exist because of ongoing channel erosion, and this ongoing erosion normally means that it is generally unwise to locate a home on the outside of a channel bend.
- The exception to this rule is when the home sits on solid rock, which is preventing any further bank erosion.



Bank stabilisation works

Bank erosion is not always so easy to solve

- When bank erosion does threaten a home, the usual response is to request that authorities stabilise the waterway.
- However, if the waterway is contained within private property, then most governments are reluctant to assist.
- There are also many circumstances where the placement of bank stabilisation measures will just relocate the erosion problems to another location.



Bank stabilisation works

Seeking professional advice on waterways

- Understanding waterways is a complex pursuit of which few will master.
- Inappropriate advice is often supplied by those whose primary experience is in design or building of retaining walls.
- The appropriate management of waterways usually requires advice from a team of experts, including:
 - waterway engineer
 - soils and/or geotechnical specialist
 - revegetation consultant
 - waterway ecologist.

Flood related stormwater issues



Photo supplied by Catchments & Creeks Pty Ltd

Overland flows passing under a fence



Photo supplied by Catchments & Creeks Pty Ltd

Concentrated overland flow



Photo supplied by Catchments & Creeks Pty Ltd

Overland flow through rear of property



Driveway entry lowered below footpath

Property fencing

- It is important to study the property fencing and consider any potential impacts it may have on the movement of overland flows.
- Historically, property fencing typically consisted of an open style that freely allowed the passage of stormwater run-off.
- However, renovated properties often install solid fencing (e.g. to enclose a swimming pool)—such fencing can interfere with the natural passage of overland flows causing property flooding.

Overland flows

- Overland flows can occur as either sheet or concentrated flow.
- In the past, homes were often elevated above the ground to allow overland flows to pass freely under the buildings.
- However, the modern practice of constructing homes directly on a slab of concrete has prevented this natural flow of stormwater run-off, consequently floor levels need to be set above the expected depth of this overland flow.

Overland flow paths

- In some cases the occurrence of overland flows is common and undaunting; while in other cases the occurrence can be rare and alarming.
- Problems usually occur when people try to interfere or change the 'natural' travel path of stormwater run-off.
- If the property is located below the roadway, then residents need to consider the risk of flows spilling from the roadway into their property, especially if the driveway entrance has been modified.



Photo supplied by Catchments & Creeks Pty Ltd

Water spilling down modified driveway

Flood related stormwater issues



Photo supplied by Catchments & Creeks Pty Ltd

Natural drainage valley

Homes built along the valley floor

- The risk of flooding from overland flows is increased when homes are constructed along the floor of natural valleys.
- Before investing in such properties it is important to confirm that appropriate measures have been taken to manage overland flows **through** the property.
- Controlling overland flows by attempting to 'pipe' all stormwater run-off under a building is **not** recommended—there will always be a bigger storm that eventually causes overland flow.



Photo supplied by Catchments & Creeks Pty Ltd

'Sag' type kerb inlet

Roadside stormwater inlets

- There are two types of roadside stormwater inlets, 'sag inlets' and 'on-grade inlets'; however, their appearance can vary from region to region.
- Sag inlets typically have a metal grate located in the middle of the kerb opening.
- These inlets normally exist at the lowest points in a road profile such as a valley.
- A sag inlet located outside a property **may** indicate that overland flows are possible through the property during major storms.



Photo supplied by Catchments & Creeks Pty Ltd

'On-grade' kerb inlet

Roadside stormwater inlets

- On-grade inlets normally have a grate at the down-slope end of the kerb opening.
- On-grade inlets can exist at almost any location along a roadway, except at depressions and valley floors.
- The existence of an on-grade kerb inlet outside a property does **not** indicate that drainage problems exist on that property.
- Older kerb inlets may look significantly different from the modern examples shown here.



Photo supplied by Catchments & Creeks Pty Ltd

Residential field inlet

Stormwater inlets located within a property

- A 'field inlet' is a stormwater inlet located within open ground.
- Field inlets are often located along overland flow paths and at depressions within a property where stormwater run-off will likely collect.
- Local flooding problems can occur if these inlets become blocked with debris.
- It is important to consider what will happen if any stormwater inlet becomes fully blocked with debris such as leaves or garden mulch.

Flood related stormwater issues



Roadside kerb inlet to stormwater pipe



Flow along roadway during major storm



Backup of tidal water into coastal suburb



Rubber 'duckbill' backflow control

Solving stormwater related flood issues

- Councils often receive requests from residents for an enhancement of the pipe drainage system passing along their road.
- In some case, such drainage works can solve local drainage/flooding problems.
- However, in many cases the solution to the flooding problems cannot be found simply through an increase in the pipe size.
- In some cases such pipe increases can actually increase flood problems.

Roads are designed to carry stormwater

- Most roads are actually designed to carry stormwater run-off from 'major' storms.
- The pipes that pass under roads are only designed to carry the stormwater run-off that results from 'minor' storm; that being storms that occur more frequently than once in two to ten years.
- The occurrence of flow on a road (left) does not necessarily mean that the piped drainage system is blocked, or that the engineers made a mistake, it could just mean that there was a lot of rainfall!

Limited benefit of drainage pipes

- In order for stormwater drainage systems to be effective, it is essential for the water level within the drainage system to be 'higher' than the floodwaters within the adjacent creek, river or ocean into which it must drain!
- In some low-lying suburbs, an increase in the size of the stormwater pipes may in fact result in an increase in 'backwater flooding' from the adjacent waterway.

Use of backflow control devices

- To limit the adverse effects of backwater flooding along drainage pipes, some drainage systems are fitted with backflow control valves.
- Backflow control devices can be very useful in low-lying suburbs, especially land protected by flood levees.
- However, there are many significant complications associated with these systems and not all stormwater engineers favour their use.

Building features



Low-set home

Low-set homes

- Currently the most common form of building construction is 'slab-on-ground'.
- These homes are referred to as low-set homes even if the building is constructed on fill (imported earth) to elevate the home above the expected flood level.
- This type of construction may not be appropriate for homes located within floodplains.
- Also, the risk of flooding by overland flows should always be investigated.



Low-set home on stumps

Homes on stumps

- Placing a home on stumps or brick footings can significantly reduce the risk of flooding and drainage problems.
- However, it is still important to ensure (through a flood search) that the floor levels are well above expected flood levels—not 'just' above, but well above.
- Also, air should be able to circulate freely under the building to allow the ground to dry out after heavy rainfall.



High-set home

High-set homes

- Elevated pole homes are generally the best option for flood-prone areas.
- However, drainage and flooding problems can arise if the lower level is enclosed to make 'better' use of the space.
- Such problems may exist if the lower level is eventually used for:
 - additional bedrooms
 - rental accommodation
 - playrooms or storerooms containing expensive equipment.



Groundwater weeping from retaining wall

Retaining walls

- Modern building practices often require the formation of a level building platform partially surrounded by retaining walls.
- Issues to consider when buying a property that contains retaining walls include:
 - how long are the walls expected to last before the building materials begin to fail and the walls need to be replaced
 - is groundwater seepage from the walls likely to become a problem—often only evident after prolonged rainfall.

Things to consider when building a home



Building on elevated ground

Location of the home on the property

- On large properties there may be a lot of flexibility on where a home is located.
- Ideally, locate buildings outside the 50 year flood level, with floor levels **at least** 300 mm above the 100 year (1%) flood.
- It is important to study how stormwater will move across your property, and where possible, locate the home away from natural drainage lines.
- **Remember;** it is not council's job to check that your home is positioned correctly.



A choice of building style

Style of construction

- There are various types of building construction; including slab-on-ground, low stumps, elevated homes with open breezeways, and pole homes.
- It is important to select the style of construction that is most suitable for your property—not just the style that is the cheapest to build!
- If the building will be flood prone, then construct one side of all walls out of water resistant materials to aid in post flood clean-up.



Slab-on-ground home

Slab-on-ground construction

- Slab-on-ground construction is the building style most likely to experience flooding and drainage problems, so its use requires good knowledge of the site's drainage and flooding characteristics.
- During major storms, the depth of flows passing around the building can cause water to spill into the home.
- If you have concerns, then seek expert advice from an appropriate drainage consultant in addition to the advice from your builder and local council.



Flood-prone non-habitable rooms

Lower-level, flood-prone rooms

- People that live in elevated homes often choose to establish 'non-habitable' rooms under the building.
- Such rooms can be used for a variety of purposes, including laundries and play rooms.
- If flooding is infrequent, these play rooms often turn into spare bed rooms.
- Never forget that these lower levels are subject to flooding, and never forget the memories and treasures that can be damaged if a flood occurs.

Managing property flooding

Controlling floods



Nutrient-rich conditions in Darling River

Floods are important for river health

- People typically approach the problem of flood damage by focusing solely on wanting to stop the occurrence of floods.
- Unfortunately the psychological and financial trauma that results from flood damage often prevents people from recognising the important role that floods play in river systems.
- The fact is, floods are as important to the long-term health of rivers as fire is to the long-term health of much of our bushland.



River dredging

Floods help to mobilise bed sediments

- All water bodies, including creeks and rivers, experience the deposition of sediments and organic matter.
- Floods are nature's way of controlling the ongoing movement of this material.
- Without floods, rivers will eventually accumulate excessive quantities of bed sediments leading to water quality and odour problems.
- Without significant flooding, many rivers would require regular dredging.



Flood control levee system

Lateral thinking

- Controlling flood damage sometimes requires the management of the floodwaters, but in most cases the best outcomes are achieved through the management of our response to floods.
- The river is not the problem—it is our response to the river that is in question.
- Our options greatly increase if we are willing to look at the problem from a different perspective—real outcomes are only achieved through the application of lateral thinking.



Raising a flood-prone house

Problem solving

Numerous measures have been adopted around the world to control flooding. These measures can generally be grouped into the following four categories:

- Remove the problem
- Remove yourself from the problem
- Change the outcomes of the problem
- Change your response to the problem

These problem solving methods are discussed in the following pages. As in most cases, problems are best solved with the foresight gained from the lessons already learnt.

Controlling floods



Flood control dam

1. Remove the problem

In the case of flooding, 'removing the problem' usually involves the following options:

- Constructing extremely large flood control dams that are not solely operated as water storage dams, but instead are maintained at a lower storage level.
- Constructing flood control levees.

However, all dams and levees can be overtopped, so these options generally just remove the smaller floods—the problem of the bigger floods still exists.



Photo supplied by Catchments & Creeks Pty Ltd

Relocation of the town of Grantham

2. Remove yourself from the problem

This approach usually involves one of the following options:

- Individuals selling their properties and moving to higher ground.
- Whole communities or towns being relocated to higher ground.

The option of people selling their home and moving to higher ground only solves the flood problem for the family moving to higher ground, not the new family moving into the flood prone home.



Photo supplied by Catchments & Creeks Pty Ltd

High-set home

3. Change the outcomes of the problem

This approach usually involves one or more of the following options:

- Changing the extent of flooding through the construction of floodplain levees.
- Lifting buildings above the expected maximum flood level.
- Relocating important items to the upper floors of buildings (assuming these upper floors are above flood level).
- Establishment of an early warning system to allow the evacuation of people.



Photo supplied by Catherine Cleary

Rebuilding after a flood

4. Change your response to the problem

This approach usually involves one or more of the following options:

- *Knowledge* – being aware of the risks associated with living on a floodplain and how to respond to these flood risks.
- *Preparation* – being prepare for future floods, including planning your evacuation procedures.
- *Acceptance* – accepting the outcomes of floods and being able to clean-up and re-engage with the community after floods.

Controlling different types of flooding



Displaced roofing material

Rainwater infiltration

The risks of building damage as a result of rainwater infiltration are best minimised by:

- Ensuring roofing materials are adequately attached to buildings in accordance with current building codes.
- Conducting roof inspections of older buildings to determine if potential drainage problems exist.



Salt damage to brickwork

Groundwater flooding

The risks of groundwater flooding are best minimised by:

- Being proactive when reacting to early warning signs such as:
 - long-term groundwater seepage
 - salt damage on walls
 - white salt stains on concrete slabs
- Installing a subsoil drainage system.
- Being aware that at some time, rainwater will fully saturate the soil and cause stormwater to flow over the ground.



Floor level set below adjacent ground

Local flooding

It is very difficult to control this type of flooding because the water usually originates from either a pipe failure or the failure to properly turn off a tap.

The risks can be minimised by:

- Installing overflow drains within toilets, bathrooms and laundries.
- Ensuring any new landscaping placed around a home does not cause surface run-off to flow towards a doorway (left) even if the area is under a roof.



Raised fencing over an overland flow path

Stormwater flooding

The risks of stormwater flooding are best minimised by ensuring:

- Any new landscaping or fencing placed around a home does not block essential overland flow paths.
- Floor levels are set above the expected overland flow water level—this may require analysis by a drainage engineer.
- A suitable overland flow bypass exists in the event of blockages within a piped drainage system.

Controlling different types of flooding



River flooding

Watercourse flooding

The risks of watercourse flooding are best managed by ensuring:

- Floor levels are set at least 300 mm above the expected 1 in 100 year (1%) flood.
- The flood storage capabilities of upstream floodplains are protected from filling and the construction of flood control levees.
- Adoption of the principle of water sensitive urban design within new developments.

Further discussion on creek and river flooding is provided over the following pages.



Backwater flooding

Backwater flooding

The risks of backwater flooding are best managed by ensuring:

- Floor levels are set at least 300 mm above the expected 1 in 100 year (1%) flood.
- The flood storage capabilities of upstream floodplains are protected from filling and the construction of flood control levees.
- Critical overland flow paths are not blocked by new buildings or property fencing.



Photo supplied by Catchments & Creeks Pty Ltd

Stormwater retention basin

Flash flooding

The risks of flash flooding are best managed by:

- Removing homes from high-risk areas.
- Establishing an early warning system.
- Construction of regional stormwater detention or retention basins.
- Rehabilitating creeks and drainage lines previously channelised or concrete-lined.
- Adoption of the principle of water sensitive urban design within new developments.



Photo supplied by Catchments & Creeks Pty Ltd

Backflow control gates

Tidal flooding

The risks of tidal flooding are best managed by:

- Ensuring floor levels are set at least 300 mm (preferably 500 mm) above the expected king tide water level.
- Installing backflow control devices on stormwater pipes.
- In extreme cases, constructing flood control levees.

Controlling different types of flooding



Elevated beach-front property

Storm surge

The risks of storm surge flooding are best managed by:

- Removing buildings from the dunal zone of coastal areas.
- Ensuring floor levels are set at least 300 mm (preferably 500 mm) above the expected 1 in 100 year (1%) storm surge level.



Coastal zone with vegetated dunal area

Wave run-up

The risks of flooding from wave run-up are best managed by:

- Retaining or re-establishing a vegetated dunal system between coastal properties and the sea front.
- Ensuring floor levels are set at least 300 mm (preferably 500 mm) above the expected 1 in 100 year (1%) storm surge level.



Reshaping of beachfront

Wind-blown wave splash

The risks of flooding by wind-blown wave splash are best managed by:

- Reconstructing beaches in front of seawalls.
- Avoiding the construction of vertical seawalls in front of homes, especially if the seawall faces the dominant wind direction.
- Constructing a recessed roadway and associated drainage system between seawalls and residential properties.
- Setting homes well back from seawalls.



Photo supplied by Catchments & Creeks Pty Ltd

Concrete flood control barrier

Tsunami

- Protection from tsunami flood waves is sometimes provided through the use of large concrete barriers; however, these barriers can still be overtopped causing significant loss of life.
- Protection from tsunamis is best achieved through:
 - the establishment of an early warning system
 - the establishment of clearly identified (signed) evacuation routes.

Controlling river flooding



River flooding, Brisbane 2011



Inundated river floodplain



Photo supplied by Catchments & Creeks Pty Ltd

Flood control dam



River flooding, Ipswich 2011

Creek and river flooding

- Technically there are no real differences between creek and river flooding.
- Creek flooding is more closely associated with 'flash flooding' where circumstances often prevent effective flood warning.
- River flooding is most commonly associated with large waterways where floodwaters can take days to travel along the waterway; thus providing ample opportunity for flood warning.

Retention of floodplain storage

- The temporary storage of floodwaters within floodplains helps to reduce the volume of water within the main flood wave, and thus reduces the severity of downstream flooding.
- Wherever possible, the flood storage capabilities of floodplains should be preserved.
- Flood control levee should be installed with caution, and then only to protect town centres, not floodplains.

Flood control dams

Major flood control dams can significantly reduce both creek and river flooding; however, there are negative consequences, including:

- The high cost of construction.
- The larger the storm, the lower the potential reduction in flood levels.
- Interference to natural river processes such as fish passage.
- A significant reduction in the natural flushing of sediment from the downstream waterway.

Town planning

- River flooding is best managed through appropriate town planning; unfortunately, relocating large towns is generally impractical.
- Minimum floor level elevations should be specified for all new buildings.
- Residents should also be aware that the 1% (1 in 100 year) flood level is not the highest expected flood level.
- Flood control levees, though a valid option in some cases, should in general only be used as a last resort.

Controlling creek flooding



Retained creek, riparian zone & floodplain



Elevated residential property sites



Re-planting within an urban waterway



Channelisation of urban waterway

Retention of floodplain storage

- Because the total volume of floodwater involved in urban creek flooding is usually significantly less than that of river flooding, any loss of floodplain storage can have a significant impact on downstream flood levels.
- Wherever practical, the natural topography and flood storage capabilities of urban floodplains should be preserved.
- Flood control is best achieved through the provision of cleared floodways located outside the creek's riparian zone.

Town planning

- Flood management in urban areas is best achieved through appropriate town planning, flood response planning, public education, and the adoption of the principles of Water Sensitive Urban Design (WSUD).
- Water Sensitive Urban Design involves:
 - preservation of existing topography
 - integration drainage corridors into designated areas of open space
 - preservation of the natural water cycle
 - protection of water quality.

Re-planting waterway catchments

- Restoring vegetation within the upper reaches of urban creeks can help to slow floodwaters and increase the effective flood storage, thus helping to reduce the severity of downstream flooding.
- Unfortunately, increasing vegetation within critical flood-prone reaches of a waterway can raise local flood levels.
- Vegetation management along urban waterways is a complex science requiring guidance of experts.

Channelisation of waterways

- The channelisation of urban waterways for flood control should only be considered as a last resort.
- The negative aspects of channelisation include:
 - potential increases in downstream flooding caused by increased flow velocities within the upper catchment
 - loss of terrestrial habitats and wildlife movement corridors
 - significant impacts on fish habitats and fish passage.

Using dams to control river flooding



Storage dam without flood control gates



Regulated (gated) dam



Non-regulated dam



Bank slumping downstream of a dam

Flood control dams

- All water storage dams have the ability to reduce the extent of flooding even if the dam does not have movable gates.
- However, some dams are specifically designed to provide both flood control benefits and water storage.
- The ability of a dam to control flooding depends on the available water storage prior to commencement of the storm.
- Gated dam spillways can provide greater flexibility in flood control.

Operation of flood control dams

- Flood control dams regulate flooding by capturing all or part of the floodwater, then releasing it at a lower flow rate than would otherwise have occurred.
- The successful operation of these dams requires the accurate prediction of the expected flood volume.
- Predicting the volume of floodwater requires the measurement or prediction of rainfall depths over all parts of the drainage catchment.

Impact of multiple, overlapping storms

- Flood control dams provide greatest benefit in the control of single peak storms.
- In the event of overlapping storms, these dams may reach their full capacity during the first storm, thus leaving little storage capacity to capture the second storm.
- In such conditions, the peak flood levels may only be slightly lower than that which would have occurred if no dam had existed.

Consequences of regulating flood flows

Some of the adverse consequences of using dams to regulate flood flows are:

- Significant impacts on fish migration.
- Increased bank slumping downstream of regulated dams, especially if the flood control gates are closed quickly.
- Prevention of the natural movement of river sediments.
- Alteration of natural processes and plant selection within downstream floodplains.

Using levees to control river flooding



Flood control levee, Launceston



Failure of earth embankment



Temporary flood levee



Roadside stormwater inlets covered

Flood control levees

- Flood control levees are possibly the most controversial of all the flood mitigation options.
- Unlike dams, which generally provide some degree of flood benefit no matter what severity the storm is, flood control levees are generally an all or nothing solution.
- The outcomes are either; no flooding, or the levees are overtopped and the flooding is just as severe as if the levees were not in place.

Long-term cost of flood damage

- Over the long-term, total flood damage costs can actually increase with the use of flood control levees.
- The existence of the levees tends to give residence a false sense of security resulting in people failing to adequately prepare for possible overtopping events.
- This means that flood damage occurs less often, but when flooding does occur, the resulting damage is increased because valuable household items are not located above potential flood levels.

Temporary flood levees

Temporary flood levees can be constructed around individual properties provided:

- Sufficient flood warnings exist to organise and construct the levees.
- Sufficient pre-flood planning has occurred resulting in the acquisition of necessary materials (plastic sheeting & sandbags).
- Suitable earthmoving equipment or contractors are available to construct the levees—alternatively, prefabricated steel levee systems can be purchased.

Temporary earth levees

Temporary earth levees can be problematic for the following reasons:

- Construction of the levees requires an accurate determination of the expected maximum flood height.
- Loosely compacted earth levees can be subject to significant leakage.
- People often forget to cover stormwater inlets, and as a result, floodwaters surcharge through the stormwater pipe network causing flooding behind the levee.

Management of floodplains



Photo supplied by Catchments & Creeks Pty Ltd

Riparian vegetation

Achieving a stable waterway

- Maintaining healthy riparian vegetation along each side of a watercourse has several benefits, including improved bank stability during floods.
- Maintaining a healthy vegetation cover is all about placing the right plants in the right place.
- Reducing plant cover may reduce flood levels, but a consequence of this action is often an increase in flow velocity, which can be more damaging than flood height.



Floating flood debris

Controlling things that can float away

- Large items removed by floodwaters can cause significant damage to downstream buildings and the blockage of culverts.
- Floodplains are often very productive agricultural lands where essential farming equipment must be stored.
- Wherever practicable, those materials that can be dislodged by floodwaters, including plastic water tanks, should be secured or placed on elevated ground.

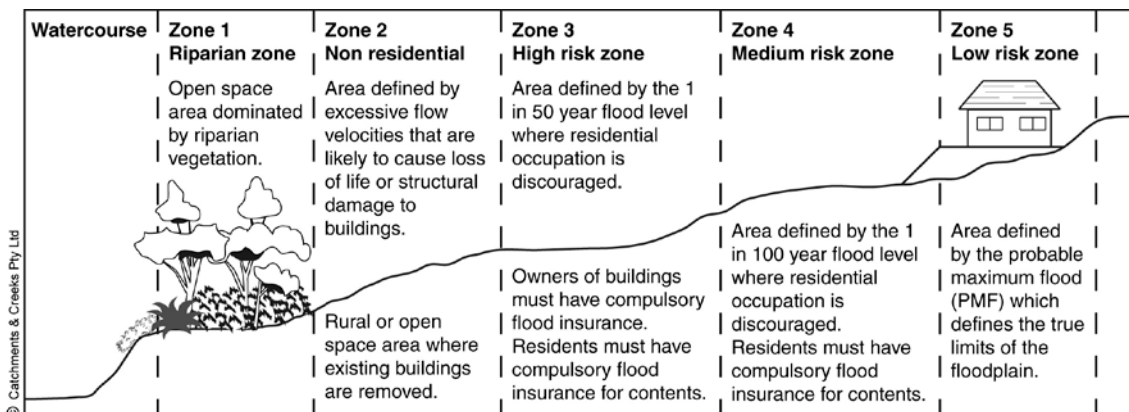


Flooded homes

Correcting the mistakes of the past

For the long-term good of existing and future residents, communities should encourage governments to correct the mistakes of the past, including:

- Re-zoning floodplains to better manage flood-prone properties and significantly reduce the structural damage and loss of life caused by floods.
- Raising high-risk buildings or relocating them to higher ground.
- Adopting an appropriate floodplain zoning scheme such as presented below.



Example land-use zoning within floodplains

Things to do before a flood

Things to do before a flood



Property flooding

Learn about your flood risk

- Familiarity and knowledge of your local environment and the risks associated with your property can help you to avoid the onset of panic during natural disasters.
- Knowledge of your flood risk helps you to better plan for, survive, and recover from flood events.
- Details on how to collect information about your flood risk are presented over the following pages.



Photo supplied by Catchments & Creeks Pty Ltd

Home emergency kit

Plan and prepare for a flood

- Knowledge of your flood risk is of little value unless it is used to better plan for future floods.
- The best time to plan your response to a flood is well before the flood occurs.
- The best time to purchase the necessary flood management equipment and emergency provisions is before flood warnings are issued.



Property evacuation

Plan your evacuation

- It is also important to investigate the flood risks associated with the roads that surround your property.
- In most cases, the roads around a property will become impassable well before the flood inundates the home.
- It is important to plan your escape route and to know the river conditions that need to exist for a safe evacuation.
- Guidance on planning flood evacuation procedures is provided later within this document.



Photo supplied by Catherine Cleary

Rebuilding after a flood

Plan your return and rebuild

- The emotional and financial costs of a flood are strongly linked to how quickly you can recover from the flood and get back to normal work and living conditions.
- Building materials can become scarce in the days and weeks following a flood; however, it would be unwise to stockpile building materials if they are likely to be washed away or damaged by the flood.
- Guidance on planning your flood recovery is provided within the final chapter.

Learning about your flood risk



Who to ask

Where to go for help

- Your local council is usually the best organisation to ask about historical and anticipated (future) flood levels.
- The local *emergency services* organisation is usually the best source of information during a flood, and the preparation of evacuation procedures, especially if it involves river flooding.
- A specialist flood or stormwater consultant is usually the best source of information on managing floodwaters on your property.

Questions for your local council

Ask your local council the following:

- What will be the water level at the 'city gauge' when my home begins to flood?
- Is it possible for my home to be isolated by floodwaters?
- Where is the nearest flood-free evacuation point (e.g. council park, shopping centre, or community centre)?
- How will I know if council's flood and/or evacuation warnings are relevant to my property?



Photo supplied by Catchments & Creeks Pty Ltd

Local council

Questions for Emergency Services

If your property is likely to be affected by river flooding, then the following information may be sourced from your local emergency services organisation, otherwise ask your council.

- Historical flood levels near your property.
- Typical rate of rise of flooding.
- Typical duration of flooding.
- Best evacuation route.
- The best source of information on flood and evacuation warnings.
- Types of flooding affecting your property.



State emergency services

Questions for your consulting engineer

If the necessary information is not currently available from government authorities, then you may need to commission an engineering consultant to answer the following:

- What are our flood risks?
- What water level is likely to exist at the official river/city gauge when our home begins to flood?
- What actions can be taken to reduce the flood risk at our home, and what actions should be taken in the event of a flood?



Preparation for imminent rural flooding

Learning about your flood risk



Flooded road crossing



Approaching storm



A flood level of 9.15 m at the river gauge



Historic flood marker

Know what safety risks may occur

- High flow velocities generally represent a greater risk to life and property than high flood levels.
- The flow velocity at your property generally relates to how close your home is to a waterway or floodway.
- Highest flow velocities often exist at road crossing, thus your evacuation **must** occur well before the roads are flooded.

Critical storm duration

- Different sized waterways respond differently to different types of storms.
- The larger the drainage catchment, the longer the duration of heavy rainfall that is required to cause severe flooding.
- Thunderstorms often cause flooding in small creeks, but such storms are unlikely to cause flooding in large river systems.
- Do you know the type of storm or catchment conditions that are likely to cause flooding at your property?

Official city gauge

- In the hours, days or weeks prior to a flood, certain authorities will issue flood warnings. These flood warnings are usually issued relative to an official river gauge.
- Well before a flood occurs, you will need to ascertain from the relevant authority the relationship between this river gauge and flood levels at your property.
- To assist you in this process, a data sheet and worked example are provided in the following pages to help you record critical flood heights for your property.

Historic floods

- Flood warnings are sometimes issued relative to a past flood event; e.g. *'Peak flood levels are expected to be 0.5 metres above the 1974 flood level'*.
- If your property has flooded in the past, then it is important to know the height these floods reached at your property. This information can also be used to define the height difference between the river/city gauge and your property.
- Historical flood information can normally be obtained from your council.

Critical flood heights

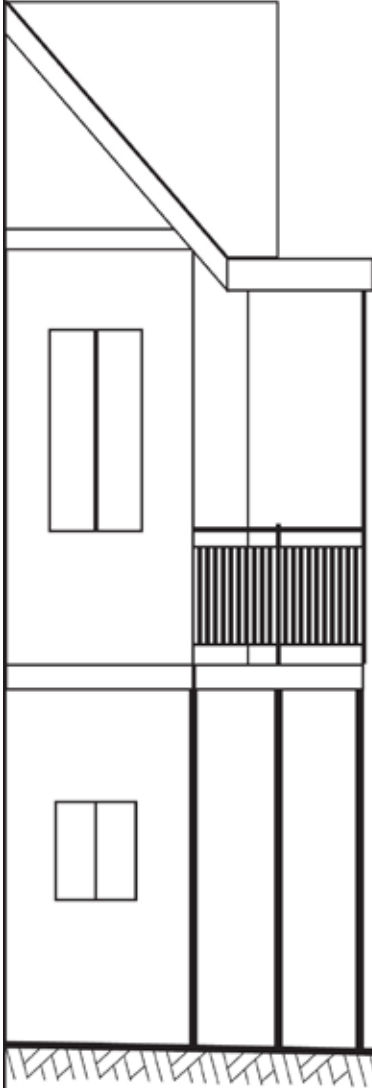
Property location: _____

	Flood height at your property	Predicted flood frequency	Flood height at river gauge
Top of roof:	-----	-----	-----
Ceiling or attic level:	-----	-----	-----
Upper floor level:	-----	-----	-----
Lower floor level:	-----	-----	-----
Lowest property level:	-----	-----	-----
Floodwaters begin to cross evacuation roads:	-----	-----	-----
Nominated property evacuation flood level:	-----	-----	-----

Critical flood heights (example)

Property location: 13 Station Road, Riverview

Note: the elevation difference between flood levels at the river gauge and flood levels at your property may vary with the severity of the flood.



Flood height at your property	Predicted flood frequency	Flood height at river gauge
Top of roof: 13.65 m		12.60 m

Ceiling or attic level: 11.45 m		10.25 m
------------------------------------	--	---------

10.7 m	1 in 100 yr	9.5 m
--------	-------------	-------

9.7 m	1974 flood	8.5 m
-------	------------	-------

Upper floor level: 9.00 m		7.65 m
------------------------------	--	--------

7.8 m	1 in 50 yr	6.5 m
-------	------------	-------

7.3 m	1996 flood	5.9 m
-------	------------	-------

Lower floor level: 6.55 m		5.15 m
------------------------------	--	--------

In this example, the 1 in 10 year flood just begins to inundate the property.

Lowest property level: 6.15 m	1 in 10 yr	4.75 m
----------------------------------	------------	--------

Floodwaters begin to cross evacuation roads:

9.85 m		8.5 m
--------	--	-------

Nominated property evacuation flood level:

7.90 m		6.55 m
--------	--	--------

Preparing your property and yourself for future floods



Displaced rainwater tank

Prepare your property for floods

- Ideally, the furnishings and equipment stored on the lower levels of homes should be of a type that can be readily relocated to higher levels.
- Where practical, secure rainwater tanks to prevent them from floating away. This is a difficult task that requires much thought.
- In rural areas, constructing earth mounds may allow both animals and motor vehicles to be elevated above floodwaters.
- It is important to store poisons and chemicals above expected flood levels.



Construction of temporary flood levee

Stockpile materials for constructing a levee

- If an earth levee needs to be formed around the house, then stockpile sufficient earth near the home to allow this to occur.
- Temporary earth levees usually require plastic sheeting to prevent leakage. Suitable quantities of plastic sheeting will need to be purchased prior to the flood.
- If required, stockpile sufficient quantities of sandbags and sand, but do **not** fill the sandbags until they are needed. The bags must be stored away from direct sunlight.



Photo supplied by Catchments & Creeks Pty Ltd

Emergency survival kit

Prepare an emergency survival kit

- Evacuation plan, important papers, and list of phone numbers
- Battery operated radio pre-tuned to emergency station or ABC
- Torch and spare batteries
- First-aid kit
- Whistles (for each person)
- Life jackets if travelling through water
- Rubber boots and heavy duty gloves
- Blankets and dry cloths
- Water, canned food and can opener



Flood evacuation

Plan your evacuation

- Plan what you will do if you need to evacuate your home, including:
 - where you will go—is there a friend that can provide accommodation
 - best evacuation route and an alternative
 - what you will take with you
 - where your pets will go and how best to transport them there.
- Remember; the best time to evacuate may be governed by the inundation of adjacent roads rather than your property.

Preparing a pre-flood checklist

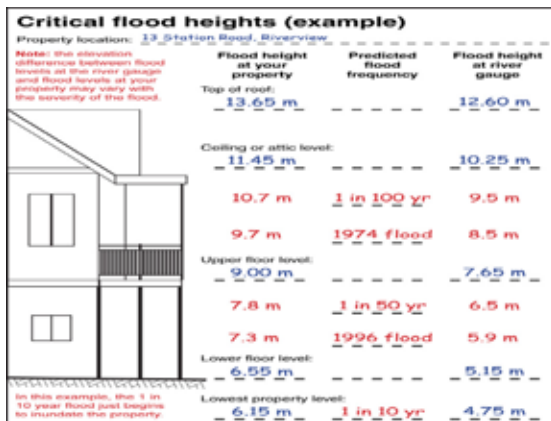


Photo supplied by Catchments & Creeks Pty Ltd

Personal emergency survival kit



Transport cage for pets



Critical flood height information



Isolated rural property

Pre-flood checklist

- Prepare a checklist of tasks to be performed prior to an imminent flood.
- Include on the checklist a list of items that you intend to take with you and then place this list in your emergency evacuation kit.
- Prepare a list of tasks that will need to be performed prior to evacuation, including shutting off the gas, and turning of the electricity.
- Prepare an evacuation route.
- Prepare a list of important phone numbers, and then laminate the list to prevent it from water damage. Include phone numbers for emergency services, local police, family members, and neighbours, especially the nearest flood-free neighbour.
- Place your important papers, including home insurance, in a central location ready for collection prior to evacuation. If necessary, photocopy important papers and keep these with a friend or relative.
- Set some time aside to scan/digitise all your important family photo albums.
- Prepare a plan for dealing with your pets and stock animals.
- Prepare a list of official river/city gauge reading that will signify the following:
 - river level at which point you will need to have evacuated your property
 - river level at which point road closures will likely occur along your chosen evacuation route
 - river level at which point floodwaters are likely to enter your property
 - river level at which point floodwaters are likely to enter your home.
- Supply a friend or relative with a copy of your evacuation plan.

In rural areas

- If necessary, secure a means of safely climbing onto the roof of your home or shed (well before the flood arrives).
- Organise the materials necessary to prepare large signs (e.g. white bed sheets) to signal aircraft of your condition, such as 'HELP' and 'OK'.
- If you could be isolated at an exposed location for an extended period of time, then pack food, hats and sun cream in your emergency kit.

Items that may need to be purchased before a flood



Stocking up on essential supplies



Car swept from a road crossing



Flood-proofing of low-level building



Temporary earth levee

Items to help you live through a flood

Items that may need to be purchased prior to a flood include:

- Emergency survival and first aid kit.
- Lots of plastic garbage bags to store and transport household items.
- Large plastic storage containers with fixable lids can be useful to store cloths and treasured items.
- Containers of disinfectant and disinfectant soap (liquid soap pump).
- Flood insurance.

Items to help in an evacuation

Items that may assist in your evacuation include:

- Flexible, waterproof travel bags or storage tubs to transport cloths and treasured items.
- Lift jackets, especially if evacuation may involve passing through floodwaters. Even when travelling in a motor vehicle, if you need to evacuate the vehicle, then a life jacket may save your life.
- Transportation cages for pets, including waterproof identification tags.

Items to seal a home off from floodwaters

Items that may assist in flood-proofing your home or business include:

- A stockpile of sand and sandbags.
- Rolls of heavy-duty plastic sheeting (must be stored away from direct sunlight).
- Rolls of duct tape and commercial tape dispensers (to attach the plastic sheeting) and check that the tape will adhere to a wet surface.
- One or more petrol-operated pumps.

Items to form an earth levee

Items that may assist you to construct and operate a temporary flood levee include:

- A stockpile of sand and sandbags.
- Sufficient quantities of earth usually need to be sourced from the property or trucked onto the property.
- Rolls of heavy-duty plastic sheeting (must be stored away from direct sunlight).
- Rolls of duct tape and commercial tape dispensers (to join individual sheets).
- One or more petrol-operated pumps.

Organising flood insurance



Policy statement

1. Storm and flood

We cover
Loss and damage caused by storm and flood e.g. rain, wind, hail, storm and damage caused by flooding from rivers, streets and canals.

We do not cover

- damage by actions or movements of the sea
but we will cover damage caused by:
 - a tsunami
 - storm surge if it occurs at the same time your home or contents are damaged by a storm or flood
- retaining walls, garden borders and free standing walls
- the surface of a tennis court
- wharf, jetty, pontoon or sea wall
- water in a tank, swimming pools or spas or their liners or covers
- the cost of cleaning mud or debris out of tanks, swimming pools or spas
- damage to swimming pools and their parts or underground tanks caused by water leaking down the sides, against the sides, or getting underneath them
- paint when there is no structural storm damage to other parts of the home

Typical insurance cover inclusions

We do not cover

- damage to retaining walls
- the repair of a leaking shower floor or base, shower cubicle walls, shower glass screening or shower doors, or any damage caused by the leak
- fixing or finding leaks that have not caused permanent damage to your home or contents (e.g. a pipe leaking water over an outdoor pathway)
- repair or replacement of the tank, pipe or container that water or liquid escaped from (e.g. we will not pay for replacing a hot water system that leaks)
- leaks from agricultural pipes (e.g. pipes manufactured with holes in them)
- fixing normal wear and tear (e.g. replacing worn out tile grouting)
- damage caused by people splashing water from shower bases, baths, basins or tubs over time
- your claim if you repair or renovate a damaged area of your home before we can inspect it and find the cause
- damage caused by liquid from a plant pot, vase, terrarium, beverage container, saucepan, bucket or watering can and watering systems or hoses.

Typical insurance cover exclusions

2. Burst pipes, leaks and overflows

We cover
Damage from leaking, overflowing or bursting pipes and water containers at the home including:

- dishwashers and washing machines
- roof gutters and rainwater downpipes, drainage and sewerage systems
- tanks (e.g. rainwater tanks, hot water systems, fish tanks but not fish bowls)
- swimming pools or spas
- water beds, baths, sinks, toilets and basins
- water collection trays in freezers, refrigerators and air conditioners.

We will also cover damage from the bursting or leaking of a water main, fire hydrant or water supply pipe at or near the home.

Exploratory costs
We will cover the reasonable cost of searching for the unknown cause of leaking pipes and restoring the damage we do to your home, **but only** if the leaking liquid is causing permanent damage to your home or contents.

If we pay for damage or exploratory costs we will also pay up to \$750 extra to replace undamaged wall tiles in the same room, stairs, hallway or passageway so they match or complement new tiles used for repairs.

Typical stormwater cover

Know what types of flooding can affect your property

- Check that the policy covers the types of flooding your home could experience.
- If you are unsure of the types of flooding, then consult with a suitable flood or stormwater consultant.
- Check if the insurance pay-out is limited to a maximum dollar value; if so, then check that the value is adequate for your needs.
- Check that the insurance covers both the building and its contents.

Flood insurance for the building

- Read and check what is included in your policy.

Flood insurance for the contents

- Read and check what is excluded from your policy.

Insurance for stormwater damage

- Remember, water damage can result from a variety of sources, including:
 - overtopping of a washing machine, bath, or toilet
 - leaking taps
 - excessive lawn or garden watering
 - leakage from a water pipe
 - breakage of a water supply main.

Things to do during a flood

Preparing for an imminent flood



Photo supplied by Catchments & Creeks Pty Ltd

Emergency survival kit



Photo supplied by Catchments & Creeks Pty Ltd

Charging mobile phone



Bureau of Meteorology flood warnings



Flood evacuation

Review your checklist

- Activate your emergency plan.
- Charge your mobile phones.
- Top-up fuel in the car and boat.
- Check your emergency kit.
- Add to your emergency kit any last minute items, including:
 - medications and prescriptions
 - food and water.
- Contact those neighbours that may need assistance.

Important phone numbers

- Keep a list of important phone numbers:
 - Key family members (to notify of your location and safety)
 - Neighbours (to check their safety)
 - Emergency services
 - Emergency rescue (000)
 - Police (number for non critical issues)
 - Your doctor
 - Local hospital
 - Contact for electricity faults
 - Contact for gas leaks and faults

Flood warning information

- Note the phone numbers of recorded flood warning message services:
 - NSW/ACT 1300 659 218
 - NT 1300 659 214
 - QLD 1300 659 219
 - SA 1300 659 215
 - TAS 1300 659 216
 - VIC 1300 659 217
 - WA 1300 659 213
 - National 1900 926 113

Notify people of your evacuation plans

- Prior to evacuating your property, notify friends of your evacuation plans, including:
 - the time you plan to leave
 - planned travel route
 - planned destination
 - planned arrival time
 - contact phone numbers.
- A trusted friend or relative should already have a copy of your evacuation plan.

Preparing for an imminent flood



Lifting household items



Lifting household items



Household items lifted onto roof



Boat ready

Prepare your home

- Remember; safety first, do not endanger yourself moving any items.
- Fill emergency water bottles while the water supply is uncontaminated.
- Elevate all poisons and chemicals above the expected peak flood level, especially those chemicals that can react with, or dissolve in water. Wrap any such items in plastic bags then seal them in plastic storage containers.
- Elevate household items above the expected peak flood level. Focus on those items that cannot readily be replaced, as well as kitchenware (to reduce the clean-up time after the flood).
- Remove perishable food from refrigerators and seal them in plastic bags.
- If possible, secure any large items that will float, such as refrigerators and rainwater tanks. Alternatively, leave refrigerators and freezer doors open (or removed).
- Remove drawers from built-ins, kitchen cabinets and freestanding furniture.
- Wooden furniture can be damaged by water, so if possible, move these items to a friend's place well before the flood.
- Ideally, household items should be stored under shelter to prevent rain damage or displacement by wind gusts.
- If time permits, lift carpets and place them in sealed plastic bags.
- Remove light bulbs from fixtures located below flood level, then place these bulbs in plastic bags.
- Remember; floodwaters often transport large quantities of river silts and mud. The job of cleaning this mud from household items can be improved if waterproof items are wrapped in disposable fabric.

Prepare your car, boat and property

- Seal the lids of outdoor garbage bins and secure them from floating away.
- Tie down timber, drums and other outdoor items that could float away—such items can become dangerous flood debris.
- If you have a boat, then make sure the boat is readily accessible and prepared for immediate use.
- Top-up fuel in the car and/or boat.

Preparing for an imminent flood



Photo supplied by Catchments & Creeks Pty Ltd

Circuit breaker electrical switchboard

Electricity

- **Fuse-based switchboard:** remove all fuses, including the ones at the main switchboard, place them in a plastic bag, and secure them above the flood level.
- **Circuit breaker switchboard:** switch each circuit breaker to the OFF position.
- **Solar electricity:** if water is expected to flood the 'inverter box' then secure black plastic over the solar panels (residents should discuss a flood response procedure upon installation of the system).



Gas bottles

Gas

- Close the main gas valve. This valve is normally located near the gas meter.
- If possible, gas cylinders/bottles should be secured (tied down) or disconnected and moved to a location above the expected flood level.



Photo supplied by Catchments & Creeks Pty Ltd

Bottled water

Water

- Close the main water valve. It usually is located at the meter box where the water supply enters your property.
- If possible, secure rainwater tanks to prevent them from floating away.
- Store drinking water in plastic water containers, or even in an elevated bathtub if necessary.
- Shut off all valves and the heat supply for hot-water tanks.



Backwater passing through toilet

Laundry, toilet and showers

If the home is protected by a flood levee, or toilets exist in basements, then:

- Place a strong plastic bag filled with sand or earth in the toilet bowl to prevent the back-flow of sewage into your home.
- Place a strong plastic bag filled with sand or earth (not water) over:
 - shower and bath outlets
 - overflow drains located in the floor of the bath room and toilet
 - laundry tub outlets.

Preparing for an imminent flood



Preparation of sandbags



Sandbagging



Plastic sheeting



Plastic sheeting

Sandbagging your property

- Sandbags are useful items during a flood, but the bags need to be filled only as they are needed because over time they can lose their flexibility.
- DO NOT overfill the sandbags, this also reduces their flexibility and increases the likelihood of leaks forming.
- Filled sandbags are often supplied by councils or *Emergency Services* organisations, but you will need to be able to transport the bags to your home.
- It is important to note that sandbags are not impervious. Floodwater will eventually filter through the bags. So they are best used when floodwaters are expected to be elevated for less than a day.
- If floodwaters are expected to lap against the sandbags for more than a day, then plastic sheeting should enclose the sandbag levee, otherwise the sandbags can be used to anchor plastic sheeting against the building (see below).
- To improve the strength of a levee, sandbags should be staked in a random fashion such that each bag overlaps the two lower bags.

Use of impervious sheeting

- If floodwaters are expected to be elevated against a building for several days, then it is advisable to use continuous lengths of plastic sheeting to help reduce leakages.
- At least 1 m of the plastic sheeting must extend across the ground to minimise leakage under the sheeting. A continuous line of sandbags or sand must then be placed on this skirting to produce a good seal.
- It is IMPORTANT to know, well before a flood occurs, if a building can withstand the hydraulic pressure of the floodwaters. If there are questions about the strength of the building, then the safe option may be to allow floodwaters to enter the building. In such cases, pervious fabric, such as commercial filter cloth, can be used to 'filter' silts from the floodwaters and reduce the post-flood clean-up.
- Remember to seal off any overflow drains located within bathrooms, toilets and laundries. Toilet overflows can become a problem during floods. The risk of such overflows increase when buildings are sealed off from floodwaters.

Preparing for an imminent flood



Formation of earth bank



Placement of plastic cover



Anchorage of plastic sheeting



Pumping floodwaters from an enclosure

Temporary earth levees

- In situations where there is sufficient open space around a home, a temporary earth levee can be formed to isolate the home from floodwaters.
- To provide stability to the levee, the earth embankment should be formed with a total width at least twice its height. Also, the ground should be scarified (broken) to improve the seal between the ground and embankment.
- Permanent earth levees are usually impervious structures because the earth is appropriately compacted during the construction phase.
- Temporary earth levees, however, normally experience some degree of water seepage because of their quick construction and poor compaction.
- Water leakage through the levee can become a problem if floodwaters are expected to be elevated for several days.
- Enclosing the earth embankment in a plastic cover can reduce the degree of leakage; however some degree of leakage should always be expected.
- Floodwaters can also enter the enclosure through the following means:
 - through stormwater pipes connected to the roof drainage system
 - through the sewerage system causing toilets to overflow
 - leakages between the ground and embankment.
- Where necessary, place a strong plastic bag filled with sand or earth in the toilet bowl to prevent the back-flow of sewage into your home.

Pumping floodwaters

- Most temporary flood control systems, including sandbags, plastic sheeting and earth levees, will experience some degree of leakage.
- Pumps are usually required to remove this water from the enclosure.
- These pumps need to have self-contained with petrol motors, not electric.
- The number of pumps required will depend on the length of the levee system.

Organising your pets and animals



Transportation of pets



Pet identification



Trapped animals



Stock animals on elevated levee

Plan for temporary accommodation

- It is wise to organise safe shelter for your pets well before the trauma of a flood evacuation commences.
- Pets should be transported within suitable cages to prevent their escape adding to the trauma of the situation.
- Relocate pets well before the flood rather than trying to take them with you through dangerous waters.
- Pets **must** be left with adequate food and water.
- NEVER tie or confine animals.

Identification tags

- Ensure all pets have identification tags with the name of the pet and a contact phone number.
- These tags need to be waterproof.
- Don't assume that you have full control of your pets. During a traumatic event, such as a flood, pets can become stressed and act in an uncharacteristic manner.
- Always carry water and food with caged animals.
- Also, be visitant of your neighbour's pets and animals.

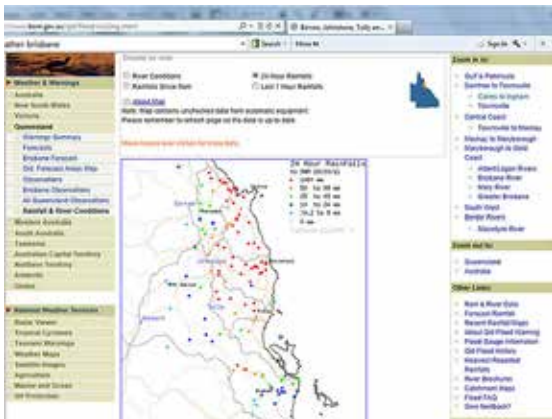
Farm animals

- Banned animals should be relocated well before floodwaters rise—animals can become uncooperative and refuse to move if they sense danger.
- Ensure all farm chemicals are stored above flood level to avoid contact with animals and their feed.
- If possible, fenced or penned stock should be moved to higher ground.
- If animals cannot be moved, then ensure they can move to higher ground without being trapped by fencing. Also, take note of the latest developments in wildlife friendly fencing.
- In broad floodplains, elevated earth mounds (islands) can be formed to provide protection for small numbers of animals. Large water-storage ring tanks can provide the benefits of both water supply and the existence of elevated embankments.
- If animals are housed in the same sheds as the farm machinery, then fasten straw bales (not hay) to protruding sharp edges and machinery blades.

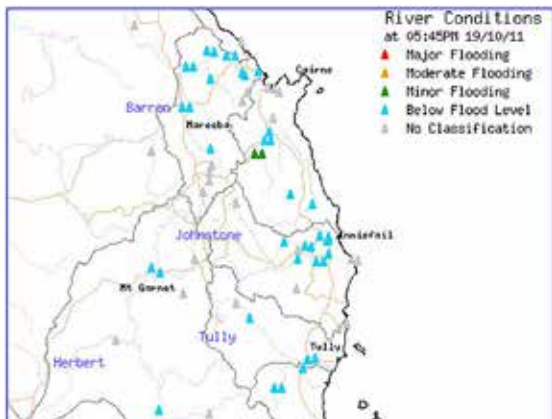
Understanding flood warnings



Official river gauge



Bureau of Meteorology website



Bureau of Meteorology flood warning



Flood evacuation

Flood warnings

- Listen to ABC radio. Find your local station by searching: <http://www.abc.net.au>
- Check the Bureau of Meteorology website: <http://www.bom.gov.au/hydro/flood>
- Check your council website.
- Expected flood heights are usually issued relative to an official river or city gauge.
- The flood heights at some gauging stations are automatically reported on specific websites.

Types of flood warnings

- The Bureau of Meteorology issues various types of weather forecasts and flood warnings.
- A **Flood Watch** is an early warning alert issued in relation to anticipated flood-producing rainfall.
- **Flood Warnings** are issued when flooding is occurring or is expected to occur within specific river catchments.
- A **Severe Weather Warning** is issued when flash flooding is expected.

Flood severity

- The Bureau of Meteorology issues **Flood Warnings** using the following flood classifications:
 - Minor flooding
 - Moderate flooding
 - Major flooding
 - Local flooding
 - Flash flooding
- A description of each of these flood warnings is provided within the glossary of terms at the end of this publication.

What you need to know

- You will need to know the relationship between the official river/city gauge and flood levels at your property.
- You will need to know the official river gauge reading at which point you should evacuate your property.
- You will need to know if authorities are likely to issue a specific evacuation order for your area, and if so, how this will be issued.
- You will need to know your preferred evacuation route plus an alternative.

Evacuating your property



Notification of evacuation centres



Moving furniture



Flood evacuation



Flooded causeway

Notification to evacuate

- You need to be aware of circumstances requiring your evacuation. For some properties it may be when a minor flood or flash flood warning is issued. For other properties it may only be when a major flooding warning is issued.
- In many towns and cities, flood warnings are issued relative to the expected flood level at the official river or city gauge.
- You will need to know what gauge level will trigger your need to evacuate.

Pack your motor vehicle

- Pack your emergency kit and a street map showing your preferred evacuation within your vehicle.
- Collect all remaining people and pets.
- If necessary, contact elderly neighbours to check if they need assistance to evacuate.
- Wear flotation vests if you expect to drive through water—don't just carry them in the car! If you need to evacuate your car, you may be too busy and too occupied to think about fitting a safety vest.

Notify people of your evacuation plans

- If you have not already done so, notify friends of your evacuation plans.
- Contacting authorities, such as the local police office, is advisable if your journey is likely to cross flooded roads and you have been unable to contact friends or relatives.

Safety first

- Be prepared to change your plans if the chosen evacuation route is no longer safe.
- Driving along flooded, still-water roadways is not recommended, and can be highly dangerous.
- DO NOT cross a flooded causeway. The road surface can be damaged, or worst, partially washed away by the floodwaters.
- The best option will likely be to return to high ground and wait for help to arrive.

Moving through floodwater



Wading through floodwaters

Wading through floodwater

- Boating, driving or walking through floodwaters **MUST** be avoided unless it is absolutely necessary.
- Avoid wading through even shallow water.
- It is very difficult to move through any moving water if the depth exceeds 1.2 m.
- If you must wade through floodwaters, wear rubber boots or heavy-sole shoes.
- Don't proceed beyond waist-depth unless absolutely necessary.
- Remain in hand contact with other people.



Boating through floodwaters

Boating in floodwater

- Wear flotation vests if you expect to move across water.
- Keep away from power lines that may hang close to the water surface.
- Keep away from any guy wires—these are the diagonal wire often associated with power poles—sparks can ignite oil or fuel on the water surface.
- Always be alert to floating debris and wildlife that may wish to enter the boat.



Flood depth marker

Driving through floodwater

- Never drive across a flooded causeway.
- Never drive along flooded still-water roadways if:
 - the water is above the car's floor pan
 - the road surface is not visible.
- If you **must** cross a flooded causeway, then first check the depth of water on the flood depth marker posts.
- Occupants, especially children, should be fitted with flotation vests if the vehicle must negotiate a watercourse crossing.



Excessive speed

Avoid excessive speed

- Always proceed slowly and steadily.
- Ownership of a truck or four-wheel-drive vehicle does **not** entitle the driver to pass through floodwaters at speed!
- Bow waves generated by fast-moving vehicles can flood smaller vehicles and send waves of floodwater into adjacent homes.

Living through a flood



Waiting out the flood



Waiting out the flood



Assisted evacuation



Bottled water

Safety first

- If you decide not to evacuate your home, then continue to assess the safety risks as well as monitoring media broadcasts.
- Listen to the radio for flood alerts and announcements of compulsory evacuation.
- Take all necessary steps to ensure the safety of yourself, your family and pets.
- Drink responsibly as you may be called upon to evacuate or lend assistance to others.

Locate yourself in a secure part of the building

- If floodwaters rise around the home, then all residents should collect in a common location away from any area of the building likely to experience damage.
- Homes can be damaged by:
 - large floating debris hitting the upstream side of the building
 - mudslides hitting the up-slope side of the building.

Be prepared to evacuate

- Be prepared for a forced evacuation.
- If a safe flood-free evacuation is not possible, then ensure everyone is wearing appropriate clothing and a buoyancy vest (life jacket). It is better to look silly and live, then to find yourself in water struggling to stay afloat.
- If you have a boat, then make sure the boat is readily accessible and prepared for immediate use.

Eating and drinking

- Fluid levels should be maintained, preferably through the consumption of bottled water rather than alcohol.
- During a flood, drink and cook only with boiled or bottled water until your water supply has been declared safe.
- Always wash your hands before preparing and eating meals, especially if you have been touching floodwater or cleaning flood-affected household items.

Living through a flood



High velocity floodwaters



Photo supplied by Catchments & Creeks Pty Ltd

Wall cracking



Turbulent floodwaters



Deposited, organically-rich silt

The speed of a flood

- Generally the most dangerous aspect of floodwater is its velocity, rather than its depth.
- The velocity of floodwater is governed by many factors including the slope of the land, the width of the flow path, and the density of vegetation through which it passes.
- Floodwaters travelling at a velocity greater than walking pace should always be considered highly dangerous.

The vibration of a flood

- Deep, fast-flowing, turbulent floodwaters can send significant vibrations through the banks of waterways.
- Once the earth between a home and the waterway becomes saturated, severe instream turbulence can transmit vibrations through the riverbank into adjacent buildings.
- The severity of these vibrations, and the resulting damage, depends on the proximity of the building and type of building foundations.

The noise of a flood

- The noise of a flood often comes as a shock to those inexperienced with floods.
- This noise can originate from several sources including:
 - water turbulence
 - floodwaters spilling over rock faces
 - the movement and vibration of buildings and trees.
- Children may need to be reassured of their safety if the noise becomes excessive.

The smell of a flood

- By their nature, sewerage treatment plants are commonly located on low ground, often within floodplains. Their location makes them vulnerable to flooding, which can result in the contamination of floodwaters.
- However, many of the foul smells commonly associated with river flooding are actually generated by the organic matter contained with the silts lifted from the riverbed. The resulting smell can be very similar to that of raw sewage.

The dangers of floodwater



Playing in floodwater

Playing in floodwaters

- Don't play or swim in floodwaters.
- Floodwaters are often contaminated with a variety of pollutants including:
 - raw sewage
 - farm chemicals
 - soil-borne bacteria.
- Even if the flooded land is familiar to you, it can still represent a safety hazard such as displaced manhole covers.



Snake

Hidden dangers

- Floodwaters can contain many health risks, and land surface hazards.
- Snakes and even crocodiles can exist within floodwaters.
- Floodwaters can cause deep scour holes unseen by people wading through the muddy water.
- Also, manhole covers placed over drains and sewers can be displaced during floods causing deep open chambers to be exposed under the turbid floodwater.



Sewer overflow

Health risks

- Once manhole covers are lifted from sewerage chambers, raw sewage can be released into the floodwater.
- Also, many of the pumping stations that carry sewage to wastewater treatment plants are likely to fail during a flood causing raw sewage to be released through overflow pipes.
- In urban areas, floodwaters are almost certainly contaminated with raw sewage.



Stranded motorist

Travelling home

- In panic, people often feel compelled to travel home, even if this means passing through unsafe floodwaters.
- During natural disasters, common sense is often overwhelmed by our need to return to our family and home.
- The first rule in flood safety is to NEVER cross a flooded causeway.
- STOP, count to ten, and remind yourself that you are in the middle of a flood!

Things to do after a flood

Recovering after a flood



Keeping in contact



Medical support



Discarded flood-damaged items



Post-flood clean-up

Step 1: Notify relatives and authorities

- If you notified friends or authorities **prior** to evacuating, then renotify these same people of your status after you have arrived at a secure location.
- Also, notify authorities if you have been injured, or you suspect you had been reported as missing by a friend or relative.

Step 2: Assess the safety risks

- Wait until authorities have declared the area safe before returning to your home.
- Many safety risks can still exist after floodwaters recede, including snakes, contaminated water, unstable building platforms and damaged asbestos sheeting.
- Wear rubber boots and rubber gloves. Leather gloves are best used only after wetted surfaces have been washed down.
- Seek medical advice if you are injured.

Step 3: Document damage and loss

- Resident should take control of the site to prevent looting and unnecessary post-flood clean-up damage.
- Before cleaning commences, photograph and record the damage for insurance purposes.
- If it is safe to do so, record the height of the flood by noting debris or water marks.
- If possible, keep a record of all damaged items removed from the house.

Step 4: Clean-up and repair

- Cleaning is better commenced while surfaces are still wet.
- Do not use electrical power to operate cleaning equipment until the electrical system is declared safe.
- Disinfect all surfaces touched by floodwaters, especially in urban areas where sewer overflows are likely to have occurred during the flood.
- Keep a list of volunteers so you can provide an appropriate 'thank you' at a later date.

Recovering after a flood



Removal of damaged goods



Alternative water supply



Electrical supply



Flooded sewerage treatment plant

Know what to through away

- Don't be too hasty to throw things away. Many products can be cleaned and made totally useable.
- Floods do **not** occur for the purpose of allowing us to replace old household items with new products at the expense of insurance companies!

Water supply

- Check with the relevant authority before reconnecting electrical, gas and water services.
- Check with authorities before drinking tap water.
- Drink and cook with only boiled or bottled water until your tank or town water supply has been declared safe.
- Your council or water supply authority may establish a temporary water supply within the town to provide safe drinking water.

Electrical supply

- Avoid crossing fallen power lines.
- If absolutely necessary, cross fallen lines mid way between poles.
- Every part of the electrical system that has been flooded must be checked by an electrician before it can be used—check your local state rules and guidelines.
- But remember; the re-establishment of power to your street does not mean your home is safe.

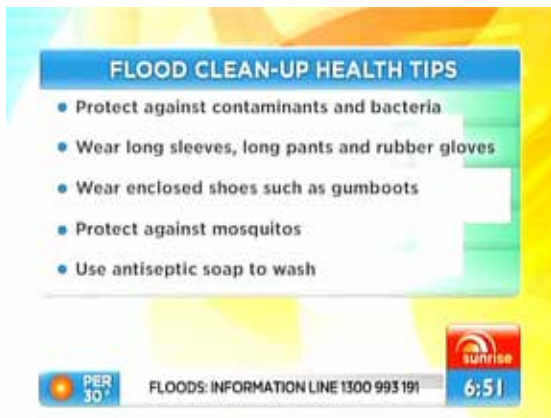
Sewerage

- By their nature, sewerage treatment plants are commonly located on low ground.
- It may be mechanically possible to flush your toilet immediately after a flood, but use of the sewerage system should be limited to the minimum necessary.
- It should be noted that in the days following severe floods, anything flushed down a toilet, laundry, kitchen or bathroom outlet will likely discharge, untreated, into your local waterway.

Recovering after a flood



Cleaning up after a flood



Media report



Retail therapy



Bouncing back from adversity

The recovery phase

- The inability of a person to control the flooding of their home can produce a sense of 'loss of power', often leading to a variety of emotions.
- Some people respond to this feeling of 'loss of power' by expressing anger towards governments or others they feel are to blame.
- Some people respond by trying to take a greater control of other aspects of their life, such as the clean-up phase.

The benefits of being well prepared

- The greatest worry often comes from the 'unknown', such as not knowing what is going to happen after the flood.
- Learning about your flood risks, your emergency procedures, and about the tricks of cleaning and repairing damaged property, all help to improve your mental state and enhance your flood recovery.
- With knowledge comes empowerment. It is for good reasons that trained emergency services personnel are often the most calm during natural disasters.

Personal recovery

- It is **important** to take the time for your own personal recovery.
- This personal recovery phase is often easier to deal with if you are able to identify your emotions and understand the various emotions that other people pass through during and after a traumatic event.
- Take the time to have a good cry.
- Enjoy a bit of 'retail therapy'.
- Think about the positive side of getting to purchase new household items.

How will you respond to a flood?

- Everyone responds differently to natural disasters, but people typically progress through the following emotional phases:
 - **Shock** and disbelief
 - **Anger** and a search for someone to blame
 - **Bargaining** for total problem removal
 - **Depression** based on the realisation that a total solution is not likely
 - **Acceptance** of the event and a focus on moving forward

Recovering after a flood



Shock



Anger



Depression



Acceptance

Shock and disbelief

- The emotional strain associated with the initial phase of shock and disbelief can be reduced through effective pre-flood planning.
- Extensive knowledge of your flood risks and the likely consequences of a flood can help a family to move quickly through these emotions and enter the rebuilding and recovery phase.
- Whole communities can benefit from public education and planning forums.

Expressing your anger

- Expressing anger can be an important phase in releasing the tension.
- Some people find solace in seeking to blame governments for natural disasters.
- Some people seek to blame others simply because they cannot face the reality that they failed to adequately plan for the flood.
- Remember; no place is safe from all natural disasters—ultimately we choose where we want to live and how we choose to manage our own flood risks.

Bargaining and depression

- It is OK to be sad, angry and confused.
- It is OK to take the time to adjust to the impact of a natural disaster.
- It is **also** OK to laugh and make fun of what is actually a serious situation.
- We all walk a different path through the emotions associated with natural disasters, and we all need to find our own path to healing.
- Some people, however, will need help moving through this period of sadness.

Acceptance and recovery

- Periods of deep depression can often prevent people from entering the recovery phase.
- Physical work is often be the best form of emotional recovery.
- Remember, 'planning' builds 'actions'.
- Actions help to build people's emotional recovery, and emotional recovery helps to build our resilience to future disasters.
- Don't sit back and wait for someone else to clean your home and fix your problems.

Cleaning up after a flood



Wearing proper footwear

Safety first

- Always take caution when moving around damaged homes as floorboards could be loose, and nails and other sharp objects can be hidden under the mud and muck.
- Regularly wash your hands with disinfectant, especially after handling contaminated articles.
- Be aware of your surroundings and always check for broken grass, damaged floorboards and loose steps.



Photo supplied by Catherine Cleary

Cleaning the house

Cleaning away the mud

- Remove all portable objects out of the house to assist in their cleaning and aid in the efficient washing of the home.
- Commencing at the upper limits of the flood marks, wash the mud and muck from all household surfaces.
- After disinfecting all surfaces touched by floodwaters, wash with warm soapy water.
- Allow several days or even weeks for the house to dry out before repainting.



Photo supplied by Catherine Cleary

Sediment deposition within kitchen

Food and kitchenware

- Discard all food directly exposed to floodwaters.
- Label all canned food with a permanent marker, then remove paper labels and wash the cans and other food containers.
- Prepare a solution of 3/4 cup of laundry bleach with 5 litres of water to act as a disinfectant for washing 'metal' cans, not aluminium cans.
- Bury or burn all decaying vegetation and food products.



Photo supplied by Catherine Cleary

Damaged bedding furniture

Bedding

- Water damaged mattresses generally cannot be cleaned and must be disposed of.
- Feather and foam rubber pillows may be washed.
- Kapok and cotton pillows should be discarded.

Cleaning up after a flood



Damaged clothing

Clothing and linen

- Fabrics that can be dry-cleaned should be air-dried away from direct heat.
- Shake, brush or vacuum loose dirt from fabrics before they are dry-cleaned.
- Washable woollens should first be rinsed repeatedly in lukewarm water.
- Dry woollens in a warm place, but not near a fire or direct sunlight. Lightweight quilts can be dried outdoors to remove odours.
- Washable fabrics should first be rinsed repeatedly in cool water after being washed with a disinfectant additive.



Damaged furniture

Furniture

- Place plastic caps or similar under any furniture that could stain carpet or flooring.
- If possible, move furniture to open areas to aid in washing down the furniture and air-drying.
- Removal all drawers, slides and easily removable fittings.
- If necessary, remove the rear panelling to allow the furniture to dry out.
- Check the Internet for guides on the removal of stains and watermarks.



Damaged electrical goods

Electrical items

- Clean refrigerators and freezers thoroughly with disinfectant.
- Allow all electrical items to dry out thoroughly before having them checked by an electrician.
- If items are still wet, then wash mud and dirt from the surface with gently hose pressure. Apply a non oil-based water repellent (e.g. isopropyl, methylated spirits) to metal components (not rubber).
- Allow to dry for seven day prior to having them inspected by a technician.



Damaged paper goods

Books and papers

- Wet paper deteriorates over time, so cleaning should be performed as soon as possible.
- Important papers can be stored in freezers until appropriate measures are in place to thaw, dry and restore the material.
- Water stains may be removed from paper using ammonia (with good ventilation).
- Books require a process of drying and pressing to dry the material without causing excessive crumpling.

Cleaning up after a flood



Cleaning rooms



Removal of wall and roof cladding



Wall cracking



Removal of flooring

Particle board and plaster sheeting

- If plaster sheeting is obviously damaged, then it will need to be replaced.
- If the panelling appears to be in good conditions, then allow it to fully dry before placing any load, such as a ladder, against the wall.
- Particle board normally swells once it becomes wet and should be replaced. Don't use excessive water to remove mud.
- Wall cavities are best dried by removing some of the wall panels.

Allow time for things to dry out

- Don't be too anxious to start your rebuild. It is important to give the building time to dry out before re-cladding walls.
- It is **important** to allow wall cavities to adequately dry out. Taking up floor coverings can help in the drying process.
- Waterlogged insulation should be removed and replaced with new material.
- Door hinges should be oiled.

Brickwork and masonry

- Mud may not affect the structural integrity of concrete and masonry, but it does affect its appearance.
- Surfaces should be cleaned with water, detergent and stiff-bristle brushes.
- The use of acid can cause staining.
- White 'salt' markings should be removed with brushing. Once dry the problem should cease.
- If cracks appear or widen after the flood, then arrange for a building inspection.

Floor and sub-floor space

- Mud should be removed from beneath floorboards. This may require lifting some or all of the floorboards.
- The drying process can be assisted through the use of industrial fans.
- Mud should be removed from around floor joists and other sub-floor members.
- Allow floorboards to fully dry before considering replacing them.
- Allow buildings to dry for several weeks before repainting.

Glossary of terms

1 in 100 year flood	A flood that has a 1% probability of being equalled or exceeded within any 12 month period at a given location.
Backwater	A region of a floodplain where flood levels are directly controlled by floodwaters backing up from an adjacent watercourse or floodway, but through which there is no discernible movement of floodwaters other than the slow filling and discharge of floodwater.
Backwater flooding	The flooding of a semi-isolated region of a floodplain as a direct result of floodwater backing up from an adjacent watercourse or floodway.
Causeway	A raised road or path constructed across low, wet ground or across tidal water.
City gauge	A river level gauging station, usually located near the town centre, used as the reference location for flood level predictions.
Concentrated overland flow	Overland flows travelling as concentrated flow rather than sheet flow such that the flow depth varies significantly across its width.
Creek	A watercourse, minor in comparison to local rivers, whether natural or artificial, permanent or ephemeral, with static or flowing water that is fresh, brackish or salty. A watercourse both natural in its appearance and ecological function, and with a significant ecological association with adjacent riparian vegetation.
Cut-and-fill construction	A process of slope modification in which soil is excavated from one section of a slope and used to construct an adjoining embankment.
Drainage	A natural or artificial means of intercepting and removing surface or sub-surface water.
Expected maximum flood level	The largest flood that could conceivably occur at a particular location, resulting from the probable maximum precipitation (PMP) and, where applicable, snowmelt, coupled with the worst flood-producing catchment conditions that can be realistically expected in the prevailing meteorological conditions. The probable maximum flood (PMF) defines the extent of flood-prone land.
Filter cloth	A synthetic non-woven material that allows water and some soil particles to pass through it. It is typically used as a protective lining for earth structures, batters of channels or to separate different soil texture layers.
Flash flood	A flood where the peak flood level is likely to occur less than 6 hours after the commencement of rainfall, or where flood levels rise rapidly relative to normal flooding conditions.
Flood control dam	A dam specifically designed to temporarily store flood run-off and then release this water under controlled conditions.
Flood risk	The probability of a given location being flooded, and the potential loss of life, or damage to life, property and services which can be directly attributed to a flood.
Flooding	The inundation of land or structures by water.
Floodplain	Land area adjoining rivers, streams, artificial channels, lakes, dams, bays, or oceans, that is inundated during flood events due to over-bank stream flows or abnormal high tides resulting from severe storms. Their extent is defined by tidal limits, or the expanse of the probable maximum flood (PMF).
Floodplain storage	The volumetric flood-holding capacity of a floodplain defined over a specified reach length and to the peak elevation of a specified flood.

Floodway	A channel or passage through which floodwaters pass.
Groundwater	The water beneath the surface of the ground.
King tide	A non-scientific term used to define the highest high waters which occur around summer and winter solstice.
Landslip	A landslide extending over relatively a short distance and composed predominantly of debris and/or earth material.
Levee	An embankment built along the banks of a watercourse or around an area of land to prevent or limit flood inundation.
Local flooding	[1] Flooding that occurs over a small land area as a direct result of a local source of water, such as a broken water supply pipe. [2] Flooding resulting from local rainfall could be expected to cause high run-off over a limited area, but not necessarily leading to significant rises in main streams.
Major flooding	Flooding which exceeds 'moderate flooding' and causes extensive inundation of rural and/or urban areas. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required.
Major storm	A storm with a frequency less than (and thus more severe than) 1 in 2 to 1 in 10 years. The critical storm frequency varies from region to region.
Minor flooding	Flooding that generally only causes a local inconvenience. Low-lying areas next to watercourses are likely to be inundated, which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.
Minor storm	A storm with a frequency greater than (and thus less severe than) 1 in 2 to 1 in 10 years. The critical storm frequency varies from region to region.
Moderate flooding	Flooding which exceeds 'minor flooding' which is likely to result in the evacuation of some houses. Main traffic routes may be covered. The area of inundation is likely to be substantial within rural areas requiring the removal of stock.
Overland flow	Any surface runoff whether flowing as sheet flow or shallow concentrated flow e.g. flow within road reserves, shallow grassed channels and over-bank flows, but not flowing within deep drains, drainage channels or streams.
Probable maximum flood (PMF)	The largest flood that could conceivably occur at a particular location, resulting from the probable maximum precipitation (PMP) and, where applicable, snowmelt, coupled with the worst flood-producing catchment conditions that can be realistically expected in the prevailing meteorological conditions. The PMF defines the extent of flood-prone land.
Rainwater intrusion	Rainwater, that has not previously touched the ground, entering a building through the roof, windows or walls.
River	A major watercourse relative to other streams within a given region, ordinarily with a high natural sediment flow, a near constant base flow and with sufficient bed width to result in an open canopy. Bed vegetation is normally sparse and usually does not play a significant role in channel stability due to the disturbing influence of the high sediment load.
River gauge	A device for measuring water levels at a given location along a watercourse.

Run-off	That part of rainfall, snow or hail not lost to infiltration, evaporation, transpiration or depression storage that flows from the catchment area past a specified point. It includes that portion of precipitation that appears as flow in streams; and drainage or flood discharges that leave an area as surface flow or as pipeline flow, having reached a channel or pipeline by either surface or sub-surface routes.
Sheet flow	Flow that passes evenly over the ground as a thin sheet of water as opposed to concentrated flow. Normally occurs on plan surfaces (ground not heavily concaved) and on uniformly grassed areas when the depth of flow is not significantly greater than the blade length of the grass.
Slab-on-ground construction	A construction method that requires the land to be levelled, usually involving cutting into the slope to form a flat area of land on which a concrete slab is laid on which a building is constructed.
Storm surge	An atmospherically driven rise in sea level caused by extreme surface winds and low atmospheric pressure associated with severe weather conditions, usually cyclones.
Storm surge flooding	Land or property flooding resulting from seawater intrusion caused by a storm surge.
Stormwater flooding	Flooding that results from stormwater run-off, usually in the form of overland flow, that originated from a local storm. The flooding waters are passing through the property on its way to a watercourse rather than backing up from an adjacent watercourse or floodway. May be considered to include 'rainwater intrusion' and 'groundwater flooding'.
Water Sensitive Urban Design (WSUD)	A holistic approach to the planning and design of urban development with aims of minimising negative impacts on the natural water cycle, protecting the health of aquatic ecosystems, and promoting the integration of stormwater, water supply and sewage management at a development scale.
Watercourse	A channel with defined bed and banks, including any gullies and culverts associated with the channel, down which surface water flows on a permanent or semi-permanent basis or at least, under natural conditions, for a substantial time following periods of heavy rainfall within its catchment.
Waterway	A term commonly interchangeable with the term 'watercourse'. The legal definition may vary from state to state, and region to region.
Wave run-up	The up-rush of a wind-generated wave across a land surface.
Wave run-up flooding	Land or property flooding resulting from wave run-up.
Wind-blown wave flooding	Flooding that results from the direct deposition of seawater on the land as a result of local landward winds blowing wave splash over a seawall.
Windstorm	A rainfall event during which strong winds occur that cause the rainfall to hit building and the land surface with significant lateral (sideways) motion. Severe windstorms can cause rainwater to hit a roof surface with such force and angle as to cause the water to infiltrate the roof cavity.