



# SES Requirements from the FRM Process

## Summary

This floodplain risk management (FRM) guideline outlines the outputs from the FRM process required to assist the State Emergency Service (SES) in effective emergency response planning (ERP). The outputs and the associated work required depend upon the type and scale of emergency response problems for the location as discussed in the FRM Guideline – Flood Emergency Response Classification for Communities.

## Introduction

The Floodplain Development Manual, 2005 requires studies and plans to incorporate extra information to enable the SES to undertake effective ERP. This requires an understanding of both the emergency response problem and associated emergency response logistics.

Effective ERP requires consideration of events other than peak flood events where areas may need evacuation as it is essential to consider the differences in logistics between:

- Historic events (testing for real events).
- A range of design events (5, 20, and 100 year average recurrence interval (ARI) flood events and the probable maximum flood, PMF).
- Shorter duration events (100 year ARI flood event and the PMF). Testing events that may be critical for evacuation logistics even though they may produce slightly lower peak flood levels. For example, where a key emergency response route may be cut leaving an area isolated in a smaller ARI event or much sooner than in the peak level design flood.

In addition, some information provided in studies now needs to also be presented in a different format to enable it to be more readily used by the SES.

## Recommendations

It is recommended that the SES be provided with information relevant to the specific location as outlined in the following sections of the guideline and in the specific formats indicated:

- Section 1 Inclusions in a Flood Study
- Section 2 Inclusions in a Floodplain Risk Management Study
- Section 3 Extra information required for areas protected by existing or proposed levees
- Section 4 Format of Data
- Section 5 Simplistic Example to Illustrate Use of the Guideline

This information is to be provided electronically at the draft study stage and in the final format on the final project CD with a summary of the inclusions provided in an appendix to the study.

## References

- Department of Infrastructure Planning and Natural Resources. "Floodplain Development Manual: the management of flood liable land", gazetted May 2005.
- McLuckie D.B. Opper S. Co-operative Management of Flood Risk, 2003. Australian National Disaster Conference. Canberra September 2003.
- McLuckie D.B. How the Floodplain Risk Management Process can assist Emergency Response Planning. Gunnedah February 2007. FRM Workshop with FMA Conference.

### Section 1 Inclusions in a Flood Study

An integral part of effectively managing the full range of flood risk requires investigations under the flood study is to provide additional flood intelligence to the SES and provide more specific information on flood behaviour and the associated risks. This includes:

- Summary of historic information and other intelligence collected as part of data collection.
- Plans indicating cross section location or chainages as per the river long section, for ease of data interpretation.
- Plans showing the base digital terrain/elevation model to AHD where appropriate and available.
- Plans showing river long sections with flood level variations for historical and design events related directly to the key warning gauge heights. Separate plans should be provided for historical and design floods. Confidence banding should be added to the planning flood long sections based upon calibration and sensitivity analyses.
- Provision of a description of physical flood behaviour in plain English terms for a layman audience. This is to include a description of the development and pattern of flood behaviour.
- Describe specific risk areas in the context of the potential consequences of flooding from more frequent, major and extreme events. The descriptive criteria in FRM Guideline Flood Emergency Response Classification of Communities should be used to delineate areas of the floodplain for different scale events.

- Where the flood study includes an assessment of flood damages, a spreadsheet of ground and floor levels for houses and flood levels for design and historic events, relative to the key flood warning gauge height is to be provided. This can be based upon the information developed for the damage assessment. The source of the base information should be included.
- Plans indicating a minimum of flood extents, floodways, flood storage areas and flood fringe areas. Definition of flood hazards should be included (where assessed) based upon the categorisation in the Floodplain Development Manual or similar approach as agreed with DECC.
- Where levees exist, the information requirements for levees outlined in Section 3, are to be met.
- Modelling of flood behaviour that defines the variation over time of flood levels, extents and velocities for each of the critical design events. This may require modelling of shorter duration 100 year ARI and PMF or equivalent extreme events to provide advice in relation to the potential differences in time available for response.

Specific input is to be prepared for the SES to consider when next updating the local flood plan. Annex A of the Local Flood Plan: describes physical flood behaviour. This section needs to be reviewed and an update drafted. The update can be based around the description in the management study but needs to be in plain English terms for a layman audience.

### Section 2 Inclusions in a Floodplain Risk Management Study

An integral part of effectively managing the full range of flood risk requires investigations under the FRM study to:

- Review the local flood plan, identify deficiencies in information and provide selected draft input, whether the existing plan specifically addresses the study area or not.

- Provide additional flood intelligence to the SES as indicated in below.
- Provide additional information for existing and proposed levees as per Section 3.

The SES will consider this information in any future review of the local flood plan.

### Section 2.1 - Specific Draft Input into the Local Flood Plan for SES Consideration

Annex B of the Local Flood Plan: describes specific risk areas in the context of flood consequences. This section needs to be reviewed and an update drafted in light of the understanding of flood behaviour and the associated consequences from the study.

The study may identify different risk factors, a larger range of flood risk, more specific information on risk and new areas of risk. The description needs to relate to specific information as outlined below and to the impacts and consequences of an extreme flood event:

- Describe the flood warning system and key warning reference gauge(s) for the area and the basis of the available warning.

Indicate the average times between flood producing rain and exceedance of critical flood levels (typically overtopping of key evacuation routes or to exceed levee design height as discussed with SES) at key warning reference gauges based upon the hydrological modelling of rainfall. Table 1 indicates the range of floods to be considered and associated information necessary.

Compare these times against warning lead times specified in the SES NSW State Flood Plan. If required warning times exceed the physical time between rainfall and critical flood levels, then a higher risk to quantitative flood forecasting, involving quantitative precipitation forecasts

from numerical weather predictions may be necessary. This involves a higher risk approach to flood forecasting than simple using recorded rainfall in hydrological modelling and should be discussed with the Bureau of Meteorology.

- Identify the flood classification of particular areas in accordance with FRM Guideline – Flood Emergency Response Classification of Communities. A plan is to be produced that shows these areas and their classification.
- For each classification in FRM Guideline – Flood Emergency Response Classification of Communities provide the information outlined for the classification in Table 2.
- This information should also be provided in a tabular form similar to Tables 3 and 4. This should be supported by specific information on impacts and consequences.
- Identify issues limiting the potential of evacuation centres in the flood plan. This may relate to evacuation routes or flooding of centres. Alternate centres may be indicated for consideration.
- Impacts of recommended management options. This should describe the changes in impacts resulting due to the implementation of each action in the recommended management plan. This should include any resultant changes to Table 3.

**Table 1 Indicative Timing to Reach Critical Consequence Height**

| Critical Consequence Heights | Levee Design Height   | Key Evac Routes Cut | Private Property Floods | Homes Start to Flood | Whole Area Flooded | Peak Flood Height m | Time to Peak hrs | Isolation Time hours | Warning Lead Time hours (from State Flood Plan) |
|------------------------------|---|---------------------|-------------------------|----------------------|--------------------|---------------------|------------------|----------------------|---|
| <b>Level m Gauge Height</b>  |   |                     |                         |                      |                    |                     |                  |                      |   |
| <b>Flood Event</b>           | Time - Flood Producing Rain to Critical Height Exceedance hrs |                     |                         |                      |                    |                     |                  |                      |   |
| Key Historical               |   |                     |                         |                      |                    |                     |                  |                      |   |
| 20 yr ARI Peak Height        |   |                     |                         |                      |                    |                     |                  |                      |   |
| 100 yr ARI Peak Height       |   |                     |                         |                      |                    |                     |                  |                      |   |
| 100 yr ARI Short             |   |                     |                         |                      |                    |                     |                  |                      |   |
| Peak Height PMF              |   |                     |                         |                      |                    |                     |                  |                      |   |
| Short Duration* PMF          |   |                     |                         |                      |                    |                     |                  |                      |   |

\* A short duration event with significant impacts at critical consequence heights is to be tested to provide an indication of the sensitivity of available lead times to storm patterns



# SES Information Requirements from the FRM Process

## Floodplain Risk Management Guideline

**Table 2 Key Considerations for Areas with Different Flood Emergency Response Classifications**

| Key Considerations   | High Flood Islands HFI | Low Flood Islands LFI | High Trapped Perimeter (HTP) Area | Low Trapped Perimeter (LTP) Area | Area with Overland Escape Route (OER) | Area with Rising Road Accessible (RRA) | Indirectly Affected Areas (IAA) |
|--|------------------------|-----------------------|-----------------------------------|----------------------------------|---------------------------------------|--|---------------------------------|
| External Access Cut, area becomes isolated   | *                      | *                     | *                                 | *                                | *                                     |  |                                 |
| Key Internal Roads Cut   |                        | *                     |                                   | *                                | *                                     | *                                      |                                 |
| Overground Flooding of Private Ground Starts                                       |                        | *                     |                                   | *                                |                                       |  |                                 |
| Over Floor Flooding of Houses/Businesses Starts                                    |                        | *                     |                                   | *                                |                                       |  |                                 |
| Over Floor Flooding of Special Evacuation Needs (Child/Aged Care & Schools) Starts |                        | *                     |                                   | *                                |                                       |  |                                 |
| Transport Infrastructure Shutdown (Railways/Airports)                              | *                      | *                     | *                                 | *                                | *                                     | *                                      | *                               |
| Flooding of Key Response Infrastructure Starts (Hospitals/Evacuation Centres)      |                        | *                     |                                   | *                                | *                                     | *                                      |                                 |
| Risk of flooding of Key Public Utilities (water/sewage/gas/power) starts           | *                      | *                     | *                                 | *                                | *                                     | *                                      | *                               |
| Whole Area Flooded or Max Flood Extents Occur                                      | *                      | *                     | *                                 | *                                | *                                     | *                                      | *                               |

\* Key considerations for Particular Flood Emergency Response Classifications

**Table 3 Impacts/Consequences at Specific Locations Relative to Gauge Height**

| Issue or Event                     | Location/Classification/Description  | Gauge Height (m Gauge) | Properties Affected |        | Properties Affected Above Floor Level |        | Indicative Time Above this Level Hrs |
|------------------------------------|--|------------------------|---------------------|--------|---------------------------------------|--------|--------------------------------------|
|                                    | egs - Evac - how & where to (self evac, SE)<br>road cut - where, how, (by local LF or river flooding RF) |                        | Residential         | Others | Residential                           | Others |                                      |
| Effective Warning Time             | Location/Classification  |                        |                     |        |                                       |        |                                      |
| Evacuation Starts                  | Description  |                        |                     |        |                                       |        |                                      |
| Access Cut                         |  |                        |                     |        |                                       |        |                                      |
| Private Property Floods            |  |                        |                     |        |                                       |        |                                      |
| Key Infrastructure Flooding Starts |  |                        |                     |        |                                       |        |                                      |
| Homes Start to Flood               |  |                        |                     |        |                                       |        |                                      |
| Businesses start to Flood          |  |                        |                     |        |                                       |        |                                      |
| All Houses Flooded                 |  |                        |                     |        |                                       |        |                                      |
| Whole Area Flooded                 |  |                        |                     |        |                                       |        |                                      |

**Notes:**

- a. A Plan is to be produced that shows these areas and their flood emergency response classification (refer FRM Guideline – Flood Emergency Response Classification of Communities and Table 2).
- b. These figures are to be indicative only



**Table 4 Consequences Relative to Gauge Height**

| Gauge Height Range (including sensitivity) m Gauge | Location (Area) | Description<br>Examples<br>evacuation - where to & how (Self evac (SE)<br>road cut - where, how (by local LF or Riverine RF flooding) | Consequences         |        |                               |        |
|--|-----------------|---|----------------------|--------|-------------------------------|--------|
|  |                 |   | No Building Affected |        | Indicative No People Affected |        |
|  |                 |   | Residential          | Others | Residential                   | Others |
| <b>Height 1</b>                                    |                 |   |                      |        |                               |        |
|  |                 |   |                      |        |                               |        |
|  |                 |   |                      |        |                               |        |
| <b>Height 2</b>                                    |                 |   |                      |        |                               |        |
|  |                 |   |                      |        |                               |        |
|  |                 |   |                      |        |                               |        |
| <b>Height 3</b>                                    |                 |   |                      |        |                               |        |
|  |                 |   |                      |        |                               |        |
|  |                 |   |                      |        |                               |        |

**Notes:**

- a. Information in Table 4 comes directly out of Table 3 but is in gauge height order.
- b. Consequences should be indicated in height increments of 0.1 to 0.5m, depending upon the overall variation in flood level.
- c. No people affected is indicative only and can be based upon no buildings affected and assumptions to be stated.

### Section 2.2 - Update of Flood Intelligence

This involves the following (where not provided in or updated since the flood study):

- Summary of historic information and other intelligence collected as part of data collection.
- Plans indicating cross section location or chainages as per the river long section, for ease of data interpretation.
- Plans showing the base digital terrain/elevation model to AHD where appropriate and available.
- Plans showing river long sections with flood level variations for historical and design events related directly to the key warning gauge heights. Separate plans should be provided for historical and design floods. Confidence banding should be added to the planning flood long sections based upon calibration and sensitivity analyses.
- Provision of a description of physical flood behaviour in plain English terms for a layman audience. This is to include a description of the development and pattern of flood behaviour.
- Describe specific risk areas in the context of the potential consequences of flooding from more frequent, major and extreme events. The descriptive criteria in the FRM Guideline on Flood Emergency Response Classification of Communities should be used to delineate areas of the floodplain for different scale events.
- A spreadsheet of ground and floor levels for houses and flood levels for design and historic events, relative to the key flood warning gauge height is to be provided. This can be based upon the information developed for the damage assessment. The source of the base information should be included.
- Plans indicating a minimum of flood extents, floodways, flood storage areas and flood fringe areas. Definition of flood hazards should be included (where assessed) based upon the categorisation in the Floodplain Development Manual or similar approach as agreed with DECC.
- Where levees exist or are proposed, the information requirements for levees outlined in Section 3 are to be met.
- Modelling of flood behaviour that defines the variation over time of flood levels, extents and velocities for each of the critical design events. This may require modelling of shorter duration 100 year ARI and PMF or equivalent extreme events to provide advice in relation to the potential differences in time available for response.

### Section 3 - Additional Information for Existing and Proposed Levees

The following additional information (where available) is to be provided to the SES in relation to existing and proposed levees in addition to the information outlined in Sections 1 and 2.

It is likely that in many cases output relating to overtopping and backwater flooding will vary between different floods. In these cases a description of each flood scenario; and details of associated required outputs and an indication of confidence will be required.

- Description of the levee, detailing, location, construction type and the areas protected.
- The name, id number and gauge zero (in metres AHD) for the relevant flood warning gauge.
- The following heights relative to the relevant flood warning gauge and their respective AEP:
  - Levee Design Height and Imminent Failure flood (where calculated)
  - Overtopping Heights of Levee Low Points
  - Levee Spillway Heights
  - Likely locations of levee overtopping and the sequence of overtopping and flooding (these outputs should be presented in a spatial format, accompanied by a description).
- Size of the population, the number of residential and commercial properties, and critical infrastructure affected by levee over-topping or failure. This output should be expressed in relation to a variety of flood magnitudes, including a worst case scenario.
- Scope for additional development in areas protected by levees, considering current zoning of land.
- The height relative to the relevant flood warning gauge that any backwater flooding commences impacting upon urban areas behind each levee and the pattern of inundation.
- Once over-topped the length of time taken to fill the basin area behind each levee and the development and pattern of flood behaviour.
- Details of ground profile (topography) inside each levee and the height of potential high points of land relative the relevant flood warning gauge.
- Location of any parts of each levee which need to be closed other than drains (example: gates for roadways and railways) and the height relative to the relevant flood warning gauge that action must be completed by.
- Knowledge of any critical issues including structural integrity affecting each levee.

### Section 4 - Format of Data

Data is to be provided electronically at the draft study stage and in the final format on the final project CD with a summary of the inclusions provided in an appendix to the study. It is to be provided in the following formats unless otherwise agreed to in writing by SES HQ.

- Text is to be provided in Microsoft Word format.
- Spreadsheets in Microsoft Excel format.
- Plans are to be readable, have legible text at A3 scale and able to be produced at that size. Electronic copies of plans produced for the studies are to be in a format compatible with Autocad, ARCGIS9 or MapInfo.
- Flood GIS outputs should be provided with polygons as a minimum with preference for the provision of grid (raster) information if available and coordinated to an appropriate grid.

### Section 5 - Simplistic Example To Illustrate Use of the Guideline

Following is a simple example of developing Tables 1 to 4 in the document. The associated information in the tables can then be used to assist in ERP.

Sites 1 and 4 shown in Figure 1 are the focus of this example. Figure 1 shows the extent of the 100 year ARI flood in the area showing that sites 1 and 4 are

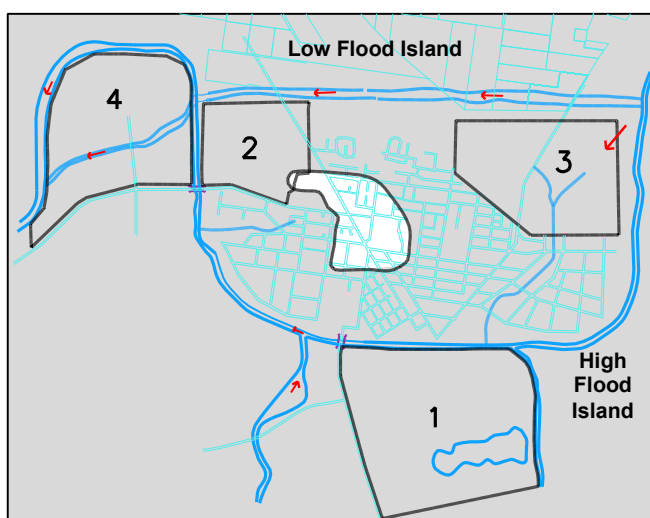
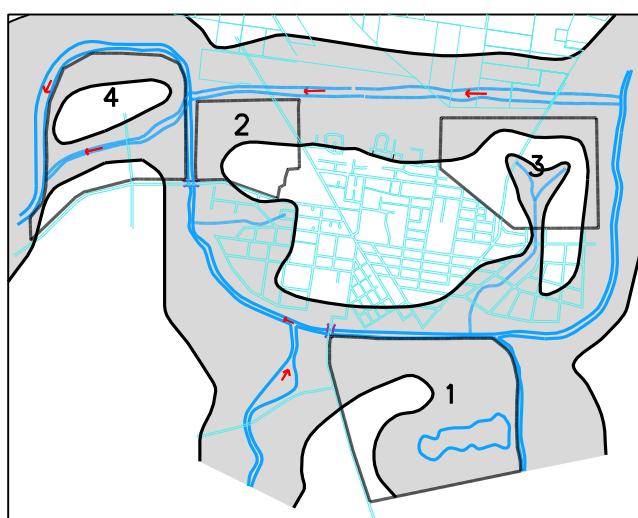
isolated. Figure 2 shows the extent of the PMF in the area and highlights that site 4 is completely inundated whilst site 1 has a reasonable sized area above the PMF. They are therefore classified as low and high flood islands respectively. The key considerations for these are outlined in Example Table 2.

Figure 3 gives flood hydrographs for the location highlighting the importance of considering timing and different duration and scales of flooding for ERP. The hydrograph is translated into key levels versus timings in the Example Table 1.

Figure 4 highlights the hydraulic categories to indicate the hydraulic function of different areas of the floodplain. Figure 5 indicates the degree and type of hazard and highlights that ERP is a key issue for both Sites 1 and 4, as these are flood islands.

Example Table 3 summarises the key emergency response impacts and consequences for Area 4 for different gauge heights. Example Table 4 combines the consequences of different areas so that actions can be summarised for the broader area relative to the gauge height they need to be completed by or occur at.

All the information developed in this simplistic example is useful for ERP.



Figures 1 and 2 Showing potential development sites with 100 year ARI (left) and PMF (right) flood extents. Note Classification of Areas. Interest is in Areas 1 and 4 only.

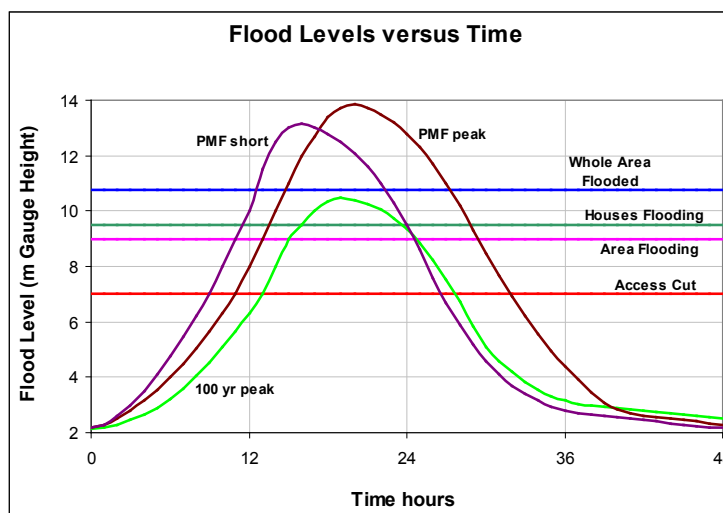
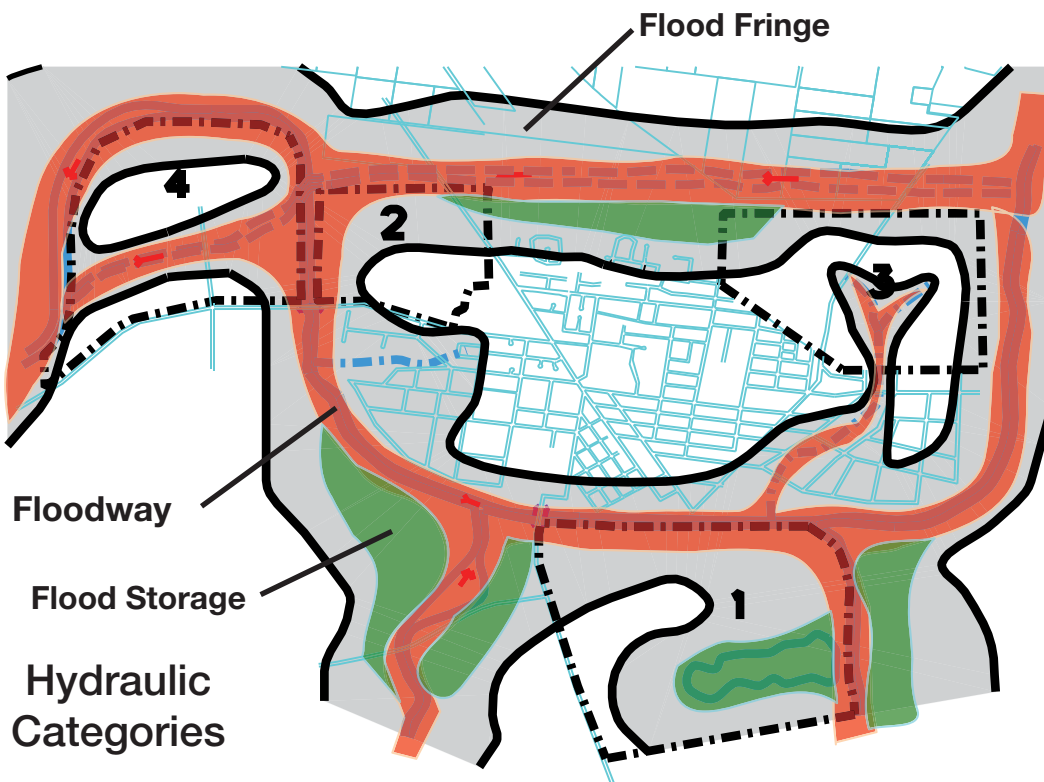
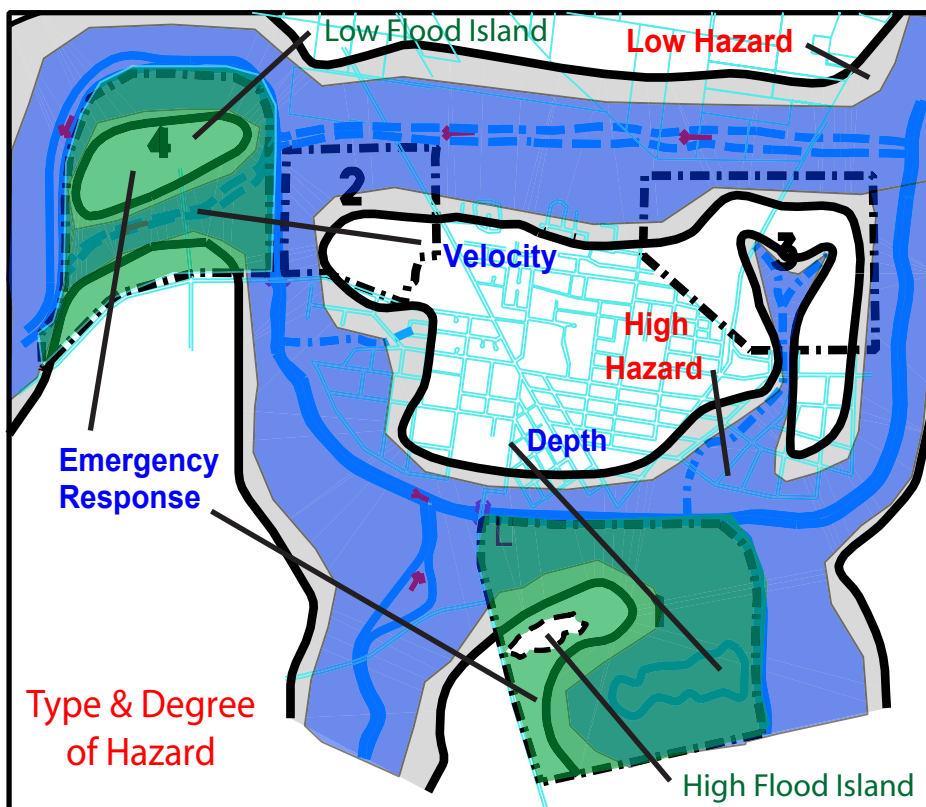


Figure 3 Flood Hydrographs for the Location



Figures 4 and 5 Hydraulic Categories and Flood Hazard Degrees and Types





**Example Table 1 Indicative Timing to Reach Critical Consequence Height**

| Critical Consequence Heights   | Bridge Cut  | Private Property Floods | Homes Start to Flood | Whole Area Flooded | Peak Flood Height m | Time to Peak hrs | Isolation Time hours |
|--------------------------------|---|-------------------------|----------------------|--------------------|---------------------|------------------|----------------------|
| <b>Critical Gauge Height m</b> | <b>7</b>  | <b>9</b>                | <b>9.5</b>           | <b>10.75</b>       |                     |                  |                      |
| <b>Flood Event</b>             | Time - Flood Producing Rain to Critical Height Exceedance hrs |                         |                      |                    |                     |                  |                      |
| 100 yr ARI Peak Height         | 13  | 15                      | 16                   | -                  | 10.5                | 19               | 15                   |
| Peak Height PMF                | 11  | 13                      | 13.5                 | 15                 | 13.85               | 20               | 21                   |
| Short Duration* PMF            | 9   | 11                      | 12                   | 12.75              | 13.15               | 16               | 17                   |

**Example Table 2 Key Considerations for Areas with Different Flood Emergency Response**

| Key Considerations   | High Flood Islands HFI | Low Flood Islands LFI |
|--|------------------------|-----------------------|
| External Access Cut, area becomes isolated   | *                      | *                     |
| Key Internal Roads Cut   |                        | *                     |
| Overground Flooding of Private Ground Starts                                       |                        | *                     |
| Over Floor Flooding of Houses/Businesses Starts                                    |                        | *                     |
| Over Floor Flooding of Special Evacuation Needs (Child/Aged Care & Schools) Starts |                        | *                     |
| Transport Infrastructure Shutdown (Railways/Airports)                              | *                      | *                     |
| Flooding of Key Response Infrastructure Starts (Hospitals/Evacuation Centres)      |                        | *                     |
| Risk of flooding of Key Public Utilities (water/sewage/gas/power) starts           | *                      | *                     |
| Whole Area Flooded or Max Flood Extents Occur                                      | *                      | *                     |

\* Key considerations for Particular Flood Emergency Response Classifications



# SES Information Requirements from the FRM Process

## Floodplain Risk Management Guideline

**Example Table 3 Impacts/Consequences at Specific Locations Relative to Gauge Height**

| Issue or Event                     | Location/Classification/Description<br>Examples<br>Evac - how & where to (self evac, SE)<br>road cut - where, how, (by local LF or river flooding RF) | Gauge Height (m Gauge) | Properties Affected |   | Properties Affected Above Floor Level |        |    |
|------------------------------------|---|------------------------|---------------------|---|---------------------------------------|--------|----|
|                                    |   |                        | Houses              | Others  | Houses                                | Others |    |
|                                    | <b>Area 4 - Low Flood Island</b>  |                        |                     |   |                                       |        |    |
| Effective Warning Time             | Min 9 hours   |                        |                     |   |                                       |        |    |
| Evacuation Starts                  | If Flood Predicted > 6.25m  | 5                      | 650                 | 31 total<br>10 Commercial<br>1 School*<br>3 Public*<br>15 Industrial<br>1 Club<br>1 Nursing Home* |                                       |        |    |
| Access Cut                         | Bridge Overtopped/Access Cut - Evac needs to be completed or assistance required  | 7                      |                     |   |                                       |        |    |
| Private Property Floods            |   | 9                      |                     |   |                                       |        |    |
| Key Infrastructure Flooding Starts |   | 9.25                   |                     |   |                                       |        |    |
| Homes Start to Flood               |   | 9.5                    |                     |   |                                       | 5      |    |
| Businesses start to Flood          |   | 9.75                   |                     |   |                                       | 150    | 1  |
| All Houses Flooded                 |   | 10.25                  |                     |   |                                       | 650    | 20 |
| Whole Area Flooded                 |   | 10.75                  |                     |   |                                       | 650    | 31 |

\* Developments which are particularly vulnerable in emergency response

**Example Table 4 Consequences Relative to Gauge Height**

| Gauge Height Range m Gauge | Location (Area)      | Description<br>Examples<br>evacuation - where to & how (Self evac (SE))<br>road cut - where, how (by local LF or Riverine RF flooding) | Consequences |        |
|----------------------------|----------------------|--|--------------|--------|
|                            |                      |  | Houses       | Others |
| 4.0m                       | Rural Areas          | Flooding Starts in Rural Areas   |              |        |
| 5.0m                       | Southern Rural Areas | Areas to Town Cut - Evacuate to Next Town  |              |        |
|                            | Area 4               | Start Evac if Peak predicted >6.25m  |              |        |
| 6.0m                       | Southern Rural Areas | Farm Buildings Flood   |              | 2      |
| 6.5m                       | Southern Rural Areas | Cut off - Evacuation needs to be completed   |              | 5      |
| 6.75m                      | Area 4               | Evacuation needs to be completed   |              | 10     |
| 7.0m                       | Area 4               | Isolated - Access to Town & next Town Cut  | 5            | 12     |
|                            | Southern Rural Areas | Rural Homes Start to Flood   | 5            | 12     |
| 9.0m                       | Area 4               | Private Homes Start to Flood   | 5            | 15     |
| 9.5m                       | Area 4               | Houses Start to Flood  | 15           | 20     |
| 10.25m                     | Area 4               | All Houses Flooded   | 665          | 35     |
| 10.75m                     | Area 4               | Whole Area Flooded   | 665          | 51     |