Flood Isolation – Do We Know What We are Doing?

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National and State Guidelines as well as many local planning controls require the consideration of potential isolation by flooding when planning and assessing development on floodplains.

However, are we properly considering all of the facets of isolation such as probability, hazard, duration, warning time, concomitant events and self sufficiency? Are our guidelines and controls logical, equitable and do they mitigate impacts? Why do they mostly only apply to development on the floodplain when non-flooded development can be significantly impacted by flood isolation?

This paper explores existing guidelines and planning controls and discusses their strengths and weakness in light of recent floods and case studies from around Australia. It suggests a more holistic way of taking flood isolation into account in strategic planning, development control and floodplain management.

Context

State and local government guidelines and planning instruments around Australia vary in their scope, their consideration of flood isolation and the planning controls which apply. It is not possible in a paper such as this to delve into the details of the multiplicity of relevant documents. Rather, the purpose of this paper is to highlight, through examples, the oversights, inconsistencies and inequities that often occur in planning controls when isolation and its consequences are not properly considered.

A good starting point for the discussion is *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia* (AIDR, 2017a) and its accompanying *Guideline 7-2 Flood Emergency Response Classification of the Floodplain* (AIDR, 2017b). Table 1 from the latter document is reproduced here. It divides the entire landscape into areas which are either flooded or not flooded in a probable maximum flood (PMF).

For those areas which are flooded, they are either identified as being isolated by floodwaters or having a rising escape route away from the floodwaters. For those which are not flooded they are either flood free or in some way indirectly affected by the flooding. One of those indirect effects can be having transport links cut which means they are isolated.

Table 1: Flood emergency response classifications

Primary classification	Description	Secondary classification	Description	Tertiary classification	Description	Example figures
Flooded (F)	The area is flooded in the PMF	Isolated (I)	Areas that are isolated from community evacuation facilities (located on flood-free land) by floodwater and/ or impossible terrain as waters rise during a flood event up to and including the PMF. These areas are likely to lose electricity, gas, water, sewerage and telecommunications during a flood.	Submerged (FIS)	Where all the land in the isolated area will be fully submerged in a PMF after becoming isolated.	Figure 1 Figure 7 with levee Figure 8 with impassable terrain
				Elevated (FIE)	Where there is a substantial amount of land in isolated areas elevated above the PMF.	Figure 2
		Exit Route (E)	Areas that are not isolated in the PMF and have an exit route to community evacuation facilities (located on flood-free land).	Overland Escape (FEO)	Evacuation from the area relies upon overland escape routes that rise out of the floodplain.	Figure 3
				Rising Road (FER)	Evacuation routes from the area follow roads that rise out of the floodplain.	Figure 4, Figure 6 with levee
Not Flooded (N)	The area is not flooded in the PMF			Indirect Consequence (NIC)	Areas that are not flooded but may lose electricity, gas, water, sewerage, telecommunications and transport links due to flooding.	Figure 5
				Flood free	Areas that are not flood affected and are not affected by indirect consequences of flooding.	

Note that the heading of the table is “Flood emergency response classifications”. My observation has been, that where agencies have detailed plans for responding to flood emergencies and they have good flood behaviour information, they generally have identified which parts of the communities fall into each of these categories.

This paper does not discuss flood emergency plans for dealing with isolation but rather planning controls for dealing with isolation and where they could be improved with regard to the classifications in Table 1.

Full range of floods

All too common are planning controls which are based solely around the 1% AEP event. For example, the Victorian Government’s *Guideline for Development in Flood Affected Areas* (DELWP, 2019) defines Flood affected land as *“Land inundated by the 1% AEP flood from time to time.”*

However, *AIDR Guideline 7-2* states that the classifications in Table 1 should be based on the PMF. While I agree with the statement in the DELWP guideline, that *"It is not usually feasible, or socially or economically justifiable to adopt the PMF as the standard for all floodplain management activities"*, the floods throughout Australia in the past three years are a reminder that floods rarer than a 1% AEP can and do occur. An area which is not isolated in the 1% AEP event may be isolated in a rarer event and we must consider the consequences in land use planning decisions and development controls.

Figure 1 is as example of an area with flood free access in a 1% AEP, becoming a flood island in a 0.2% AEP flood (equivalent to the flood of record at this location) and completely inundated by several metres of water in a PMF.

We also need to consider floods more frequent that the 1% AEP event. The following is an extract from a Victorian local floodplain development plan.

New or replacement buildings should….have an accessway to the building envelope that:

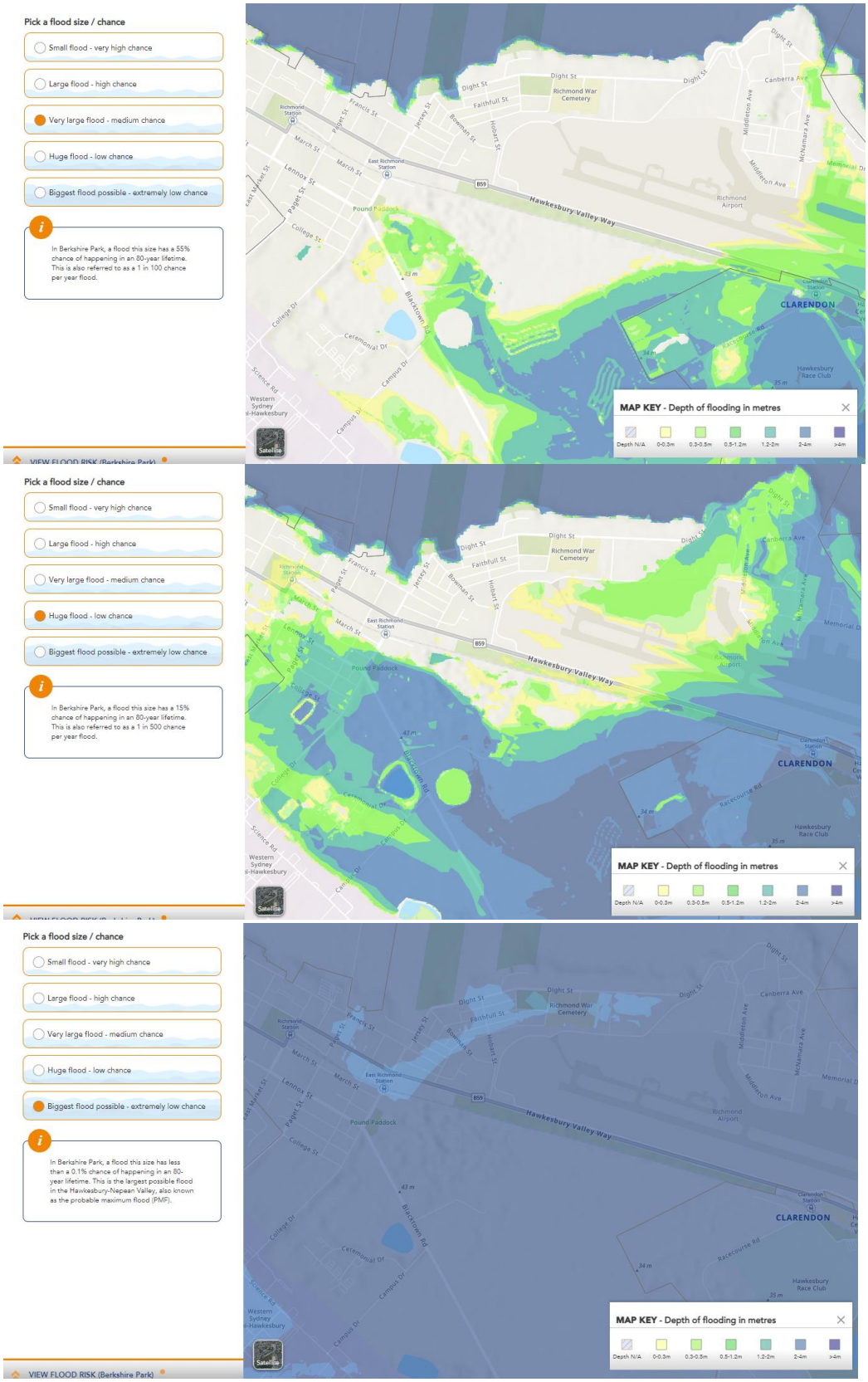
- *does not traverse land where the flood depth is estimated to exceed 300mm during a 1% AEP flood event under the 1.2m sea level rise scenario; and*
- *is not subject to flooding where the product of depth and velocity (VxD) exceeds 0.4 metres squared per second during the 1% AEP flood event;*

Notwithstanding arguments about what flood hazard constitutes isolation or is safe to traverse (more on that later), the range of flood levels can have a significant influence on how often such an accessway has water across it. Where the range of flood levels is large, a flood approaching a 1% AEP frequency would be necessary before there is any water over the road. However, if the range of flood levels is small, a very frequent flood may cover the road. This should be taken into consideration when setting development controls such as this.

The Gold Coast City Council flood overlay code requires consideration of the more frequent floods where it states:

PO11
All proposed development must demonstrate that sufficient access or egress will be available to enable evacuation during a range of floods, up to and including the designated flood.

The designated flood frequency varies depending on land use and a particular hazard



Flood Impact of 1% AEP, 0.2% AEP and PMF

Hazard

There is much debate about what flood depth or hazard constitutes isolation. The Victorian local floodplain development plan above would appear to have used the Hydraulic hazard vulnerability curves illustrated in Figure 2 to set a threshold depth and hazard below which water across the accessway does not constitute an unacceptable hazard to those using it during a flood.

Emergency service organisations around the country tend to be more conservative and recommend against walking, riding or driving through any depth of floodwater. Part of their argument is that it is not possible to see what lies beneath the surface of the water which may increase the hazard. This is a valid argument because Figure 2 is simply considering stability in a range of hydraulic hazards but hazard is made up of more than simply hydraulic hazard.

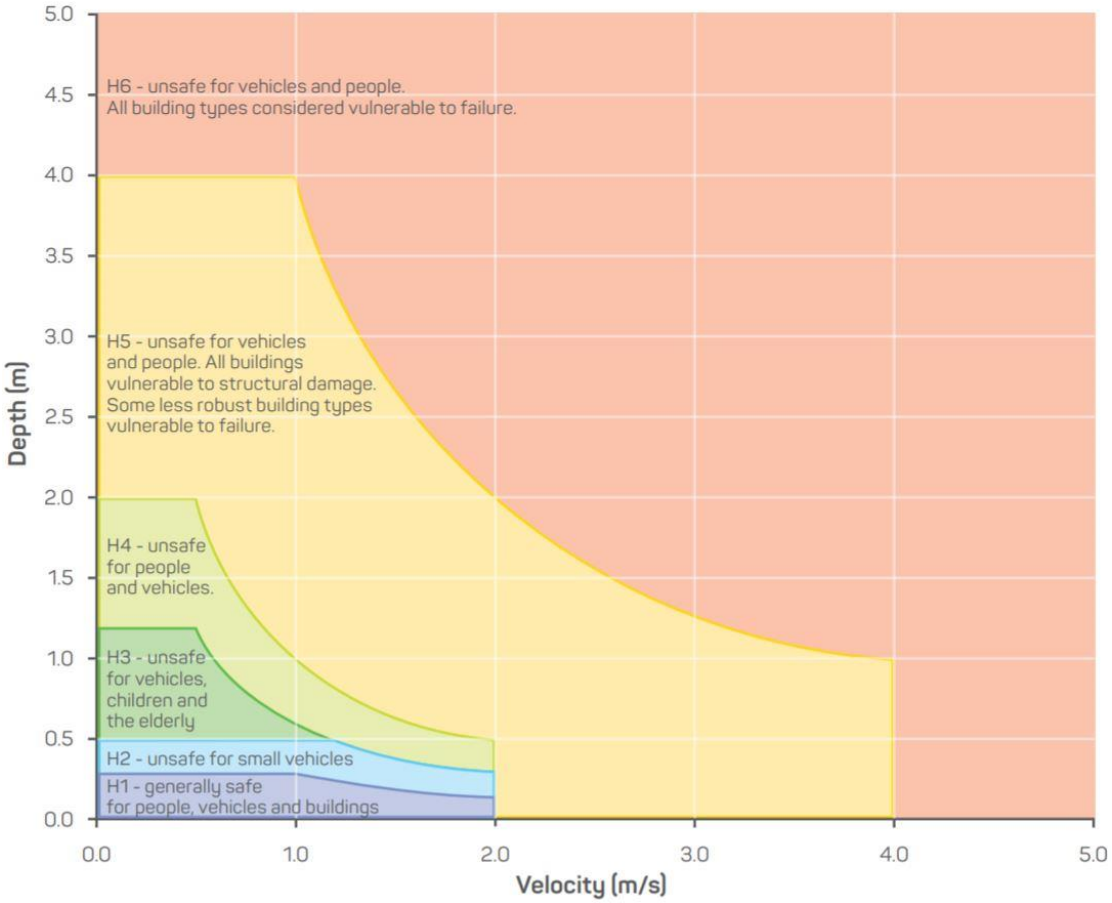


Figure 2: Hydraulic hazard vulnerability curves (Geoscience Australia, 2019)

This is illustrated from the location where the aforementioned Victorian local floodplain development plan applied. Implicit in that plan is an assumption that less than 300mm depth of low velocity floodwater across the road does not

constitute a sufficient hazard to make isolation unacceptable with a frequency of 1% AEP.

When the evacuation route looks like that in Figure 3, there would seem to be logic in the argument because the terrain on either side of the road is at a similar level to the road formation and there are tall visual markers to give a driver an idea where the road formation sits. However, Figure 4 is the same evacuation route on the outskirts of town and there is nothing to visually guide a driver away from driving off a shallow flooded road into a deeply flooded verge because the fence posts on the left are below the road level.

Figure 3: Evacuation route through town.

Figure 4: Evacuation route on the outskirts of town.

Other important factors which contribute to the hazard and which should be taken into consideration when determining the appropriateness of isolation are the availability of flood warning and the rate of flood rise.

Where there is a long warning lead time and rates of rise are slow it may be appropriate to rely on access along a road which can have shallow flooding in rare flood events. However, if floods can rise rapidly with little or no warning it is possible that the hydraulic hazard on the road could change quickly from low to high hazard while people are using it because there would be no forecast that the event was going to be rarer than the event for which it was decided access would be safe.

Duration

I have yet to see a planning instrument which takes into account the duration of isolation in setting planning controls. However, this is an important consideration.

If the duration is very short (minutes to a few hours) the occupants of the development are less likely to:

1. be inconvenienced by the isolation and therefore not be motivated to leave the development during the flood
2. have enough time to decide to traverse hazardous floodwaters
3. experience a secondary emergency such as a medical episode or building fire.

On the other hand, longer durations of isolation, particularly more than 24 hours, not only increase the probability of the above but research suggests that even people who have voluntarily decided to shelter in place and have made what they believe to be adequate preparations, can have second thoughts (BNHCRC 2017). This can lead to people seeking to be rescued or traversing hazardous floodwaters.

Vulnerability

There are many planning instruments which place additional planning controls on particular types of developments because of their greater vulnerability due to the impacts of flooding, including isolation.

For example, many local councils in NSW adopt a matrix approach to floodplain development controls and will have a land use category of Sensitive Uses and Facilities and then will discourage development of these uses anywhere which is below the PMF (Figure 5). This seems eminently sensible.

Land Use Categories	Identified Land Uses
Sensitive Uses and Facilities	Community facilities or Public administration buildings which may provide an important contribution to the notification and evacuation of the community during flood events; Child care centres; Hospitals; Residential care facilities; Seniors housing; Educational establishments.

Flood Plain Matrix Planning and Development Controls

Flood Risk Precincts (FRP's)	Planning Consideration	Floor Level	Building Components	Structural Soundness	Flood Affectation	Car Parking & Driveway Access	Evacuation	Management & Design
High Flood Risk	Concessional Development	4, 5	1	1	1	1, 5	3, 4, 6	2, 3, 4
	Open Space & Non-Urban	1, 5	1	1	1	2, 4, 6, 7	1, 4	2, 3, 4
	Tourist Related Development	X	X	X	X	X	X	X
	Commercial & Industrial	X	X	X	X	X	X	X
	Residential*	X	X	X	X	X	X	X
	Filling	X	X	X	X	X	X	X
	Subdivision	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Sensitive Uses & Facilities	X	X	X	X	X	X	X
Medium Flood Risk	Concessional Development	4, 5	1	1	1	1, 5	3, 6	2, 3, 4
	Open Space & Non-Urban	1, 5	1	1	2	2, 4, 6, 7	1, 4	2, 3, 4
	Tourist Related Development	2, 5	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Commercial & Industrial	2, 5	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Residential*	2, 5	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Filling	X	X	X	X	X	X	X
	Subdivision				1		5, 3, 4	1
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Sensitive Uses & Facilities	X	X	X	X	X	X	X
Low Flood Risk	Concessional Development							
	Open Space & Non-Urban					2, 4, 6, 7		
	Tourist Related Development	2, 5			2	1, 3, 5, 6	4	
	Commercial & Industrial	2, 5			2	1, 3, 5, 6	4	
	Residential*	2, 5			2	1, 3, 5, 6	3, 4	
	Filling				1			
	Subdivision				2		5	1
	Critical Uses & Facilities	3	2	2	2	1, 3, 5, 6	2, 4, 6	2, 3, 4
	Sensitive Uses & Facilities	X	X	X	X	X	X	X

*for redevelopment of existing dwellings refer also to 'Concessional Development Provisions"

Legend

Not Relevant X Unsuitable Land Use

Figure 5: Typical flood planning control matrix discouraging vulnerable development on floodplain.

However, having assessed the risks for several aged care facilities in recent years, I am now of the opinion that in some circumstances aged care facilities may actually be less vulnerable to some types of flooding than other land uses which are not discouraged.

For example, where flood isolation is short and rare and the facility is immune from extreme flooding entering the building, an aged care facility may have a lower risk profile than residential or commercial development because:

- residents can be prevented from leaving the premises
- they usually have three days' supply of food and medication on hand as a matter of course
- there are staff on site with sufficient medical training to deal with minor medical incidents
- in some jurisdictions the buildings must have fire suppression systems

many have emergency power supplies to deal with potential loss of power from a variety of causes, not just floods.

Isolated from What

A concern often raised by emergency service organisations is that there is an increased probability of secondary incidents such as medical emergencies or building fires during a flood and isolation of development from those services places building occupants at increased risk.

This is true but often in context it is not the floods isolating a proposed development which is the problem but the floods which isolate the emergency service and health premises. During a study into a potential shelter in place policy for Fairfield City Council in Western Sydney, we considered the location of fire and ambulance stations and public and private hospitals.

As Figure 6 shows, flooding cuts off Fairfield Ambulance Station from most of the LGA and some of the non-flooded parts of the LGA are cut off from the hospitals and the fire stations.

Outside the Floodplain

Another common issue is that planning instruments do not consider the impacts of flooding on development outside of the floodplain and therefore do not apply flood development controls to them.

Figure 7 is an example from a recent court case where the two block outlined were partly within the extent of the 1% AEP flood and the planning controls prevented them from building new or additional dwellings on the block unless it could be demonstrated that the evacuation route was not through hazardous floodwaters in a 1% AEP flood.

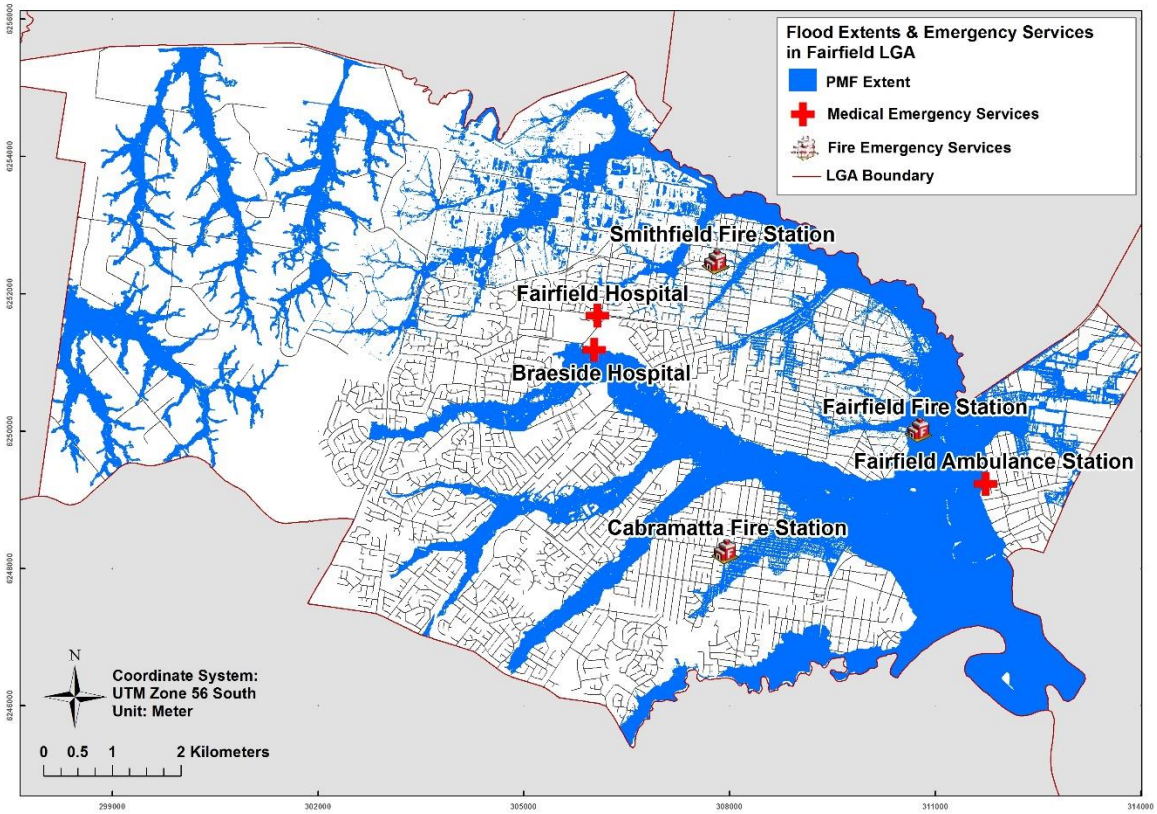


Figure 6: Emergency facilities in Fairfield (NSW) LGA.

Figure 7: Isolation caused by the 1% AEP flood.

This was despite the fact that new buildings could be built on the blocks above the 1% AEP flood level. While that may seem reasonable, the blocks at their rear were not subject to the same development control because those blocks were entirely above the 1% AEP flood level yet they need to use exactly the same flood affected access road. In this case land with the same isolation risk was treated differently on the basis of where the property boundaries stood in relation to the 1% AEP flood extent.

Another example is the coastal town in Figure 8 which shows the extent of the PMF surrounding the oldest and highest part of town. There are no flood planning controls which apply to the flood free areas shown nor to the adjacent areas which are above the 1% AEP plus free board. Yet this town gets isolated by a 20% AEP flood and that isolation can last for several days in more extreme floods.

The self-sufficiency of the town must come into consideration when determining the appropriateness of isolation. This particular town is big enough to have a police station, a fire station, ambulance station, community health centre, three medical practices, a pharmacy and a Coles supermarket. While this suggests that the town may continue to function during all sorts of floods, it must be pointed out that the supermarket, community health centre, ambulance station, pharmacy and all three medical practices are within the area circled in pink which gets isolated from the rest of the town in a flood somewhere between the 20% and 5% AEP events. The nearest hospital is a further 15km upstream along a road which goes under at multiple locations in a similar event.

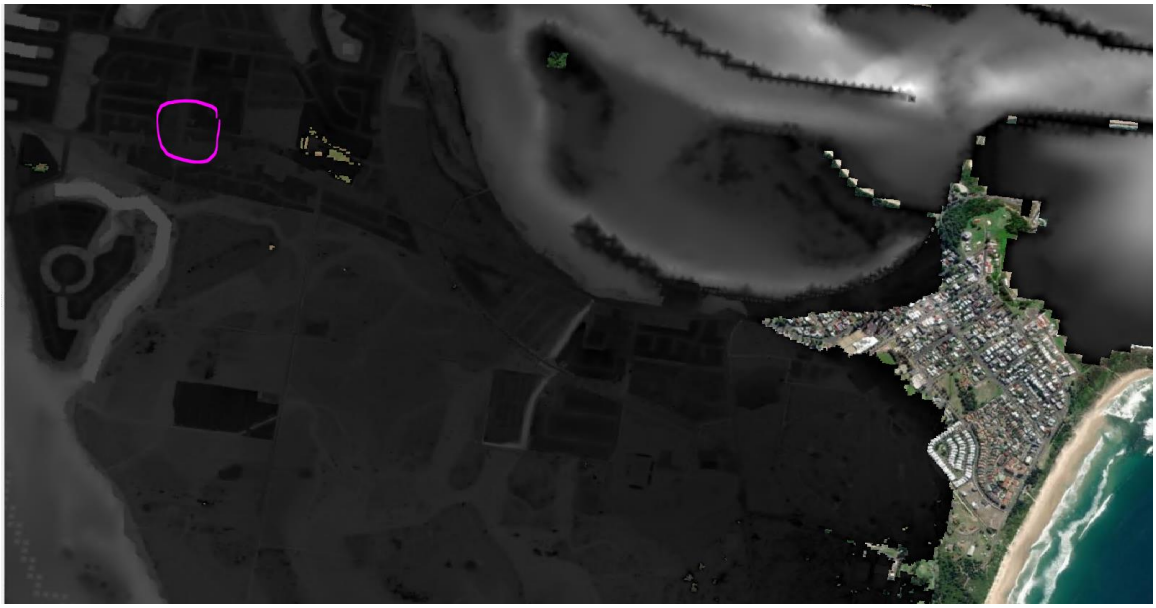


Figure 8: Coastal town isolated by PMF

Progress

Attempts are being made to better take isolation into account in planning instruments. For example, the Sunshine Coast Planning Scheme flood overlay code Performance Outcome PO4 states:

"Development does not compromise the safety of people resulting from the residual flood or storm tide inundation risk associated with events exceeding the DFE [defined flood event] *or DSTE* [defined storm tide event]*, up to and including the probable maximum flood (PMF) or probable maximum storm tide (PMST)."*

Not only does this require the consideration of events up to the PMF but it is an objective based, rather than a prescriptive, development control which requires that residual risks for events which exceed the defined flood event (in this case the 1% AEP) do not compromise people's safety.

It then provides two alternative acceptable outcomes.

Development provides an effective evacuation route that remains passable, with sufficient flood warning time, to enable people to progressively evacuate to areas above the PMF or PMST in the face of advancing flood or storm tide waters for events exceeding the DFE or DSTE. OR

Development incorporates building floor levels or surface levels within each lot, as adequate safe refuges, that are above the PMF or PMST.

The challenge that a planning instrument presents such as this presents is that it begs the questions:

- What is an effective and passable evacuation route?
- What is sufficient flood warning time?
- What is an adequate safe refuge?

I suggest that the answers to those questions will depend on the individual circumstances of the development and need careful consideration of the various factors discussed earlier in this paper.

However, these factors also need to be taken into consideration at the strategic planning level. Risks associated with isolation need to be factored into rezoning decisions and decisions about where flood planning controls apply. I would go as far to say that in many places these need to be applied retrospectively to areas of existing development, including some areas which sit above not only the flood planning level but also the PMF.

References

- Australian Institute for Disaster Resilience (2017a) *Managing the Floodplain: A Guide to Best Practice in Flood Risk Management in Australia Handbook 7*
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