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19 May 2014

Mr Brent Devine
NSW Planning and Infrastructure
GPO BOX 39
SYDNEY NSW 2001

Attention: Brent Devine

Dear Mr Devine,

Director General Requirements for Gazcorp Industrial Estate Western Sydney Employment Area, 813-913 Wallgrove Road, Horsley Park (your reference: SSD 5248)

This letter details the NSW State Emergency Service's (NSW SES) submission to the applicant's response to the Director General's Requirements (DGRs) for the proposed Industrial Estate Western Sydney Employment Area at 813-913 Wallgrove Road, Horsley Park. It should be noted that the NSW SES was not directly notified about this proposal, however in the future the NSW SES would appreciate being notified for any DGRs that highlight flooding as a potential issue for a proposed development.

The NSW State Emergency Service (NSW SES) is the agency responsible for dealing with floods, storms and tsunami in NSW (see *State Emergency and Rescue Management Act 1989* (NSW); *State Emergency Service Act 1989* (NSW)). This role includes, planning for, responding to and coordinating the initial recovery from floods. As such, the NSW SES has an interest in the public safety aspects of the development of flood prone land, in particular, the potential for changes to land use to either exacerbate existing flood risk or create new flood risk for communities in NSW. These issues are detailed throughout the State Government's Floodplain Development Manual, 2005 (FDM).

NSW SES General Floodplain Risk Management Advice

The NSW SES recommends that consideration of flooding issues is undertaken in accordance with the requirements of NSW Government's Flood Prone Land Policy of

which the FDM and relevant planning directions under the *Environmental Planning and Assessment Act, 1979* (NSW) set out guidance on how to comply with the policy.

As with all such matters, the consent authority will need to be satisfied that the planning proposal is substantially in accordance with the FDM. In this regard, attention is drawn to the following principles outlined in the FDM which are considered to be of particular importance to the NSW SES role:

- Risk assessment should consider the full range of flooding, including events up to the Probable Maximum Flood (PMF) and not focus only on the 1% AEP/100 year ARI flood.

- Zoning should not enable development that will result in an intolerable increase in risk to life, health or property of people living on the floodplain.

- Risk assessment should have particular regard to flood warning and evacuation demand on existing and future access/egress routes. Consideration should also be given to the impacts of localised flooding on evacuation routes.

- In the context of future development, self-evacuation of the community (i.e. unassisted evacuation) should be achievable in a manner which is consistent with the NSW SES's principles for evacuation.

- Future development must not conflict with the NSW SES's flood response and evacuation strategy for the existing community.

- Evacuation must not require people to drive or walk through flood water.

- Development strategies relying on deliberate isolation or sheltering in buildings surrounded by flood water are not equivalent, in risk management terms, to evacuation.

- Development strategies relying on an assumption that mass rescue may be possible where evacuation either fails or is not implemented are not acceptable to the NSW SES.

- The NSW SES opposes the imposition of development consent conditions requiring private flood evacuation plans rather than the application of sound landuse planning and flood risk management.

To ensure that these and other flood management issues in the landuse planning context are fully considered please refer to the following guidelines developed by the then Department of Land and Water Conservation for the Hawkesbury-Nepean Flood Management Advisory Committee as part of the Hawkesbury-Nepean Flood Management Strategy:

- Building Guidelines
- Landuse Guidelines
- Sub-Division Guidelines

These documents can be found on the NSW SES web site at: http://www.ses.nsw.gov.au/communitysafety/floodsafe/hawkesbury-nepean-floodsafe.
Additional information regarding the NSW emergency management arrangements for flood can be found in the NSW State Flood Plan: http://www.ses.nsw.gov.au/communitysafety/floodsafe/floodplanning/.

The following specific issues relating to emergency management should particularly be considered for the proposed industrial development on flood prone land.

Impacts of cumulative development on emergency management capability

As mentioned above, the FDM recommends that the full range of flooding be considered, up to the Probable Maximum Flood (PMF) event. To achieve consistency with the principles of the FDM in land use planning, it is important not only to consider the PMF for the area subject to development, but also the areas that may be affected downstream. This will aid in understanding the cumulative impacts of development on the floodplain and especially help determine if or what evacuation routes may exist or be required during floods up to and including the PMF. It is important for the NSW SES and other emergency service organisations to know these cumulative impacts, in order to understand the communities at risk and whether there is sufficient time available for evacuation.

It is noted that the Director General's Environmental Assessment Requirements (14 May 2012) requires the applicant to address these issues mentioned above. Point 15 requires:

> '*a comprehensive assessment of the impact of flooding on the proposed development and any flood risk to people and properties for the full range of the floods up to the probable maximum flood (PMF) event including potential long term cumulative impacts from potential development. This assessment should address any relevant provisions of the NSW Floodplain Development Manual (2005)…' (page 14)*

It is noted that the *813-913 Wallgrove Road, Horsley Park Regional Hydraulic Modelling and Impact Report* (BMT WBM, 25 October 2013) ('*the Hydraulic Modelling and Impact Report*') has investigated and reported on the impacts on neighbouring properties, noting that *'the proposed development will not significantly increases in flood levels external to the site'*. The report then notes

> *'(h)owever there are small areas along the western and southern boundaries of the development where there are increases in flood level of up to about 4 cm'* (page 13), and '*there is an increase in depth along Wallgrove Road'* for the modelled 100 year ARI flood event (page 13) of which is '*…likely to increase…the duration of flooding along Wallgrove Road…in the order of 3-5hours*' (page 14).

Although the surrounding impacts have been addressed for the 100 year ARI flood event, there is no information or discussion within *the Hydraulic Modelling and Impact Report* regarding the impact of flooding on the proposed development. There is some discussion of how the flooding will be addressed through onsite detention basins in the *Stormwater Concept Plan* (Brown Consulting, August 2013), but this also only addresses flooding up to the 100 year ARI flood.

Additionally, the limited modelling presented for the 100 year ARI is not consistent with the requirements of the FDM which requires consideration of the full range of flood events. Although modelling has been conducted for the 500 year and 2000 year ARI, this is limited to the change in flood depth surrounding the site. *The Hydraulic Modelling and Impact Report* does not give any indication of the increased length of time that Wallgrove Road would be flooded for. There is also very little in the way of description of the effects on the development from the 500 year and 2000 year ARI modelled floods.

Evacuation and road network considerations

Consideration should particularly have regard to effects on existing and future access/egress routes within and surrounding the development for a full range of floods up to and including the PMF. This should also consider the impacts of localised overland flooding on evacuation routes.

The community should be able to self-evacuate (or evacuate unassisted) in a manner which is consistent with the NSW SES's principles for evacuation. Consideration of the flood emergency response classification of communities (see the attached Department of Environment & Climate Change (now part of Department of Planning and Environment) floodplain risk management guideline) can assist in understanding whether a community can self-evacuate during a flood.

The *Stormwater Concept Plan* indicates that Wallgrove Road is the primary access road to the proposed development. *The Hydraulic Modelling and Impact Report,* however, does not indicate whether Wallgrove Road is the only access road to and from the site during a flood, or if there are other available roads that allow access/egress to/from the site in floods. As mentioned above this is an important emergency management consideration for the purposes of evacuation and should be addressed by the applicant.

An additional matter that should be addressed is the impact of the closure of Wallgrove Road on other road users, not just those intending to access the proposed development site. It may be that there are other roads other than Wallgrove Road available, however this is not specified in any of the supporting documentation.

The material available also does not '*…detail an emergency response plan to manage floods above the flood planning level…',* another requirement at point 15 in the DGR. The preparation of such a plan would, amongst other things, enable the applicant to establish whether there were adequate access/egress routes available, however, as mentioned above, any emergency response plan used for the purposes of obtaining consent would be contrary to the FDM.

Flash Flood considerations

Consideration should also be given to the potential risk from flash flooding in this area. Flash flooding is defined by the Commonwealth Bureau of Meteorology as *'flooding occurring within about six (6) hours of rain, usually the result of intense local rain and characterised by rapid rises in water levels'.* The potential for flash flooding to occur in this catchment both in its current state and under the proposed development scenario cannot fully be determined from the material available. Should the area be subject to flash flooding, safe evacuation may not be possible due to insufficient warning times and inadequate warning systems.

Emergency Management issues during flash flood events

Information in regards to land use planning and emergency management considerations in flash flood environments, is included in the attached Australian Fire and Emergency Services Authorities Council Limited (AFAC) national best practice guideline titled: 'Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events' ('AFAC guideline').

Specifically, section 3.3 of the AFAC guideline recommends:

> '(g)iven the life risk posed by flash flooding...new urban areas...should facilitate rapid and safe evacuation from flash flood-prone locations, (and) should account for the likelihood that some people may be trapped inside buildings...'

The NSW SES supports the emergency management strategy of the AFAC guidelines, and notes the indication in the guideline of the inherent risks of seeking 'refuge' or 'sheltering-in-place', at section 3.15:

> '...remaining in buildings likely to be affected by flash flooding is not low risk and should never be a default strategy...even if the buildings are considered likely to withstand the impact of flash flooding. Where the available warning time and resources permit, evacuation should be the primary response strategy'.

If you would like to discuss any of the above issues or require any further information please do not hesitate to contact me on **(02) 4251 6638**.

Yours sincerely,

Marcus Morgan
Landuse Risk Management Officer
NSW State Emergency Service

CC: Deputy Region Controller, Sydney Southern Region
Manager, Emergency Risk Management

Attachments:

1. Department of Environment & Climate Change (15 August 2007) 'Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities.' Version 1.0

2. Australasian Fire and Emergency Service Authority Council (18 April 2013) 'Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events.' Version 1.0

Flood Emergency Response Planning Classification Of Communities

Summary

This guideline was developed in conjunction with the State Emergency Service (SES) to provide a basis for the flood emergency response categorisation of floodplain communities (both existing and future). Classification provides an indication of the relative vulnerability of the community in flood emergency response and when used with FRM Guideline SES Information Requirements from the Floodplain Risk Management (FRM) Process it identifies the type and scale of information needed by the SES to assist with emergency response planning (ERP).

Introduction

The Floodplain Development Manual, 2005 requires flood studies and FRM studies and plans to address the management of continuing flood risk to both existing and future development areas. As continuing flood risk varies across the floodplain so does the type and scale of emergency response problem and therefore the information necessary for effective ERP.

This guideline provides a basis for the categorisation of floodplain communities into various flood ERP classifications. Table 1 provides an indication of the response required for areas with different classifications. However, these may vary depending on local flood characteristics and resultant flood behaviour i.e. in flash flooding or overland flooding areas.

These classifications are defined in Section 1 and are determined by using the flowchart provided, Figure 1.

Recommendations

It is recommended that the ERP classification of the floodplain be undertaken for the 20 and 100 year average recurrence interval (ARI) and Probable Maximum Flood (PMF) events.

References

Department of Infrastructure Planning and Natural Resources. “Floodplain Development Manual: the management of flood liable land”, gazetted May 2005.

Table 1 Response Required for Different Flood ERP Classifications

Classification	Response Required		
	Resupply	Rescue/Medivac	Evacuation
High Flood Island	Yes	Possibly	Possibly
Low Flood Island	No	Yes	Yes
Area with Rising Road Access	No	Possibly	Yes
Areas with Overland Escape Routes	No	Possibly	Yes
Low Trapped Perimeter	No	Yes	Yes
High Trapped Perimeter	Yes	Possibly	Possibly
Indirectly Affected Areas	Possibly	Possibly	Possibly

Queries can be directed to your regional DECC floodplain risk management contact or duncan.mcluckie@dnr.nsw.gov.au

Version No: 1.0 Status: Final Issue date 15/08/2007 Authorisation: Director Coast & Floodplain Management

Section 1 Flood ERP Classification of Communities

To assist in the planning and implementation of response strategies the SES classifies communities according to the impact that flooding has on them. Flood affected communities are those in which the normal functioning of services is altered either directly or indirectly because a flood results in the need for external assistance. This impact relates directly to the operational issues of evacuation, resupply and rescue. The classifications used are described below.

NOTE: These definitions are described in terms of the impact of a PMF or equivalent extreme event. Because of the difference in flood effects at lower levels, the operational classification of an area during an actual flood of lower severity could be different to the PMF planning classification. The classification of the area should also be undertaken for the 100 year ARI flood event (or dominant planning flood) and stated on any classification.

Section 1.1 Flood Islands

These are inhabited or potentially habitable areas of high ground within a floodplain linked to the flood-free valley sides by a road along a low ridge. The road can be cut by floodwater, closing the only evacuation route and creating an island. After closure of the road the only access to the area is by boat or by aircraft.

Flood islands are classified according to what can happen after the evacuation route is cut as follows:

- High Flood Island (HFI). The flood island includes enough land higher than the limit of flooding (i.e. above the PMF) to cope with the number of people in the area. During a flood event the area is surrounded by floodwater and property may be inundated. However, there is an opportunity for people to retreat to higher ground above the PMF within the island and therefore the direct risk to life is limited. The area will require resupply by boat or air if not evacuated before the road is cut. If it will not be possible to provide adequate support during the period of isolation, evacuation will have to take place before isolation occurs.
- Low Flood Island (LFI). The flood island is lower than the limit of flooding (ie below the PMF) or does not have enough land to cope with the number of people in the area. During a flood event the area is isolated by floodwater and property will be inundated. If floodwater continues to rise after it is isolated, the island will eventually be completely covered. People left stranded on the island may drown and property will be inundated.

Section 1.2 Trapped Perimeter Areas

These would generally be inhabited or potentially habitable areas at the fringe of the floodplain where the only practical road or overland access is through flood prone land and unavailable during a flood event. The ability to retreat to higher ground does not exist due to topography or impassable structures. Trapped perimeter areas are classified according to what can happen after the evacuation route is cut as follows.

- High Trapped Perimeter (HTP) Area. The inhabited or potentially inhabited area includes enough land to cope with the number of people in the area that is higher than the limit of flooding (ie above the PMF). During a flood event the area is isolated by floodwater and property and may be inundated. However, there is an opportunity for people to retreat to higher ground above the PMF within the area and therefore the direct risk to life is limited. The area will require resupply by boat or air if not evacuated before the road is cut. If it will not be possible to provide adequate support during the period of isolation, evacuation will have to take place before isolation occurs.
- Low Trapped Perimeter (LTP) Area: The inhabited or potentially inhabited area is lower than the limit of flooding (ie below the PMF) or does not have enough land to cope with the number of people in the area. During a flood event the area is isolated by floodwater and property may be inundated. If floodwater continues to rise after it is isolated, the area will eventually be completely covered. People trapped on the island may drown.

Queries can be directed to your regional DECC floodplain risk management contact or duncan.mcluckie@dnr.nsw.gov.au
Version No: 1.0 Status: Draft Issue date 30/05/2007 Authorisation: Director Coast & Floodplain Management

Section 1.3 Areas Able to be Evacuated

These are inhabited areas on flood prone ridges jutting into the floodplain or on the valley side. However, their categorisation depends upon the type of evacuation access available, as follows.

- Areas with Overland Escape Route (OER) are those areas where access roads to flood free land cross lower lying flood prone land. Evacuation can take place by road only until access roads are closed by floodwater. Escape from rising floodwater is possible but by walking overland to higher ground. Anyone not able to walk out must be reached by using boats and aircraft. If people cannot get out before inundation, rescue will most likely be from rooftops.
- Rising Road Access (RRA) Areas are those areas where access roads rising steadily uphill and away from the rising floodwaters. The community cannot be completely isolated before inundation reaches its maximum extent, even in the PMF. Evacuation can take place by vehicle or on foot along the road as floodwater advances. People should not be trapped unless they delay their evacuation from their homes. For example people living in two storey homes may initially decide to stay but reconsider after water surrounds them.

These communities contain low-lying areas from which persons will be progressively evacuated to higher ground as the level of inundation increases. This inundation could be caused either by direct flooding from the river system or by localised flooding from creeks.

Section 1.4 Indirectly Affected Areas (IAA)

These are areas which are outside the limit of flooding and therefore will not be inundated nor will they lose road access.

However, they may be indirectly affected as a result of flood damaged infrastructure or due to the loss of transport links, electricity supply, water supply, sewage or telecommunications services and they may therefore require resupply or in the worst case, evacuation.

Section 1.5 Overland Refuge Areas

These are areas that other areas of the floodplain may be evacuated to, at least temporarily, but which are isolated from the edge of the floodplain by floodwaters and are therefore effectively flood islands or trapped perimeter areas. They should be categorised accordingly and these categories used to determine their vulnerability.

Queries can be directed to your regional DECC floodplain risk management contact or duncan.mcluckie@dnr.nsw.gov.au
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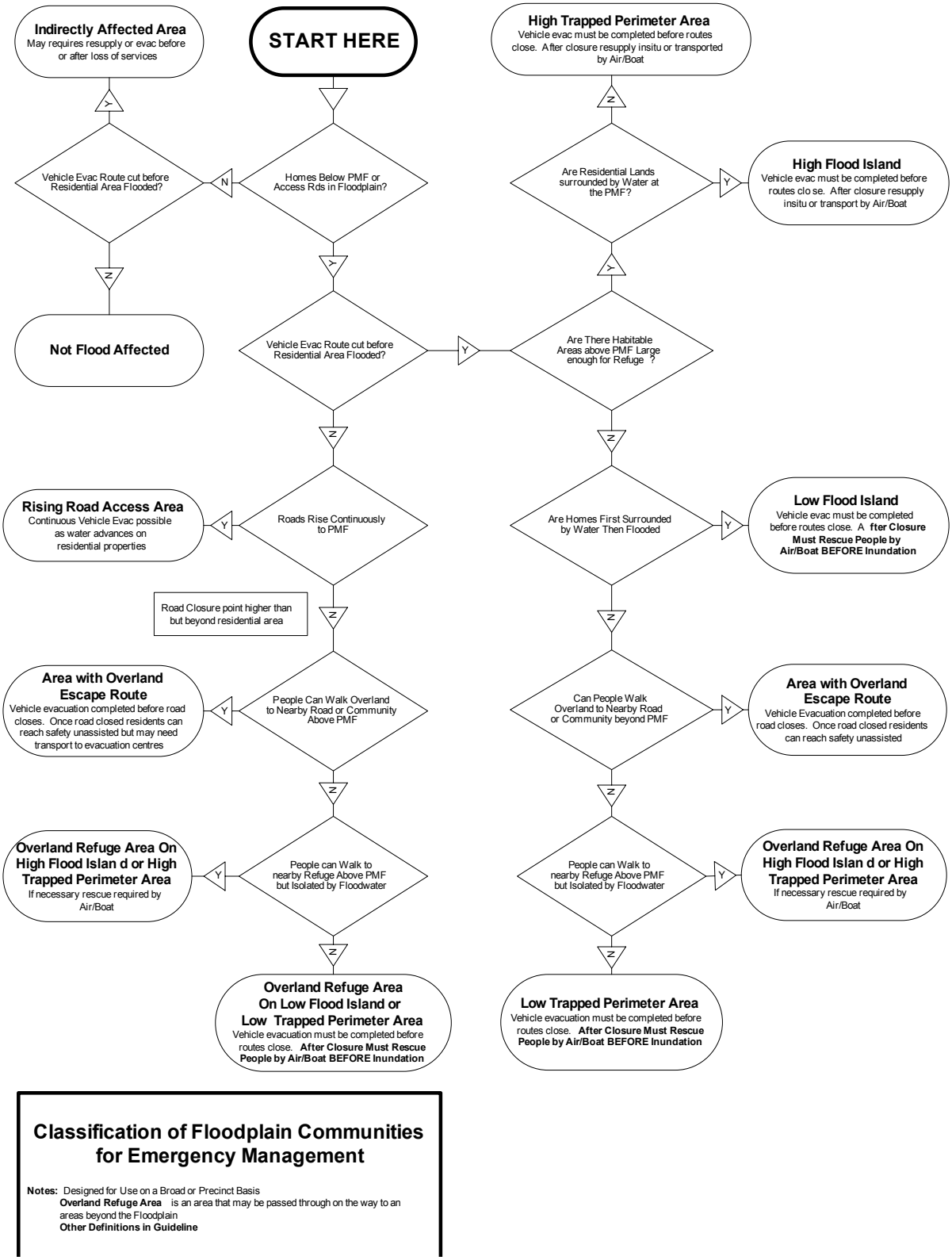
Figure 1 – Preliminary Flow Chart for Flood Emergency Response Classification



Queries can be directed to your regional DECC floodplain risk management contact or duncan.mcluckie@dnr.nsw.gov.au
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afac
Australasian Fire and Emergency Service Authorities Council

Guideline on Emergency Planning and Response to Protect Life in Flash Flood Events

GUIDELINE

Version 1.0

18 April 2013

Acknowledgement

This guideline has been developed based on research carried out by NSW SES that investigated risk to life factors in flash flood environments, and operational experience. The Australian Government Attorney General's Department and the NSW State Government provided project funding to NSW SES (through the Natural Disaster Mitigation Program) and other state and federal agencies provided input.

An earlier version of this guideline was authored by NSW SES and this guideline has drawn from that document. The work of NSW SES in researching and preparing that initial version is gratefully acknowledged.

Version Control

Version	Author	Edits	Date
0.1		Initial draft	
0.2		Incorporate comments on initial draft	10 July 2012
0.3		Incorporate references to Victorian and Queensland inquiries	3 September 2012
0.4	P Considine	Minor edits before circulation to ACSES Directors	28 September 2012
0.5	S Opper	Final edits and incorporate feedback (SA, NSW, AFAC)	29 November 2012
0.6	P Considine	Version for approval	December 2012
1.0	Paul Considine	Approved by Council	18 April 2013

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1 How/why to use this document

AFAC Guidelines are a preferred or advisable course of action. Member agencies are expected to be aware of Guidelines and to have considered how best they apply to relevant circumstances faced by the agency. Guidelines are addressed to AFAC member agencies, and agency personnel should refer to their agency operating procedures for further information.

This Guideline is to assist and support agencies planning for and responding to protect life in incidents involving flash flooding. It reflects a consensus on best practice for dealing with such incidents as at the date of publication. The guideline focusses on risk to life and does not address issues such as property protection through flood mitigation (permanent or temporary) or protection of critical infrastructure.

The guideline is not a ready-made operational action plan and needs to be applied in the context of individual locations and with specific knowledge of the flash flood risk for each community.

2 Introduction

Flash flooding may be defined as flooding that occurs within 6 hours or less of the flood-producing rainfall within the affected catchment.

Flash flood environments are characterized by the rapid onset of flooding from when rainfall begins (often within tens of minutes to a few hours) and by rapid rates of rise and by high flow velocity. The duration of flash flooding is often relatively short by comparison to riverine floods. However, safety of isolation is subjective and there is no evidence-based method for determining the tolerable duration of isolation that might result from floods, that is, the question of what is a safe period of isolation is not resolved.

As is the case for other types of flooding, the management of flash flooding involves both pre-incident planning (with the involvement of the potentially affected community) and operational planning and decision-making. This guideline discusses the issues associated both the pre-incident and the incident phase of flash flood management and provides suggestions for the handling of each of these phases.

3 Guideline

The relationship between land use planning and flash flood emergency management

1. Flash flooding can have significant consequences for both the natural and the built environments. Unfortunately, many communities have inherited the legacy of land use planning decisions that have not explicitly allowed for the safety of the people living or working there. For example, no consideration of the warning lead time required for a comprehensive response.

2. Urban development that has not adequately considered flash flood risk can compromise community safety and specific issues include:
    - Inadequate access or egress roads;

- Poorly designed or maintained drainage systems leading to exacerbation of the flood hazard (depth, velocity, duration);
- Building design with the only entry or exit through high hazard areas;
- Building design that is structurally inadequate to withstand expected depth and velocity of flood flow; and
- Building design that does not provide for a refuge place where trapped occupants might be able to survive the expected depth of water inside of the building.

3. Given the life risk posed by flash flooding and the inherent limitations on how it can be managed, new urban areas should be designed within the limits of existing flash flood forecast capability, should facilitate rapid and safe evacuation from flash flood-prone locations, should account for the likelihood that some people might become trapped inside buildings, and should involve a thorough understanding of how people will behave in a flash flood event and the risks they face.

4. Urban designers and agencies that are responsible for managing flood risk should work closely together. Flood studies undertaken at the time of urban design are a critical source of information for emergency management planning and inter-related warning systems.

Pre-incident planning

5. Particularly in areas where urban planning and building design issues exacerbate flash flood risk, failure to properly plan and prepare is a major barrier to effective emergency management of flash floods.

6. Pre-incident planning for flash flood events requires flash flood risk locations to be identified and mapped. This may be a function of emergency response agencies or of local or state government. Jurisdictions should clearly establish whose role this is.

7. The safest place to be in a flash flood is well away from the affected area. Accordingly, pre-event planning for flash floods should commence with an assumption that evacuation is the most effective strategy, provided that evacuation can be safely implemented.

8. Evacuation too late may be worse than not evacuating at all because of the dangers inherent in moving through flood waters, particularly fast-moving flash flood waters. The timescale over which flash floods occur may limit the feasibility of evacuation as a response measure.

9. Pre-incident planning needs to include a realistic assessment of the time required to evacuate a given location via safe evacuation routes. This requires determination of whether there are barriers to evacuation posed by available warning time, availability of safe routes, and resources available.

Assessing Building Structural Suitability

10. Pre-incident planning for known flash flood prone areas should include a triaging of structures in the location into:
    - **Clearly unsuitable** to withstand flash flooding (by reason of lack of structural integrity or likely submersion);

- **Apparently suitable** to withstand flash flooding (strong construction and sufficient building height to permit occupants to move above the level of the probable maximum flash flood, and useable egress for escape/rescue), or
- **Neither clearly unsuitable nor apparently suitable** –this is a self-evident subset resulting from the identification of suitable and unsuitable buildings. The resolution of this ambiguity should be matter of some priority. Conservatively, buildings in this category could be treated as unsuitable until proven otherwise.

11. A structurally suitable building, in the context of a flash flood refuge during entrapment, means a building which is strong enough to withstand lateral flood flow, buoyancy and suction effects and debris impact load, which is high enough in terms of maximum possible depth of flooding over internal habitable space (for example floor or mezzanine level), and which has usable emergency egress for rescue of trapped occupants.

12. In flash flood environments it is theoretically possible (provided that data is available) to identify buildings that meet criteria relating to structural characteristics and internal floodwater depth and therefore to determine if a building is structurally suitable. In the absence of a more detailed engineering-based code the following observations can be made:
    - Single storey slab-on-ground dwellings are unlikely to be suitable but this depends on maximum flood depth. Light weight relocatable homes and caravans are almost certain to be unsuitable.
    - Reinforced concrete or steel-framed multi-level buildings are more likely to be suitable but this also depends on maximum flood depth.
    - Ideally the building should have sufficient area of habitable floor that will be flood free in a probable maximum flood (PMF) to comfortably accommodate the likely numbers of occupants.
    - As a minimum, there must be an accessible refuge of last resort such as an attic, mezzanine storage area or other robust structure that is likely to be survivable even in the PMF and has some form of emergency egress to facilitate rescue of trapped occupants.

Pre-incident planning for evacuation

13. Because of the rapid onset of flash flooding and associated high velocity floodwaters, up to 75% of flash flood deaths occur while people are outside buildings attempting to leave or return, and directly exposed to floodwater[1]. This suggests that if evacuation has not occurred prior to the arrival of floodwater, taking refuge inside a building may generally be safer than trying to escape by entering the floodwater.

14. However, some deaths (25% of the total) occur among people trapped inside buildings. Details are not well documented and these deaths could be the result of the building filling with flood water to a depth occupants cannot survive, or because those trapped inside are swept away when the building fails. Other causes of death could be serious injury or an emergency medical condition while access to emergency assistance is compromised. Fires might also break out in buildings surrounded by floodwater, in which case occupants might not be able to evacuate as they would usually do.

[1] Haynes, K., Coates, L., Leigh, R., Gissing, A., McAneney, J., Handmer, J., and Opper, S., 2009. *Shelter-in-place v. Evacuation in Flash Flood Environments*, presented to the Joint NSW and Victorian Food Management Conference - Albury Wodonga 2009

15. For these reasons, remaining in buildings likely to be affected by flash flooding is not low risk and should never be a default strategy for pre-incident planning or incident action planning, even if the buildings are considered likely to withstand the impact of flash flooding. Where the available warning time and resources permit, evacuation should be the primary response strategy. Detailed information on planning considerations for evacuation is provided in Manual 20 of the Australian Emergency Manuals series at p34 (revised edition 2009).

16. Pre-incident plans should identify available warning mechanisms and triggers for warnings to be issued to permit the earliest possible warning in time-critical situations. This should include consideration of the use of formal and informal warning and support networks for vulnerable persons, as these networks may be able to provide assistance more quickly than emergency services organisations in a complex, time-critical setting.

17. Pre-incident plans should aim to identify clearly unsuitable buildings in flash-flood prone locations, so as to allow evacuation and rescue efforts to be prioritised where warning cannot be given in time to effect evacuation of the entire affected area.

18. Where pre-incident plans have identified clearly unsuitable structures with vulnerable occupants in flash-flood prone areas, consideration must be given to adopting highly conservative evacuation triggers which will balance the inconvenience of potentially unnecessary evacuation against the life risk inherent in failing to evacuate these structures.

19. It is reasonable for pre-incident planning to take into account the possibility that inadequate time will be available for a full evacuation. In these circumstances, it may be appropriate to move people from clearly unsuitable structures into nearby apparently suitable structures. This will reduce the risks associated with evacuating in hostile environmental conditions. For this reason pre-incident planning should identify the nearby apparently suitable structures in a locality that could be used for this purpose.

20. The pre-incident planning of evacuation must include operational contingency plans for the rescue of individuals who do not, for whatever reason, evacuate in a timely manner. This will involve a consideration of where resources for rescue operations will be obtained and staged, and the tactics to be used in rescue operations.

Flash flood warning systems[2]

21. Successful evacuation strategies require a warning system that delivers enough lead time to accommodate the operational decisions, the mobilisation of the necessary resources, the warning and the movement of people at risk. Ideally time should also be available to establish evacuation centres if they are required.

22. Where pre-incident planning identifies existing warning lead times as being non-existent, too short or based on too much uncertainty, improvements to warning systems within existing hydro-meteorological capability should be a priority.

[2] See further discussion in *Review of the 2010–11 Flood Warnings & Response* [Victorian Floods Review], recommendation 5 and pp45-48; and *Queensland Floods Commission of Inquiry, Interim Report* chapter 4.1.1, 4.25 and recommendations 4.11 and 4.30-4.32

23. Weather forecasting and flash flood prediction is undergoing continual improvement. This is the result of a number of factors including better science and the influence of technology. The advent of faster and more 'accurate' weather and hydrological modelling and enhanced real-time observation systems such as Doppler radar are examples of such advances[3].

24. However, although forecast 'accuracy' is improving for 24-72 hour periods, the near-to-real-time period of 1-6 hours, the period most relevant to flash flood environments, remains a significant forecasting challenge.

25. Effective evacuation typically requires lead times of longer than just a couple of hours and this creates a dilemma for flash flood emergency managers. Due to the nature of flash flood catchments, flash flood warning systems based on detection of rainfall or water level generally yield short lead times (often as short as 30 minutes) and as a result provide limited prospects for using such systems to trigger planned and effective evacuation.

26. Warning systems based on weather forecast can yield longer lead times but provide only a qualitative assessment of the potential for flash flooding over a broad geographical area. A forecast-based warning also inherently provides less certainty in either the location or rainfall volume from which to derive the expected depth and timing of flash flooding. This makes it difficult to provide timely and accurate advice to at-risk communities about flash flooding, in particular, in relation to advice about who needs to evacuate and when to evacuate.[4]

27. Initiating evacuation of large numbers of people from areas prone to flash flooding based on these uncertain triggers may be theoretically defensible in a purely risk-avoidance context but it is likely to be viewed as socially and economically unsustainable. Frequent evacuations in which no flooding occurs, which statistically will be the outcome of forecast-based warning and evacuation, could also lead to a situation where warnings are eventually ignored by the community.

28. These considerations call for flash flood emergency managers to engage with flash flood prone communities, both to discuss and agree on appropriate triggers for agency-led evacuation, and to educate the community on appropriate behaviour in the event of flash flooding occurring with no or very little warning (including messages about the dangers of late evacuation, and strategies such as moving from unsuitable to suitable buildings).

Incident operations

Full evacuation

29. Incident controllers must consider whether the lead warning times they have available to them permit a safe evacuation of a location threatened by flash flood, as identified in the pre-incident plan. If sufficient time is available then properly planned and executed evacuation is the most effective strategy. Note that in a flash flood context, the setting up of evacuation centres may be a secondary consideration to the need to move people promptly away from dangerous locations.

[3] See Australian Emergency Manual 21 *Flood Warning* for further discussion

[4] Improvements in the spatial and temporal resolution of numerical weather and hydrological modelling are being made and future warning systems will be more able to identify at-risk communities.

30. The dangers to be considered in relation to evacuation include the possibility of flooding of evacuation routes while the process is underway, with evacuees possibly being overwhelmed by floodwaters, and/or exposure to adverse weather conditions such as lightning, hail, heavy rain, strong winds, flying debris or falling trees and power lines. The decision whether to evacuate will include a consideration of these factors.

Partial/targeted evacuation

31. If insufficient time or resources are available for a full evacuation, incident controllers must consider whether a partial evacuation, starting with structures triaged as clearly unsuitable, can be carried out. If no pre-incident triage has taken place, triaging of affected structures can still be attempted as part of the incident response, based on the criteria in paragraphs 11-12, above. It is clearly better for a pre-incident triage process to be conducted in favourable weather conditions, and without the pressures of time and other incident imperatives.

32. Incident controllers should prioritise their resources to the task of identifying obviously unsuitable buildings, and evacuating occupants. If time does not allow for removing people completely from the area expected to be impacted, this may involve moving occupants from obviously unsuitable buildings to nearby apparently suitable buildings.

33. Incident controllers will have to bear in mind that even for a building which meets the criteria of structural suitability, building occupants will still be exposed to indirect flood risks relating to:
    - Their own decision making and behaviour (drowning if they change their mind and attempt to leave after entrapment);
    - Their mobility (not being able to reach the highest part of the building);
    - Their personal safety within the building (fire & accident); and
    - Their health while isolated (pre-existing condition or sudden onset e.g. heart attack).

    These factors may be relevant to the likelihood of having to conduct rescue operations.

Information operations

34. Information operations for a flash flood incident must be focused on issuing public information and warnings about whether evacuation is appropriate or whether it is too late to do so, and must provide clear advice to the public on what they are expected to do.

35. Incident controllers might have to rely on real-time event-based public information activity to try and get safety advice about evacuation and surviving entrapment to the community. These messages need to be pre-written and accessible at very short notice. There will be no time to craft these advices on the day.

36. Public information should advise people to leave risk areas early, not to attempt to escape through floodwater, and if they become trapped to move to the highest point of a suitable building to await the end of the event, and to call ‘000’ if they require rescue. This may include providing advice to people on moving from obviously unsuitable buildings to more suitable ones.

37. This advice should be provided even when it is intended to implement full or partial evacuation, due the likelihood that not all community members will evacuate.

Rescue

38. Rescue during the flood will be required if occupants of buildings unsuitable for refuge cannot be evacuated before the onset of flooding. Rescue might also be required from buildings that are clearly suitable for refuge if, for example, the occupants experience a life-threatening condition.

39. Irrespective of intentions to evacuate people at risk, when severe weather is predicted that might result in flash flooding, agency strategic planners and incident controllers need to consider the availability and pre-positioning of flood rescue resources.

40. Incident controllers should expect to have insufficient resources to conduct simultaneous rescues from all affected structures and must be prepared to prioritise rescue operations based on pre-incident or at-incident triaging of structures.

41. Incident controllers should prioritise available rescue resources to focus on:
    a. Structures that are clearly unsuitable to withstand flash flood;
    b. Persons known to be vulnerable, structures of unknown suitability, and finally apparently suitable structures. It may be appropriate to defer allocating resources to calls for help from apparently suitable structures, in favour of visiting clearly unsuitable structures to verify occupants are not trapped.

42. The dynamic risk assessment by incident controllers, sector commanders and other decision-makers as to whether to effect rescues will include the risk to rescuers and the persons to be rescued from the flash flood and weather environments, and the possibility of persons remaining in relative safety in apparently suitable structures until conditions have abated.

4 Glossary of Terms

Flash flooding:	Flooding that occurs within 6 hours of the precipitating weather event, and often involves rapid water level changes and flood water velocity. The definition excludes flooding caused by dam failure, storm surge or tsunami although similar emergency management principles may apply to these events
Pre-incident planning:	The process of gathering and analysing information in advance of any actual or imminent incident, in order to develop plans for addressing emergency incidents before they arise
Probable maximum flood (PMF):	An estimation of the largest flood that could occur at a particular location
Structurally suitable building:	A building which is strong enough to withstand lateral flood flow, buoyancy and suction effects, and debris impact load, and provides habitable space above the probable maximum flood level
Triage:	In the flash flood context, a process of categorizing buildings based on their assessed relative ability to withstand flash flood environments

5 Further Reading

Users of this guideline should refer to the various manuals in the Australian Emergency Manuals series dealing with flood management which include: Flood Preparedness, Flood Response, Flood Warning and Managing the Floodplain. These can found at www.em.gov.au

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