June 2015

Flood and Coastal Hazard Evaluation Report

This document responds to the requirements of the Queensland State Planning Policy July 2014 for a natural hazard evaluation report for flood hazards.

Contents

Context 2

Executive Summary 4

Definitions 6

Comparison 7

1. Outcome Sought: Identify natural hazard areas 10
2. Outcome Sought: Include provisions that seek to achieve an acceptable or tolerable level of risk, based on a fit for purpose natural hazards and risk assessment 14
3. Outcome Sought: Include provisions that require development to avoid natural hazard areas, support disaster management response and recovery, avoid an increase in the severity for the natural hazard, maintain or enhance natural processes. 25
4. Outcome Sought: Facilitating the location and design of community infrastructure to maintain the required level of functionality during and immediately after a natural hazard event. 38

References 42

Appendix A: Maximum Possible Flood and Storm Tide Inundation 43

Appendix B: Conflict between Development and Natural Hazard Areas 45

Appendix C: Draft Planning Scheme Policy Positions Summary Table – Flood Hazard and Coastal Hazard 48

Appendix D: MBRC Floodplain Risk Management Framework 55

Appendix E: Interim Floodplain Risk Management Plan 91

Appendix F: Freeboard Review and Recommendations Report (BMT WBM, 2014) 155

Appendix G: Draft Coastal Hazard Overlay Code and Flood Hazard Overlay Code 182

Appendix H: Mapping Differences between Draft and Revised Draft Planning Scheme 225

Context

The Queensland Government's *Sustainable Planning Act 2009* (**SPA**) requires councils to review their planning scheme on a regular basis (every 10 years). Since 2011, Moreton Bay Regional Council (**Council**) has been working towards developing a new single planning scheme that will replace the former schemes of Caboolture, Redcliffe and Pine River Councils.

The new draft Moreton Bay Regional Council Planning Scheme (new **Draft planning scheme**) aims to address a number of current and future challenges facing the region. These include the following:

- responding to growth and increasing population;
- encouraging economic development opportunities;
- sustainable living including improved transport options;
- housing choices to improve affordability; and
- increasing community resilience to natural disasters.

The new draft planning scheme will determine how and where development may occur, and includes planning for infrastructure to support future growth.

In December 2013 the Council submitted the initial draft planning scheme to the Queensland Government for approval to place the initial draft planning scheme on public display and invite submissions. In June 2014, the Minister for State Development, Infrastructure and Planning (**the Minister**) approved the initial draft planning scheme to go on public display subject to conditions. Public exhibition of the initial draft planning scheme was held between 4 July and 15 August 2014 and was extended to 1 September 2014. Some 7,650 submissions were received on the initial draft planning scheme, approximately 80% of which included comments on flooding and coastal related matters.

Following exhibition, the Queensland Government also released a new guideline and technical manual to support the implementation of its State interests in the State Planning Policy and instructed Moreton Bay Regional Council to use the guideline and technical manual in finalising its planning scheme. These guidelines make specific reference to appropriate procedures and protocols for managing natural hazards through the planning framework.

With respect to flooding and coastal risks, the Council has been implementing a process of flood and coastal management for more than 5 years wherein a large number of technical studies that define flooding and coastal hazards have now been completed, and are being used to direct various management initiatives through a program of works and further studies. This includes recommending specific planning and development controls for future development in order to manage existing and future risks to the community, property and infrastructure.

Given the significant community interest in the flooding and coastal provisions within the initial draft planning scheme, Council has reviewed its approach to addressing flooding and coastal risks in the new draft planning scheme. This review has focussed on a number of elements including the following:

- flood and coastal hazard risk assessment;
- technical robustness of the flooding and storm tide mapping;
- freeboard requirements; and
- strategic planning and code drafting.

As an outcome of this review, aspects of the initial draft planning scheme have been modified. This includes the provision of a new Flood hazard overlay map and code, a new Coastal hazard overlay map and code, and a

new Overland flow overlay map and relevant provisions in the zone codes. The provisions included in the new overlay codes reflect the community's tolerability for flood and coastal risks across the region.

The Council is satisfied that the new draft planning scheme coordinates and integrates the core matters, including any State and regional dimensions of the core matters, as required by section 88 of the SPA.

It is expected that the new draft planning scheme will be adopted by Moreton Bay Regional Council in 2015 following the final approval from the Deputy Premier and Minister for State Development, Infrastructure and Planning.

Executive Summary

Statutory requirements

This report outlines the process undertaken by the Council in developing the flood risk and coastal risk assessment used to inform the new draft planning scheme.

The Council (and the Minister) must be satisfied that the new draft planning scheme coordinates and integrates the matters for the preparation of a planning scheme, including their State and regional dimensions, in accordance with section 88 of the SPA. Relevantly:

- The South East Queensland Regional Plan (**SEQRP**) is a regional dimension (section 90(3) of the SPA) of a planning scheme matter. Among other things, it provides as follows:
    - Reduce the risk from natural hazards, including the projected effects of climate change, by avoiding areas with high exposure and establishing adaptation strategies to minimise vulnerability to riverine flooding, storm tide or sea level rise inundation, coastal erosion, bushfires and landslides. (Policy 1.4.1)
    - Planning schemes and development decisions shall be in accordance with the Queensland Coastal Plan (now State Planning Policy), including the range of potential sea level rises. (Policy 1.4.3)
    - Ensure development other than maritime infrastructure avoids erosion prone areas, storm tide inundation hazard areas, and undeveloped sections of tidal waterways in accordance with the Queensland Coastal Plan (now State Planning Policy). (Policy 2.4.2)
    - Avoid areas of unacceptable risk, including additional risks from climate change, and areas where development may unacceptably increase flood risk elsewhere. (Policy 11.6.1)

- The State Planning Policy (**SPP**) and the State Planning Policy - State Interest Guideline (Natural hazards, risk and resilience) (**SPP Guideline**) are a State dimension (section 90(4) of the SPA) of a planning scheme matter. Among other things, they provide as follows:
    - The risks associated with natural hazards are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards. (SPP)
    - A planning scheme is to:
        - Identify natural hazard areas for flood and coastal hazards (Policy 1 SPP and SPP Guideline).
        - Include provisions that seek to achieve an acceptable or tolerable level of risk based on a risk assessment consistent with AS/NZS ISO 31000:2009 Risk Management (Policy 2 SPP and Guideline).
        - Avoid natural hazard areas or mitigate the risks of the natural hazard to an acceptable or tolerable level (Policy 3 SPP and Guideline).

In addition, the preparation of the new draft planning scheme is to be supported by a natural hazards study for each hazard identifying the likelihood and characteristics of the natural hazard in the planning scheme area and the outcomes of that study or studies need to be explicitly communicated in the planning scheme (Policy 1.1 SPP Guideline). The SPP Guideline and the requirements for a natural hazards study were confirmed as being applicable to the preparation of the new draft planning scheme in correspondence from the Department of State Development, Infrastructure and Planning (DSDIP) dated 27 August 2014. This report demonstrates compliance with section 88 of the SPA, in particular how the outcomes of the natural hazards studies (flood hazard investigations and coastal risk assessment reports) are dealt with in the new draft planning scheme.

Technical investigations and studies

To understand and respond to the risks from flooding and coastal processes the Council has carried out a number of technical investigations and studies over the past five years.

These investigations have been used to map the Coastal planning area and Flood planning area, within which are areas of High risk, Medium risk and balance areas , which have subsequently been considered as part of a formal flood and coastal risk management process. In addition, erosion prone areas under the State Planning Policy (SPP) and overland flow paths have been identified.

Following a risk-based evaluation and assessment approach, existing and future development is to be limited and managed through a range of measures as outlined in the Council's Flood and Storm Tide Risk Management Studies.

Future development, including redevelopment, will be controlled through a series of planning scheme provisions including land use strategies and development controls specified in the new draft planning scheme. The purpose of these provisions is to ensure that future development is risk-appropriate. That is, depending on the development type, different levels of risk can be considered acceptable. As an overarching principle, however, the new draft planning scheme requires the minimisation of risk to personal safety and damage to property and infrastructure as a result of flood and coastal hazards for all development within the coastal planning area for coastal hazards and the flood planning area for flood hazards.

Overlay maps define the Coastal planning area, the Flood planning area and overland flow paths. Land with the most frequent exposure to coastal and flood hazards are in the Limited Development Zone.

The applicable planning scheme provisions are in the:

1. Limited Development Zone code;
2. Coastal hazard overlay code;
3. Flood hazard overlay code.

Provisions related to Overland flow path have been integrated into the respective zone codes in section 6 of the new draft planning scheme which is consistent with the drafting technique for other overlays in the draft planning scheme.

The Coastal planning area is identified on the Coastal hazard overlay map. In the Coastal planning area are the High risk storm tide inundation area, Medium risk storm tide inundation area and the Balance coastal planning area. The Erosion Prone Area reproduced from current State government mapping is also included within the Coastal planning area.

The Flood planning area is identified on the Flood hazard overlay map. In the Flood planning area are the High risk area, Medium risk area and the Balance flood planning area. Included as figures in the Flood hazard overlay code are Drainage investigation areas. These are areas where the risk of the flood hazard might be managed and mitigated by a Drainage master plan such that development can occur consistent with the applicable zone and precinct.

Definitions

The following terms used in this report have the following meaning assigned to them.

AEP: Annual Exceedance Probability	A measure of the chance of an event occurring in any one year. For example 1% AEP means that there is a 1 in 100 chance that an event of that size will occur in a year.
Consequence	The implication of event occurring. With respect to flooding and storm tide inundation, this can involve tangible impacts such as direct property damage, as well as intangible impacts such as increased personal stress and trauma due to an event. Within the risk standard, consequence can range from insignificant up to catastrophic.
Hazard	Where the occurrence of a natural event, such as flooding or coastal erosion, conflicts with existing uses and values of the land and area affected by the event, causing the potential for consequential loss or damage.
Likelihood	The chance that an event will happen. Within the risk standard, likelihood can range from almost certain up to extremely rare.
Overland flow	Surface flooding due to rainfall within the immediate vicinity along natural depressions and swales that flow into more formal waters (creeks and rivers). Typically flood depths from overland flooding do not exceed 300 – 500mm.
PMF: Probable Maximum Flood	Maximum flooding conditions that can theoretically occur due to maximum theoretical precipitation from a storm event.
River and Creek flooding	Flooding of well-established floodplains that drain upstream catchments. There is usually a low-flow watercourse (creek or river), however, the extent of flooding can significantly exceed the normal riverine corridor. Flooding can extend to the limits of the Probably Maximum Flood (PMF).
Risk	Is the combination of the likelihood of an event occurring and the consequential impacts if such an event was to occur. Risk management involves the evaluation of risk into acceptable, tolerable and intolerable levels, and then treatment of those risks that are considered intolerable and tolerable.
Storm duration	The length of time that a rainfall event occurs. During the storm, rainfall can have varying intensity. Critical storm duration involves the shortest time for runoff from the whole catchment to occur simultaneously.
Storm tide	When the water level of the ocean/sea increases above normal tidal levels due to the effects of a storm or cyclone. This includes barometric (air pressure) effects and set-up due to wind and waves.

Comparison

The following table represents a summary of the changes that has been made between the initial draft planning scheme and the new draft planning scheme regarding flood and coastal hazards.

Initial Draft MBRC Planning Scheme	**New Draft MBRC Planning Scheme**
Use of Limited Development (Constrained Land) Zone – approximately 7,196 privately owned allotments affected by this zoning.	Use of Limited Development Zone has been reduced and approximately 127 premises are materially affected by the application of the zone
Mapping for the Limited Development (Constrained Land) Zone previously included all land mapped as High Hazard (intolerable and extremely intolerable risk areas). Overlay mapping included only on one overlay, the Flood Hazard Overlay, which represented the following: a. areas of High Hazard as identified through MBRC's Risk Assessment process (detailed in section 2); b. Medium Hazard as identified through MBRC's Risk Assessment process (detailed in section 2)[1]; c. Overland flow paths	Mapping for the Limited Development Zone has reflected the increased risk tolerance and only mapped areas of extremely intolerable risk. Overlay mapping now included as three separate overlays: 1. Coastal hazard overlay 2. Flood hazard overlay 3. Overland flow overlay Mapping now represents the following: 1. In the Coastal hazard overlay – a. areas of High risk and Medium risk as identified through MBRC's Risk Assessment process (detailed in section 2); b. the Erosion Prone Area under the State Planning Policy in accordance with current State Government mapping; c. the extent of the Coastal planning area, to which specific assessment criteria applies. 2. In the Flood hazard overlay - a. areas of High risk and Medium risk as identified through MBRC's Risk assessment process (detailed in section 2); b. the extent of the Flood planning area, to which specific assessment criteria applies; 3. In the Flood hazard overlay code – a. Drainage investigation areas where works in accordance with an approved Drainage master plan are required to manage flood hazards. 4. In the Overland flow path overlay – a. Overland flow for a 1% AEP event, where the relevant provisions in the zone codes apply. 5. The Council's Flood Check website - a. Year 2100 Highest Astronomical Tide level is identified for the purposes of the Coastal hazard overlay code. The overall impact is significantly reduced

[1] The extent of the Medium Hazard area was previously extended beyond the mapped medium risk boundary to the extent of the Probable Maximum Flood or the DFE, whichever was the greater.

Initial Draft MBRC Planning Scheme	New Draft MBRC Planning Scheme
	particularly in the Coastal hazard overlay as the 1% AEP 2100 was driving the medium hazard extent. (refer to Table 3 for further details and Appendix H for example maps that illustrate the differences in the mapping outputs).
Definition of Defined Flood Event was: *Is the 1% Annual Exceedance Probability (AEP) flood event for the fully developed catchment including an allowance for greenhouse climate change and general sea level rise to the planning horizon year 2100.*	Definition of Defined Flood Event: *The higher of the 1% AEP flood event or the 1% AEP storm tide inundation event for the fully developed catchment including an allowance for greenhouse climate change and general sea level rise to the planning horizon year 2100.*
Levels of assessment in relation to flood risk were addressed through the zone tables of assessment	Levels of assessment for the Coastal hazard overlay and the Flood hazard overlay are now addressed through a new section 5.10 Tables of assessment for overlays. There are no proposed changes to the levels of assessment in relation to overlay flow.
Assessment criteria related to flood hazard were included in all zone codes (and dwelling house code)	For the Coastal hazard overlay and the Flood hazard overlay, assessment criteria have been removed from the zone codes and are now included in two separate overlay codes: 1. Coastal hazard overlay code 2. Flood hazard overlay code Assessment criteria for the Coastal hazard overlay code and Flood hazard overlay code are tailored to the levels of risk identified by the revised risk assessment provided in Figure 8 of this Evaluation Report, such that different land use policy intents and development requirements apply to different risk areas within each of the overlays. This minimises development regulation in the Balance coastal planning and Balance flood planning areas where there is low or negligible risk, and provides requirements in the Medium and High risk areas that are sufficient to avoid, manage or mitigate the risks present in these areas. Other mechanisms also exist within the codes that support the application of the risk based approach to the assessment criteria. These include the Year 2100 Highest Astronomical Tide level in the Coastal hazard overlay code, and the requirements for development within a Drainage investigation area to be subject to a Drainage master plan in the Flood hazard overlay code. Assessment criteria in relation to overland flow have been updated but remain in the zone codes.
A Flood hazard, Coastal hazard and Overland flow planning scheme policy was not included	A Flood hazard, Coastal hazard and Overland flow planning scheme policy has been prepared to help guide the assessment of development in accordance with the applicable overlay codes.
Balance of the planning scheme	Consequential amendments have been made to the

Initial Draft MBRC Planning Scheme	New Draft MBRC Planning Scheme
	new draft planning scheme (including administrative provisions, revisions to the strategic framework, local plans, development codes and other supporting definitions) to incorporate the new overlay approach given that the initial draft planning scheme did not contain any overlays and to align land use policy intent to the revised risk management approach adopted by the Council.

1. Outcome Sought: Identify natural hazard areas

1.1. State Interest: Confirm the flooding extent

Identify across the whole local government area the areas that may flood.

Local Flood Investigation Studies

The Council has prepared appropriate and current flood (riverine and creek) and storm tide studies for all catchments within the local government area. These technical studies were used to establish flood mapping across the whole of the local government area. Each of these studies was overseen by a technical steering group which included industry experts, elected members and State Government representatives. The studies identified potential extents of flooding across all catchments. Current and future flood scenarios were investigated in order to support the Council's public flood awareness, emergency management, capital works and strategic planning programs.

The studies undertaken to generate flood mapping and utilised to inform the initial draft planning scheme include:

- Boundary Conditions, Joint Probability and Climate Change, SKM, July 2012
- Bribie Island, Aurecon, June 2012
- Brisbane Coastal Creeks, Aurecon, October 2012
- Burpengary Creek, BMT WBM, November 2012
- Byron Creek, Worley Parsons, July 2012
- Caboolture River 2013 Model Maintenance Report, BMT WBM, December 2013
- Caboolture River, BMT WBM, June 2012
- Design Rainfall, Worley Parsons, November 2012
- Existing Historic and Future Floodplain Land Use, SKM, August 2010
- Floodplain Parameterisation, SKM, October 2012
- Floodplain Structures, Aurecon, July 2010
- Floodplain Terrain, Worley Parsons ,November 2010
- Hays Inlet, BMT WBM, June 2012
- Lower Pine River, BMT WBM, April 2013
- Mary River, Worley Parsons, July 2012
- Neurum Creek, Worley Parsons, July 2012
- Pumicestone Passage, Aurecon, June 2012
- Redcliffe, BMT WBM, June 2012
- Sideling Creek, Worley Parsons, July 2012
- Stanley River, Worley Parsons, August 2012
- Storm tide Hazard Study, Cardno, May 2009
- Upper Pine River, Worley Parsons, July 2012

Since consultation on the initial draft planning scheme, Council has received updated modelling for a number of catchments utilising the latest ground level data captured by air survey in 2014 and recently constructed infrastructure. Where available, this data has been incorporated into the new draft planning scheme.

These studies were carried out by highly experienced consultants to current industry standards using consistent and appropriate tools and methods. The Council recognises that there are still limitations associated with these studies, but that these limitations are consistent with studies of this type. Periodic updates of these studies will be required in the future to capture anticipated changes to the catchment and also future improvements in technology. To account for model limitations, standard floodplain management

practice recommends the application of additional provisions when defining future development levels (i.e. freeboard).

Flood mapping across the local government area will be reviewed as part of future updates of the flood studies, and will continue to be updated on a periodic basis.

The studies listed above mapped the potential flood extents for a range of flood frequencies (e.g. 20% AEP, 1% AEP, 0.1% AEP) up to the Probable Maximum Flood for both flood and storm tide inundation (refer to Maps 1 & 2 in Appendix A). Flood information derived from these studies is publicly accessible on-line through the Council's Flood Explorer interactive flood mapping tool (for access to this service please refer to www.moretonbay.qld.gov.au/floodcheck).

Verification

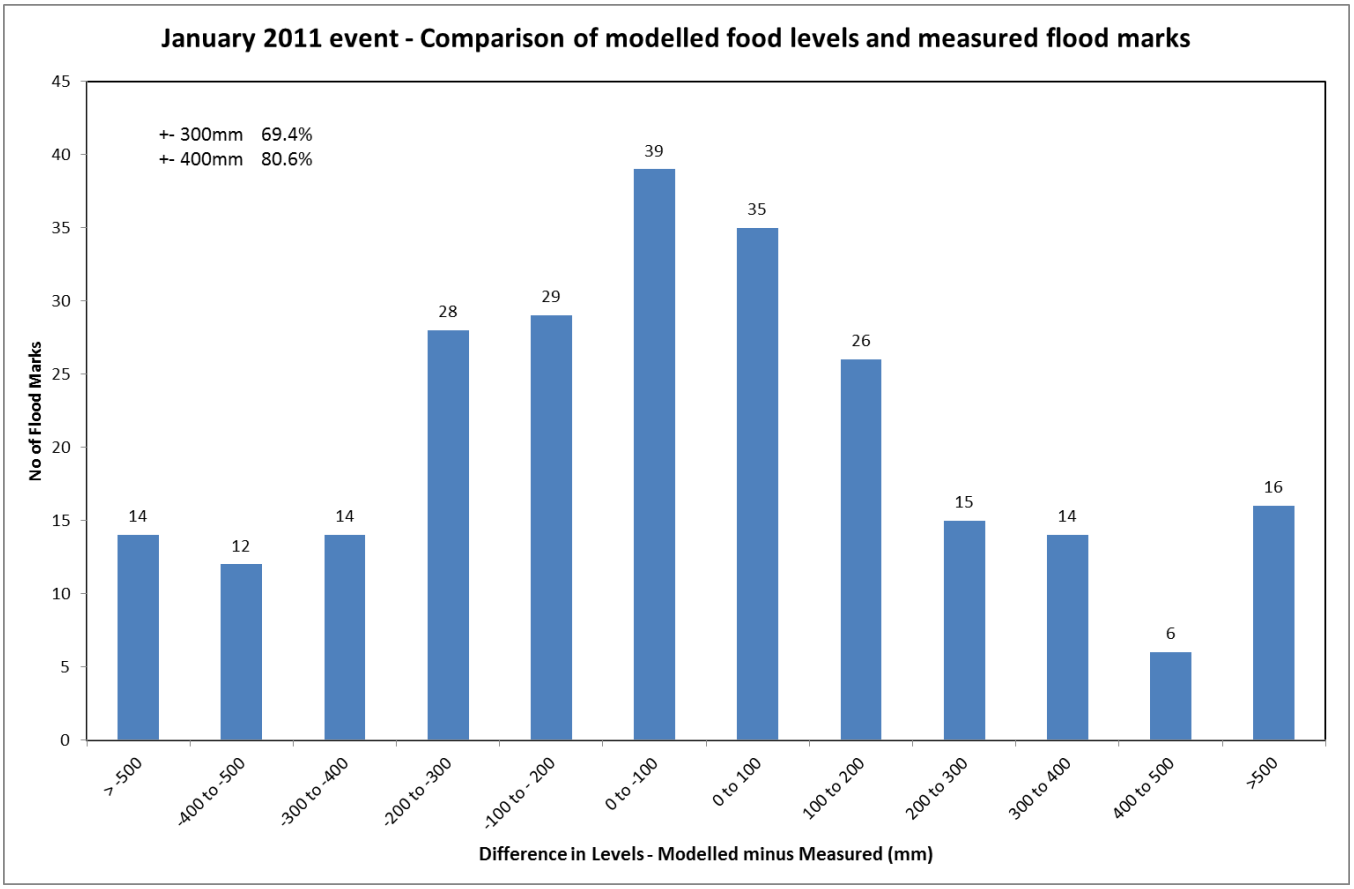
Flood mapping for each catchment was derived using computer-based models of rainfall, runoff and surface hydraulics. The parameters used in these models were calibrated by comparing model predictions to actual observations of rainfall and water level for certain historical flood events. This includes measurements recorded at flood monitoring stations as well as surveyed flood marks.

To assist in the model calibration process, the Council specifically sought historic flood mark information from the community through a combination of targeted 'mail-outs' and advertising in local papers. Residents were invited to send the Council information or upload their flood information at the following website www.moretonbay.qld.gov.au/flooddata

In January 2011, during the course of preparing the river and creek studies, the Moreton Bay region experienced a significant flood event. Rainfall and flood levels for this event were well recorded and became one of the primary sources of calibration data (in addition to other significant flooding events, including May 2009, October 2010 and January 2013) for the suite of flood models that were under development at that time. More than 50 rain gauges were available to record rainfall during the January 2011 event and approximately 248 suitable flood marks were collected.

Figure 1 shows a histogram of the fit between the predictions by the computer models and the actual flood observations for the January 2011 flood. This comparison demonstrates that the Council's flood models have generally performed well in matching large flood behaviour, with 70% of flood observations within +/- 300mm of predicted levels. This level of accuracy supports the use of these flood models for the purpose of preparing design flood estimates for planning and building purposes (e.g. a 1% AEP event), recognising the need to also include freeboard provisions to account for inherent uncertainties in flood estimations as well as other factors that may impact on flood behaviour at specific locations (e.g. debris build-up at a culvert).

Figure 1 *Comparison of flood marks recorded for the January 2011 flood against respective modelled equivalents*



Where there were insufficient local flood records within a particular catchment to enable calibration of a specific computer model, the model parameters were transposed from nearby catchments within the local government area where the calibration of local models was possible. This practice of regional calibration is considered appropriate. The approach is particularly well suited to the flood model library that has been developed by the Council since all models have been constructed consistently using the same software tools and methods WBNM hydrologic model, TUFLOW hydraulic model consistent design event and sensitivity analysis scenarios).

Another very significant rainfall event occurred on the afternoon of 1 May, 2015. While analysis of this event is still underway, preliminary findings suggest that in some parts of the local government area, the rainfall intensity exceeded the 1% AEP conditions. Approximately 330 flood marks across the local government area were captured and surveyed by the Council for this event. It is anticipated that the observed data associated with the 1 May 2015 event (measured rainfall, river levels and flood marks) will be used as part of the on-going review, update and validation of the Council's existing flood modelling suite. Future improvements in the flood modelling suite will result in updates to the Council's adopted flood mapping.

Outputs		
1	*Map the potential flood extent for the complete LGA*	*Compliant – Refer to Appendix A*
2	*Compilation of localised flood studies for the LGA*	*Compliant*

1.2. State Interest: Identify flood investigation areas

Identify those flood prone areas that overlap with areas of existing development and proposed development.

The Moreton Bay Region has a complex network of waterways, floodplains and coastal areas. Flooding within the region can range from overflows of underground drainage within small urban catchments through to inundation of broad floodplains associated with large rivers and creeks as well as storm tide inundation of coastal plains through various coastal inlets. The floodplains and adjoining areas have experienced substantial urbanisation, particularly over the last three decades, which has heightened the risks associated with flooding.

The frequently inundated parts of the floodplain (e.g. more than 5% annual chance of flood inundation) have been generally preserved as open space or retained as semi-rural land. However, some urban development has encroached into the floodplain with the potential to be inundated on an irregular basis. Map 3 in Appendix B shows where there is existing urban development (total parcel size of less than 3000 m^2) that would be inundated by a 1 in 100 annual chance event (i.e. 1% AEP) due to flooding (riverine and creek) or coastal (storm tide) inundation. These locations within the floodplain are generally where historic approvals were given when standards were different to today or where there was historically poor understanding of potential flood behaviour. These areas are the focus of investigation for flood and storm tide mitigation as part of the Council's current capital works and emergency management programs. Planning controls are also proposed in the new draft planning scheme to progressively address some of the flood risk through the process of building renewal and re-development.

Areas of existing and proposed settlement and development that occur within the extreme flood and storm tide inundation extents are shown on Map 4 in Appendix B. This highlights the potential for impact beyond the 1% AEP flooding and storm tide inundation extents.

The flood information has been used to inform the strategic planning framework and to help identify potential new urban land release areas across the local government area that would not be unduly constrained by future flooding.

Outputs		
1	*A map of existing and proposed settlement and development areas that occur within the flood extent*	*Compliant – Refer to Appendix B*
2	*List of settlement/development areas that have a localised flood study and those that do not have a localised flood study*	*Compliant – All urban and rural areas in the Moreton Bay Regional Council area have a localised flood study (refer to list in section 1.1)*

2. Outcome Sought: Include provisions that seek to achieve an acceptable or tolerable level of risk, based on a fit for purpose natural hazards and risk assessment

2.1. State Interest: Undertake a suitable "fit for purpose" flood investigation

For each investigation area, choose a level of investigation that will provide the level of detail required to make evidence based planning decisions.

Policy 1 of the SPP Guideline requires natural hazard areas for flood and coastal hazards to be identified on a fit for purpose natural hazard study. The level of precision for the study should be determined at a local level by the responsible local government. The Council decided to and has undertaken 'advanced' flood investigations for all catchments within the local government area. This means that investigations have been locally-specific, using a sufficient level of detail to make evidence-based planning decisions. There are no gaps in spatial coverage, as is appropriate for a large rapidly urbanising region.

These investigations have been undertaken and supervised by qualified professionals that have advanced specialist knowledge of current Australian flood investigation techniques and significant experience using the Council's nominated hydrologic and hydraulic modelling software.

The Council's suite of flood investigations is contemporary, having been undertaken over the preceding 5 year period. All flood extents and depths are mapped against the latest detailed aerial laser surveys available.

Flood information is held in a version controlled spatial database (i.e. mapping) and periodically updated as improvements are made to the underlying flood models. The maps used by the Council therefore represent the best available information and data.

For river and creek flooding, the flood information database for the region includes maps for:

- a range of flood likelihoods from the once every year (on average) event up to the Probable Maximum Flood. For each flood likelihood, the mapping covers the flood extent, level, depth, velocity, hydraulic hazard category and stream power (a measure of energy dissipation on the bed and banks of a stream over stream distance, which provides an indication of the potential for channel erosion);
- a range of sensitivity scenarios applied to the 1% AEP flood event including for example the impact of climate change (increased rainfall; increased sea level), future development and blockage of culverts and other structures. Several of these sensitivity scenarios have been used to establish the Council's Defined Flood Event (DFE) for flood planning purposes.

As part of the current model maintenance program, the Council has developed more detailed and comprehensive information for storm tide inundation. This has improved the accuracy of estimates for storm tide inundation depths, velocities and hazards compared to the initial storm tide studies undertaken by the Council.

Included within the suite of scenarios undertaken by the Council is a future 1% AEP (2100 conditions), that includes a combination of sea level rise, increased rainfall and wind intensity, storm tide coincidence, future development conditions and structure blockage. These conditions have been targeted for future planning provisions.

The Council also has overland flow path mapping for all minor gullies, and large surface depressions.

The suite of flood and storm tide information has been applied to the preparation of a comprehensive assessment of flood and storm tide hazard using methodologies outlined in the Floodplain Risk Management Study and the Storm Tide Risk Management Study respectively. Risk maps have been derived using the most up to date information and analysis available about the likelihood and behaviour (extent, level, depth, velocity, hydraulic hazard) of flood and storm tide inundation.

The Council provides to the community free on-line access to some of the above flood information as is considered relevant for flood awareness and planning purposes (notably the 5% AEP, 1% AEP, 0.1% AEP and probable maximum flood events). This access includes an interactive flood mapping tool known as 'Flood Explorer' as well as a property-based Flood Check Property Report available for each of the 170,000 (approx.) properties within the Moreton Bay region (for access to these services please refer to www.moretonbay.qld.gov.au/floodcheck).

Outputs		
1	*The LGA flood mapping utilises localised flood studies*	*Compliant*

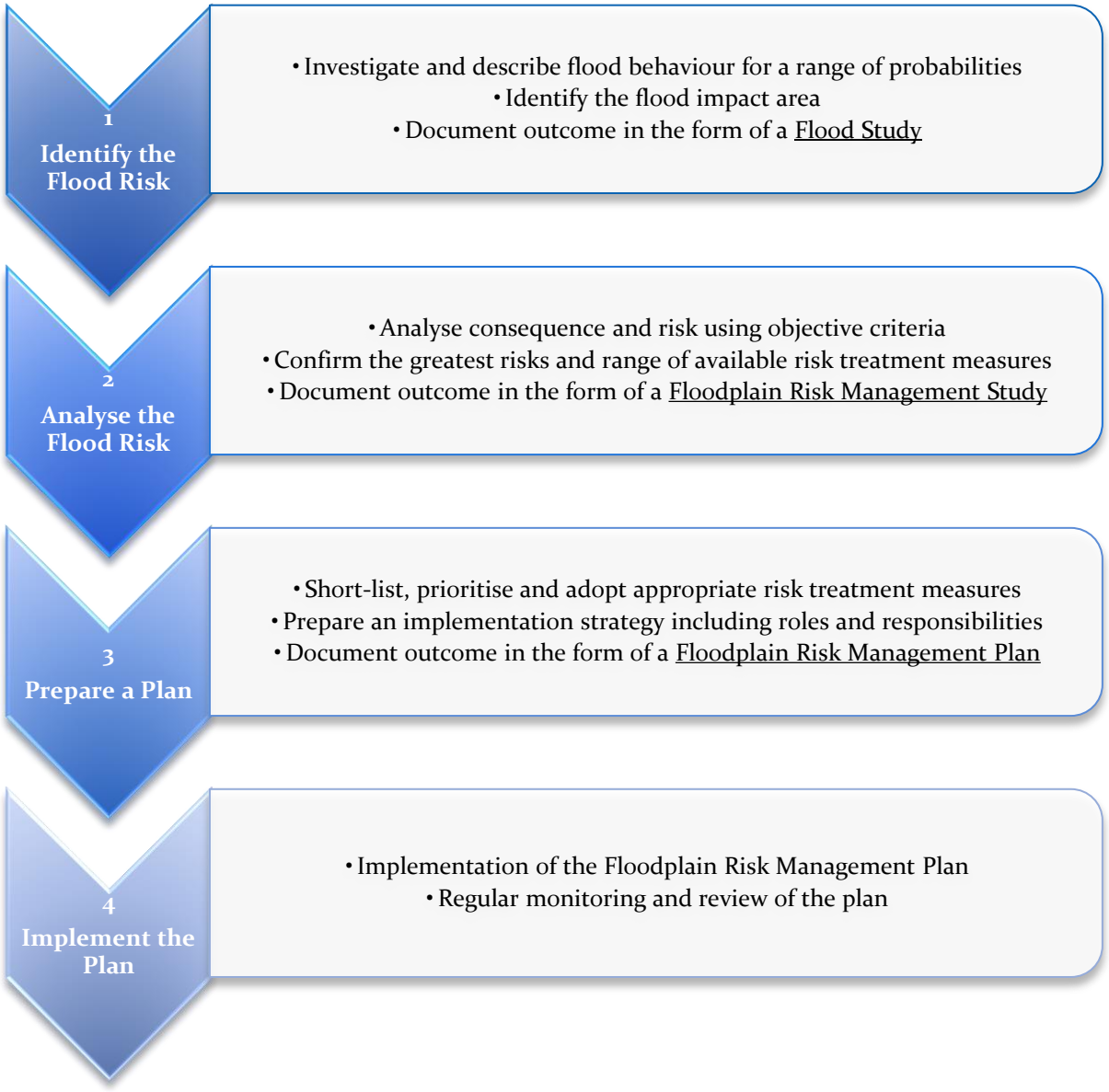
2.2. State Interest: The Risk Assessment and subsequent planning provisions are developed in a manner consistent with the Risk management process outlined in AS/NZS ISO 31000:2009

AS/NZS ISO 31000:2009 establishes a four (4) step process to risk assessment. These steps can be summarised as:

1. Risk identification
2. Risk analysis
3. Risk evaluation
4. Risk treatment

The process identified in AS/NZS ISO 31000:2009, aligns with the Council's Flood Risk Management Framework (FRMF) which is summarised in Figure 2.

Figure 2 MBRC Flood Risk Management Framework



The work undertaken by the Council to identify the flood risk (Stage 1), is described in detail in sections 1.1, 1.2 and 2.1 of this report. The suite of information derived from Stage 1 has been applied to the analysis of

both the flood and storm tide risk (Stage 2) and the derivation of risk treatment measures (Stage 3) through two independent studies:

1. Floodplain Risk Management Study prepared by Molino Stewart - *MBRC Floodplain Risk Management Study Phase 1 June 2013* (**Molino Stewart, 2013**); and
2. Storm Tide Risk Management study prepared by GHD - *Storm Tide Management Study April 2012* (**GHD, 2012**).

   (Collectively, the **Risk Management Studies**)

The Risk Management Studies set out methodologies for analysing the risk associated with a range of flood events. In accordance with ISO 31000:2009, risk is defined as the combination of the likelihood of the occurrence of an event and the consequence if the event occurs. In both Molino Stewart, 2013 and GHD, 2012, likelihood is interpreted as the flood frequency, while hydraulic hazard categories were used to define the flood behaviour characteristics, which provide an indicative measure of the consequences of floods. Figures 3 and 4 demonstrate the derivation of hydraulic hazard categories, which relates to the depth and velocity of flood waters for flood (river and creek) and storm tide events.

The river and creek hydraulic hazard categories H1-H5 were derived from the Newcastle Concept Flood Planning Report (BMTWBM, 2009), which is modified from Floodplain Management in Australia (CSIRO, 2000) and the NSW Floodplain Development Manual (NSW Government, 2005).

The storm tide hydraulic categories H1-H5 were derived in GHD, 2012 giving consideration to the potential impacts of combined wave action and storm surge. Along the immediate coastal foreshores, direct wave impact combined with storm tide conditions can create significant hazard to people and property. To capture this effect, GHD, 2012 based the hydraulic hazard categorisation on the Federal Emergency Management Agency (USA) (FEMA) guidelines (i.e. FEMA 'V' zones and 'A' zones).

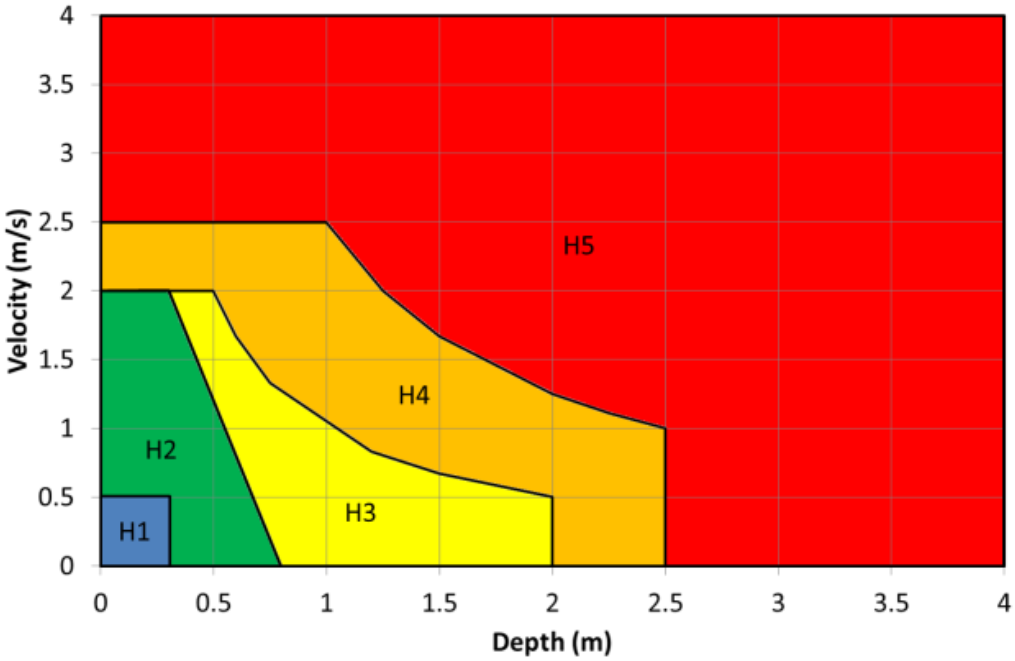
The GHD approach of five hydraulic categories (see Figure 4) was considered by the Council to be more detailed and locally focused than the standard State Government method for determining high and medium hazard zones for storm tide inundation. The Coastal Hazard Technical Guide (DEPH, April 2013) relevantly states that high hazard occurs where "*The inundation depth is 1m or more with breaking waves of 0.9m or higher, and/or peak flows with a product of depth x velocity of 0.3m/s or greater*". While both methods have limitations, having regard to the risk based approach that underpins the overall construction of the flood planning controls, the GHD approach for hazard mapping is considered more appropriate.

At the time of preparation of the GHD, 2012 study, storm tide inundation was not modelled dynamically as part of Council's flood modelling suite. Instead, storm tide was assumed to inundate coastal plains using a 'bathtub' approach based on the storm tide levels determined in Moreton Bay by Cardno, 2009. In the absence of specific information GHD, 2012, made assumptions about storm tide velocities in order to determine hydraulic hazard. As part of the current model maintenance program, the Council has been able to dynamically model storm tide inundation as part of their flood modelling suite and produce more accurate storm tide mapping that relies on more current aerial laser surveys and supersedes the storm tide mapping relied upon in GHD, 2012. Thus, while the hydraulic hazard categorisation methodology developed by GHD 2012 remains suitable, the storm tide mapping has been superseded by the more recent modelling completed by the Council.

With respect to waves, potential consequences of wave impact forces on structures would be greatest at the open coastline interface and would reduce relatively rapidly with distance inland as wave energy is dissipated. As such, inclusion of waves as part of a hazard assessment would only be required within the coastal fringe, an area that is largely consistent with the State's Erosion Prone Area. Thus, special provisions associated with future development in the Erosion Prone Area should encompass consideration of wave impacts on structures as well as inundation and foreshore erosion.

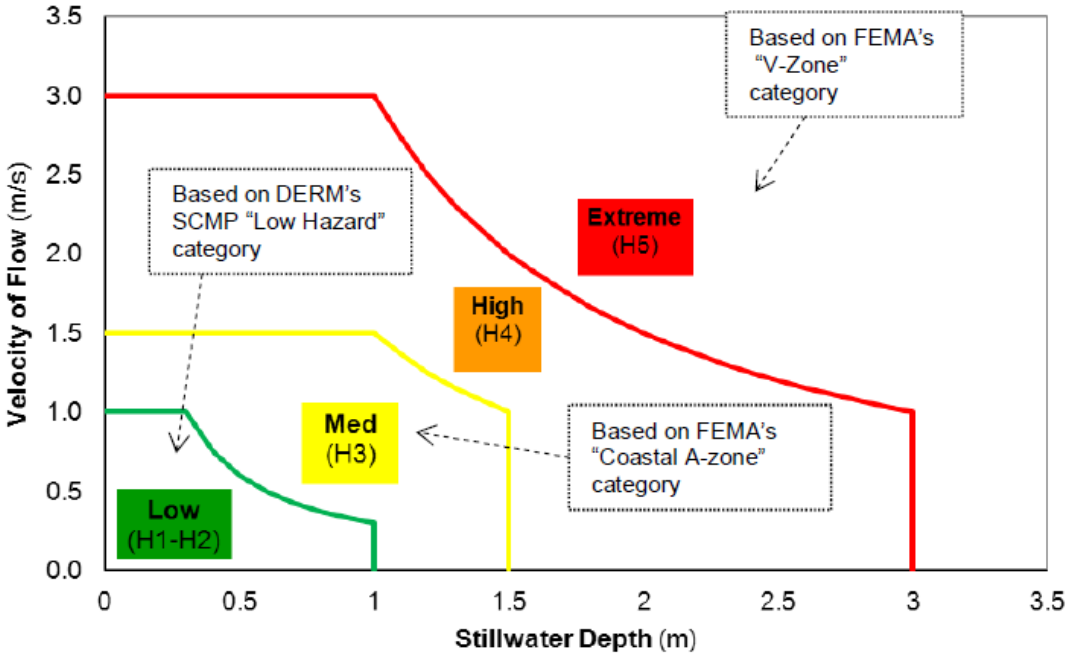
The general consequences associated with each of these hydraulic behaviour categories are described in Table 1.

Figure 3 Hydraulic Hazard Categorisation (Flood (River and Creek))



Source: BMTWBM "Newcastle Concept Flood Planning Report 2009" and Molino Stewart, 2013

Figure 4 Hydraulic Hazard Categorisation (Coastal - Storm Tide)



Source: GHD, 2012

Table 1 Hydraulic Behaviour Categories and their respective consequences

Low Risk to Life and property		***High Risk to Life and property***		
H1	***H2***	***H3***	***H4***	***H5***
Insignificant [1]	***Minor*** [1]	***Moderate*** [1]	***Major*** [1]	***Catastrophic*** [1]
No significant life risk *Property risk only to items which come in direct contact with floodwaters such as building contents*	*Low life risk. Able bodied adults can walk safely.* *Cars can float and precautions must be followed to keep them out of floodwaters*	*Moderate life risk.* *Able bodied adults cannot safely walk* *Only large vehicles (trucks) can safely travel.*	*Major life risk* *Light frame buildings (e.g. houses) can fail structurally*	*Extreme life risk* *Majority of buildings could fail*

1. Equivalent from National Emergency Risk Assessment Guidelines October 2010 (NERAG 2010)

The risk is defined based on the hydraulic hazard category, but also gives consideration to specific risk elements, such as risk of isolation and risk to life.

Using the data derived from Stage 1, the flood frequencies were combined with the hydraulic hazard categorisation (H1-H5) in accordance with a generalised risk matrix for river and creek flooding as well as storm tide inundation.

Within the risk matrix, the Council has adopted a categorisation of risk consistent with the SPP Guideline -

- **Acceptable risk** – A risk that, following an understanding of the likelihood and consequences, is sufficiently low to require no new treatments or actions to reduce risk further. Individuals and society can live with this risk without feeling the necessity to reduce the risks any further.
- **Tolerable risk** – A risk that, following an understanding of the likelihood and consequences, is low enough to allow the exposure to continue, and at the same time high enough to require new treatments or actions to reduce risk. Society can live with this risk but believe that as much as is reasonably practical should be done to reduce the risks further.
- **Intolerable risk** – A risk that, following an understanding of the likelihood and consequences, is so high that it requires actions to avoid or reduce the risk. Individuals and society will not accept this risk and measures must be put in place to reduce risks to at least a tolerable level.

For the purpose of this document and alignment with State Government terminology, unacceptable risk is considered to also be intolerable risk.

In general, the risk matrix (as per Figure 5) shows what combinations of hydraulic hazard (as an indicator for consequence) and flood frequency (i.e. likelihood) are acceptable, tolerable and intolerable. Note the generalised risk matrix in Figure 5 below is shown as a general example only. The matrices used during the development of the new draft planning scheme are described in later sections.

Figure 5 Generalised Risk Matrix (example only)

	Low Hydraulic Hazard	Medium Hydraulic Hazard	High Hydraulic Hazard
Low Probability	Acceptable	Acceptable	Tolerable
Medium Probability	Acceptable	Tolerable	Intolerable
High Probability	Tolerable	Intolerable	Intolerable

2.3. State Interest: Identify risks to existing and proposed land uses

Floodplains can generally be separated into different areas based on the behaviour of floodwaters during events. The general classification is floodway, flood storage and flood fringe. Floodways are those areas that convey the majority of flood flow. Obstructions within floodways due to existing or proposed land uses can have a significant impact on flood behaviour upstream and downstream. Flood storage covers those areas where floodwaters are temporarily detained during flood events. Significant infilling within flood storage areas due to existing or proposed development may have an impact on the routing of floodwaters through the catchment. Flood fringe areas are located around the periphery of the flood extents. Infilling of these areas is not expected to have a notable impact on flood behaviour.

As a means of prioritising future actions and activities to mitigate flooding and storm tide inundation risks, the Risk Management Studies produced separate risk matrices for different asset/value types at risk within the floodplain. These included the following:

- personal safety in existing residential buildings;
- personal safety in existing commercial buildings;
- residential buildings;
- commercial and industrial buildings;
- isolation;
- road access; and
- infrastructure.

The Council considered the risks to personal safety and property separately for residential, commercial and industrial land uses. Formulation of the different risk matrices considered the exposure, vulnerability and tolerability of these assets/values in combination with the relevant flood frequencies/likelihoods. These risk matrices articulate the results of the risk analysis for these asset types/values and along with detailed risk maps for flooding (river and creek) and storm tide inundation, form part of the Risk Management Studies. It is important to note that these risk maps differ from the general flood extent information provided to the community through the Council's web-site and Flood Check, and are to be used by the Council primarily for floodplain management purposes. It is also important to note that risk mapping presented in GHD, 2012 is now superseded by more up to date modelling undertaken by the Council. The outcomes of the Storm Tide Risk Management Study will therefore need to be reviewed and validated using recent dynamic storm tide results from the flood modelling suite.

Outputs		
1	*A flood risk map for the investigation areas*	*Compliant – Refer to Floodplain Risk Management Study and Storm Tide Risk Management Study*

2.4. State Interest: Determine the acceptable, tolerable and intolerable levels of risk for each land use type located in the local government area

From the perspective of planning for existing and proposed land uses, it was determined that the most relevant asset type/values risk matrices, as described in Section 2.3 above, for development of the new draft planning scheme were those related to residential and commercial buildings. In established urban areas, management tools such as emergency management and capital works are the most effective way to manage the risk to people and property, however where new development or re-development is proposed, the planning scheme can introduce measures that reduce the risk to life and future damage to property. The flood (river and creek) and storm tide risk matrices are included in the relevant documents.

Due to the complexity of the floodplain and for application to the new draft planning scheme it was considered necessary to utilise one risk matrix (combining river and creek flooding and storm tide inundation) that is applicable to both residential buildings and commercial and industrial buildings. The compilation matrix is referred to as the Combined Flood Risk Matrix and is shown in Figure 6, and is adapted from GHD, 2012 and Molino Stewart, 2013.

Figure 6 Combined Flood Risk Matrix (Version 1)

Likelihood level		*NERAG 2010*[1]	**Consequence level**				
Current MBRC flood mapping (Flood Check)							
Coastal hazard	*Flood hazard*		*Insign-ificant*	*Minor*	*Moderate*	*Major*	*Catastrophic*
Storm Tide Floodplain Extent 0.01% AEP 2014 (1:10,000 ARI)	River and Creek Floodplain Extent (PMF)	*Rare*	A	A	T	T	I
0.1% AEP 2014 (1:1,000 ARI)	0.1% AEP 2014 (1:1,000 ARI)	*Unlikely*	A	T	T	I	I
1% AEP 2014 (1:100 ARI)	1% AEP 2014 (1:100 ARI)	*Possible*	T	T	I	I	I
5% AEP 2014 (1:20 ARI)	5% AEP 2014 (1:20 ARI)	*Likely*	T	I	I	I	I
Hydraulic Hazard category			*H1*	*H2*	*H3*	*H4*	*H5*

A	Acceptable
T	Tolerable
I	Intolerable

1. National Emergency Risk Assessment Guidelines October 2010 (NERAG 2010)

The Combined Flood Risk Matrix (Version 1), became the basis for discussions with the Council regarding the new draft planning scheme zones and provisions that could be utilised to manage the level of risk.

During the initial workshops with the Council, two significant changes were made to the Combined Flood Risk Matrix (Version 1). The first change altered the H5 hazard in a PMF event from an intolerable to a tolerable risk (refer Circle 1 in Figure 7 below). The Council felt strongly that the extent of this event was important for residents to be aware of, hence it should be mapped on the Council's Flood Check, however the infrequency of the event should not unnecessarily burden future development within those areas.

The second major change was on the recommendation of the Council's officers. The use of 3 risk categories (acceptable, tolerable and intolerable) potentially limited Council's planning control options. State Planning Policy outcomes regarding acceptable, tolerable and intolerable risks are relatively simplistic in that areas of acceptable risk do not require any further treatment (e.g. planning controls) in order to mitigate risk, while areas of intolerable risk are generally considered unsuitable and unacceptable for new residential development. Therefore, only areas of tolerable risk have the flexibility for managing risk through a diversity of development control measures.

Within the intolerable risk areas, it was acknowledged that two broad policy positions were required as follows:

1. retreat from the areas of highest risk (combining frequency and hazard); and
2. no intensification of development and hazard resilient design and built form requirements for building work in the balance of the intolerable risk areas.

To reflect these outcomes in the Combined Risk Matrix, the 'extremely intolerable' risk category was introduced (refer Circle 2 in Figure 7 below).

Figure 7 Combined Flood Risk Matrix (Version 2)

Likelihood level		*NERAG 2010*[1]	**Consequence level**				
Current MBRC flood mapping (Flood Check)			*Insignificant*	*Minor*	*Moderate*	*Major*	*Catastrophic*
Coastal hazard	*Flood hazard*						
Storm Tide Floodplain Extent 0.01% AEP 2014 (1:10,000 ARI)	River and Creek Floodplain Extent (PMF)	*Rare*	A	A	T	T	T 1
0.1% AEP 2014 (1:1,000 ARI)	0.1% AEP 2014 (1:1,000 ARI)	*Unlikely*	A	T	T	I	EI
1% AEP 2014 (1:100 ARI)	1% AEP 2014 (1:100 ARI)	*Possible*	T	T	I	EI	EI
5% AEP 2014 (1:20 ARI)	5% AEP 2014 (1:20 ARI)	*Likely*	T	I	I	EI	EI 2
Hydraulic Hazard category			*H1*	*H2*	*H3*	*H4*	*H5*

A	Acceptable
T	Tolerable
I	Intolerable
EI	Extremely Intolerable

1. National Emergency Risk Assessment Guidelines October 2010 (NERAG 2010)

Upon public notification of the initial draft planning scheme, the Intolerable and Extremely Intolerable risk areas defined the extent of the Limited Development Zone, which was identified as the High risk area on the draft Overlay Map - Flood Hazard. The Medium risk area was made up of a combination of Tolerable risk and the extent of the defined flood event (1% AEP 2100), while the Low risk area extended to the limits of the Probable Maximum Flood.

The public notification of the initial draft planning scheme provided an opportunity for the Council to gauge community tolerance for flood risks. Approximately 80% of all of the submissions received dealt with these matters as part of the submission. In response, the combined flood risk matrix was further reviewed to reflect an increased tolerance of risk on the basis of the implementation of planning and development controls intended to mitigate the risk. The review included professional input from BMT WBM Pty Ltd (flood modelling and management) and MWH Global (land use planning).

A number of recommendations were made by the independent review (refer Table 2). Notably, the matrix was changed so that there are no 'acceptable' risk areas within the Flood planning area or Coastal planning area (thus allowing some degree of risk treatment, such as planning controls) within the full extent of the Flood hazard overlay and Coastal hazard overlay areas. Also, sub-categories of risk within the tolerable risk area were introduced to distinguish between very low, low and medium tolerable risks. The revised combined matrix (Version 3) is shown in Figure 8.

Figure 8 Combined Flood Risk Matrix (Version 3)

Likelihood level		*NERAG 2010*[1]	**Consequence level**				
Current MBRC flood mapping (Flood Check)			*Insign-ificant*	*Minor*	*Moderate*	*Major*	*Catastrophic*
Coastal hazard	*Flood hazard*						
Storm Tide Floodplain Extent 0.01% AEP 2014 (1:10,000 ARI)	River and Creek Floodplain Extent (PMF)	*Rare*	T-VL	T-VL	T-L	T-L	T-L
0.1% AEP 2014 (1:1,000 ARI)	0.1% AEP 2014 (1:1,000 ARI)	*Unlikely*	T-L	T-L	T-M	I-H	EI-H
1% AEP 2014 (1:100 ARI)	1% AEP 2014 (1:100 ARI)	*Possible*	T-M	T-M	T-M	EI-H	EI-H
5% AEP 2014 (1:20 ARI)	5% AEP 2014 (1:20 ARI)	*Likely*	T-M	T-M	T-M	EI-H	EI-H
Hydraulic Hazard category			*H1*	*H2*	*H3*	*H4*	*H5*
Risk to Life			*Low risk to life*		*High risk to life*		
Approximate floodplain hydraulic category			*Flood fringe*	*Flood storage*		*Floodway / flood conveyance*	

EI-H	Extremely Intolerable High Risk
I-H	Intolerable High Risk
T-M	Tolerable Medium Risk
T-L	Tolerable Low Risk
T-VL	Tolerable Very Low Risk

1. National Emergency Risk Assessment Guidelines October 2010 (NERAG 2010)

Table 2 Preliminary Recommendations of Peer Review

	Recommendation	Reason	Council position
1	Separate into Coastal hazard overlay and Flood hazard overlay	• 2014 SPP treats as separate hazards with different risks and policy requirements. • Development requirements can be better targeted to the risk. • Improves the clarity of the mapping	Agreed
2	Remove the identification of Low risk areas from both overlays	• 2014 SPP does not require these areas to be mapped. • The Balance coastal planning area and Balance flood planning area includes low risk areas and very low risk areas.	Agreed
3	Reduce Medium risk areas for Coastal hazard overlay	• Defined flood event (DFE) was previously used as a mapping rule to define the extent of the Medium risk area. • After review, Medium risk determined using the combined flood risk matrix (Figure 8) and current climate mapping (i.e. 2014).	Agreed
4	Reduce High risk areas by accepting greater risk tolerance (H2/H3 for 1:20 and 1:100 events)	• Risk tolerance is a matter for the Council to decide under 2014 SPP subject to Council acting reasonably. • Council decides based on community consultation that the community has a higher tolerance for risk than originally thought. • Development requirements can be imposed to mitigate or manage the increased risk tolerance; • High risk area defined by H4 or H5 as described in combined flood risk matrix (Figure 8) and using current climate	Agreed

	Recommendation	Reason	Council position
		mapping (i.e. 2014). • Preliminary review by engineering and planning experts indicates that the revised risk assessment with appropriate development requirements is not unreasonable.	
5	Include State Erosion Prone Areas under the State Planning Policy as High risk areas	• 2014 SPP requires these areas to be mapped as High risk areas. • 2014 SPP requires restrictive development requirements. • Significant risks to property and people.	Agreed
6	Include State 2100 permanent inundation area (2100 Highest Astronomical Tide, or HAT 2100) as High risk area	• 2014 SPP states that Council "may choose" to include these areas. • Significant legal and financial risks if public is not notified of permanent future inundation with sea level rise. • Development requirements allow filling to this level in high risk areas and medium risk areas to avoid permanent future inundation. • Filling to the HAT 2100 is permitted on certain properties in the Coastal planning area (including in the High risk area, where complying with the balance requirements of the code) to reduce the level of risk.	1. Agreed to not include Year 2100 Highest Astronomical Tide level as within the extent of the High risk area. 2. Agreed to identify Year 2100 Highest Astronomical Tide level on the Council's Flood Check website and not on the Coastal hazard overlay. 3. Agreed to use Year 2100 Highest Astronomical Tide level to manage filling in areas at risk from permanent inundation.
7	Further studies	• Current risk assessment is based on 2014 flood events - risk assessment required for 2100 flood events (considering climate variability). • Council should prepare an Adaptation Strategy to manage flood risk and changing coastal risks.	Agreed

Outputs	
A table of land uses with risk categories of acceptable, tolerable and intolerable. Special consideration should be given to the location of community infrastructure	*Compliant – The Combined Flood Risk Matrix considers the community's tolerance to flooding affecting residential and non-residential uses. In regard to community infrastructure specific provisions have been included to reduce the level of risk.*

3. Outcome Sought: Include provisions that require development to avoid natural hazard areas, support disaster management response and recovery, avoid an increase in the severity for the natural hazard, maintain or enhance natural processes.

3.1. State Interest: Confirm the planning scheme provisions that achieve acceptable and/or tolerable levels of risk through the local government area.

The peer review produced summary tables for flood (river and creek) and coastal (storm tide and erosion prone area) risk. The tables reflect the broad policy position of the Council post public notification and the peer review. The tables include –

1. the Council and the community's tolerance to risk in the High risk, Medium risk and Balance areas;
2. the features that comprise the proposed Coastal planning area, including the following:
   2.1. High risk area, comprising the Erosion Prone Area and High risk storm tide inundation area;
   2.2. Medium risk area, comprising the Medium risk storm tide inundation area;
   2.3. Balance coastal planning area, comprising the land not in the Medium or High risk areas and within the boundaries of the Coastal planning area; and
   2.4. Year 2100 Highest Astronomical Tide level;
3. the features that comprise the proposed Flood planning area, including the following:
   3.1. High risk area;
   3.2. Medium risk area; and
   3.3. Balance flood planning area, comprising the land not in the High risk area or Medium risk area and within the boundaries of the Flood planning area;
4. the proposed zoning of the land relative to risk;
5. the measures and provisions used in the new draft planning scheme to achieve an acceptable and tolerable level of risk including -
   - the policy framework for operational work and building work in the High and Medium risk areas and each Balance planning area;
   - the policy framework for material change of use in the High and Medium risk areas and each Balance planning area; and
   - the policy framework for reconfiguring a lot for the High and Medium risk areas and each Balance planning area.

The summary tables are included in Appendix C. As shown in the summary tables, risk 'avoidance' is used for the areas at highest risk of flooding and inundation. This is achieved through the designation of a Limited Development Zone where no new development or intensification of existing uses is permitted. For other parts of the floodplain, risk is to be managed through specific land use policy intent development controls for material change of use for operational work, reconfiguring a lot and building works as applied to areas of different risk, and 'acceptance' for areas where planning controls are not relevant (notably for areas outside the planning area extents).

Freeboard provisions are also used to manage the risks associated with uncertainty in flood and storm tide inundation estimations. A detailed review of freeboard requirements has been undertaken by the Council in order to establish appropriate provisions as incorporated into the summary tables. The independent review of freeboard requirements is provided in Appendix F.

The new draft planning scheme includes provisions that reflect the outcomes recommended in the summary tables.

The Risk Management Studies also outline non-planning mitigation measures to address existing and future risk. This includes the consideration of measures aimed at improving community resilience to events (e.g. improving the evacuation of residents) and reducing the potential impacts through physical works (e.g. levees and tidal gates). With respect to existing development, floodplain management can focus on reducing the likelihood of an impact occurring and reducing the resulting consequences if the development is impacted.

Development provisions within the new draft planning scheme are consistent with current industry best practice for floodplain and coastal risk management are in accordance with the Flood Hazard Model Code in the SPP Guideline. The provisions are largely consistent with other nearby local government areas both in terms of content and the application of climate change projections. The risk-based approach effectively considers both the likelihood and consequence of events and the identification of appropriate development controls.

Outputs	
The planning scheme provisions are the outputs of this evaluation question – submission to the State should include: • *A map or list identifying locations where planning measures are required;* • *A table listing planning measures and other risk management measures that have been used in various locations;* • *The planning provisions used to ensure that the community is not exposed to an unacceptable level of risk;* • *The hazard and risk information that is available or will be required to achieve the planning provisions;* • *Table of residual risk.*	*Compliant – the new draft planning scheme incorporates –* • *A Coastal planning area and a Flood planning area, to which relevant development controls apply;* • *A table listing the planning measures is included in Appendix C;* • *The planning provisions are contained within the Flood hazard overlay code and a Coastal hazard overlay code;* • *The hazard and risk information is included in the planning scheme mapping;* • *The Council's response to residual risk has been incorporated into the Tables included in Appendix C.*

3.2. State Interest: Confirm that the land use planning provisions have been developed within a broader risk management framework

In 2009, the Council produced a Floodplain Risk Management Framework (FRMF) to help guide the decision-making by the Council on integrated floodplain management across the whole local government area.

The objectives of the FRMF were as follows:

- To ensure that all levels of government and the local community are aware of their responsibilities for managing flood risk.
- To ensure floodplain management functions are integrated within a broader sustainable land management framework.
- To ensure that flood risk and flood behaviour is understood and considered in a strategic manner in the decision-making process and that land use is consistent with flood risk and potential damages.
- To ensure land use planning and development controls minimise both the exposure of people to flood risk and damage costs to property and infrastructure.
- To ensure a broad range of floodplain management measures (both structural and non-structural) are considered and flood mitigation measures appropriate to the location and acceptable to the local community are used to manage flood risk where economically, socially and environmentally viable.

This Framework addresses the management of floods arising from heavy rainfall (river and creek flooding), storm tide, and urban flash flooding (overland flow paths). A copy of the Flood Risk Management Framework for the Moreton Bay Region is included in Appendix D.

The Council's approach to achieving the objectives of the FRMF involves four (4) steps:

- Step 1: Identify the Flood Risk (i.e. Flood Study);
- Step 2: Analyse the Flood Risk (i.e. Floodplain Risk Management Study);
- Step 3: Prepare a Plan (i.e. Floodplain Management Plan); and
- Step 4: Implement the Plan.

Since 2009, the Council has systematically been undertaking technical studies and investigations in accordance with the FRMF. As part of Step 1, the Council has undertaken detailed flood investigations (or flood studies) for all the catchments across the local government area, developing a database of up to date hydrologic and hydraulic models simulating a range of flood frequency events and sensitivity scenarios. These studies have identified the areas within the local government area which are subject to potential flooding in varying events. As well as flood investigations of river and creek catchments, the Council has also undertaken a storm tide study, which provides an assessment of coastal inundation of low-lying coastal floodplains, as well as overland flow path mapping (undertaken in 2012). In total, 22 technical studies have been completed over the past five years to help define the flood risk across the Moreton Bay Region.

Step 2 of the FRMF commenced in 2011, when the Council undertook a "Storm Tide Management Study", prepared by GHD, to identify areas of risk within the local government area due to the potential impacts of storm tide. The Storm Tide Management Study identified potential risks to personal safety as well as potential damage to property and infrastructure. It is important to note that risk areas identified in the GHD, 2012 study are now superseded by up to date modelling and mapping using dynamic storm tide simulations in the Council's modelling suite.

In 2012-2013, the Council also undertook phase 1 of a Floodplain Risk Management Study, prepared by Molino Stewart, to address the issues associated with flooding from rivers and creeks within the local government area. Again, risks to life and property were evaluated on the basis of the preceding technical flood studies for the various catchments. Flood risks took into consideration the potential for isolation, availability of

evacuation routes to high ground as well as areas which were isolated in smaller events but are potentially fully inundated during extreme events.

Both the storm tide management study and the phase 1 floodplain risk management study identified significant urban development that is potentially at risk of flooding and ocean inundation. Areas at risk have been prioritised, and in accordance with risk management protocols, were evaluated as areas of 'acceptable', 'tolerable' and 'intolerable' risk.

For Step 3 of the FRMF, the Council commissioned an Interim Flood Risk Management Plan (FRMP), prepared by Molino Stewart in 2013. The interim FRMP covers flooding (river and creek), storm tide and overland flow paths. It assesses various risk management options within the framework of existing development controls. Taking a broad consideration of floodplain risk management, the Interim FRMP considers emergency management, flood warning, community education and a wide spectrum of physical works (including property-based works and more regional approaches to flood mitigation). The FRMP also provides planning context to flood risk management, with consideration given to existing planning scheme arrangements, state policies, and recommendations from the Queensland Flood Commission of Inquiry, with comparison to industry best practice.

The FRMP provides a number of recommendations for managing flood and coastal risks across the Moreton Bay Region. These include a range of reviews and amendments to the MBRC Local Disaster Emergency Management Plan as well as recommendations for changes to the draft planning scheme, notably relating to establishment of DFE and DSTE conditions, freeboard requirements and various development controls (including the use of flood resistance materials). A copy of the Interim FRMP is included in Appendix E. Detailed consultation with relevant authorities will be carried out as the FRMP is finalised and implemented by the Council.

3.3. State Interest: The strategic framework will set the vision and land use direction for the planning scheme and forms the basis for ensuring that only appropriate development occurs in flood hazard areas

The Strategic Framework acknowledges the presence of natural hazards across the Moreton Bay Region, and provides clear direction on the appropriate land use planning response to development in order to mitigate the potential conflicts arising within areas affected by natural hazards, including flood and coastal hazard areas. The Strategic Framework emphasises the Council's intention to build community resilience to natural hazards including the projected effects of climate change by -

1. Respond to the risk from natural hazards, including projected changes in weather, by avoiding areas with high exposure and establishing adaptation strategies to minimise vulnerability to riverine flooding, storm tide, coastal erosion, bushfires and landslides;
2. Respond to the risk from natural hazards, including projected changes in weather, by establishing adaptation strategies to minimise vulnerability to heatwaves and high temperatures, reduced and more variable rainfall, cyclones and severe winds, and severe storms and hail; and
3. Recognise and respond to changes in urban climates due to land use conversion and urban heat island effect from increased development intensity.

The Strategic Framework identifies district specific responses to the impacts of flood and coastal hazards that have been reflected in the new draft planning scheme zones, overlays and relevant development provisions. This approach to accommodating growth will also entail a greater focus on the health and personal safety of existing and future communities through measures designed to protect people, property and infrastructure from the impacts of natural hazards, now and in the future and directing growth away from areas that are currently considered high risk or will become high risk in the future as a consequence of climate change and sea level rise.

The areas at greatest risk are generally located in two place types –

1. Coastal villages at Pumicestone Passage and Deception Bay including Toorbul, Donnybrook, and Beachmere; and
2. Coast and riverland areas around Bribie Island, Deception Bay, Bramble Bay and Hays Inlet and along the waterways of Caboolture River, Burpengary Creek, Saltwater Creek, Freshwater Creek, the Pine River, the North Pine and South Pine Rivers.

The urban form in these areas is essentially linear following the waterways and coast line of the planning area. Minimal development is envisaged within the existing Coastal Villages in the life of the new draft planning scheme.

Coastal Villages Place Type

The Coastal villages are exposed to existing and future coastal hazard events including storm tide and erosion events which are projected to increase in the future. Therefore limited development and limited investment in infrastructure is anticipated in these areas. Mitigation options that will avoid the hazard, including retreat, avoidance, and defence and a cost-benefit analysis to determine the most cost effective works or actions, taking into account long-term social, financial and environmental factors will be required.

Relevant Specific Outcomes

1. *Land within this place type is exposed to coastal hazard and to projected increases in future hazard events which will constrain future development of the coastal villages.*
2. *Development is designed to avoid exposure to riverine flood events, and to the extent practical, mitigate the potential impacts of storm tide, erosion and projected sea level rise.*
3. *Development does not increase the risk of shoreline erosion.*

4. *Limited development occurs within the coastal villages.*
5. *Development that does occur is infill and redevelopment for low density detached housing that maintains the small-scale, low density character of the coastal villages.*
6. *Infrastructure is not subject to coastal hazards.*
7. *Development retains the natural hydrological characteristics of waterways, wetlands and coastal areas including groundwater, and mitigates disturbance of acid sulphate soils and the mobilisation and release of nutrients of concern from nutrient hazard areas.*

Coast and Riverlands Place Type

The place type includes the Region's 45km of coastline, extending from the Pine River estuary and Hays Inlet in the south alongside Deception Bay past the Caboolture River estuary and up to the Pumicestone Passage and Bribie Island.

The coastline is part of the internationally recognised Moreton Bay Ramsar site in recognition of its important wetland types and values. It also incorporates areas of great environmental significance and coastal lowlands containing estuarine areas, tidal flats and marine deposits, beach ridge and sand dune areas. Internationally significant numbers of migratory shorebirds can be seen foraging along the shorelines and mudflats of the coastal lowlands during the summer months and resident shorebirds can be seen all year round.

The place type has significant environmental values that have been impacted by development over many years as the Region has experienced rapid urbanisation. Projected changes in weather conditions is likely to lead to and increased occurrence of natural hazards e.g. flooding, storm tide and erosion events, and increased wave heights and wind conditions. This will further threaten environmental values. Future development pressure on the coast and major river floodplains needs to be carefully managed to minimise additional adverse impacts on the environment and exposure of our communities and development to hazard impacts. Exposed and vulnerable areas along the coast and rivers of the region are expected to bear the brunt of hazard impacts; hence the Coast and riverlands place type is intended to preclude development that would place people and infrastructure at extreme risk.

Relevant Specific Outcomes

1. *Land within this place type is exposed to coastal hazards and is not suitable for urban development.*
2. *The area will be managed to allow natural fluctuation of foreshore and associated ecosystems.*
3. *The nature, scale and intensity of coastal activities are appropriate to the low key, low intensity, recreational, education and environmental character and function of this area.*
4. *The existing pattern of development within the place type is not intensified and in some locations building and rebuilding will not be possible.*
5. *Development and coastal activities are limited to uses that are allied to and compatible with the long term protection of the areas environmental values and are not sensitive to hazard events.*
6. *An adequate level of service for road access is maintained for visitors to the area to provide safe access in areas susceptible to flooding and for use in emergencies.*
7. *Limited infrastructure services are provided, and new infrastructure likely to be severely damaged in hazard events is avoided unless otherwise warranted.*
8. *Development retains the natural hydrological characteristics of waterways, wetlands and coastal areas including groundwater, and mitigates disturbance of acid sulphate soils and the mobilisation and release of nutrients of concern from nutrient hazard areas; and*

9. *The risk of downstream or upstream shoreline, bed or bank erosion through altered hydrology, development or unnatural disturbance is not increased.*

Mountain Ranges, Forests and Waterways Place Type

The mountain ranges, forests and waterways place type consists of protected areas, private lands which are more than 80% forests; ridge lines and steep slopes, Council managed natural reserves, and flood plains associated with waterways.

Residential development will be in the form of dispersed dwellings and farm buildings with limited infrastructure services provided. Non-residential development is provided in appropriate locations but is small in scale with a particular focus on tourism activities.

The protected areas within the Mountain ranges, forests and waterways place type are the cornerstones upon which the Council's strategy for protection of the Region's green infrastructure is founded. The place type also contains the headwater of the Region's drinking water supply catchments. Protection of water quality in these upper catchment areas is critical to achieving downstream water quality. The environmental values in these areas are given preference over development that would impact on these values.

Relevant Specific Outcomes

1. The Mountain ranges, forests and waterways place types areas are managed to mitigate risks posed by bushfires and natural events to people, property and the natural environment.
2. Land extensive or intensive rural uses are managed to maintain sustainable production from the land and to avoid degrading the significant conservation or scenic values or integrity of the waterways.

Other Urban Place Types

The Strategic Framework recognises that the impacts of flooding and storm tide inundation will extend beyond these place types and within the other urban place types identified a specific strategic outcome is included that states -

"New development is designed to avoid exposure to flood and storm tide inundation events and coastal erosion."

3.4. State Interest: A local planning instrument should map or identify natural hazard areas

The Defined Flood Event (DFE) adopted by the Council is the higher of the 1% AEP flood event or the 1% AEP storm tide inundation event for the fully developed catchment including an allowance for greenhouse climate change and general sea level rise to the planning horizon year 2100.

The DFE is largely consistent with design standards adopted nationally and internationally, and accords with the level of risk that is generally considered to be acceptable for future habitable development (i.e. over a 75 year average lifespan, there is a 53% chance of experiencing a 1% AEP flood or larger).

The potential impacts of continuing catchment development and future climate change represent a significant challenge for all local government, as the risk profile of affected land will change over time. If development was approved based on the extent of acceptable risks in 2014, then by the end of the development design life (say in 50 – 100 years), the risks to this development could become intolerable or unacceptable (with lives and property potentially exposed to significant hazard). Within areas that are anticipated to be affected by projected sea level rise, this issue is a major concern for land use planning.

The Council has an obligation to consider existing and future risks due to natural hazards, especially in a planning context where decisions made today will have long-lasting implications (e.g. intensification of land use, development of major infrastructure). From a planning perspective, a timeframe of 2100 has been adopted for estimating future flood extents. This therefore includes adopting projections for rainfall intensity and increased sea level rise in accordance with the weight of current scientific information. As the State Government has removed the mandatory requirement for adopting 0.8m sea level rise by 2100, the Council is now required to establish for itself an appropriate allowance for sea level rise. In this regard, based on the weight of scientific evidence at hand (including recent IPCC projections), the Council has chosen to retain a value of 0.8m for sea level rise. This value is consistent with the value adopted by other neighbouring local governments. This sea level rise value has been incorporated into flood and storm tide modelling and mapping for future (2100) conditions and the DFE.

The Council has used a Flood hazard overlay within the new draft planning scheme to identify –

1. The extent of the Flood planning area, within which development controls such as minimum floor levels apply; and
2. Areas subject to high and medium flood risk as a result of river and creek flooding (based on current available information).

The Flood planning area is defined by the extent of flooding associated with the PMF event, while the outermost extent of the Medium risk area represents the extent of the current climate 1% AEP flood event. Whilst the PMF is an extremely unlikely event, it represents the area where the potential for flooding should be a consideration. This does not imply that specific controls are always necessary across the entire floodplain, but rather, a recognition that floods bigger than the DFE can occur, and when they do, the community will be dependent on essential services and emergency facilities to minimise loss of life. Additionally, development controls are graduated across the floodplain, reflecting the risk-based approach to regulation that is sought by the State Planning Policy. In this regard, the High and Medium risk areas identified in the overlay trigger more stringent land use policy and assessment criteria than the balance area up to the PMF which provides for largely built form and other management measures rather than significant land use control. The Balance flood planning area is defined as the area not within the High risk or Medium risk areas but still included within the Flood planning area boundary. These Balance areas represent areas of low or negligible risk. Development requirements for the Balance flood planning area are minimal, such as minimum floor levels, and are provided in the Flood hazard overlay code of the new draft planning scheme.

Outside of the Flood planning area no flood considerations are relevant. The Flood hazard overlay is used to trigger a Flood hazard overlay code, which contains relevant land use, works and building controls in order to manage potential flood risks associated with new development.

The Council has also used a Coastal hazard overlay within the new draft planning scheme to identify –

1. The extent of the Coastal planning area, within which development controls such as minimum floor levels apply;
2. Areas subject to High and Medium risk as a result of storm tide inundation (based on current available information);
3. Erosion Prone Area, as defined by current (2014) State Government mapping.

The Council's Flood Check website will also identify the Year 2100 Highest Astronomical Tide levels for the Coastal hazard overlay code.

The Coastal planning area is defined by the extent of extreme storm tide inundation including future sea level rise. Given the low-lying topography of the Coastal planning area, the overlay has been extended to the closest practical cadastral boundary. The outermost extent of the Medium risk storm tide inundation area represents the extent of the current climate 1% AEP storm tide event. The Balance coastal planning area is defined as the area not within the Erosion prone area and the High or Medium risk storm tide inundation areas but still included within the Coastal planning area. The Balance coastal planning area represents areas of low or negligible risk. Development requirements for the Balance coastal planning area are minimal, such as setting minimum floor levels, and are provided in the overlay code of the new draft planning scheme.

Outside the Coastal planning area no coastal hazard considerations are relevant. The Coastal hazard overlay is used to trigger a Coastal hazard overlay code, which contains relevant land use, works and building controls in order to management potential coastal risks associated with new development. Again, a risk-based approach to regulation has been utilised to inform the development controls in the various areas within the Coastal hazard overlay (refer to points 1-4 above).

The Council has made updated flood modelling information (including inundation extents) available on its web page since January 2013. Mapping of High and Medium flood and coastal risks has been prepared to support the Draft planning scheme.

3.5. State Interest: A local planning instrument should clearly articulate how it addresses flood hazards through the zoning

Through the new draft planning scheme, the Council has utilised five (5) mechanisms to manage the risks posed by flood and coastal hazards these include–

1. Limited Development Zone;
2. Coastal hazard overlay and code;
3. Flood hazard overlay and code, including identification of Drainage investigation areas; and
4. Overland flow path overlay and accompanying provisions included in the relevant zone codes.

The Council has used the Limited Development Zone only in locations where risks to personal safety and property are considered extremely unacceptable intolerable risks, and could not be reasonably mitigated through building works or other measures. The Limited Development Zone has a table of assessment that reflects the Strategic Framework and the Council's policy position of progressive retreat from these areas over time by not permitting any new development or minor works on existing development that would otherwise extend the life of the development.

The initial draft planning scheme included 7,196 privately owned allotments that were either partially or fully covered by the LDZ designation, of these up to 3,187 were viewed as potentially undevelopable. The new draft planning scheme includes 2,852 privately owned allotments either partially or fully covered by the LDZ designation. Of these 127 are considered undevelopable because of the current flood hazard. The 127 undevelopable allotments include 16 with existing buildings (including dwelling houses) and 11 which are vacant.

All land contained within the LDZ is located below the current 1% AEP. Under the existing three (3) planning schemes, these areas are constrained from further development because of the risk to property and the impact on the capacity and characteristics of the floodplain.

Under the new draft planning scheme, 2,722 allotments which are partially included in the LDZ are developable. These allotments have a split zoning including LDZ and another zone. These allotments all have areas of land where development can occur in accordance with the zoning.

3.6. State Interest: If a local planning instrument includes an overlay code it should address natural hazards and associated risks to people, property, economic activity, social wellbeing and the environment

As explained in section 3.5, through the new draft planning scheme, the Council has utilised five (5) mechanisms to manage the risks posed by flood and coastal hazards these include–

1. Limited Development Zone;
2. Coastal hazard overlay and code;
3. Flood hazard overlay and code, including identification of Drainage investigation areas; and
4. Overland flow path overlay and accompanying provisions included in the relevant zone codes.

The Coastal hazard overlay code, Flood hazard overlay code and Overland flow path provisions have been used to reflect the outcomes sought by the Strategic Framework. In developing the overlays and respective codes, the Council is addressing flood and coastal risks to personal safety, property and infrastructure damage, societal wellbeing, environmental sustainability and the economic viability of the region. The overlay codes aim to provide risk-appropriate development within the overlay areas that balances the resilience of the development against the expected frequency and impacts of flooding and coastal inundation.

This overarching purpose of the overlay codes will be achieved through various performance outcomes. In general, the overlay outcomes will ensure:

(a) Development is compatible with the level of risk associated with flooding and coastal processes;

(b) Development siting, layout, design and evacuation access minimises risks to personal safety in all flood and coastal events;

(c) Development and infrastructure is resilient to flooding and coastal events by ensuring that the location and design accounts for the potential risks to property associated with flood risks and coastal risks;

(d) Development and infrastructure mitigates existing and future flood and coastal risk through siting, layout, design, construction and operation whilst maintaining amenity;

(e) Development does not unduly burden disaster management response and recovery efforts after significant flooding and coastal events;

(f) Development involving essential community buildings and infrastructure remains functional during and immediately after significant flood and coastal events;

(g) Development directly, indirectly or cumulatively, does not cause an unacceptable adverse impact on flood and coastal risks at other properties or land and associated potential for damage within the Flood hazard overlay area and Coastal hazard overlay area;

(h) Development involving the manufacture, handling or storage of hazardous materials does not adversely impact on public safety and the environment as a result of any flood or coastal event;

(i) Development maintains essential landform characteristics and vegetation within the Flood hazard overlay area and Coastal hazard overlay area that provide risk mitigation to community and infrastructure;

More detailed overall outcomes are also provided relative to the differing levels of risk in the High risk area, Medium risk area and Balance planning area for each overlay, as well as any other areas within the overlay such as the Drainage investigation areas in the Flood planning area.

Development provisions within the codes have been based on the model code provided within the SPP Guideline. The codes have been tailored to reflect local circumstances and the structure/style of the initial draft planning scheme.

The development provisions have been structured to reflect both the risk approach and ease of use - for example, all provisions related to development for dwelling houses are consolidated within one section of each code without the need to review the entire code. Similarly, development in the respective Balance planning areas of each overlay have been consolidated and tailored to minimise regulatory burden in these areas of lower risk.

Development in a Drainage investigation area identified in Figure 8.3.1 of the Flood hazard overlay code is development on premises that have been identified as suitable for master planning and capital works that could manage and mitigate the applicable risk such that development can occur consistent with the applicable zone and permit. A Drainage investigation area has generally been designated only for premises included in either the General residential zone - Next generation neighbourhood precinct or the General residential zone - Urban neighbourhood precinct and subject to Medium or High flood risk (and coastal risk(s) if present). These are areas where appropriate trunk drainage and provision of overland flow paths may be sufficient to reduce the flood risks, in which case the area would be suitable for future development.

A Drainage Master Plan is to be prepared for each Drainage investigation area which will provide an overarching plan that coordinates land use, built form and infrastructure in a manner that provides clear direction on the development capability of the area, sets out infrastructure (including mitigation infrastructure) requirements and responsibilities, and addresses the risk to which the area is subject. Through the respective Drainage Master Plan, more detailed appreciation of the opportunities to support development of the area consistent with the underlying zone or local plan may be explored.

The Council is likely to advance the preparation of Drainage Master Plans over time in accordance with an on-going program of work. Where a Drainage Master Plan has not already been prepared by the Council for an area, applicants for development within that area may prepare the relevant Drainage Master Plan for the specific area in accordance with the requirements of the Flood Hazard, Coastal Hazard and Overland Flow Planning Scheme Policy for consideration by Council.

With regard to the Coastal hazard overlay code, the Year 2100 Highest Astronomical Tide level is also provided as a regulatory mechanism for filling requirements[2]. This enables landowners who have properties at risk from permanent inundation the opportunity to defend their properties by raising surface levels to that level (subject to compliance with the balance of the code provisions).

For premises in the High risk areas of the Coastal planning area or the Flood planning area (where not included in a Drainage investigation area), development for residential and non-residential uses are limited because of the intolerable nature of the risk in these locations. For example, building work for a dwelling house must can only occur where it complies with engineering design, floor level and resilient materials requirements.

Development on premises in the Medium risk areas is less restrictive because of the tolerable nature of the risk.

All development within the planning areas must comply with the relevant land use policy, site layout, earthworks and built form requirements in each of the applicable overlay codes.

Outside of the High and Medium risk areas, there are no specific land use policy restrictions in either overlay code. Built form planning controls on minimum building floor levels, reconfiguring a lot for the purpose of subdividing a lot to create additional lots and operational works will preside up to the extent of the relevant Flood planning area or Coastal planning area. The table of assessment under the relevant zone calls up specific provisions (including self-assessable provisions, where relevant) of the Flood hazard overlay code or Coastal hazard overlay code.

3.7. State Interest: If a planning scheme policy is included in a planning scheme to address flooding it should articulate how it addresses flood hazards

The Council has taken a risk-based approach to managing the impacts of flooding and storm tide inundation across the local government area. By undertaking comprehensive flood investigations across all catchments and coastal areas and following a detailed risk management process, the Council has reduced the amount of work needed to be undertaken by an individual applicant prior to the lodgement of a development application. Provided developments are in accordance with the relevant overlay codes, no further detailed investigations should be required unless developments are proposed in sensitive locations.

The Planning Scheme Policy - Flood hazard, Coastal hazard and Overland Flow (**PSP**) provides requirements for additional information to be submitted by an applicant, for example, in identified areas where local drainage works may be required to reduce the risk to property from flooding.

[2] Note: The Year 2100 Highest Astronomical Tide level is not used to define the extent of any risk area. Filling to the level is permitted in some areas to remove permanent inundation from lots in the future. The Year 2100 Highest Astronomical Tide extent is derived from State Government mapping previously made available by the EPH.

Specifically, the PSP contains requirements for the following:

- Structural Engineering Design Report;
- Site based (localised) Coastal Engineering Report;
- Site based (localised) Flood Report;
- Site based (localised) Overland Flow Report; and
- Drainage Master Plan.

The PSP also contains an Appendix which lists approved Drainage Master Plans.

4. Outcome Sought: Facilitating the location and design of community infrastructure to maintain the required level of functionality during and immediately after a natural hazard event.

4.1. State Interest: Siting of the infrastructure is compatible with the level of hazard, (see table: flood immunity levels for community infrastructure

The Storm Tide Risk Management Study (GHD, 2012) and the Floodplain Risk Management Study (Molino Stewart, 2013) considered the risk posed by flood and storm tide to critical infrastructure, including water supply infrastructure, electricity transmission lines and substations, emergency services including police, fire brigade and SES stations, sewage and waste infrastructure and health services including hospitals and health centres. As outlined previously, the storm tide risks identified by GHD, 2012, require review and updating using the most recent storm tide modelling results prepared by the Council through their updated flood modelling suite.

Floodplain Risk Management Response

Forty nine existing critical infrastructure facilities that have some flood risk have been identified. There are no unacceptable risks, and the tolerable risks are primarily in the emergency services category. Also notable is that the Caboolture Water Depot, Beachmere Reservoir and Caboolture Private Hospital have an acceptable level of risk. Other infrastructure facilities, including some waste and wastewater treatment facilities do not appear to be flood affected.

The network critical infrastructure that has a flood risk (the electricity grid in this case) is identified separately. There were some segments that had an unacceptable level of risk. As the assessment was based on flood depth, this may be over-estimating the risk because the lines are suspended above the watercourse and floodplain generally. Notwithstanding, this preliminary analysis highlights these areas as potential locations for more detailed investigation.

The Floodplain Risk Management Study (Molino Stewart) sets out the relevant risk matrix.

Storm Tide Risk Management Response

Following a review and update of the Storm Tide Management Study using the most recent dynamic storm tide modelling results, the previously recommended suite of management actions will also require review. It is anticipated that this will be carried out in the near future by the Council, with proposed responses to address storm tide risk to be incorporated into the Council's future works program as appropriate.

New Draft planning scheme

Individual service providers usually have in place their own risk management planning process that manages exposure to natural hazards such that risk is kept to acceptable levels. As well as minimum floor levels, this would ordinarily consider other elements of risk management, such as flood-proofing (to minimise damage and maintain functionality) and emergency evacuation.

In accordance with the State Planning Policy *Technical Manual: Guidance for considering natural hazards, risk and resilience when designing land for community infrastructure*, the new draft planning scheme also gives consideration to potential future risks to community infrastructure development by nominating the minimum level of flood and storm tide inundation immunity such that future risks associated with the development remain acceptable. For community infrastructure that has more severe consequences if impacted, the minimum level of immunity is higher.

The flood planning level for all non-habitable non-residential development, which includes community infrastructure, is the DFE plus a specified freeboard. The DFE includes 1% AEP conditions at the year 2100. For riverine and creek areas, the DFE is approximately equivalent to the present day (2014) 0.1% AEP (1 in 1,000 year chance event), while in coastal areas the DFE is approximately equivalent to the present day (2014) 0.01% AEP (1 in 10,000 year chance event). These specifications are more stringent than the SPP Guideline, which does not require consideration of future conditions.

4.2. State Interest: Where flood areas cannot be avoided, the risks associated with flooding must be mitigated to acceptable or tolerable levels

People and social wellbeing

The Council has developed and implemented a Local Disaster Management Plan with the assistance of emergency services, health agencies, utility providers, transport agencies and many others form the Moreton Bay Region Local Disaster Management Group. The Local Disaster Management Plan is available publicly on Council's webpage. The Local Disaster Management Plan is supported by specific capital works and disaster management actions that will be identified through Council's Catchment Management Program, which is directly responding to the outputs of the Floodplain and Storm Tide Risk Management Studies. The Risk Management Studies have provided specific recommendations on reviews and amendments to the Local Disaster Management Plan in order to improve mitigation of flood and coastal risks to the community.

The new draft planning scheme overlay codes outline performance outcomes that must be achieved by future development to ensure the safety of people and the maintenance of critical community services and functions during and after significant events. This requires appropriate siting and design considerations for all development proposed within the Flood planning area and Coastal planning area.

Property and economic

Mitigation of risks to property has been investigated by in the Risk Management Studies. This included risks and potential economic losses associated to individual private assets as well as existing infrastructure, especially road access for the purposes of evacuation.

Critical evacuation routes were defined as routes linking major roads to evacuation centres and selected critical infrastructure (i.e. emergency services stations, major electricity sub-stations, WTP, STP, health centres). The risk to road access was calculated on a road segment basis using the Draft Road Hierarchy and the risk categories identified through the Study. The risks were calculated both with and without the draft evacuation routes provided by MBRC. Without the critical evacuation routes, the most notable risks are to the D'Aguilar and Bruce Highways as these are important roads which can be cut by relatively frequent floods. When the critical evacuation routes are included, the risk increases on several roads, particularly the Beachmere evacuation route.

The Risk Management Studies investigated the cost implications for critical infrastructure in the case of particular events. The cost curves generated are being utilised to inform the Coastal Adaptation Plan and Catchment Management Plans currently being prepared. The extent of future works may increase the tolerability to risk and consequentially the land use planning outcomes in future planning schemes.

Future critical infrastructure is identified and discussed in section 4.1, with appropriate consideration of immunity levels prescribed within the new draft planning scheme. Further to this, infrastructure development should also be designed to maximise resilience and maintain functionality beyond the immunity levels, as far as practical and economically feasible.

Environmental

The Council has considered flood impacts on the environment, particularly those which could pose a direct or indirect impact. The new draft planning scheme responds to these issues in a number of ways:

- Only very limited development and filling is permitted within the river and creek 1% AEP floodplain in order to preserve the flood conveyance capacity of this corridor;
- Council is managing revegetation and rehabilitation works within the river and creek 1% AEP floodplain in order to slow the velocity of flood waters, reduce channel erosion and reduce the risk to established properties and the natural environment within the floodplain;
- In established coastal communities where storm tide risks are dominant and the floodplain extensive (thus filling would have no impact on flood or inundation behaviour), filling is permitted in order to increase the resilience of existing urban areas to future flooding;
- Hazardous industry and materials are managed to reduce the likelihood of their accidental release as a result of flood events;
- New urban areas are located out of the future 1% AEP floodplain.

4.3. State Interest: A business continuity plan includes the level of immunity achieved by siting and design and how the required level of service will be achieved during and immediately after a more severe flood event

In addition to the work undertaken as part of the Floodplain Risk Management Framework, the Council has developed and implemented a Local Disaster Management Plan with the assistance of emergency services, health agencies, utility providers, transport agencies and many others from the Moreton Bay Region Local Disaster Management Group. The Local Disaster Management Plan is available publicly on Council's webpage. The Council is currently undertaking a business continuity plan for all operations, which will be completed by the end of 2015.

The Council has committed to two major programs aimed at further improving the organisations response to the risk posed by flood and storm tide inundation:

1. Coastal Management Strategy and Adaptation Plan; and
2. Catchment Management Plans for all 14 catchments across the region.

Coastal Management Strategy and Adaption Plan (CMSAP)

In the 2015/16 financial year the Council has committed funding to commence a Coastal Management Strategy and Adaptation Plan for the region. The CMSAP will provide a single point of reference for the Council's response to State policies such as the Coastal Management Plan and the State Planning Policy (including the associated guidelines). The CMSAP is to identify areas at risk from coastal hazards (coastal erosion, storm tide inundation, permanent inundation) and adaptation strategies to mitigate coastal risk for communities over the long term, rather than a development-by-development basis.

Generally, the CMSAP is to:

- Develop a vision, fundamental principles and strategic outcomes for Council's Coastal Management Strategy in a similar structure to Council's existing infrastructure strategies and include workshops with key stakeholder organisations and Councillors.
- Identify potential management options to be explored in future stages including the consideration of possible costs, impacts, failure risks, trade-offs and benefits through a risk management process.
- Socio-economic assessment to determine the most cost-effective adaptation measures, taking into consideration long term social, financial and environmental factors.

- Identification of preferred management options, including optimal timing for investment, trigger points indicating when activity or work is to begin and review process for decision making taking into account risks and uncertainties.
- Include consultation/engagement with key stakeholder organisations, community, elected members and Council staff.

Catchment Management Plans

In 2014, the Council commenced its Catchment Management Planning Program, involving each of the 14 catchments within the Moreton Bay Regional Council area. The Catchment Management Plans will integrate infrastructure, land use and emergency management planning to deliver a consolidated plan that manages water quality, flood and storm tide mitigation responses within each catchment.

References

1. Moreton Bay Regional Council, 2011; Moreton Bay Regional Council Strategic Framework, December 2011
2. Moreton Bay Regional Council, 2011; MBRC Floodplain Risk Management Framework, GHD & Molino Stewart, February 2011
3. Moreton Bay Regional Council, 2013; MBRC Floodplain Risk Management Study, Molino Stewart, June 2013.
4. Moreton Bay Regional Council, 2013; MBRC Interim Floodplain Management Plan (draft), Molino Stewart, June 2013
5. GHD (2011); MBRC Storm Tide Management Study: Stage 1 – Scoping Report, 18 February 2011.
6. Moreton Bay Regional Council, 2012; MBRC Storm Tide Management Study, GHD, April 2012
7. Molino, S., & Roso, S. (2012), A Framework for Holistic Risk Based Floodplain Planning, Moreton Bay Regional Council
8. Queensland Reconstruction Authority, 2012; Planning for stronger, more resilient floodplains, Queensland Government, September 2012
9. BMT WBM (2010); Hydraulic Modelling (Detail) Regional Floodplain Database – Sub-Project 2B Report, December 2010
10. Standing Committee Agriculture and Resource Management (SCARM); Floodplain Management in Australia, Best Practice Principles and Guidelines, Report No. 73
11. Department of State Development, Infrastructure and Planning, 2014; State Planning Policy – Natural Hazards, Risk and Resilience – Technical Manual, DSDIP, August 2014
12. Department of State Development, Infrastructure and Planning, 2012; Queensland Development Code – Construction of Buildings in Flood Hazard Areas, October 2012
13. Department of State Development, Infrastructure and Planning, 2013: Queensland Planning Provisions Version 3.0, October 2013
14. Queensland Government (2009); Guideline State Coastal Management Plan: Mitigating the Adverse Impacts of Storm Tide Inundation. EPA Qld PWS
15. DERM (2011); Queensland Coastal Plan. State of Queensland, March 2011
16. DERM (2011); Queensland Coastal Hazards Guideline. State of Queensland, March 2011
17. DLGP, DES (2003); State Planning Policy 1/03 Guideline: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide

Appendix A: Maximum Possible Flood and Storm Tide Inundation

Map 1: Extent of Probable Maximum River and Creek Flood

Map 2: Extent of Probable Maximum Storm Tide

Map 1 - Map of the region showing the extent of River and Creek PMF

Natural Hazards Evaluation Report: Flood

June 2015

Moreton Bay Regional Council

N

0 4 8 Kilometers

SCALE (A4) 1:300,000

River and Creek PMF

Projection: Map Grid of Australia, Zone 56

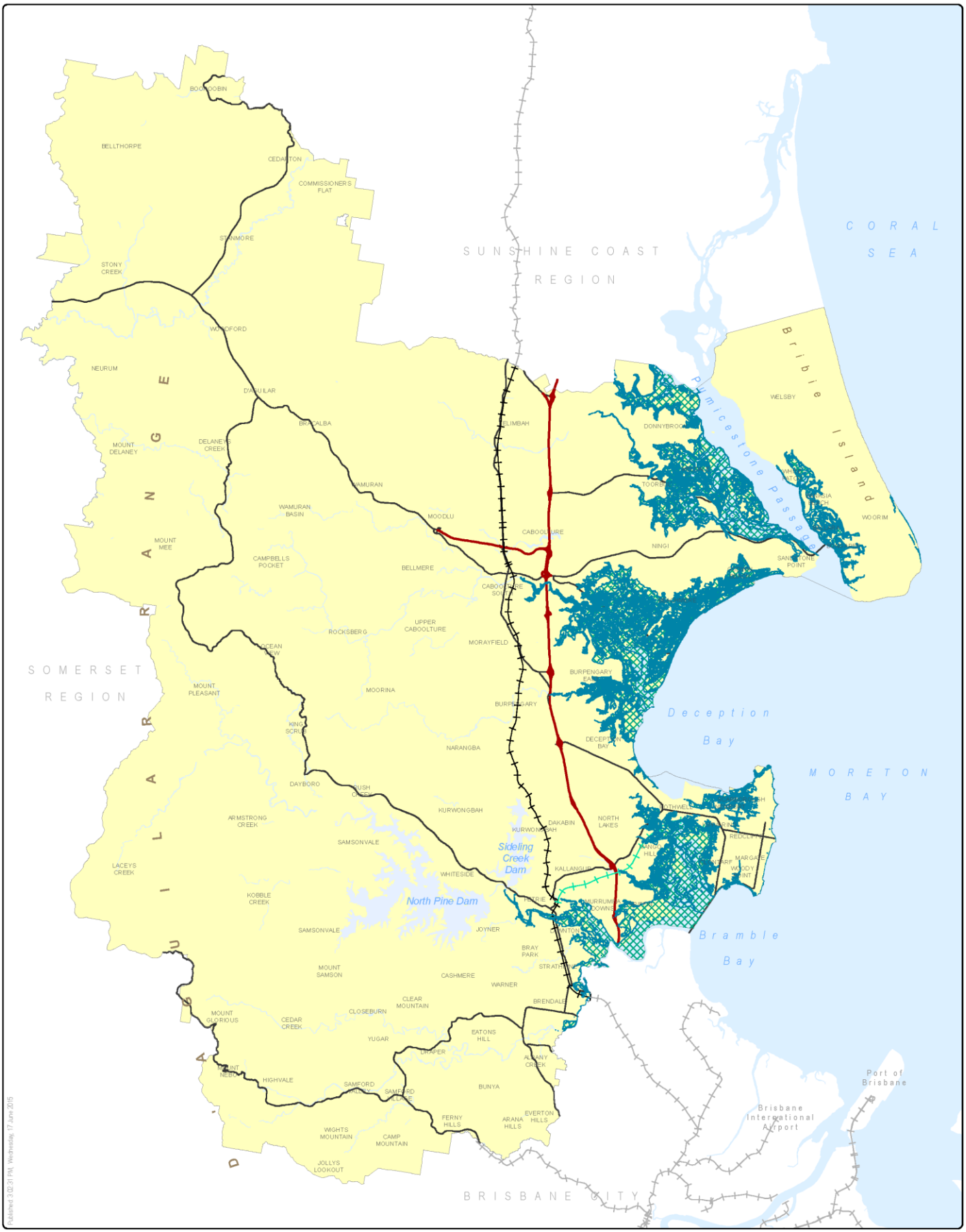
Horizontal Datum: Geocentric Datum of Australia 1994

Map 2 - Map of the region showing the extent of Storm Tide PMF

Natural Hazards Evaluation Report: Flood

June 2015

Moreton Bay Regional Council



N

0 4 8 Kilometers

SCALE (A4) 1:300,000

Projection: Map Grid of Australia, Zone 56

Horizontal Datum: Geocentric Datum of Australia 1994

Storm Tide PMF

Published: 3:02:31 PM, Wednesday, 17 June 2015

File: 1409-10-CA-Map2_ExtentofStormTidePMF.mxd

Appendix B: Conflict between Development and Natural Hazard Areas

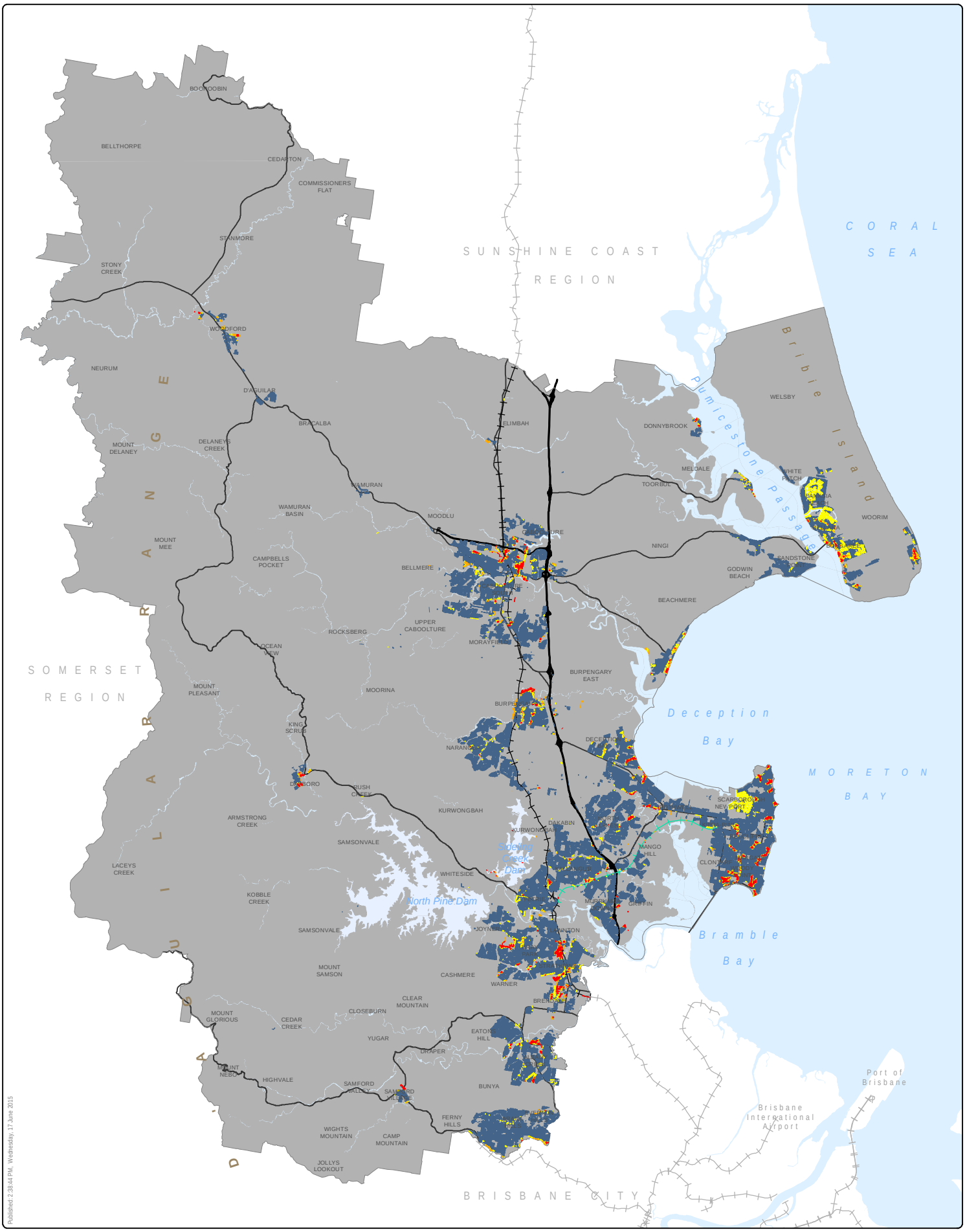
Map 3: Thematical map showing urban properties inundated by 1% AEP

Map 4: Existing and Proposed development that occur within the flood extent

Map 3 - Thematical map showing urban % of properties inundated in 1% AEP

Natural Hazards Evaluation Report: Flood

June 2015



Published 2:38:44 PM, Wednesday, 17 June 2015

N

0 4 8 Kilometers

SCALE (A4) 1:300,000

Projection: Map Grid of Australia, Zone 56
Horizontal Datum: Geocentric Datum of Australia 1994

Property not in 1% AEP

Less than 25% of property in 1% AEP

25% - 75% of property in 1% AEP

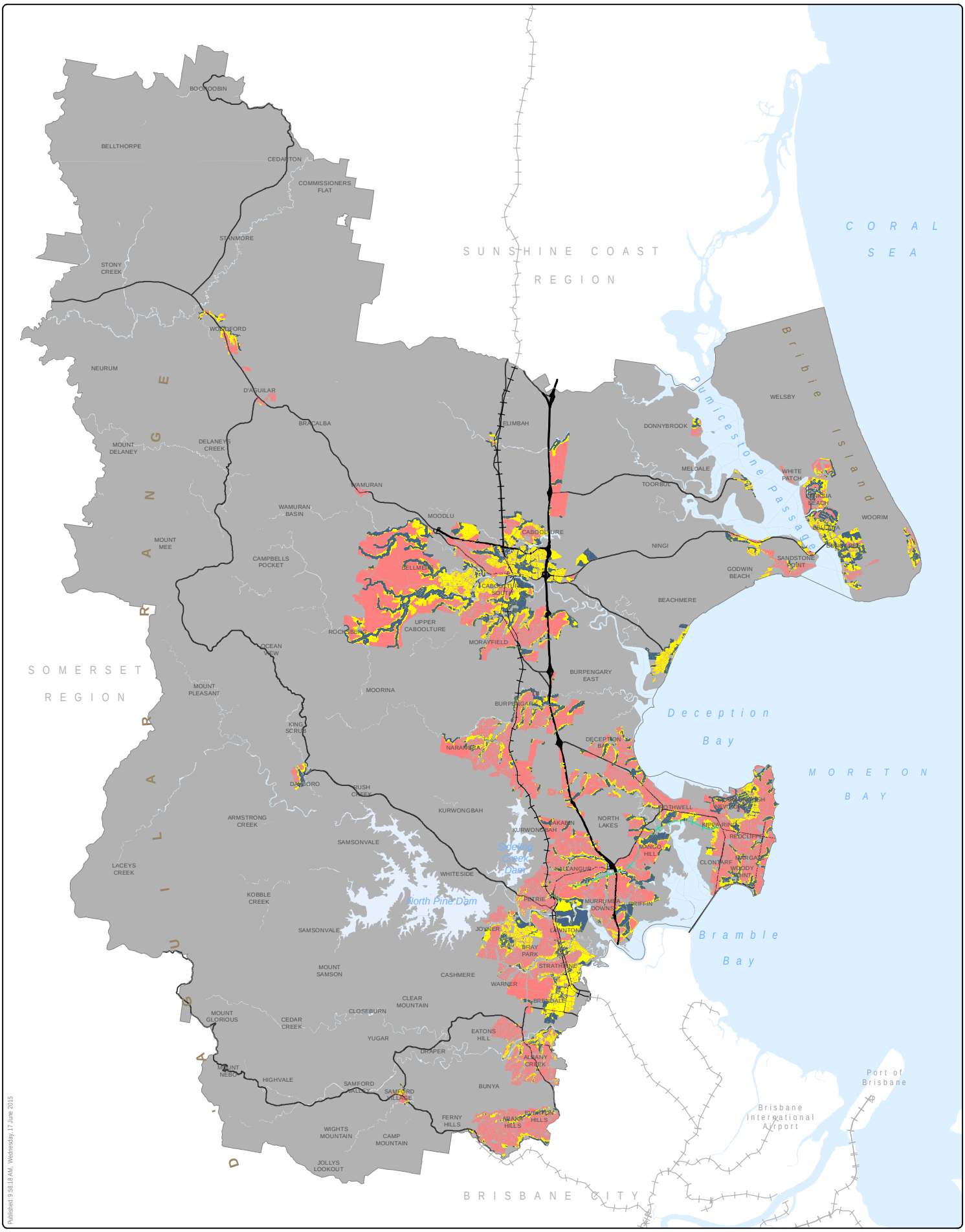
> 75% of property in 1% AEP

FIG-1409-10-CA-Map3_UrbanPropertiesAffectedBy1pcAEP.mxd

Map 4 - Existing and proposed development that occur within the flood extent

Natural Hazards Evaluation Report: Flood

June 2015



Published 9:58:18 AM, Wednesday, 17 June 2015

N

0 4 8 Kilometers

SCALE (A4) 1:300,000

Projection: Map Grid of Australia, Zone 56
Horizontal Datum: Geocentric Datum of Australia 1994

Existing and Future Development Areas

PMF Floodplain (In Development Areas)

Frequent Floodplain (1%AEP) (In Development Areas)

File: 1409-10-CA-Map4_UrbanPropertiesInPMF_NotIn1pcAEP.mxd

Appendix C: Draft Planning Scheme Policy Positions Summary Table – Flood Hazard and Coastal Hazard

Coastal hazard overlay

Risk category (SPP July 2014)	Overlay Area (Coastal planning area) (Greater of the extent of Storm Tide 0.01% 2014 or 1% AEP 2100 or the Erosion Prone Area)		Zone	Operational work or Building work	Material change of use (MCU)	Reconfiguring a lot (ROL)
Intolerable risk (I)	High risk area (comprising Extremely unacceptable risk area (I-EU) and Unacceptable risk area (I-E)	High risk stormtide inundation area (*2014 SPP State Interest Requirement - mandatory*)	Limited Development Zone for Extremely unacceptable risk area (I-EU)	Filling/excavation (Impact) not permitted Building work not associated with MCU where limited to not less than 50m^2 in area for permitted uses (Impact)	Lawful use continues MCU (Impact) – exception for: • Outdoor sport and recreation (Code) • Park (No change) • Permanent plantation (Code) • Cropping (forestry for wood production) (Code)	ROL (Impact) to create lots only for Park and Permanent plantation

			Existing zone for Unacceptable risk area (I-U)	Filling/Excavation (Impact) except in General Residential Zone, Centre Zone, Community Facilities Zone, Recreation and Open Space Zone or Industry Zone (Code) where:
				• Permitted to raise land to Highest Astronomical Tide 2100 level
				• No drainage risks to surrounding properties
				
				Building work not associated with a MCU (Code) where:
				• Finished floor level –
				  • Development (new) – Defined flood event (1% AEP 2100) + defined freeboard
				  • Minor building work (extensions) – Existing finished floor level
				• Building design –
				  • Development (new) – Structural engineering design and coastal engineering reports required
				  • Minor building work (extensions) – structural engineering design report and resilient materials under Water Resilient Products and Building Techniques For Rebuilding After a Flood (Dept. Housing and Public Works)
					Lawful use continues
					
					MCU (Impact) – exception for:
					• Dwelling house (Code)
					• Outdoor sport and recreation (Code)
					• Park (No change)
					• Permanent plantation (Code)
					• Cropping (forestry for wood production) (Code)
					• Tourist park (Code)
					• Home based business (Code)
						ROL (Impact) to create lots only for Park or Permanent plantation

Risk category (SPP July 2014)	Overlay Area (Coastal planning area) (Greater of the extent of Storm Tide 0.01% 2014 or 1% AEP 2100 or the Erosion Prone Area)		Zone	Operational work or Building work	Material change of use (MCU)	Reconfiguring a lot (ROL)

		Erosion Prone Area (2014 SPP State Mapping excluding sea level rise)
		
		(*2014 SPP State Interest Requirement - mandatory*)
			Existing zone	Filing/excavation (Impact) not permitted
				
				Building work not associated with MCU (Impact) where:
				• Minor building work (extension):
				  • Finished floor level – existing finished floor level
				  • Structural engineering design and resilient materials under Water Resilient Products and Building Techniques For Rebuilding After a Flood (Dept. Housing and Public Works)
				• Existing development – Redevelopment if coastal risks addressed:
				  • Structural engineering design and coastal engineering reports required
				  • No drainage risks to surrounding properties
				  • Finished floor level - defined flood event (1% AEP 2100) + defined freeboard
				  • Resilient materials under Water Resilient Products and Building Techniques For Rebuilding After a Flood (Dept. Housing and Public Works)
					Lawful use continues
					
					MCU (Impact)
						ROL (Impact) to create lots only for Park or Permanent plantation

Tolerable risk (T)	Medium risk area
	(T-M)
		Medium risk stormtide inundation area
		
		(*2014 SPP State Interest Requirement - mandatory*)
			Existing zone	Filling/excavation (Impact) except in General Residential Zone, Centre Zone, Community Facilities Zone, Recreation and Open Space Zone or Industry Zone (Code) where:
				• Permitted as a minimum to the Year 2100 HAT level and as a maximum to the level of the defined flood event (1% AEP 2100)
				• No drainage risks to surrounding properties
				
				Building work not associated with MCU (Code) where:
				• Finished floor level –
				  • Development (new) – Defined flood event (1% AEP 2100) + defined freeboard
				  • Minor building work (extensions) – Existing finished floor level
				• Building design –
				  • Development (new) – Structural engineering design report
				  • Minor building work (extensions) – Structural engineering design report and resilient materials under Water Resilient Products and Building Techniques for Rebuilding After a Flood (Dept Housing and Public Works)
					Lawful use continues
					
					MCU as per existing zone (No change) except for :
					• Dwelling house (Code)
					• Residential accommodation building where not involving a dwelling house and not involving a vulnerable use (Code)
					• Vulnerable uses (Impact).
						ROL (Code) to create lots only for a lot on a building format plan and for Park or Permanent plantation

	Balance coastal planning area (T-L and T-VL)	Balance area within the extent of the Coastal planning area comprising land outside the High risk area and Medium risk area and below the greater of Storm Tide 0.01% or 1% AEP 2100 (*2014 SPP State Interest Requirement – discretionary but required to identify coastal hazard requirements and respond to risks associated with climate change. To be mapped as an area without colour*)	Existing zone	Filling/excavation (Impact) except in General Residential Zone, Centre Zone, Community Facilities Zone, Recreation and Open Space Zone or Industry Zone (Code) where: • Permitted as a minimum to the Year 2100 HAT level and as a maximum to the level of the defined flood event (1% AEP 2100) • No drainage risks to surrounding properties Building work not associated with a MCU (Self) but subject to finished floor level: • Development (new) – Defined flood event (1% AEP 2100) + defined freeboard • Minor building work (extensions) – Existing finished floor level and resilient materials under Water Resilient Products and Building Techniques for Rebuilding After a Flood (Dept Housing and Public Works)	MCU as per existing zone (No change)	ROL to create lots as per existing zone (No change)
Acceptable risk (A)	No risk area	Land outside of the Coastal planning area	Existing zone	No coastal hazard assessment requirements	MCU as per existing zone (No change)	ROL as per existing zone (No change)

Flood hazard overlay

Risk category (SPP July 2014)	Overlay Area (Flood planning area) (Greater of the extent of PMF 2014 OR 1% AEP 2100)		Zone	Operational work or Building work	Material change of use (MCU)	Reconfiguring a lot (ROL)
Intolerable risk (I)	High risk area (comprising Extremely unacceptable risk area (I-EU) and Unacceptable risk area (I-E)	High risk flood hazard area (*2014 SPP State Interest Requirement - mandatory*)	Limited Development Zone for Extremely unacceptable risk area (I-EU)	Filling/excavation (Impact) not permitted Building work not associated with a MCU (Impact)	Lawful use continues MCU (Impact) - exception for: • Outdoor sport and recreation (Code) • Park (No change) • Permanent plantation (Code) • Cropping (forestry for wood production) (Code)	ROL (Impact)to create lots only for Park and Permanent plantation

			Existing zone for Unacceptable risk area
			(I-U)
				Filling/excavation (Code) not permitted
				
				Building work not associated with a MCU (Code) where:
				• Finished floor level:
				  • Development (new) – Defined flood event (1% AEP 2100) + defined freeboard
				  • Minor building work (extensions) – Existing finished floor level
				• Building design:
				  • Development (new) – Structural engineering design report
				  • Minor building work (extensions) – Structural (engineering design report and resilient materials under Water Resilient Products and Building Techniques for Rebuilding After a Flood (Dept Housing and Public Works)
				  • Must not impede flows or cause worsening on neighbouring properties
					Lawful use continues
					
					MCU (Impact) – exception for:
					• Dwelling house (Code)
					• Outdoor sport and recreation (Code)
					• Park (No change)
					• Permanent plantation (Code)
					• Cropping (forestry for wood production) (Code)
					• Tourist park (Code)
					• Home based business (Code)
						ROL (Impact) for creating lots only for Park and Permanent plantation

Tolerable risk (T)	Medium risk area
	(T-M)
		Medium risk flood hazard area
		
		(*2014 SPP State Interest Requirement - mandatory*)
			Existing zone	Filling/excavation (Impact) not permitted except in the Coastal planning area (Code) where:
				• To raise land to the level of the defined flood event (1% AEP 2100)
				• No drainage risks to surrounding properties
				
				Building work not associated with a MCU (Code) where:
				• Finished floor level:
				  • Development (new) – Defined flood event (1% AEP 2100) + defined freeboard
				  • Minor building work (extensions) – Existing finished floor level
				• Building design:
				  • Development (new) – Structural engineering design report
				  • Minor building work (extensions) – Structural engineering design report and resilient materials under Water Resilient Products and Building Techniques for Rebuilding After a Flood (Dept Housing and Public Works)
				  • Must not impede flows or cause worsening on neighbouring properties
					Lawful use continuesMCU as per existing zone (No change) except for:
					• Dwelling house (Code)
					• Residential accommodation building where not involving a dwelling house (Impact)
					• Vulnerable use (Impact)
						ROL (Impact) except for creating lots only for a community title lot (Code)

Risk category (SPP July 2014)	Overlay Area (Flood planning area) (Greater of the extent of PMF 2014 OR 1% AEP 2100)		Zone	Operational work or Building work	Material change of use (MCU)	Reconfiguring a lot (ROL)
	Medium risk area (T-M)	Drainage master plan area (*removed from Medium risk flood hazard area on the basis that it is subject to a Drainage master plan which is intended to mitigate the flood hazard)*	Existing zone	Filling/excavation (Impact) permitted where to level required by Drainage master plan or as a minimum to the Year 2100 HAT level and as a maximum to the level of the defined flood event (1% AEP 2100) Building work not associated with a MCU (Code) Development is not required to comply with the overall outcomes for the relevant High risk area, Medium risk area or Balance flood planning area where a Drainage master plan demonstrates that the development: • Addresses coastal hazards • Addresses infrastructure limitations • Does not result in adverse local drainage, flood and coastal impacts	MCU (Impact) - exception for Dwelling house (self)	ROL (Impact) to create lots
	Balance flood planning area (T-L and T-VL)	Balance area of the Flood planning area comprising land outside the High risk flood hazard area and Medium risk flood hazard area and below the greater of PMF 2014 or 1% AEP 2100 (*2014 SPP State Interest Requirement – discretionary but required to identify flood hazard requirements and respond to risks associated with climate change. To be mapped as an area without colour*)	Existing zone	Filling/excavation (Code) permitted where: To raise land to the defined flood event (1% AEP 2100) subject to the land currently being above 1% AEP 2014 • No drainage risks to surrounding properties Building work not associated with a MCU (Self) where finished floor level: • Development (new) – Defined flood event (1% AEP 2100) + defined freeboard • Minor building work (extensions) – Existing finished floor level • Must not impede flows or cause worsening on neighbouring properties	Lawful use continues MCU as per existing zone (No change)	ROL to create lots as per existing zone (No change)
Acceptable risk (A)	No risk area	Land outside of the Flood planning area	Existing zone	No flood hazard assessment requirements	Lawful use continues MCU as per existing zone (No change)	ROL as per existing zone (No change)

Appendix D: MBRC Floodplain Risk Management Framework

Moreton Bay Regional Council

Floodplain Risk Management Framework

October 2014

Document Control:

Revision	Date	Document Purpose	Author(s)
0	October 2014	Initial external release to support planning scheme	Moreton Bay Regional Council

Table of Contents

1. Introduction 1
1.1. Background 1
1.2. Vision 1
1.3. How to Use this Framework 2
1.4. Previous Studies and Planning Decisions 2
1.5. January 2011 Flood Event 2
2. Floodplain Risk Management Concepts 3
2.1. Factors for Effective Floodplain Risk Management 3
2.2. Best Practice Principles - Floodplain Risk Management 3
3. Legislative Imperative 6
3.1. Sustainable Planning Act 2009 6
3.2. State Planning Policy July 2014 7
3.3. Disaster Management Act 2003 (as amended to 2010) 8
3.4. Coastal Protection and Management Act 9
3.5. Queensland Reconstruction Authority Act 9
3.6. Queensland Floods Commission of Inquiry 10
3.7. The Floodplain Risk Management Plan 10
4. Floodplain Risk Management Framework 12
4.1. Framework Objectives 12
4.2. Floodplain Risk Management Committee 14
4.3. Attainment Levels 14
4.4. Step 1 - Identify the Flood Risk 14
4.5. Step 2 - Analyse the Flood Risk 15
4.6. Step 3 - Prepare a Floodplain Risk Management Plan 17
4.7. Step 4 - Implement the Floodplain Risk Management Plan 18
5. Roles & Responsibilities 19
5.1. Commonwealth Government 19
5.2. State Government 19
5.3. Local Government 21
5.4. Developers 22
5.5. The Flood Prone Community 23
6. Glossary 24

Table Index

Table 4.1 Typical Floodplain Risk Management Measures.....17
Table 6.1 Glossary of Terms 24

Figure Index

Figure 3.1 Legislation and Floodplain Risk Management Process.....11
Figure 4.1 MBRC Floodplain Risk Management Framework 13

1. Introduction

1.1. Background

Flooding is perhaps the most manageable of all natural hazards. There is typically more uncertainty about the onset of other events such as tropical cyclones, drought, earthquakes and bushfires.

It is relatively straightforward to determine how and why a flood occurs, and where it will happen. Flooding can be planned for, its effects can be mitigated and regulations can be put in place to address the residual problem remaining after mitigation. The parameters we do not know are mainly when, and how large, the flood will be.

There is a growing expectation within the community that State and Local Governments will be capable of managing natural hazards in an efficient and effective manner, which minimizes loss of life and property and ideally the avoidance of a potential disaster.

Significant areas of the Moreton Bay Regional Council MBRC area are subject to flooding including river and creek flooding, storm tide and overland flow.

It is within the above context that Council has determined to develop a strategic framework within which its floodplain risk management measures will be conceptualised, assessed and implemented.

This Floodplain Risk Management Framework is not currently a formal requirement of any State legislation; however this does not prevent Council from being pro-active in the implementation of relevant investigation and planning activities to inform formal flood planning and disaster management processes.

1.2. Vision

The vision for Council's Framework is that:

"Floodplains in MBRC will be managed for the long-term benefit of the community such that hazards to people and damages to property and infrastructure are minimised and the intrinsic environmental values of the floodplain are protected"

This vision is developed from the vision contained in the Government's State Planning Policy 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide, published in 2003 as follows:

"The Queensland Government considers that development should minimise the potential adverse impacts of flood, bushfire and landslide on people, property, economic activity and the environment."

Council's vision should be followed using a value-based approach to the management of flood risk that balances social, economic, environmental and flood risk parameters to determine whether particular development or use of the floodplain is appropriate and sustainable. With this approach, the FRMF avoids the unnecessary alienation of flood prone land. It also ensures that flood prone land is not the subject of uncontrolled development, inconsistent with its exposure to flooding.

The Framework has been prepared in accordance with best practice to meet the following broad principles:

- All levels of government and the local community know and accept their responsibilities for managing flood risk and all relevant agencies provide aid to the

community in recovering from the devastating impacts of flooding

- Flood risk and flood behaviour is understood and considered in a strategic manner in the development decision-making process
- Land use planning and development controls minimise both the exposure of people to flood hazard and the potential damages to property and infrastructure
- A broad range of floodplain management measures are assessed across a broad range of floods up to the Probable Maximum Flood, and floodplain management measures appropriate to the location and acceptable to the local community economically, socially and environmentally are used to manage flood risk
- All relevant agencies work in partnership to provide flood forecasting and warning systems and emergency response arrangements that cope with the impacts of flooding on the community in light of the available flood intelligence

1.3. How to Use this Framework

The Floodplain Risk Management Framework provides a guide to the development and implementation of Floodplain Risk Management Plans, developed to establish sound, long-term floodplain management outcomes that satisfy the social and economic needs of the community as well as being attuned with the natural ecosystems within the floodplain.

The Framework document describes:

- Basic floodplain risk management concepts (**Section 2**)
- The legislative imperative for floodplain risk management (**Section 3**)
- The Floodplain Risk Management Framework itself (**Section 4**)
- The roles and responsibilities of relevant stakeholders in implementing the Framework (**Section 5**)

The Framework is to be read and interpreted in a global sense with reference to the overall Framework objectives described in **Section 4.1.1**. This document is targeted at a strategic management level.

1.4. Previous Studies and Planning Decisions

The Framework introduced in this document aims to provide a consistency of approach across a significant local government area in South-east Queensland, leading to the achievement of the Vision outlined in **Section 1.2** above. The establishment of this Framework does not negate the results of any previous flood studies and planning decisions undertaken by either MBRC or its predecessors. These studies and decisions are important tools in floodplain management within MBRC and will remain so until there is a need to revisit or upgrade the results and outcomes.

1.5. January 2011 Flood Event

While introducing this Framework it is important to reflect on one of the most significant flood events that has struck our region in the recent past. On Tuesday 11 January 2011, a heavy rain event resulted in approximately 400mm of rain falling over a 10 hour period. The heaviest rainfall occurred in a wide band stretching along the hinterland between Elimbah and Samford and west as far as Woodford. The resultant flooding caused considerable damage to both public and private infrastructure across numerous floodplain areas

downstream.

This event and similar experiences across Queensland focussed attention on the impacts of flooding and the way in which these can be managed. The Queensland Floods Commission of Inquiry and Queensland Reconstruction Authority were both established by the State Government as a result.

For Moreton Bay Regional Council, the impacts of this event have re-affirmed the importance of a pro-active and strategic response to the management of our floodplains. The successful implementation of this Framework will mean that our region and our community can improve its resilience and reduce impacts when further flooding is experienced in the future.

2. Floodplain Risk Management Concepts

It should be noted in all the discussion that follows, “floodplain” is defined as land that is subject to inundation by floods, regardless of source, up to and including the Probable Maximum Flood (PMF) event. This is synonymous with the term “flood prone land”.

2.1. Factors for Effective Floodplain Risk Management

Drawing on “Floodplain Risk Management in Australia: Best Practice Principles and Guidelines” (SCARM Report 73, 2000), the factors that contribute to effective floodplain management are:

- An authority with the primary responsibility for floodplain management policy and practice
- Appropriate and effective legislative powers for the responsible authority, with powers applied on a catchment-wide basis
- Appropriate mechanisms for coordination of land use planning and floodplain management on a catchment-wide basis
- A community awareness of the flooding problem and the planning/management process, and a willingness to become involved
- Completion of flood studies and floodplain management studies overseen by a steering committee representing all interested or affected parties
- Provision of adequate resources to undertake studies and implement measures
- Access to technical advice, standards and guidelines for the authority responsible for floodplain management
- Legal provisions ensuring that the responsible authority exercises its powers responsibly, such as legal liability for the consequences of decisions
- Provision for intercession by a central authority when necessary

While some of these factors raise State- or Nation-wide issues in their application, many relate directly to the application of sound floodplain management by a Council or local government authority.

2.2. Best Practice Principles - Floodplain Risk Management

There are a number of best practice principles that should be pursued in effective floodplain

management as follows:

2.2.1. A Pro-Active Response

The fundamental best practice principle of floodplain management is the adoption of a pro-active response to the flood problem, a response that first recognises the various flooding problems and then moves to address these issues and problems before they develop to or are experienced at extreme levels.

It is this principle that is the driving force behind the development of the MBRC Floodplain Risk Management Framework.

2.2.2. Community Expectations

Floodplain management must strive to ensure that the community is:

- Able to live and work on floodplains without risk to life and safety or unacceptable risk of damage to goods, possessions and infrastructure because of flooding;
- Secure in the knowledge that effective arrangements are in place to alleviate the economic and social costs of flooding and foster recovery of the flooded area and its residents/occupants; and
- Actively involved in the floodplain management process, both in the development of a Floodplain Risk Management Plan and in meeting their obligations under that plan.

2.2.3. Policy and Implementation

Effective policy and legislation are vital in providing a reliable social and legal foundation for floodplain management and thus it is essential that there is an integrated policy framework within all agencies that supports the management of floodplains and addresses the reduction of flood risk to life and property.

2.2.4. Recognize the three distinct types of Flood Problem

Current floodplain management practice recognises three distinct types of flood problems, described below:

- The ‘existing’ problem refers to existing buildings and developments on flood prone land. Such buildings and developments, by virtue of their presence and location, are exposed to an “existing” risk of flooding.
- The ‘future’ problem refers to buildings and developments that may be built on flood prone land in the future. Such buildings and developments may be exposed to a “future” flood risk, i.e. a risk that does not materialise until developments occur or that may result from climate change.
- The ‘residual’ problem refers to the risk associated with floods generally and with those floods that exceed management measures already in place. That is, unless a floodplain management measure is designed to withstand the PMF, it will be exceeded by a sufficiently large flood at some time in the future. It is not a matter of if, but of when. Unless the Defined Flood Event (DFE) used for planning controls is based on the PMF, a larger flood than that used to determine the DFE can always occur. It is not a matter of if but when. The difference in flood levels, damages, and the area of inundation and the number of dwellings to be evacuated in the PMF event relative to the event upon which the DFE is based, serves to alert a council to the upper limit of the costs and consequences of

flooding.

2.2.5. Risk Appreciation

Best practice principles to foster the community's appreciation of flood risk, exposure to flood hazard and appropriate responses include:

- Documentation of flood risk by relevant agencies in an easily understood manner on flood maps, flood searches and fact sheets to enable individuals and the community to assess flood risk.
- On-going community education by all relevant agencies in conjunction with emergency management agencies through a co-ordinated community education plan.

2.2.6. The Floodplain Risk Management Plan

The implementation of a comprehensive investigative and planning process that develops a Floodplain Risk Management Plan is the most effective and equitable way to realise the multiple objectives of floodplain management.

2.2.7. The Flood Emergency Plan

Preparation of a flood emergency plan encompassing flood preparedness, prevention, response and recovery arrangements is the most effective way to address the residual flood risks associated with flood events.

It should be noted that flood warning should be an integral part of the flood response arrangements.

2.2.8. Appropriate Land Uses

The careful matching of land use to flood hazard both maximises the benefits of using the floodplain and minimises the risks and consequences of flooding.

2.2.9. Flood Maps

Flood maps that show the extent, depth and hazard of flooding for nominated flood events are an important tool for the preparation of Floodplain Risk Management Plans and flood emergency plans.

However, there needs to be:

- Recognition that flood maps are necessarily inexact.
- Considerable care taken with the depiction and explanation of flooding features so that the map is easily understood by the local community and is not subject to misleading interpretation.

The land use planning controls that flow from flood maps should be incorporated into statutory planning instruments in a timely and expeditious manner.

2.2.10. Floodplain Risk Management Measures

There are three generally recognised ways of managing floodplains to reduce flood losses:

- By modifying the behaviour of the flood itself (Flood Modification);
- By modifying or removing existing properties and/or by imposing controls on

property and infrastructure development (Property Modification); and

- By modifying the response of the population at risk to better cope with a flood event (Response Modification).

Floodplain management measures should not be considered in isolation. Rather, they must be considered collectively on a risk management basis that allows their interactions, their suitability and effectiveness, and their social, ecological and economic impacts to be assessed on a catchment-wide, cumulative basis.

2.2.11. Flood Behaviour

An understanding of flooding behaviour, i.e. flood discharges, flood levels, flood velocities, duration of flooding, rate of rise of floodwaters, etc. is fundamental to the preparation of effective floodplain management and flood emergency plans. It must be recognised that the behaviour of each flood will have a unique combination of these parameters and none are likely to behave across all parameters in the way predicted by design flood events used in flood models. For example, several real floods and a design flood may all have the same peak but are likely to have different rates of rise and durations.

2.2.12. Performance Indicators and Data Collection

Flood behaviour, damage and other data should be collected expeditiously after an actual flood event has occurred, allowing an evaluation of the flood modelling and the effectiveness of floodplain management measures. Simultaneously, flood emergency operations should be reviewed in consultation with communities and, where necessary, modified.

3. Legislative Imperative

There are number of significant pieces of legislation that support the establishment of a Floodplain Risk Management Framework within Council's area of responsibility. These Acts of Parliament are:

- The Sustainable Planning Act (2009); and
- The Disaster Management Act 2003 (as amended to 2010).
- Coastal Protection and Management Act (1995 as amended to 2010)
- Queensland Reconstruction Authority Act 2011

Much of this legislation is currently under review. The following discussion therefore needs to be read in the context of the potentially dynamic nature of flood related legislation at this time.

3.1. Sustainable Planning Act 2009

The Sustainable Planning Act (2009) (SPA) replaced the Integrated Planning Act (IPA) – the currently published guidelines on the application of the Act are based on the IPA and are in the process of review. However, as the Acts have the same objectives and purposes, the guidelines remain relevant to the current situation.

The Purpose of the Act is "to seek to achieve ecological sustainability by:

(a) managing the process by which development takes place, including ensuring the

process is accountable, effective and efficient and delivers sustainable outcomes; and
(b) managing the effects of development on the environment, including managing the use of premises; and
(c) continuing the coordination and integration of planning at the local, regional and State levels."

Note that under this Act, Ecological sustainability is defined as "a balance that integrates—

(a) protection of ecological processes and natural systems at local, regional, State and wider levels; and
(b) economic development; and
(c) maintenance of the cultural, economic, physical and social wellbeing of people and communities."

To achieve the requirements of the Act, local government is required to prepare Planning Documents that identify areas of natural hazard, which includes flooding from all sources, so that its development decision making process:

- is accountable, coordinated, effective and efficient; and
- takes account of short and long-term environmental effects of development at local, regional, State and wider levels, including, for example, the effects of development on climate change; and
- applies the precautionary principle; and
- seeks to provide for equity between present and future generations; and
- ensures the sustainable use of renewable natural resources and the prudent use of non-renewable natural resources by, for example, considering alternatives to the use of non-renewable natural resources; and
- avoids, if practicable, or otherwise lessening, adverse environmental effects of development, including, for example climate change and urban congestion; and adverse effects on human health.

3.2. State Planning Policy July 2014

The State Planning Policy July 2014 (SPP) provides a comprehensive set of principles to ensure all state interests in land use planning and development are incorporated into planning schemes and the development assessment system.

State Interest – natural hazards, risk and resilience, seeks for the "risks associated with natural hazards are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards".

The associated "Natural hazards risk and resilience" state interest guidelines and technical manual outlines the fit-for-purpose assessment of flood hazard risk to deliver the policy outcomes of:

- Identifying natural hazard areas for flood, bushfire, landslide and coastal hazards based on a fit for purpose natural hazard study
- Including provisions that seek to achieve an acceptable or tolerable level of risk based on a fit for purpose risk assessment consistent with AS/NZS ISO 31000:2009 Risk Management.
- Including provisions that require development to:
    - avoid natural hazard areas or mitigate the risks of the natural hazard to an

acceptable or tolerable level, and
    - support, and not unduly burden, disaster management response or recovery capacity and capabilities, and
    - directly, indirectly and cumulatively avoid an increase in the severity of the natural hazard and the potential for damage on the site or to other properties, and
    - maintain or enhance natural processes and the protective function of landforms and vegetation that can mitigate risks associated with the natural hazard.
- Facilitating the location and design of community infrastructure to maintain the required level of functionality during and immediately after a natural hazard event.

3.3. Disaster Management Act 2003 (as amended to 2010)

The Disaster Management Act 2003 (DMA) forms the legislative basis for disaster management arrangements for Queensland including:

- establishing disaster management groups for the State, Disaster Districts and Local Government areas;
- detailing planning requirements at each level;
- maintaining the role and operations of the State Emergency Service (SES) and establishment of Emergency Service Units (ESUs); and
- providing for the conferring of powers on selected individuals and groups.
- The main objectives of the DMA are:
- To help communities mitigate the potential adverse effects of an event; and prepare for managing the effects of an event; and to effectively respond to and recover from a disaster or an emergency situation.
- To provide for effective disaster management for the state,
- To establish a framework for the management of the SES to ensure the effective performance of their functions.
- The Objects of the current DMA have been amended to include reference to the following principles of disaster management (inter alia):
- effective disaster management requires planning across all four phases of disaster management: prevention, preparation, response and recovery;
- that all hazards, whether natural or caused by humans, should be managed using a disaster management framework;
- that it is primarily local governments that are responsible for managing disasters in their local government area and that district and state groups should provide local governments with appropriate resources and support to be able to manage disaster operations.

The functions of a local government under the DMA are to:

- ensure it has a disaster response capability (as outlined under s80 (2) of the DMA);
- approve its local disaster management plan prepared under part 3 of the DMA;

- ensure information about an event or a disaster in its area is promptly given to the District Disaster Coordinator (DDC) for the Disaster District in which its area is situated;

- perform other functions given to the local government under this Act.

Local government is best situated to provide first-hand knowledge and understanding of social, economic, infrastructure and environmental issues within their respective communities and are ideally placed to support its community from a disaster management perspective. This is achieved through the Local Disaster Management Group (LDMG) where Local Governments coordinate their response to a disaster.

Section 57 (1) of the Disaster Management Act 2003 requires local governments to develop a local disaster management plan (LDMP) as a part of their response capability for disaster management in their area. Section 57 (2)(f) further requires that the LDMP must address matters stated in the disaster management guidelines and Section 58 states that the LDMP must be consistent with the disaster management guidelines.

Section 63 (1) gives authority to the Chief Executive of the Department to prepare guidelines to inform State, District and Local Groups about the preparation of plans and matters to be included in plans.

3.4. Coastal Protection and Management Act

The Coastal Protection and Management Act (CPMA) form the legislative basis for coastal management within Queensland. One of the main objectives of the CPMA is to "ensure decisions about land use and development safeguard life and property from the threat of coastal hazards".

While the operation of the Queensland Coastal Plan was suspended on 8 October 2012, the State Policy for Coastal Management is still in effect. Relevant principles of the State Policy for Coastal Management include:

- Natural coastal processes including erosion and accretion are able to occur without interruption
- Structures (including all infrastructure) in erosion prone areas are designed, located and managed to ensure that impacts on coastal processes are avoided or minimised.
- Buildings and structures (including all infrastructure) are established on State coastal land only where they are essential, provide a public service, and cannot be feasibly located elsewhere.
- Management and use of coastal land is guided by plans of management.

3.5. Queensland Reconstruction Authority Act

The *Queensland Reconstruction Authority Act* (QRAA) provides for the effective and efficient recovery of State of Queensland and its communities from the impacts of disaster events. The definition of disaster for the purposes of the QRAA is taken to be that contained in the *Disaster Management Act 2003*.

The QRAA enables the establishment of the Queensland Reconstruction Authority (the Authority). The main function of the Authority's CEO is to "ensure proper planning, preparation, coordination and control of development for the protection, rebuilding and recover of affected communities". Section 112 gives the Minister power to direct a local government to take action about local planning instruments.

3.6. Queensland Floods Commission of Inquiry

While the recommendations of the Queensland Floods Commission of Inquiry are not legislative in nature, it is expected that the Queensland State Government will put into effect these recommendations through changes to planning legislation. Of particular relevance to this Framework is Recommendations 2.12 which states:

"Councils in floodplain areas should, resources allowing, develop comprehensive floodplain management plans that accord as closely as practicable with best practice principles"

3.7. The Floodplain Risk Management Plan

Although a Floodplain Risk Management Plan is not a formal requirement of either the Sustainable Planning Act (2009) or the Disaster Management Act (2003), this does not prevent local government from implementing investigation and planning activities which will inform formal flood planning and disaster management processes and documenting a process for conducting these activities in the form of a framework.

There is a growing expectation within the community that state and local governments will be capable of managing natural disasters in an efficient and effective manner, which minimizes loss of life and property.

It is within the context of the Legislative requirements above and the community expectations that Council is developing its Floodplain Risk Management Framework as a pre-cursor to development of a Floodplain Risk Management Plan.

The relationship of the Legislation and the floodplain risk management process is shown in **Figure 3.1**.

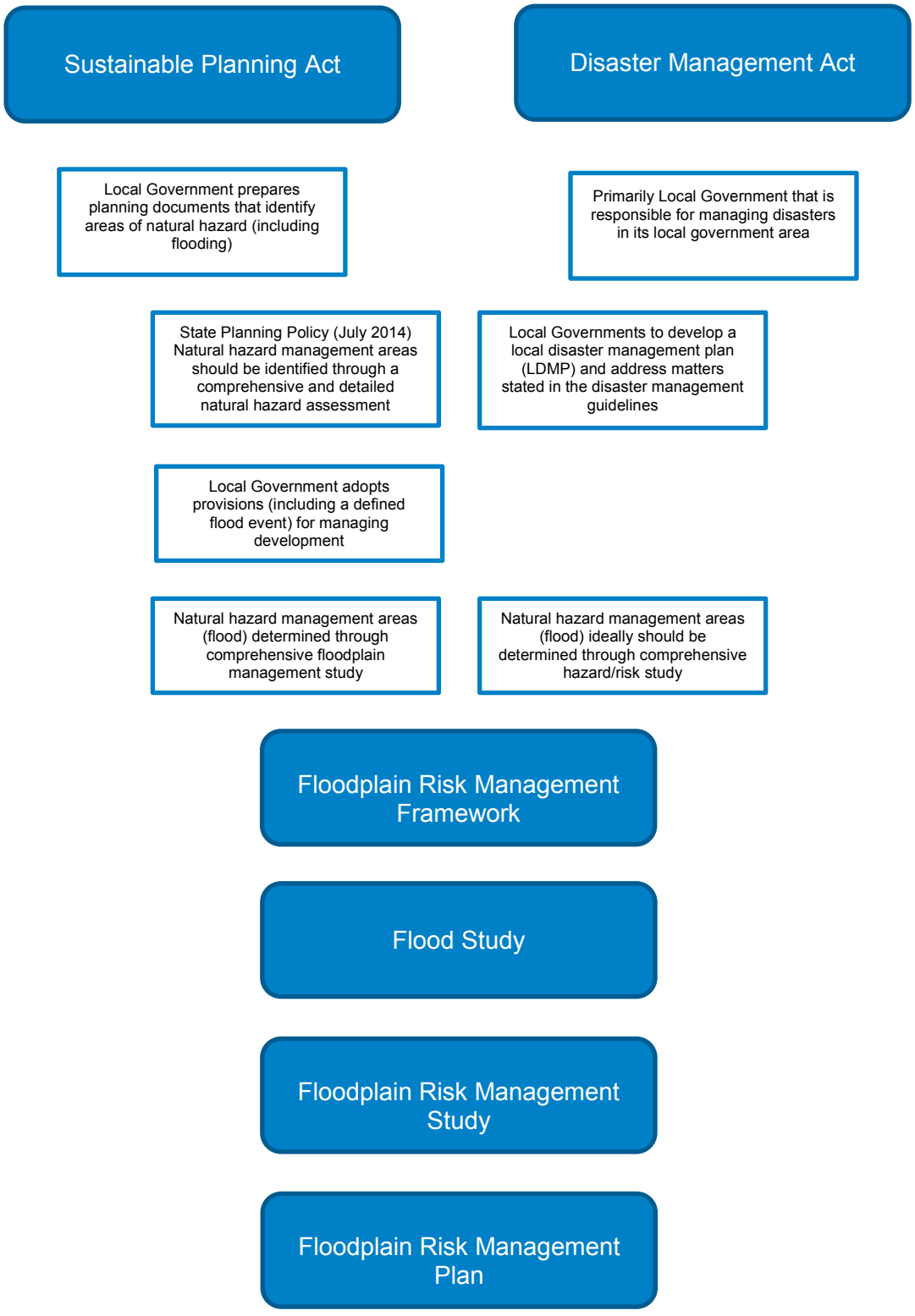


Figure 3.1 Legislation and Floodplain Risk Management Process

4. Floodplain Risk Management Framework

4.1. Framework Objectives

The objectives of the Framework are:

- To ensure that all levels of government and the local community are aware of their responsibilities for managing flood risk.
- To ensure floodplain management functions are integrated within a broader sustainable land management framework.
- To ensure that flood risk and flood behaviour is understood and considered in a strategic manner in the decision-making process and that land use is consistent with flood risk and potential damages.
- To ensure land use planning and development controls minimise both the exposure of people to flood hazard and damage costs to property and infrastructure.
- To ensure a broad range of floodplain management measures (both structural and non-structural) are considered and flood mitigation measures appropriate to the location and acceptable to the local community are used to manage flood risk where economically, socially and environmentally viable.

The formulation and implementation of a Floodplain Risk Management Plan describing a course of action to address the above objectives is a cornerstone of the Framework. The development and implementation of a Floodplain Risk Management Plan is achieved through the application of a four step process described in **Figure 4.1** below.

This Framework is generally addressed to the management of floods arising from heavy rainfall (river & creek flooding), storm tide, and urban flash flooding (overland flowpaths). The special circumstances relating to unusually high tides (e.g. so-called “king” tides), tsunami, local ponding from heavy rainfall and dam failure are outside the reach of the Framework however the general principles may apply when Council is ready to pursue strategic planning for these forms of flooding.

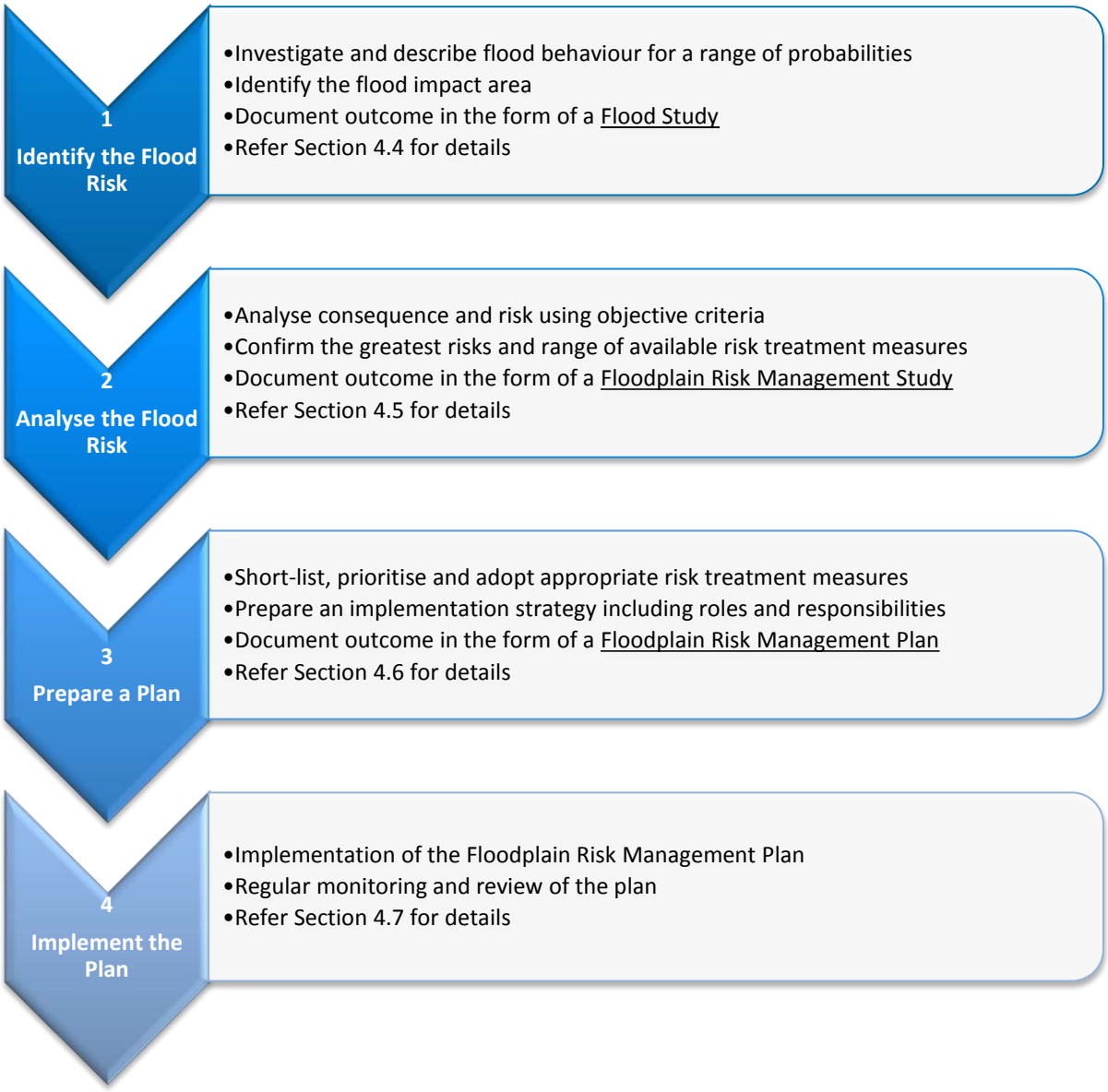


Figure 4.1 MBRC Floodplain Risk Management Framework

4.2. Floodplain Risk Management Committee

During the application of the Framework the formation of a Floodplain Risk Management Committee (the Committee) is recommended. The committee can be a technical steering group, a separate entity or part of an existing committee such as the Local Disaster Management Group (LDMG), however the LDMG must be focused on flooding issues when operating as a Floodplain Risk Management Committee.

It would generally be chaired by Council however special arrangements would be needed if studies and plans require co-ordination with adjoining local government areas.

Responsibility for planning matters lies with the Council as a whole and as the Committee is advisory in nature, it should report directly to Council. Its principal objective is to assist council in the development and implementation of one or more Floodplain Risk Management Plans for its service area. The Committee is both the focus of, and a forum for, the discussion of technical, social, economic and ecological issues and for the distillation of possibly differing viewpoints on these issues.

Once the Committee has completed the primary task of developing the Floodplain Risk Management Plan including its implementation strategy, and council has adopted these, it is suggested that a limited group remain to oversee implementation.

4.3. Attainment Levels

The Framework recognizes two levels of attainment for each step in the procedure:

- Basic – the level of detail achieved supports a basic understanding of the risks and the management measures that are available for their treatment. One of the recommended measures of a basic Floodplain Risk Management Plan should be progression towards an advanced level of attainment for the entire region or, as a minimum, those floodplain precincts where risks are considered likely to be greatest. A basic plan may be completed in the absence of a formal Floodplain Risk Management Committee, generally only deals with existing risk (not future risk) and does not require hydrologic and hydraulic modelling.

- Advanced – the level of detail achieved supports a detailed understanding of the risks and management measures that are available for their treatment including detailed evaluation and prioritisation of measures and clear recommendations for their implementation. Advanced planning should not be undertaken in the absence of supervision by a Floodplain Risk Management Committee.

4.4. Step 1 - Identify the Flood Risk

Identifying flood risk first requires the collection of a variety of data to assess flood behaviour and the effectiveness, costs and benefits of management measures. It is important to define the data currently available and that needed for the study, to identify information gaps. The Floodplain Risk Management Committee should initiate studies, where gaps exist, to collect the social, economic, flooding, ecological, land use, cultural, and emergency management data required in management studies. Where relevant data exists this should be collated and referred to in investigations.

Data collection is not an end in itself; it is input to enable preparation of properly informed studies, management plans and floodplain management decisions associated with each type of flood affectation. There are three major types of flooding within the Moreton Bay Region requiring investigation:

- River and Creek Flooding

- Storm Tide (tropical cyclone or east coast low)
- Overland Flow

Other forms of flooding (not specifically addressed by the Framework) include unusually high tides (e.g. so-called “king” tides), tsunami, local ponding from heavy rainfall and dam failure.

A flood study is a comprehensive technical investigation of flood behaviour. It defines the nature of flood risk by providing information on the extent, level and velocity of floodwaters and on the distribution of flood flows across various sections of the floodplain for the full range of flood events up to and including the PMF.

Flood studies are necessary because detailed knowledge of flood characteristics is required to deal with existing problems, future development and the residual flood risk. Major components of a flood study involve determining discharge (hydrologic aspects) and water levels, velocities, etc (hydraulic aspects) for floods of varying severity. Council has determined that WBNM is the preferred method for hydrologic studies and that the numerical modelling system TUFLOW is to be used for investigating the hydraulic aspects of the floodplain.

The flood study also determines hydraulic and hazard categories within the floodplain for the potential range of floods and land use scenarios in order to consider cumulative effects. The FRMF recognises three hydraulic categories (floodways, flood storage and flood fringe) and five hazard categories.

Investigating the full range of flood events up to and including the PMF enables changes in the nature and consequences of flooding to be assessed as flood severity increases. These may include increases in velocity and depth, changes in hazard category, the creation of ‘islands’ (which may be completely inundated in larger events), and the number of properties inundated etc.

Determining appropriate areas for different types of development generally depends upon flood exposure of the land, as defined by hydraulic and hazard categorisation. This information is also weighed objectively in selecting Defined Flood Events.

Finally, climate change may affect the weather events that cause flooding, sea levels may continue to rise and the pattern of flood producing storms may change significantly in terms of both frequency of event and intensity. Their potential impacts need to be considered when identifying the flood risk.

4.5. Step 2 - Analyse the Flood Risk

Once Step 1 is completed a Floodplain Risk Management Study is to be prepared to objectively analyse the risks associated with flooding and to identify, assess and compare various flood management options.

The Floodplain Risk Management Study draws together the results of the flood study and data collection exercises. It provides information and tools to allow strategic assessment of the impacts of management options for existing, future and residual flood risk on flood behaviour and hazard and the social, economic, ecological and cultural costs and benefits of options. It also provides the basis for robust decision making in the management plan.

The suite of flood management measures that a management study will propose generally involves a mix of options as it is unusual for a single management option to manage the full range of flood risk. Determining the optimum mix of measures can require complex studies, exercise of professional judgement and extensive community consultation. Typical options considered are indicated in **Table 4.1** and should include:

- **property modification measures** including development controls in new areas, and voluntary purchase and house raising in developed areas;
- **response modification measures** such as evacuation and associated operational logistics; and
- **flood modification measures** including levees and bypass channels

The impact of management works or proposed developments on flooding behaviour elsewhere should be assessed on a cumulative rather than individual or ad-hoc basis within the context of the management plan. This includes both the effect of development on flood behaviour and the number of people who may require evacuation, particularly in rare flood events. Where mitigation works are considered, they should be designed to produce net positive ecological outcomes, where practical and feasible. Mitigation works should also consider potential changes to the weather events that cause flooding. Accordingly the design life of projects must be subject to close scrutiny so as to avoid costly upgrading or redesign of adopted measures.

Table 4.1 Typical Floodplain Risk Management Measures

Flood Modification Measures	Property Modification Measures	Response Modification Measures
flood control dams	zoning	flood plans
bypass floodways	building and development controls	flood prediction and warning
levees	voluntary purchase	evacuation arrangements
channel improvements	house raising	recovery plans
retarding basins	flood proofing buildings	community education
flood gates	flood access	community preparedness

4.6. Step 3 - Prepare a Floodplain Risk Management Plan

The purpose of a Floodplain Risk Management Plan is to provide input into the strategic and statutory planning roles of councils and to prioritise the range of management measures adopted from the Floodplain Risk Management Study. It does not, by intent, purport to be the only document relevant to development of flood prone land. The management plan provides the type of information necessary for adequate forward planning for flood prone land.

The advantages to both council and the community in general of having a properly considered Floodplain Risk Management Plan in place include:

- Having a proper basis for managing and using flood prone land to provide a balance between danger to personal safety and economic losses due to flooding, and social, ecological and cultural interests. This provides the current and future community best value from managing and using its floodplains;
- Optimising use of community infrastructure, such as roads, water supply and sewerage;
- Minimising personal danger to residents, visitors and emergency response personnel and community flood damage;
- Land can be identified for development and the impacts of its development on flooding and the affects of flooding on the development can be effectively considered. This provides a sound basis for incorporating floodplain management outcomes in revising council's planning instruments and development controls. It allows the community to grow in a responsible and socially cohesive fashion in consideration of flood issues. It also provides for increased certainty, from a flood perspective, for development applications in line with the relevant Planning requirements; and
- Having a basis for more timely assessment of development applications for flood prone land, especially where council's Planning Instruments and development control

plans and/or policies have been altered, in light of the management plan, to incorporate appropriate zonings, and flood related controls. Individual development applications are thus limited to the best way to achieve the required outcomes on individual sites.

Review of management plans should be triggered by the following instances:

- Elapsed time - review regularly, around every 10 years, down to 5 if a flood has occurred in the meantime
- After significant flood events which provide additional data on flood behaviour
- Where significant changes occur to the factors influencing the decisions in the plan, including changes to local flood plans
- Where impediments to implementation exist that warrant a review
- Where changes in future land use trends outside those considered in the management plan are proposed

This review should account for changes across the full range of issues originally addressed and consider any associated emergent issues.

4.7. Step 4 - Implement the Floodplain Risk Management Plan

Once a Floodplain Risk Management Plan has been adopted, it needs to be implemented. Certain components can be implemented relatively quickly, such as incorporating flood related development controls into policy and Planning Instruments and flood education programs. Others require additional investigations and design, and funding.

It is unlikely that any management plan could be implemented immediately in its entirety. For example, availability of funding will determine when mitigation works can commence. Consequently, an implementation strategy is required to stage components dependent on funding availability and the management plan needs to consider adoption of interim measures. The implementation strategy should be developed during the preparation of the management plan and incorporated in the plan.

5. Roles & Responsibilities

The primary responsibility for the application of sound floodplain management rests with local government. However, all levels of Government can contribute to or have partial responsibility for floodplain management.

5.1. Commonwealth Government

The Commonwealth Government has a general responsibility for the economic and social well being of the nation. To this end, the Commonwealth Government currently:

- Encourages the development of effective long-term strategies for the sustainable management of the nation's floodplains;
- Provides flood forecasting services by the Bureau of Meteorology;
- Supports the development of emergency management capabilities through the activities of Emergency Management Australia; and
- Provides financial assistance under the Natural Disaster Relief & Recovery Arrangement (NDRRA), which is administered by the Department of Finance in conjunction with State and Territory Treasury Departments when flood damage and disruption is greater than a pre-set amount.

5.2. State Government

The roles of each State Government Agency are summarised below. The principal floodplain management role of State and Territory Governments has been stated as follows (DPIE, 1992):

"....to develop appropriate standards and strategic approaches for floodplain management and to ensure that they are applied in a coordinated and integrated fashion across the State. This role encompasses the provision of expert technical support via a principal water resources authority(s), of planning advice through a state planning agency and of effective counter disaster and welfare services".

5.2.1. Department of Environment and Heritage Protection

The Department of Environment and Heritage Protection (DEHP) is responsible for administering the *Coastal Protection and Management Act 1995*. DEHP provides a framework for how communities and environment can adapt to climate change impacts with a key focus on how coastal communities can better prepare for projected sea level rise, storm tide and erosion risks.

5.2.2. Department of State Development Infrastructure and Planning

The Department of State Development Infrastructure and Planning (DSDIP) is responsible for administering the *Sustainable Planning Act 2009*. DEDIP undertakes regional and statewide planning and establishes legislation and codes relating to planning and development.

5.2.3. Department of Natural Resources and Mines

The Department of Natural Resources and Mines (DNRM) is responsible for the sustainable management of water resources and catchment management. DNRM is also responsible for the monitoring of the flow and height of rivers and streams.

5.2.4. Department of Local Government

The Department of Local Government (DLG) is responsible for ensuring the Local

Governments of Queensland are strong, sustainable and resilient. DLG works with Local Government to undertake community planning, asset management and financial management.

5.2.5. Department of Community Safety (Emergency Management Queensland)

The Department of Community Safety (DCS) is responsible for the administration of the *Disaster* Management *Act 2003.* DCS provide disaster awareness and hazard reduction services through community safety and education programs and are the lead agency for the co-ordination of activities undertaken before, during and after a disaster or emergency to minimise adverse community impacts.

5.2.6. Department of Transport and Main Roads

The Department of Transport and Main Roads (DTMR) is responsible for providing a safe and efficient road network that deals with flood impacts by minimising the flood risk to the travelling public, and restoring relevant flood affected infrastructure. DTMR is also responsible for predicting road closures/re-openings and possible failure modes, if any.

5.2.7. Department of Communities, Child Safety and Disability Services

The Department of Communities, Child Safety and Disability Services in the lead agency for human recovery services (coordination, emergency accommodation, food and clothing, financial support) following an event.

5.2.8. Department of Energy and Water Supply

The Department of Energy and Water Supply (DEWS) is responsible for the bulk water and distributor-retailers as well as the operation and management of referable dams. DEWS is also responsible for the review and implementation of the Queensland Urban Drainage Manual.

5.2.9. Queensland Reconstruction Authority

The Queensland Reconstruction Authority (QRA) is responsible for administering the *Queensland Reconstruction Authority Act 2011* and is the lead agency for the delivery of the Queensland Flood Commission of Inquiry recommendations relating to Floodplain management.

5.2.10. Obligations of State Government Agencies

It is a fundamental best practice principle of floodplain management that government agencies, be they Local, State or Commonwealth, are bound by the best practice principles of the FRMF.

Government agencies, whether State or Commonwealth, undertaking works or developments on flood prone land must comply with the provisions of Floodplain Risk Management Plans. When planning such works or developments, it is essential that the agency takes into account the nature and extent of the flood problem, the impact of the development on flood behaviour, and the impact of flooding on likely hazard levels at the development site.

If the proposed development is or could form part of infrastructure required for flood emergency management, e.g. a police station, hospital, telephone exchange or school, consideration should be given to relocating the development at a flood-free site (if possible), or ensuring that the proposed development can meet its intended emergency use when a flood eventuates.

Government agencies should seek the advice of local government with respect to flood behaviour, EMQ with respect to flood emergency procedures, Department of Infrastructure and Planning, as well as Council, in relation to planning considerations and the natural resource and environmental protection agencies in relation to environmental matters.

5.3. Local Government

Local government has a number of roles and responsibilities in the effective management of the floodplain. The principal roles and responsibilities are detailed below.

5.3.1. Prepare and Maintain Flood Models and Mapping

Flood models and associated studies provide important data for local government to understand the likelihood, extent and consequences associated with a range of flood events within the local government area. They also provide the foundation for raising public awareness of flood risks through flood mapping and information necessary for floodplain management decision making.

Flood models and mapping is most appropriately prepared by local government since local government holds much of the local knowledge and spatial data necessary for preparation of reliable flood models and maps.

As part of this responsibility local government should also put into place appropriate flood information management systems to ensure the information is managed and kept up to date.

5.3.2. Preparation of Floodplain Risk Management Plans

Flood prone land needs to be managed in accordance with its flood risk. This is achieved through the preparation and implementation of a Floodplain Risk Management Plan, which also considers the social, environmental and economic costs and benefits of the use and management of flood prone land. As part of this process, the council requires sound information concerning flood behaviour, flood impacts and the other planning factors that affect the use of flood prone land.

The preparation of a Floodplain Risk Management Plan is most effectively undertaken within the process described in the Framework, involving the compilation of a flood study and a floodplain risk management study prior to defining a Floodplain Risk Management Plan. The floodplain risk management process should involve comprehensive community consultation and public exhibition of the Floodplain Risk Management Plan to facilitate community understanding and acceptance of the proposals.

5.3.3. Planning Schemes

Local government should incorporate the planning provisions of Floodplain Risk Management Plans into statutory planning instruments.

5.3.4. Flood Emergency Plans

The preparation of a local flood emergency plan is the responsibility of local government as well as the provision of manpower, equipment and facilities to assist in flood response activities.

For the local flood emergency plan to be effective, local government needs to work in concert with EMQ to promote flood awareness in the community by supplying flood data and advice to property owners, residents, visitors, potential purchasers and

investors. In recognition of the turnover in residents, and human fallibility, such information should be provided on a regular basis.

5.3.5. Implementation and Review of Management Strategies

Once a Floodplain Risk Management Plan has been adopted, local government is responsible for the administration of many of the provisions of the plan, including:

- The investigation, design, construction and maintenance of structural flood mitigation works;
- The establishment of a formal asset management program for floodplain management measures;
- The administration of land use controls;
- The administration of building controls (e.g. minimum floor levels);
- The provision and maintenance of plant, equipment and manpower, as specified in the local flood emergency plan for the area; and
- Fostering, in conjunction with EMQ, improved flood awareness through public education programs.

Floodplain management measures, be they structural or otherwise, constitute a valuable community asset; public funds have been spent on analysis, design, construction and implementation of these management measures. As such, the measures need to be effectively managed and maintained to ensure that they will perform as required, on those infrequent occasions when they are needed.

5.4. Developers

5.4.1. Conforming Developments

Once a Floodplain Risk Management Plan has been prepared, most if not all of the provisions and conditions relating to suitable or 'conforming' developments on the floodplain will be specified in the plan. This will assist developers in their preparation of applications for such developments.

Before preparing and submitting applications, developers are advised to liaise with local government regarding the provisions and conditions of conforming developments.

5.4.2. Non-Conforming Developments

A Floodplain Risk Management Plan does not necessarily exclude non-conforming developments. However, it serves to alert both local government and the developer to the fact that, in general terms, non-conforming developments are not appropriate to the flood risk and flood hazard at the proposed site.

Should a developer wish to propose a non-conforming development, particularly where a developer derives financial benefit from developing the land, a number of detailed technical studies will need to be undertaken at the developer's expense to justify the proposal.

Developers are strongly advised to liaise with local government regarding the scope and detail of issues to be addressed in the supporting studies. If there are significant adverse impacts, the proposal must specify compensatory measures that reduce the impacts to acceptable levels. Compensatory measures may be subject to approval by

consent authorities.

5.5. The Flood Prone Community

The community has a basic responsibility in regard to the management of residual flood risk - to both inform themselves and keep up to date with appropriate action to take in the event of a flood.

Residual flood risk can best be addressed through flood emergency plans. If these plans are to be successful, it is essential that the community knows what to do and how to do it effectively when flood warnings are issued. Council and EMQ have an important role to play in raising flood awareness through public education campaigns.

In areas where structural flood mitigation works have been built, individuals should be aware that in general the works do not eliminate flood hazard, and that problems and danger can arise when floods greater than the design flood event occur. When levees are overtopped, water levels within the protected area can rise quickly and evacuation routes may be cut, creating hazardous conditions.

All of these issues should be addressed in the Floodplain Risk Management Plan for the area. As part of these plans, flood prone individuals should be made aware of the flood risk to which they are exposed, the functioning of the flood warning and evacuation systems, and appropriate actions to be taken when warnings are issued. This information should be freely available from the local agency. The general community - both flood prone and flood-free individuals - should be encouraged to inform themselves of flooding matters.

6. Glossary

Table 6.1 Glossary of Terms

Term	Description of Term
Annual exceedance probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage (see also ARI).
Australian Height Datum (AHD)	The national surface level datum approximately corresponding to mean sea level.
Average annual damage (AAD)	AAD is the average damage per year that would occur in a nominated development situation from flooding over a very long period of time.
Average recurrence interval (ARI)	The long-term average number of years between the occurrence of a flood as big as or larger than the selected event. ARI is another way of expressing the likelihood of occurrence of a flood event.
Caravan and moveable home parks	Standards relating to their siting, design, construction and management can be found in the Regulations under the Residential Tenancies and Rooming Accommodation Act.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Consent authority	The council, government agency or person having the function to determine a development application for land use.
Defined flood extent	Area of land covered by the largest known flood, used for flood planning and management measures. Its return period (ARI) is defined by MBRC.
Defined Flood Event (DFE)	Flood event(s) selected for floodplain management purposes. DFEs are the combinations of flood levels (derived from significant historical flood events or floods of specific AEPs) and relevant freeboards.

Term	Description of Term
Development	In the Framework: Infill development: refers to the development of vacant blocks of land that are generally surrounded by developed properties and is permissible under the current zoning of the land.
	New development: refers to development of a completely different nature to that associated with the former land use.
	Redevelopment: refers to rebuilding in an area and generally does not require either re-zoning or major extensions to urban services.
Discharge	The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m^3/s).
Ecologically Sustainable Development (ESD)	Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased.
Effective warning time	The time available after receiving advice of an impending flood and before floodwater prevents appropriate flood response actions being undertaken.
Emergency management	A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.
Flash flooding	Flooding which is sudden and unexpected, often caused by sudden local or nearby heavy rainfall. It is often defined as flooding which peaks within six hours of the causative rain.

Term	Description of Term
Flood	A stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood awareness	Awareness is an appreciation of the likely effects of flooding and knowledge of the relevant flood warning, response and evacuation procedures.
Flood education	Flood education seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.
Flood fringe areas	The remaining area of flood prone land after floodway and flood storage areas have been defined.
Flood liable land	Flood liable land is synonymous with flood prone land (i.e. land susceptible to flooding by the PMF event). Note that the term flood liable land covers the whole floodplain, not just that part below the Flood Planning Area (FPA).
Flood mitigation standard	The average recurrence interval of the flood, selected as part of the floodplain management process that forms the basis for physical works to modify the impacts of flooding.
Floodplain	The area of land which is subject to inundation by floods up to and including the PMF event, i.e., flood prone land.
Floodplain management options	The measures that might be feasible for the management of a particular area of the floodplain.

Term	Description of Term
Floodplain Risk Management Plan	A management plan developed in accordance with the principles and guidelines in the FRMF. It usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives.
Flood planning area	The area of land below the DFE and thus subject to flood related development controls.
Flood proofing	A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages.
Flood prone land	Land susceptible to flooding by the PMF event. Flood prone land is synonymous with flood liable land.
Flood readiness	Readiness is an ability to react within the effective warning time.
Flood risk	Potential danger to personal safety and potential damage to property resulting from flooding. Flood risk is divided into 3 types, existing, future and residual risks. They are described below. Existing flood risk: the risk a community is exposed to as a result of its location on the floodplain. Future flood risk: the risk a community may be exposed to as a result of new development on the floodplain. Residual flood risk: the risk a community is exposed to after floodplain management measures have been implemented. For an area without any floodplain management measures, the residual flood risk is simply the existence of its flood exposure.
Flood storage areas	Flood storage areas are locations where significant volumes of flood water are held back by natural controls. These areas may be considered to be a sub-category of floodway as the development controls applied in the area are basically the same.

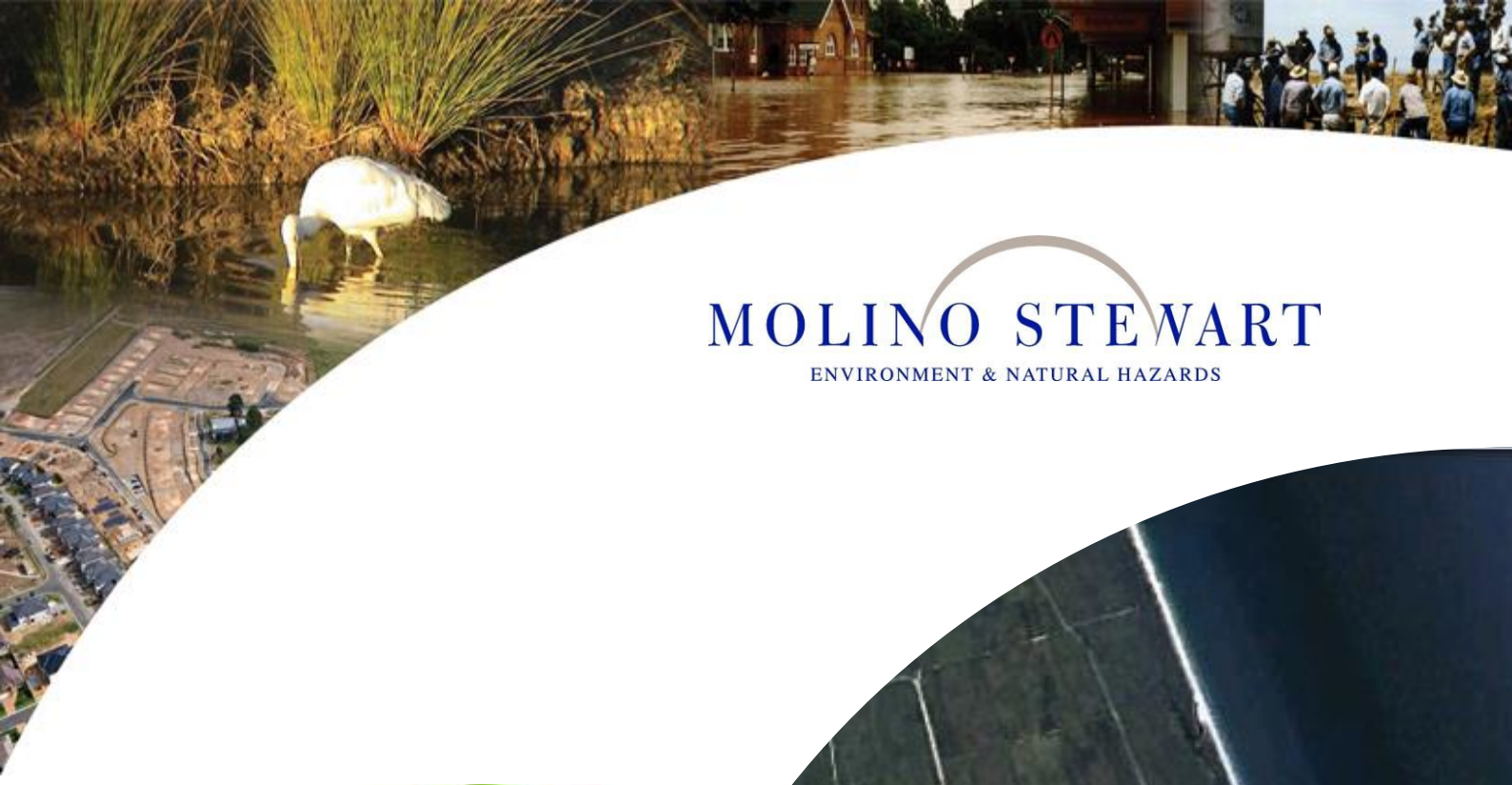
Term	Description of Term
Floodway areas	Those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the DFE is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. Freeboard is included in the Defined Flood Event.
Habitable room	In a residential situation: a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Hazard	A source of potential harm or a situation with a potential to cause loss. In relation to the FRMF, the hazard is flooding which has the potential to cause damage to the community.
Hydraulics	Term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.
Hydrograph	A graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.
Hydrology	Term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.
Local Flood Sub-Plan	A sub-plan of a disaster plan that deals specifically with flooding. They can exist at state, regional and local levels. Local flood sub-plans are prepared under the leadership of EMQ.

Term	Description of Term
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam. Not directly addressed by the FRMF.
Local drainage	Smaller scale problems in urban areas. They are outside the definition of major drainage in the FRMF.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Major drainage	Councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purposes of the FRMF, major drainage involves: The floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or Water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in: Danger to personal safety and property damage to both premises and vehicles; and/or Major overland flowpaths through developed areas outside of defined drainage reserves; and/or The potential to affect a number of buildings along the major flow path.

Term	Description of Term
Minor, moderate and major flooding	Both EMQ and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood: Minor flooding: causes inconvenience such as closing of minor roads and the submergence of low level bridges — Moderate flooding: low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered — Major flooding: appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated.
Modification measures	Measures that either modify the flood, the property or the response to flooding.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood	The PMF is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation coupled with the worst flood producing catchment conditions. It is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain.
Probable maximum precipitation	The probable maximum precipitation (PMP) is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to PMF estimation.
Probability	A statistical measure of the expected chance of flooding (see AEP).

Term	Description of Term
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In floodplain investigations, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Stage	Equivalent to water level (both measured with reference to a specified datum).
Stage hydrograph	A graph that shows how the water level at a particular location changes with time during a flood.
Survey plan	A plan prepared by a registered surveyor.
Value-based approach	The value-based approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains. The value-based approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into council plans, policy, and Planning Instruments. At a site specific level, it involves consideration of the best way of conditioning development allowable under the Floodplain Risk Management Plan, local floodplain management policy and Planning Instruments.
Water surface profile	A graph showing the flood stage at any given location along a watercourse at a particular time.

Appendix E: Interim Floodplain Risk Management Plan



MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS

Moreton Bay Regional Council

Interim Floodplain Risk Management Plan

Draft Interim FRMP

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

Interim Floodplain Risk Management Plan

DRAFT INTERIM FRMP

for

Moreton Bay Regional Council

by

Molino Stewart Pty Ltd
ACN 067 774 332

JUNE 2015

MOLINO STEWART PTY LTD ABN 95 571 253 092 ACN 067 774 332

PO BOX 614, PARRAMATTA CBD BC, PARRAMATTA NSW 2124 TEL: (02) 9354 0300 FAX: (02) 9893 9806

www.molinostewart.com.au

MOLINO STEWART
ENVIRONMENT & NATURAL HAZARDS

DOCUMENT CONTROL

Document Reference	0551 MBRC Interim FRMS Draft
Project	Interim FRMP for MBRC
Document Type	Draft Interim FRMP
Author	Neil Benning

REVISION HISTORY

Date	**Version**	**Name**	**Comments**
6/3/2013	1	Neil Benning	First draft for review
22/3/2013	2	Steven Molino	Draft for client review

DOCUMENT APPROVAL

For Molino Stewart	
Name	Steven Molino
Position	Principal
For Moreton Bay Regional Council	
Name	**Elissa McConaghy**
Position	**Senior Strategic Planner** *Infrastructure Networks*

CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Council area 1
1.3 The Queensland Context 1
1.4 MBRC Context 2
1.5 This Study 2

2 REVIEW OF PLANNING CONTROLS 3
2.1 State Planning policies 3
2.2 Local Government Planning Schemes 3
2.3 Queensland Flood Commission of Inquiry 5

3 REVIEW OF TECHNICAL DATA 12
3.1 General 12
3.2 Storm Tide Management Study, 12
3.2.1 Methodology 12
3.2.2 Key Activities 12
3.2.3 Results 13
3.2.4 Recommendations 13
3.3 Overland Flow study 14
3.3.1 Objectives 14
3.3.2 Methodology & Results 14
3.3.3 Model Limitations 15
3.3.4 Conclusion 15
3.4 Regional Floodplain Database 15
3.4.1 Objectives 15
3.4.2 General Approach 16
3.4.3 Conclusions & Recommendations 16
3.5 Floodplain Risk Management Study 17
3.5.1 Background 17
3.5.2 Objectives 17
3.5.3 Outputs 17
3.5.4 Conclusions & Recommendations 18
3.6 Review findings 21

4 REVIEW OF EMERGENCY MANAGEMENT 22
4.1 General 22
4.1.1 Local Disaster Emergency Management Plan 2011 22
4.1.2 Threat Specific Sub-plan 23

5 FLOODPLAIN RISK MANAGEMENT OPTIONS 25
5.1 General 25
5.2 Response Modification Measures 25
5.2.1 Local Threat Specific Sub-plans 26
5.2.2 Flood Prediction and Warning 26
5.2.3 Flood Education 26
5.2.4 Recovery Planning 27
5.3 Flood Modification Measures 27
5.3.1 Flood Mitigation Dams 27
5.3.2 Detention Basins 28
5.3.3 Bypass Floodways 28
5.3.4 Levees 29
5.3.5 Channel Modifications 30
5.3.6 Floodgates 30
5.3.7 Temporary Flood Barriers 31
5.4 Property Modification Measures 32
5.4.1 Property Modification - Works 32
5.4.2 Property Modification - Planning 33
5.4.3 Designated Flood Event 34

6 DFE & DSTE 35
6.1 Designated Flood Event (DFE) 35
6.2 Designated Storm Tide Event (DSTE) 35
6.3 Natural Hazard Management Area 35
6.4 Interim Recommendation 35

7 FREEBOARD 37
7.1 Background 37
7.2 What Is Freeboard? 37
7.3 What Freeboard to Adopt? 37

8 THE INTERIM PLAN 39
8.1 General 39
8.2 Response Modification 39
8.3 Flood Modification 39
8.4 Property Modification 40
8.5 Costs, Priorities & Implementation 40
8.5.1 Costs 40
8.5.2 Funding Requirements 40
8.5.3 Priorities 40

9 THE FUTURE **41**
9.1 Studies 41
9.2 Response Modification Measures 41
9.3 Flood Modification Measures 41
9.3.1 Changes to Infrastructure 42
9.3.2 Levees / Temporary Flood Barriers 42
9.3.3 Detention Basins 42
9.3.4 Channel Modification 42
9.4 Property Modification Measures 42
9.4.1 DFE / DSTE 43
9.4.2 Freeboard 43
9.4.3 Zonings Development Controls and Building Controls 44

10 REFERENCES **45**
10.1 Technical 45
10.2 Planning 45

LIST OF TABLES

Table 1 - MBRC Current Planning Framework relating to DSTE, SLR, NHMA 4
Table 2 - Responses to QFCI Recommendations 6
Table 3 - Catchment Identifiers 17
Table 4 - Topographic Classification - MBRC 18
Table 5 - Numbers of Properties in Risk Situations 18
Table 6 - Risk to Personal Safety (Residential Properties) 18
Table 7 - Risk to Personal Safety (Commercial) 18
Table 8 - Risk to Property (Residential) 19
Table 9 - Risk to Property (Commercial) 19
Table 10 - Risk of Isolation 19
Table 11 - Average Annual Damages 19
Table 12 - Unacceptable Risk – Infrastructure 20
Table 13: Floodplain Management Measures 25
Table 14 - Freeboard Summary 37

1 INTRODUCTION

1.1 BACKGROUND

In 2010 Moreton Bay Regional Council commenced development of a Floodplain Risk Management Framework (FRMF) in order to conceptualise, assess and implement floodplain risk management measures. The vision for the Framework is that:

"Floodplains in the Moreton Bay Region are managed for the long-term benefit of the community such that hazards to people and damages to property and infrastructure are minimised and the intrinsic environmental values of the floodplain are protected."

The primary output of the Framework is a Floodplain Risk Management Plan, which is to be achieved through the application of a four step process based on:

- Identifying the Flood Risk;
- Analysing the Flood Risk;
- Preparing the Floodplain Risk Management Plan; and
- Implementing the Floodplain Risk Management Plan

1.2 COUNCIL AREA

The Moreton Bay local government area (LGA) is located immediately to the north of Brisbane, Queensland.

The Moreton Bay LGA covers a total of 2,070 km² extending between the northern suburbs of Brisbane to the southern edge of the Glass House Mountains.

Fourteen (14) separate drainage catchments are located within the Moreton Bay LGA including those of the Pine and Caboolture Rivers, the headwaters of the Mary River, the Stanley River (a major tributary of the Brisbane River) and numerous large creek catchments.

Some of these drainage catchments straddle the boundary of the Moreton Bay region. This means there is 630 km² of additional catchment area that is located outside the local government area but contributing to the floodplains located within the region. The catchment area that impacts on the LGA therefore has a total footprint of more than 2,700 km².

The study area contains a diverse mix of land uses (e.g. rural, semi-rural, urban and forest) and provides a key urban growth corridor for South-East Queensland, expecting to accommodate another 150,000 people over the next 20 years.

1.3 THE QUEENSLAND CONTEXT

Following the 2010/2011 floods, the Queensland Government took two major steps:

- It initiated a Queensland Floods Commission of Inquiry (QFCI) to examine all issues with regard to flood management, including land planning; and
- It created the Queensland Reconstruction Authority (QRA) to address the reconstruction of flood affected areas and to produce guidelines for stronger, more resilient floodplains.

The QRA released a draft Temporary State Planning Policy (TSPP), which commenced operation on 14 November 2011, whereby local governments are required to identify the natural hazard management area for flood by reference to the 1% Average Exceedance Probability (generally equivalent to a 1 in 100 year Average Recurrence Interval) flood.

Alternatively, local authorities could use the 'Interim Floodplain Assessment Overlay mapping' and 'Model Code' provided by the Queensland Reconstruction Authority (with amendments where a Council considers them appropriate).

The final report of the Queensland Floods Commission of Inquiry was publicly released on 16 March 2012. This report dealt at considerable length with the land planning systems of the State and their application by Councils. The recommendations were designed to insert into the land planning system uniform controls which will ensure that

the risk of flood is consistently recognised and planning assessments made with regard to it.

1.4 MBRC CONTEXT

In 2012, Moreton Bay Regional Council commenced preparation of a planning scheme for the whole region. The new planning scheme development has taken precedence over the preparation of the Floodplain Risk Management Plan, in that Council has decided to focus on an interim floodplain risk management plan predominantly aimed at providing the specific analysis and detail necessary to draft the planning scheme.

The "Interim Floodplain Risk Management Plan" is to recommend management controls for development within the Moreton Bay Regional Council area.

Council has recently completed modelling for overland flow paths and rivers/creeks and is progressing rapidly with the risk assessment phase.

Council proposes to undertake a comprehensive Floodplain Risk Management Plan, incorporating a full suite of available strategies to manage risk on the floodplain, during the 2013/14 financial year.

Moreton Bay Regional Council was created by an amalgamation of Caboolture, Pine Rivers, and Redcliffe councils in 2008. It is understood that the planning schemes of each of the constituent councils amalgamated to create Moreton Bay Regional Council continue to apply in their previous areas of operation. While there may be specific areas that require local conditions, there is a need for a consistent approach to floodplain risk management across the whole of the MBRC area of operations.

Accordingly, any Interim Floodplain Risk Management Plan must incorporate the relevant findings of the QFCI and the Guidelines and TSPP issued by the QRA but must also be consistent with the Moreton Bay Regional Floodplain Risk Management Framework and also reflect current best practice across Australia.

1.5 THIS STUDY

MBRC engaged Molino Stewart to undertake the preparation of an Interim Floodplain Risk Management Plan in January 2013.

2 REVIEW OF PLANNING CONTROLS

2.1 STATE PLANNING POLICIES

There are two important planning policies that currently cover flood management in Queensland. These planning schemes are:

- State Planning Policy (SPP) 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide
- Temporary State Planning Policy (TSPP) 2/11 (TSPP) – Planning for stronger, more resilient floodplains.

The SPP 1/03 details the process by which Council may designate a Natural Hazard Management Area (Flood) (NHMA). Section 5.2 states that, wherever practicable, natural hazard management areas should be identified through a comprehensive and detailed natural hazard assessment study. Outcome 4 of the SPP requires natural hazard management areas to be identified when planning schemes are made or amended.

The SPP sets out in Section 5.8 that in relation to flood hazard management, the State's position is that generally, the appropriate flood event for determining a natural hazard management area (flood) is the 1% Annual Exceedance Probability (AEP) flood.

The TSPP 2/11 creates the statutory mechanism by which Council may look to adopt the Interim Floodplain Assessment Overlay as part of their existing planning scheme. The TSPP suspends the effect of paragraph A3.1 and A3.2 of Annex 3 of SPP 1/03. The effect of the TSPP is to allow amendments to an existing planning instrument under the SPP for a NHMA (flood) to include:

- Land inundated by a Defined Flood Event (DFE) and identified in a planning instrument; or
- The Interim Floodplain Assessment Overlay mapping and Model Code provided by the Queensland Reconstruction Authority; or
- The Interim Floodplain Assessment Overlay mapping and Model Code as amended by the relevant Local Government.

The TSPP therefore allows MBRC to designate a NHMA (Flood) through a minor planning scheme amendment process.

TSPP 2/11 commenced on 14 November 2011 and was officially to remain in effect for a period of 12 months. At the time of writing, there has been no official extension to the TSPP with the State focusing on the development of the Single State Planning Policy. Part 1 of the Single SPP, draft Proposed State Interests was released in late 2012.

2.2 LOCAL GOVERNMENT PLANNING SCHEMES

Flood management in the MBRC area is presently covered by three planning schemes, one for each of the previous local government areas of Caboolture, Pine Rivers, and Redcliffe.

Table 1 summarises the current planning framework with respect to the defined storm tide event (DSTE), natural hazard management area (NHMA), sea level rise (SLR) and freeboard allowance across the three jurisdictions of MBRC.

The DFE for each planning schemes is the 1 in 100 year ARI, however the DSTE, SLR, NHMA and Freeboard are all different.

Freeboard allowance varies amongst the three jurisdictions from 225mm to 750mm. NHMA are depicted in terms of an overlay map for the Pine Rivers jurisdiction whereas no map is available for Caboolture and Redcliffe. The former Caboolture Shire has a DSTE base on the Qld Coastal Plan Hazard Maps. The SLR allowance adopted is the 2050 planning horizon varies across the three jurisdictions, yet it is no less than the Queensland Coastal Hazards Guideline (ref 20 - 300mm).

Table 1 - MBRC Current Planning Framework relating to DSTE, SLR, and NHMA

Variable	**MBRC Planning Scheme Jurisdictions**		
	Pine Rivers	**Redcliffe**	**Caboolture**
DFE	Fluvial – 100 yr ARI	Fluvial - 100 yr ARI	Fluvial - 100 yr ARI
DSTE (and corresponding DSTE level)	Storm Tide – 100 yr ARI level of 2.01m AHD as defined in the study Pine River and Hays Inlet Storm Surge Study (JWP & Cardno Lawson Treloar, December 2004)	Storm Tide - None, site specific assessments required for major development or standard minimum habitable floor height above kerb for small infill development	Storm Tide – based on the Default Storm Tide Level (Qld Coastal Plan Coastal Hazard Maps)[1]. An assumed HAT value of 1.3m AHD is assumed by Council
SLR (2050)	490mm allowance (DSTE level +SLR rounded down to 2.5m AHD for administrative purposes)	Site specific assessment required. Best practice applied at that time (no less than the Queensland Coastal Hazards Guideline (300mm).	300mm allowance as per State Defined maps
Freeboard	Fluvial – Section PSP28/4.10.1/Part 2: 750mm for new development affected by flooding in natural watercourses. Storm Tide – 750mm (based on the fact that PSP28 is silent on Storm Tide freeboard)	Fluvial - 30m buffer and 300mm freeboard (PSP 10) Storm Tide – 225mm	Section PSP4/8.9: 300mm on top of 100 yr ARI. This applies for both fluvial and storm tide events.

Natural Hazard Management Area	Overlay Map 8, Coast and River Lands Locality	Fluvial - Overlay Map 3 (includes the 30m buffer) Storm Tide – No overlay map available	No overlay map available - "natural Q100 flood hazard areas are depicted on Council's computerised spatial mapping system (GIS)."

[1] Referring to the draft Qld Coastal Plan (2011) as it was not enacted at the time when this STMS was prepared

2.3 QUEENSLAND FLOOD COMMISSION OF INQUIRY

The Queensland Floods Commission of Inquiry was established on 17 January 2011 to conduct a forensic examination into the events of the 2010/11 floods. The matters within the Commission's terms of reference included:

- Preparation and planning for the floods by governments and the community
- The performance of insurers in meeting their responsibilities
- All aspects of the response to the 2010/11 floods, particularly measures taken to inform the community and protect life and property
- Management of essential services
- The adequacy of forecasts and early warning systems
- The operation of dams
- Land use planning to minimise flood impacts.

On 16 March 2012, the Commission released its final report into the 2010/11 floods. The report was the result of extensive inquiry by the Commission into the matters within its terms of reference. The Commission's inquiries included considering over 700 written submissions, conducting 68 days of public hearings, taking evidence from 345 witnesses and convening community consultation sessions and meetings.

The final report contains 177 recommendations directed at a broad range of matters related to the 2010/11 floods, including: floodplain management, planning and building issues, the performance of private insurers, the impact of floods on operational and abandoned mines, the emergency response to the floods and dam management.

Of the report's 177 recommendations, 123 relate to areas of Queensland Government responsibility, 56 relate to local government responsibilities, eight relate to Commonwealth Government responsibilities, and seven recommendations relate to private entities.

Many recommendations are directed at both state and local governments or are dependent on action by the state to establish a consistent framework for implementation at a local level. These are presented in the format of "The State should do…" and then, "If the State does not do…, Council should do…".

In responding to the QFCI recommendations, MBRC has undertaken a range of actions and measures. These are detailed in **Error! Reference source not found.**.

Table 2 - Responses to QFCI Recommendations

State requirements	QFCI	Council's Current Actions	MBRC Potential Actions	Recommendations
Temporary State Planning Policy 2/11 (Council identification of Natural Hazard Management Areas (flood). Through the identification of NHMA (Flood) Local Governments can amend their existing planning schemes)	A recent flood study should be available for use in floodplain management for every urban area in Queensland. Where no recent study exists, one should be initiated.	Council has done • A Storm Tide Management Study (STMS); • An Overland Flow Path Mapping Study; and • A set of 14 Regional Floodplain Database Hydrologic and Hydraulic Modelling Reports.		Need to merge all data into a comprehensive approach to defining risk and management measures
The Sustainable Planning Act (2009) - Local government is required to prepare planning documents that identify areas of natural hazard, which includes flooding from all sources	By reference to the order of priority determined in accordance with recommendation 2.5, the Queensland Government and councils should together ensure that the council responsible for each urban area in Queensland has access to current flood study information. This will include determining: **A)** a process or processes by which the flood studies will be completed, including the involvement of the Queensland Government and relevant councils **B)** how, and from whom, the necessary technical and financial resources will be obtained **C)** a reasonable timeframe by which all flood studies required will be completed.	Council has done • A Storm Tide Management Study (STMS); • An Overland Flow Path Mapping Study; and • A set of 14 Regional Floodplain Database Hydrologic and Hydraulic Modelling Reports. Council has developed the Regional Floodplain Database - the RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area. **Flood search is now free for all registered parcels from Council's website**		In accordance with the MBRC FRMF, TSPP1/03 Guideline and best engineering practice, a consideration of the full range of flood risk needs to be considered in setting a DSTE. As a result, different DSTE levels for different areas will be recommended within the catchment (when exposed to different ranges of flood risk) and a different planning level (in m AHD) for different planning horizons. The NHMA should reflect those differences in DSTE levels and planning levels accordingly.
The Disaster Management Act 2003 (as amended to 2010): the functions of a local government under the DMA are to: ensure it has a disaster response capability (as outlined under s80 (2) of the DMA); approve its local disaster management plan prepared under part 3 of the DMA; ensure information about an event or a disaster in its area is promptly given to the district disaster coordinator for the disaster district in which its area is situated.	As far as is practicable, councils should maintain up-to-date flood information.	Council has done • a region wide flood investigation referred to as the 'Overland Flow Path Mapping Project" • Council has completed a Storm Tide Mapping Project • Council has developed the Regional Floodplain Database - the RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area.	Currently reviewing MBRC Emergency Management Plan and Sub-plans	Emergency Management Plan and Sub-plans need to incorporate findings of up to date river and creek, storm tide and overland flow studies.

State requirements	QFCI	Council's Current Actions	MBRC Potential Actions	Recommendations
Temporary State Planning Policy 1/03 Guideline: Mitigating the Adverse Impacts of Flood, bushfire and landslide. Section 5.2 states that the intention of the State Planning Policy is that, wherever practicable, natural hazard management areas should be identified through a comprehensive and detailed natural hazard assessment study. Outcome 4 of the SPP requires natural hazard management areas to be identified when planning schemes are made or amended, and these should be integrated with the planning strategies.	When commissioning a flood study, the body conducting the study should: • check whether others, such as surrounding councils which are not involved in the study, dam operators, the Department of Environment and Resource Management, and the Bureau of Meteorology, are doing work that may assist the flood study or whether any significant scientific developments are expected in the near future, and decide whether to delay the study • discuss the scope of work with the persons to perform the flood study as well as surrounding councils which are not involved in the study, dam operators, the Department of Environment and Resource Management, and the Bureau of Meteorology.	Council is doing this already		
	Elected representatives from councils should be informed of the results of each flood study relevant to the council's region, and consider the ramifications of the study for land planning and emergency management.	Council is doing this already		
	Councils in floodplain areas should, resources allowing, develop comprehensive floodplain management plans that accord as closely as practicable with best practice principles.	Council is in the process of developing a floodplain management study. In the interim, Council has commissioned an Interim Floodplain Risk Management Plan.		
	For urban areas or areas where development is expected to occur: **A)** councils with the requisite resources should develop a flood map which shows 'zones of risk' (at least three) derived from information about the likelihood and behaviour of flooding **B)** councils without the requisite resources to produce a flood behaviour map should develop a flood map which shows the extent of floods of a range of likelihoods (at least three).	Council has done a region wide flood investigation referred to as the 'Overland Flow Path Mapping Project" Council has completed a Storm Tide Mapping Project Council has developed the Regional Floodplain Database - the RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area.		
	Councils and the Queensland Government should display on their websites all flood mapping they have commissioned or adopted.	Council is doing this now		
	Flood maps, and property specific flooding information intended for use by the general public, should be readily interpretable and should, where necessary, be accompanied by a comprehensible explanatory note.	Flood search is free for all registered parcels from Council's website		

State requirements	QFCI	Council's Current Actions	MBRC Potential Actions	Recommendations
	Councils that do not currently do so should consider offering an online database which allows the public to conduct a search on a parcel of land to find development approvals relevant to that parcel of land.	Council has developed the Regional Floodplain Database - the RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area.	access to this database should be given to the public	
	Councils should consider using the limited development (constrained land) zone in their planning schemes for areas that have a very high flood risk.			Council should adopt a freeboard commensurate with the risks associated with the land in question. Single freeboard may not be warranted under social, economic and environmental concerns, as well as any flooding concerns.
	If the Queensland Government does not include a requirement for such an overlay map in the model flood planning controls (Recommendations 5.1 and 5.2), councils should include a flood overlay map in their planning schemes. The map should identify the areas of a council region: • that are known not to be affected by flood • that are affected by flood and on which councils impose planning controls (there may be subsets in each area to which different planning controls attach) • for which there is no flood information available to council.	Council has done a region wide flood investigation referred to as the 'Overland Flow Path Mapping Project" Council has completed a Storm Tide Mapping Project Council has developed the Regional Floodplain Database - the RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area.		
	If the Queensland Government does not include such a code in the model flood planning controls (Recommendation 5.4), councils should include in their planning schemes a flood overlay code that consolidates assessment criteria relating to flood.			Will be recommended in Interim Floodplain Risk Management Plan
	If the Queensland Government does not include such a policy in the model flood planning controls (Recommendation 5.6), councils should include in their planning schemes a planning scheme policy that: • for development proposed on land susceptible to flooding, outlines what additional information an applicant should provide to the assessment manager as a part of the development application, or • for development proposed on land where potential for flooding is unknown requires an applicant to provide - as part of the development application, information to enable an assessment of whether the subject land is susceptible to flooding, and - upon a determination the subject land is susceptible to flooding, more detailed information to allow an assessment of the flood risk.			Will be recommended in Interim Floodplain Risk Management Plan

State requirements	QFCI	Council's Current Actions	MBRC Potential Actions	Recommendations
	If the Queensland Government does not include such assessment criteria in model flood planning controls, (Recommendations 7.1 and 7.2) councils should include assessment criteria in their planning schemes that require community infrastructure (including the types of community infrastructure which are identified in the Sustainable Planning Regulation 2009 and which the community needs to continue functioning, notwithstanding flood) to be located and designed to function effectively during and immediately after a flood of a specified level of risk.			Will be recommended in Interim Floodplain Risk Management Plan
	If the Queensland Government does not include such assessment criteria in the model flood planning controls (Recommendation 7.4), councils should include assessment criteria in their planning schemes that require the impact of flood on commercial property to be minimised.			Will be recommended in Interim Floodplain Risk Management Plan
	When approving applications for development which involve the manufacture or storage of hazardous materials, councils should not restrict the conditions imposed to ones which are solely reliant on human intervention to remove the materials in the event of flood.			Will be recommended in Interim Floodplain Risk Management Plan
	If the Queensland Government does not include such assessment criteria in the model flood planning controls (Recommendation 7.11), councils should include assessment criteria in their planning schemes that require that: **A)** the manufacture or storage of bulk hazardous materials (as defined in State Planning Policy 1/03) take place above a certain flood level, determined following an appropriate risk based assessment, or **B)** structures on land susceptible to flooding and used for the manufacture or storage of bulk hazardous materials (as defined in State Planning Policy 1/03) be designed to prevent the intrusion of floodwaters.			Will be recommended in Interim Floodplain Risk Management Plan
	If the Queensland Government does not include such assessment criteria in the model flood planning controls (Recommendation 7.24), councils should consider including assessment criteria in their planning schemes that address: • the prospect of isolation or hindered evacuation • the impact of isolation or hindered evacuation.			Will be recommended in Interim Floodplain Risk Management Plan.
	Councils should, resources allowing, maintain flood maps and overland flow path maps for use in development assessment. For urban areas these maps should be based on hydraulic modelling; the model should be designed to allow it to be easily updated as new information (such as information about further development) becomes available.	Council has developed the Regional Floodplain Database - the RFD includes the development of coupled hydrologic and hydraulic models for the entire local government area.		

State requirements	QFCI	Council's Current Actions	MBRC Potential Actions	Recommendations
	Councils should make their flood and overland flow maps and models available to applicants for development approvals, and to consultants engaged by applicants.	Maps are now available Flood and overland flow maps and models available to applicants for development approvals, and to consultants engaged by applicants.		While maps are available, methods to explain maps in electronic view, as well as face-to-face need to be developed. Will be recommended in Interim Floodplain Risk Management Plan
	Councils should take care when imposing conditions to ensure that each condition has purpose; standardised conditions should not be included where they have no application to the development in question.			Will be recommended in Interim Floodplain Risk Management Plan
	Councils should not rely on a condition requiring an evacuation plan as the sole basis for approving a development susceptible to flooding.			Agree very strongly – MBRC should adopt recommendation.
	Councils should consider providing advice to development applicants during pre-lodgement meetings, and at the time of receiving a development application, about the way in which the development will be assessed for flood risk and what flood information council will be relying on to make this assessment.			Need to establish clear guidelines for addressing development applications, taking into account size, value and risks (all risks) into account.
	All councils should, resources allowing, map the overland flow paths of their urban areas.	Council has done a region wide flood investigation referred to as the 'Overland Flow Path Mapping Project"		
	If the Queensland Government does not include such a policy in the model flood planning controls (Recommendation 8.3), councils should include a planning scheme policy in their planning schemes that sets out the information to be provided in development applications in relation to stormwater and flooding. The policy should specify: • the type of models and maps to be provided • the substantive information required to be shown in the development application • how the assumptions and methodologies used in preparing the models and maps should be presented • the form in which the information on stormwater and flooding is to be presented in the application. Councils should review their assessment processes to ensure that: • the person with primary responsibility for the assessment of the development application considers what expert input is required • where a development application is subject to comment by a number of professionals, the responsibilities and accountability of each contributor are clear • where flood-related information is referred to an expert for advice, the expert is required to comment on the extent of compliance by reference to each relevant assessment criteria and identify and explain any inability to comment.	Council has adopted a consistent methodology for flood modelling across all of its catchments	Develop a standard stormwater and flooding policy across the Council. Develop a flood modelling guideline for developers and their consultants to ensure assumptions and methods used for their flood modelling are consistent with those used by Council.	

State requirements	QFCI	Council's Current Actions	MBRC Potential Actions	Recommendations
	Councils should consider amending their planning schemes to include provisions directed to consideration of the flood resilience of basements as a factor in determining the appropriateness of a material change of use.			Will be recommended in Interim Floodplain Risk Management Plan
	In assessing and determining development applications for material change of use in areas susceptible to flood, councils should consider whether the new developments locate essential services infrastructure above basement level, or, alternatively, whether essential services infrastructure located at basement level can be constructed so that it can continue to function during a flood.			Will be recommended in Interim Floodplain Risk Management Plan
	Councils should consider implementing a property buy-back program in areas that are particularly vulnerable to regular flooding, as part of a broader floodplain management strategy, where possible obtaining funding from the Natural Disaster Resilience Program for this purpose.			Will be recommended in Interim Floodplain Risk Management Plan
	Councils should support and encourage business owners to develop private flood evacuation plans by providing the following to business owners in areas known to be affected by flood: • information about the benefits of evacuation plans • contact details of relevant council and emergency service personnel for inclusion in evacuation plans			Will be recommended in Interim Floodplain Risk Management Plan
	Councils should consider making available to business owners locality specific information that would assist them to develop evacuation plans for commercial premises, for example, any evacuation sub-plan created under Emergency Management Queensland's disaster evacuation guidelines.			Will be recommended in Interim Floodplain Risk Management Plan

3 REVIEW OF TECHNICAL DATA

3.1 GENERAL

The technical basis for floodplain risk management within the Moreton Bay Regional Council area rests on three strands of investigation:

- A Storm Tide Management Study (STMS);
- An Overland Flow Path Mapping Study; and
- A set of 14 Regional Floodplain Database Hydrologic and Hydraulic Modelling Reports.

The following sections consist of a summary review of the currently available studies and conclude with recommendations for further investigations as part of the longer term Floodplain Risk Management Plan.

3.2 STORM TIDE MANAGEMENT STUDY,

This Storm Tide Management Study (STMS) was undertaken by consultants GHD, and is dated April 2012.

3.2.1 Methodology

The methodology adopted in the STMS followed the MBRC Floodplain Risk Management Framework (Draft). The stages involved in the study included:

- Data collection, collation and review;
- Review of the Defined Storm Tide Event, Sea Level Rise and MBRC Natural Hazard Management Area;
- Hydraulic hazard categorisation;
- Topographic classification;
- Flood risk assessment;
- Flood damages calculation;
- Proposed management options; and
- Consideration of Climate Change implications.

The STMS determined the likelihood of storm tide risk based solely on the 2009 Storm Tide Hazard Study (STHS) commissioned specifically for MBRC. However, GHD noted a key limitation in the 2009 Study is that the modelling in the 2009 Study is limited to producing peak still water levels. No hydrodynamic propagation of storm tide into the floodplain was undertaken and thus there is no estimate of peak velocities resulting from the storm tide events.

3.2.2 Key Activities

The main activities in the STMS included:

- Four categories of hazard within the storm tide floodplain were determined based on an extension of existing fluvial floodplain guidelines and used to assign hazard for all required return periods within the study area. This hazard categorisation was then used within the flood risk assessment.
- The floodplain's topography was categorised to assist in determining areas at risk of isolation during flood, evacuation routes and areas with lower flood risk. Six different floodplain topographic categories were determined for the whole study area.
- A systematic flood risk analysis was carried out to determine five different flood risks: (a) risk to personal safety; (b) risk to property; (c) risk of isolation; (d) risk to road access; and (e) risk to infrastructure. The study area was divided into 10 geographical areas referred to as 'flood precincts', which in turn were prioritised in terms of their flood risk rating. The Beachmere flood precinct was identified as the geographic area with the highest flood risk from storm tide.
- Flood damage estimation from storm tide was carried out based on an extension of existing fluvial floodplain guidelines. Average Annual Damages for both the estimated existing and the potential future climate change scenario were determined for the whole of the study area as well as for the individual flood precincts.
- The existing MBRC Defined Storm Tide Event (DSTE), Natural Hazard

Management Area (NHMA), Sea Level Rise (SLR) and freeboard provisions were reviewed and potential alternatives were identified for further consideration.

- Management options such as planning instruments review and appropriate warning and evacuation procedures were identified as being the most efficient management options to mitigate identified storm tide risks.
- Climate change implications were examined, particularly the potential impact of climate change on the risk assessment results and the management options.

3.2.3 Results

The results of the STMS indicate that:

- Without velocity data, extreme flood hazard was predominately driven by maximum flood depth.
- Extreme flood hazard is located predominantly at river estuaries and canal systems where water depth is high. The extent of extreme flood hazard in populated areas is minimal and localised (e.g. Beachmere) even for the rarer events (e.g. 1,000 and 10,000 year ARI design events).
- The active wave zone (i.e. the strip of land adjacent to the coastline which is affected by waves) is identified as having high to extreme flood hazard. Usually the high hazard does not extend significantly inshore. The definition of hazard within the active wave zone is limited due to the absence of hydrodynamic model results and based on empirical relationships.
- High flood hazard areas are predominantly driven by water depth as well as wave activity (e.g. coastline north of Caboolture River). Localised pockets of high flood hazard do occur throughout the study area for a number of return periods and include areas in Toorbul, Bellara, Newport (including the airport) and Dohles Rocks.
- Medium and Low hazard areas are mostly characterising the built areas within the Study Area.

Overall, along the Moreton Bay coastline storm tide risk varies considerably, indicating pockets of high and extreme hazard during rare events (100 year ARI events or rarer), some of which are populated or have the potential to be developed.

The dominant storm tide mechanism affecting Moreton Bay was adopted as the East Coast Low whose characteristics are of a relatively slow moving storm tide long-wave entering into the floodplain. However, it should be noted that the most recent event was as a result of a decaying cyclonic system (Tropical Cyclone Oswald) travelling south from an area near Townsville.

3.2.4 Recommendations

The study recommended:

- Carrying out a further investigation of the preferred management options for the different flood risks identified considering in detail the impact potential climate change may have in adopting them. Proposed management options may have to be reviewed when MBRC's Coastal Hazard Adaptation Strategy is prepared as per SPP 3/11 (Coastal Hazard Adaptation Strategies).
- Revise the risk acceptability thresholds and the Defined Storm Tide Event by carrying out a MBRC, community and stakeholder consultation.
- Revise the MBRC Floodplain Risk Management Framework (Draft) to include lessons from this study.
- Ongoing future reviews of the Defined Flood Event and Natural Hazard Management Area be undertaken at intervals of not more than 10 years reflecting updated understanding of the storm tide hazard and related climate change implications. This recommendation is in line with the QCP recommendations.

In terms of improving the outcomes of the STMS, it was recommended that:

- The 2009 Storm Tide Hazard Study recommendation relating to tropical cyclone and east coast low impacts is revised to appropriately depict probability assigned to the resulting still water levels.
- A hydrodynamic model of the inundation scenarios and processes should be

developed to refine the analysis carried out as part of this study.

- A property floor level survey in the storm tide floodplain be undertaken to better depict risk to property and flood damage estimates. The damages estimates need to be based on a set of consistent stage-damage curves. Additionally, it would be advisable to consider incorporating damages resulting from wind and fluvial flooding joint probability events.
- Review the isolated population trigger value in the risk of isolation risk table to reflect the MBRC population density within isolated areas.
- Consider funding mechanisms, maintenance and compliance with the QCP for the management options put forward.
- Define the active wave zone in more detail using empirical methodologies or hydrodynamic model results where available
- The risk analysis results of this STMS are recommended to be shared with DCS, EMQ, and utility providers since it will provide them with valuable information in managing their operations and assets.
- Review the STMS in view of the enacted QCP (SPP 3/11).

3.3 OVERLAND FLOW STUDY

The overland flow flooding information was based on an MBRC Technical Report titled Overland Flow Path Mapping November 2012.

Council became aware of the need for overland flow path mapping across the region in response to a thunderstorm event in November 2008 affecting Council's southern suburbs. The need for mapping has since been supported by the 2011 Queensland Floods Commission of Inquiry Recommendations.

3.3.1 Objectives

Council's Overland Flow Path mapping project sought to achieve the following objectives:

- Provide detailed mapping of all overland flowpaths across the region, in particular densely populated urban areas;
- Provide consistency of approach across the region;
- Permit the identification of areas that are of high and low risk of overland flooding;
- Develop a model system that would permit selective future upgrade in areas of high risk.

Providing Council with regionally reliable overland flow path flood data will also help to prioritise a capital program of drainage upgrades.

More recently the Queensland Floods Commission of Inquiry made the following recommendations in its final report which also provides justification for Council.

> *8.1* ***Councils should, resources allowing, maintain flood maps and overland flow path maps*** *for use in development assessment. For urban areas these maps should be based on hydraulic modelling; the model should be designed to allow it to be easily updated as new information (such as information about further development) becomes available.*
>
> *8.2* ***Councils should make their flood and overland flow maps and models available*** *to applicants for development approvals, and to consultants engaged by applicants.*

3.3.2 Methodology & Results

The methodology involved 'rainfall on grid' hydraulic modelling of the 895 catchments (identified within the 14 major catchments of the MBRC area) and post processing the data (depth and velocity) to map areas at risk from overland flows.

The TUFLOW model methodology produced consistent reliable output for velocity, depth and flows within each of the 895 catchments. This is a suitable basis for post processing to determine the overland flow path extent. This extent highlights areas where there is a risk of overland flow occurring.

3.3.3 Model Limitations

The overland flow flood mapping has been prepared using a model representation of the ground surface and assumed rainfall characteristics. Accordingly the flood mapping has inherent uncertainty due to these assumptions.

Whilst the data has been prepared using a reliable methodology, there are some key limitations, raised in the report, that need to be highlighted:

- The mapping does not include very small flowpaths at the upper reaches of catchments. These are beyond the resolution of the terrain data used.
- Flow paths disregard building footprints and hence pass right through them. In these situations a more detailed local assessment is recommended to assess actual building susceptibility to overland flow. In many cases overland flow may not actually enter the building.
- Some over-estimation is present at the outlets of the 895 catchments. This is generally covered by the existing interim 100 year river and creek flood surface or has been manually corrected.
- The mapping is not able to identify local effects created by impermeable fences or fences that become impermeable through the accumulation of debris, etc. In these circumstances, the actual flood extent could be greater than predicted.
- The data shows an extent of potential inundation only. It is not appropriate to provide levels as typically the overland flowpaths identify shallow inundation that is running along the ground contours and therefore any flood level provided will be subject to surface conditions and localised modifications.

3.3.4 Conclusion

Overland flowpaths and local drainage network vulnerability have not been well recognised in traditional flood studies.

Council identified a low cost methodology for the efficient preparation of overland flowpath mapping across a large region. In particular the use of automated tools for the preparation and post-processing of model files allowed council to achieve the project objectives in a timely and cost efficient manner.

The mapping is useful for:

- Understanding local drainage flood characteristics;
- Identifying hot spots of high flood damage and nuisance;
- Describing local drainage flood behaviour to residents and stakeholders making land use decisions;
- Providing the Development Services and Building Services branches of Council overland flow flood behaviour information to assist with determining appropriate building and development controls;
- Prioritise a program of drainage upgrades.

It should also be noted that the mapping is not presented separately on Council's website; it is presented as a scenario within the Rivers & Creeks mapping.

3.4 REGIONAL FLOODPLAIN DATABASE

The projects under this program involved hydrologic and hydraulic modelling of the identified sub-catchments within the MBRC local government area. The work was carried out by a range of consultants between 2009 and 2012. All reports are available to be read from Council's website.

3.4.1 Objectives

Key objectives of this study are as follows:

- Utilise the existing broad scale model to develop a detailed and dynamically linked two-dimensional and one-dimensional (2D/1D) hydrodynamic model of the relevant catchment using input data that were determined and provided by MBRC or other consultants; and
- Provision of all relevant flood information obtained from the modelling, which will form the base input data for Stage 3 of the RFD.

3.4.2 General Approach

The general approach for this study is summarised as follows:

- Review existing broad scale WBNM hydrologic model and results;
- Review existing broad scale TUFLOW modelling;
- Refine the TUFLOW modelling to include a refined grid size and any additional structure and topographical information;
- Investigate the feasibility of calibrating and/or verifying the combined WBNM and TUFLOW models using two historical events. There was sufficient historical information available for this task, therefore calibration was undertaken;
- Undertake a critical storm duration assessment for the 10 year ARI event, 100 year ARI event and the PMF;
- Simulate a large range of design flood events (1, 2, 5,10, 20, 50,100, 200, 500, 1000, 2000 year ARI events and PMF events) for up to three selected critical durations;
- Assess model sensitivity to future land use patterns, Manning's 'n', structure blockage, climate change and downstream boundary conditions;
- Provide a concise report describing the adopted methodology, study data, model results and findings. The emphasis of the RFD project is on digital data management. Therefore only the 100 year ARI event was mapped in this report; and
- Compilation of models and model outputs for provision to MBRC.

3.4.3 Conclusions & Recommendations

The hydrologic modelling works undertaken in these studies utilised the WBNM (Watershed Bounded Network Model) software to calculate flood flow hydrographs for a range of design storm events. These were used as inflows to the hydraulic model developed for the various basins/sub-catchments.

The hydraulic assessment under this project included the development of a detailed 5m grid TUFLOW hydraulic model, a dynamically-linked 2D/1D hydrodynamic numerical model for the UPR minor basin to run all the selected critical durations for the 1, 2, 5, 10, 20, 50 and 100 ARI design events to achieve the highest resolution design event flood results.

A detailed 10m grid TUFLOW hydraulic model was also developed to run the very large and extreme flood events including the 200, 500, 1000, 2000 year ARI and the PMF events as well as the calibration/validation and model sensitivity analysis runs. The chosen 10m cell size was considered to be sufficiently detailed to determine flood behaviour for the extreme large events, calibration/validation and sensitivity analysis runs without extensive model run times.

Separate critical storm duration assessments have been undertaken for the minor events (1, 2, 5 and 10 year ARI event), moderate and major events (20, 50 and 100 year ARI), very large and extreme events (200, 500, 1000, 2000 year ARI and the probable maximum flood (PMF) event) to determine three (3) critical storm durations for each design flood event for the purpose of predicting the peak flood behaviour.

Based on the critical duration assessments, the TUFLOW model was utilised to run for the following three (3) nominated storm durations for each design flood event:

- Minor events (1, 2, 5 and 10 year ARI) - 2hr, 3hr and 24hr;
- Moderate and major events (20, 50 and 100 year ARI) - 2hr, 3hr and 24hr; and
- Very large and extreme events - 2hr, 3hr and 5hr.

The 15 minute burst in a 270 minute 100 year Embedded Design Storm (EDS) has been adopted and applied to the TUFLOW model. The EDS is useful for initial investigations into changes in model parameters and minor basin characteristics, as it reduces the number of model runs required. The adopted EDS storm was utilised as a base case for the comparison to model sensitivity, climate change and future land use scenarios.

The Regional Floodplain Database is focused on structuring model input and output data in a GIS database held by MBRC. Therefore, all

model input and output data in digital format was provided to MBRC at the completion of the individual study. The data included all model files for all the design events, sensitivity analysis, climate change assessment and future land-use scenarios.

3.5 FLOODPLAIN RISK MANAGEMENT STUDY

3.5.1 Background

As part of the Regional Floodplain Database project (RFD), Moreton Bay Regional Council (MBRC) is seeking to compliment and build upon its library of model data by creating products that will support Council's future floodplain management decisions. This desire has manifested into the Moreton Bay Regional River and Creek Floodplain Risk Management Study – Phase 1, currently being completed by Molino Stewart Pty Ltd.

Table 3 - Catchment Identifiers

Catchment	Abbreviation
Brisbane Coastal Catchments	BCC
Bribie Island	BRI
Burpengary Creek	BUR
Byron Creek	BYR
Caboolture River	CAB
Hays Inlet	HAY
Lower Pine River	LPR
Mary River	MAR
Neurum Creek	NEU
Pumicestone Passage	PUM
Redcliffe	RED
Sideling Creek	SID
Stanley River	STA
Upper Pine River	UPR

Phase 1 of the Floodplain Risk Management Study will feed into the rest of the RFD and assist in the floodplain management decision making process.

3.5.2 Objectives

The project objective is to generate data that will assist in Council's decision making process as well as provide data for the future MBRC Floodplain Risk Management Study – Phase 2 and the MBRC Floodplain Risk Management Plan (Rivers and Creeks).

The overall objective of the project is essentially to define the flooding problem on a catchment scale. Further detailed investigations of the key floodplain management issues may uncover that the risks have been over or under stated in some cases.

Specifically, the study aims are to:

- Undertake Topographic Categorisation of the catchment
- Determine the hydraulic hazard for a range of events for the catchment
- Assess the risks to personal safety, property, isolation and key infrastructure
- Estimate the likely flood damages within the catchment.
- Identify key areas and provide a summary of key floodplain management issues for detailed review and investigation.

Many of the tasks and processes undertaken in the Phase 1 Study have been completed.

3.5.3 Outputs

Using the data generated by the Regional Floodplain Database projects the DTM and floor level data already held by Council, this study produced the following data for the 14 catchments identified by MBRC:

- Topographic Classification
  - Connected Flood Free (CFF)
  - Isolated Flood Free (IFF)
  - Low Flood Island (LFI)
  - Rising Road Access (RRA) to IFF
  - Rising Road Access (RRA) to CFF
  - Overland Escape Route(OER) to IFF
  - Overland Escape Route (OER) to CFF
- Hydraulic Hazard Classification
- Risk Assessment
  - Risk to Personal Safety (Residential)
  - Risk to Personal Safety (Commercial)
  - Risk to Property (Residential)
  - Risk to Property (Commercial)
  - Risk of Isolation
  - Risk to Road Access
  - Risk to Critical Infrastructure
- Flood Damage Estimation
- Summary of Floodplain Issues

3.5.4 Conclusions & Recommendations

This study was designed to provide additional data relating to the risks associated with the occupation of the floodplains of the MBRC area, both now and into the future.

This data would then be used to provide the technical data for Phase 2 of the Floodplain Risk Management Study and the eventual Floodplain Risk Management Plan.

Summary Results are presented in the following Tables.

Table 4 - Topographic Classification - MBRC

Classification	% Total Area
CFF	36
IFF	40
RRA	7
OER	13
LFI	4

Table 5 - Numbers of Properties in Flooded Topographic Categories

Category	Residences	Commercial and Industrial Buildings
RRA	20,609	1,515
OER	1,867	207
LFI	5,503	817
Total	27,979	2,539

Table 6 - Risk to Personal Safety (Residential Properties)

Status	Number
Acceptable	11,253
Tolerable	8,667
Unacceptable	6,273

Table 7 - Risk to Personal Safety (Commercial)

Status	Number
Acceptable	1,145
Tolerable	783
Unacceptable	451

Table 8 - Risk to Property (Residential)

Status	Number
Acceptable	10,623
Tolerable	5,039
Unacceptable	1,493

Table 9 - Risk to Property (Commercial)

Status	Number
Acceptable	782
Tolerable	574
Unacceptable	347

Table 10 - Risk of Isolation

Risk	Building Count*	Estimated Population**
No Risk	147,352	207,131
Acceptable	13,921	19,569
Tolerable	31,564	44,369
Unacceptable	76,102	106,976

*Includes all buildings (sheds, garages etc.)

**Based on 2011 Census Data, total MBRC LGA population proportioned to each risk level.

Table 11 - Average Annual Damages

Event ARI	Total Damage ($million)	Contribution to AAD ($million)	Percentage of Total AAD
5	142.9	21.4	2
10	189.4	16.6	1
20	232.8	10.6	1
50	285.4	7.8	2
100	376.0	3.3	3
200	466.9	2.1	5
500	627.2	1.6	12
1000	765.7	0.7	16
2000	887.2	0.4	25
PMF	4,154.7	1.2	33
	Total AAD	65.8	

Table 12

Note that Risk to Infrastructure is a complex set of results and is best seen in the context of the project report. As an indication of the breadth of coverage applied by Risk to Infrastructure, the following have been identified as having an Unacceptable Risk:

- One segment of subarterial road;
- 73 segments of arterial road;
- 12 segments of highway;
- 28 segments or motorway;
- 117 segments of critical evacuation routes (some of which are included in the list of road segments above);
- 91 segments of electricity transmission lines;
- Evacuation centres, emergency service stations and waste management facilities as listed in

It should also be noted that due to data limitations, the risk to road and electricity infrastructure may be overestimated and it is recommended that more detail be obtained for the locations where an unacceptable risk has been identified.

Furthermore, there was insufficient data available to be able to assess the risks to rail, water, sewerage, gas or telecommunications infrastructure.

Table 12 - Unacceptable Risk – Infrastructure

Infrastructure Type	Facility	Catchment
EMERGENCY	Strathpine Community Hall	LPR
EMERGENCY	PCYC Arana Hills	BCC
EMERGENCY	Dayboro Community Hall	UPR
EMERGENCY	Bribie Island Recreation Hall	BRI
EMERGENCY	Albany Creek Police Station	LPR
EMERGENCY	Burpengary Police Station	BUR
EMERGENCY	Bribie Island Police Station	BRI
EMERGENCY	Petrie Police Station	LPR
EMERGENCY	Ambulance - Caboolture	CAB
EMERGENCY	Caboolture Fire Station	CAB
EMERGENCY	Deception Bay Police Station	BUR
EMERGENCY	Strathpine Police Beat Shopfront	LPR
EMERGENCY	Rural Fire Brigade Station	LPR
EMERGENCY	Rural Fire Brigade	PUM
WASTE	Toorbul Transfer Station	PUM
WASTE	Murrumba Downs Waste Depot	LPR

3.6 REVIEW FINDINGS

The review of the technical studies has indicated the following that will need to be addressed in either the interim Floodplain Risk Management Plan or the longer term Plan, to be developed once a broader range of studies are completed.

The issues to be addressed include:

- For Storm Tide scenarios:
  - Carrying out detailed investigation of potential management options for Storm Tide scenarios. These will have to conform to SPP 3/11 (Coastal Hazard Adaptation Strategies);
  - Regular reviews of the MBRC DFE, DSTE and Natural Hazard Management Area are undertaken at intervals of not more than 10 years;
  - A hydrodynamic model of the Storm Tide inundation scenarios and processes be developed to appropriately establish probabilities and relevant design levels, and to define the active wave zone;
- For Overland Flow:
  - The inter-relationship of overland flow to both Creek and River flows and Storm Tide (as tailwater) needs to be developed. The potential application of an envelope of worst case scenarios need to be investigated.
- For Rivers & Creeks:
  - Although these studies are well researched and carried out (though details cannot be checked in this study), the need to match the creek/river flood event with the potential tailwater levels arising from storm tides/surge may require further revision and adjustment of the very

downstream flood depths and flow velocities.

- Across all Flood scenarios
  - As an Interim Measure, the results of the various investigations should be adopted for use in planning decisions. However, there remain questions regarding joint probabilities of events, the adoption of designated flood or storm tide levels/events and whether an envelope of worst case (or other case) scenarios should be adopted for the long-term;
  - The risk assessments should be undertaken on a consistent basis and addressing a consistent set of risks, based on the Phase 1 FRMS work;
  - A property floor level survey is needed in the storm tide floodplain (up to the probable maximum event) to better depict risk to lives and property and to improve flood damage estimates.
  - The damage estimates need to be revised, based on a set of consistent stage-damage curves. The damage estimates also need to consider joint probability events.
  - Determine potential funding mechanisms, maintenance and compliance with the QCP for the management options put forward.
  - Review the Interim Plan in view of the Queensland Coastal Plan (February 2012) and the Temporary State Planning Policy 2/11: Planning for stronger, more resilient floodplains (September 2011).
  - Community and stakeholder consultation and engagement are essential to the acceptance and adoption of relevant planning controls. It is also essential to the application of emergency measures and actions in the event of a major flood in the MBRC area.

4 REVIEW OF EMERGENCY MANAGEMENT

4.1 GENERAL

The emergency management (Response Management) plans within MBRC are the MBRC Local Disaster Emergency Management Plan 2011, a broad-brush description of emergency management arrangements, and the Threat Specific Sub-plan – Severe Weather Event (August 2011), which provides the mechanisms for managing creek and river flooding, storm tide events and overland flooding within MBRC.

4.1.1 Local Disaster Emergency Management Plan 2011

The review of this document must commence with a discussion on the definition and use of the word/term Risk.

a) Risk

Risk is becoming more commonly used in the planning for and the response to a range of natural phenomena that may result in a disaster for the natural or man-made environment.

But what is Risk? How do we define this apparently valuable yet amorphous concept so important in our lives and, in some cases, professional life? Some definitions below may help:

AS/NZS ISO 31000:2009 defines Risk as "effect of uncertainty on objectives" – to the layman, that is gibberish, to the professional, it leaves much to be desired as a definition for use in educating the population "at risk". Note 3 to this definition reads "Risk is often characterised by reference to potential events and consequences, or a combination of these" (underlining by author).

National Emergency Risk Assessment Guidelines (October 2010) define Risk as "The effect of uncertainty on objectives. For emergency risk assessments the effect is usually a negative deviation from the expected and is characterised by hazardous events and the likelihoods of particular consequences."

Australian Emergency Management Glossary defines Risk as:

- "A concept used to describe the likelihood of harmful consequences arising from the interaction of hazards, communities and the environment."
- "The chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood."
- "A measure of harm, taking into account the consequences of an event and its likelihood. For example, it may be expressed as the likelihood of death to an exposed individual over a given period."
- "Expected losses (of lives, persons injured, property damaged, and economic activity disrupted) due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability."

Both the NSW Floodplain Development Manual (2005) and the NFRAG Consultation Draft of Managing the Floodplain (v9 NFRAG–August 2012) provide a definition of Risk as a "chance of something happening that will have an impact". They continue that Risk is "measured in terms of consequences and likelihood" and, in the context of the Manual in particular, "it is the likelihood of consequences arising from the interaction of floods, communities and the environment".

If Risk is a combination of likelihood (or probability) and consequence, then it cannot be defined as a chance, as chance is solely related to likelihood (or probability) and does not account for consequence.

BusinessDictionary.com provides a number of definitions of Risk (only two used here):

1. A probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action.

6. In the workplace: Product of the consequence and probability of a hazardous event or phenomenon.

It would seem that definition 6 contains the true definition of what risk managers want to address – risk must be an effect/a product of the combination of the likelihood/chance/probability of the hazard occurring and the consequences of that hazard occurring.

Finding: It is understood that the 2011 plan is under review and it is recommended that a definition of Risk as a "Product of the consequence and probability of a hazardous event or phenomenon" be adopted for that review.

b) Other Issues

- Glossary and other references (footnotes, etc.) need to refer to AS/NZS ISO 31000:2009 rather than AS/NZS 4360:2004. Definitions/Glossary should be amended as necessary.
- Reorder or possibly recast Section 1.1 "Purpose of Plan" so that the primary function is initially established as "reducing the impact of a natural disaster on the MBRC region so that the consequences for the community are mitigated/minimised".
- Bring Social data up-to-date with 2011 Census data. Use detailed suburb or division data to highlight potential issues with language, custom, etc.
- Locations of Emergency Services and medical facilities should be listed, as well as highlighting the LDCC at Strathpine offices. The listings in the Threat Specific Sub-plan would be appropriate here however their locations, and the location of the LDCC, should be examined in light of the risk assessments carried out in Molino Stewart Pty Ltd (2013) MBRC Floodplain Risk Management Study Stage 1 (Draft).
- Essential Services should be mapped/highlighted for immediate identification.
- Where are the sensitive facilities, what hazards do they face and what measures have been adopted to address these issues?
- Section 2.3.1 and Tables need significant review.
- Would not use term "insignificant risk" (p35) – it may be significant to those injured, displaced or suffering some financial loss and it is an impact, not a risk. Maybe a term of "minimal impact" would be better.
- Make sure hyperlinks work (e.g. www.disaster.qld.gov.au/publications does not)

4.1.2 Threat Specific Sub-plan

a) General

It is important to note for this Sub-plan that the Bureau of Meteorology does not issue site specific flood warnings in the MBRC region. Because the catchments within MBRC are considered as "flash flood", under the BoM's definition, it only provides severe weather/thunderstorm warnings for the region.

To address this, MBRC has constructed its own network of rain gauges and stream gauges and is preparing a flood warning manual to emulate site specific warnings of the BoM (as supplied to other areas). This documentation and process must be incorporated into the Sub-plan.

b) Sensitive Land Uses and Critical Utilities and Uses

The Sub-plan annexures need to fully list in the document:

- **Sensitive land uses** generally either:
  - Need to be evacuated during periods of flood because of the vulnerability of occupants;
  - Are essential to flood operations and recovery; or
  - Would, if affected during flood events, unreasonably affect the ability of the community to return to normal activities after flood events.
- **Sensitive land uses** include:
  - Community facilities or Public administration buildings which may provide an important contribution to the notification and evacuation of the

community during flood events(e.g. SES Headquarters and Police Stations, but excluding counselling services, community development centres, libraries, museums, galleries, visitor information centres, and the like);

- Child care centres;
- Hospitals;
- Residential care facilities;
- Seniors housing; and
- Educational establishments.

- **Critical Utilities and Uses** are those which would:
  - Cause significant pollution or create other hazardous situations
  - Be needed to provide essential services during and after a flood
- Critical Utilities and Uses include:
  - Hazardous industries;
  - Hazardous storage establishments;
  - Offensive industries;
  - Offensive storage establishments;
  - Liquid fuel depots;
  - Public utility undertakings which may cause pollution of waterways during flooding;
  - Telecommunication facilities; and
  - Waste management facilities.

In addition to the above land uses, electricity substations are a particular type of public utility undertaking which are particularly vulnerable to flooding and are part of an essential service. Regional and zonal electricity substations supply large numbers of customers, often outside of the flood affected area. It is preferable to avoid locating these within the floodplain.

c) Other Issues

- Section 3.1 states "LDMG will most likely provide the following". It is considered preferable, in plans of this nature, that a more positive/active approach is adopted to this and other matters, e.g., "LDMG will provide…" or "LDMG will issue…".
- Section 4.12 needs to discuss and advise on value adding to warnings. LDMG may wish to consider specific formatting of flood warning messages so that there is both technical (river height, timing) and potential impact (streets flooded or areas cut off) included in the warning. The warning should also give advice as to what measures the persons affected should take, from evacuation now to protection of buildings or contents.
- Section 4.12.3 needs to define what is meant by minor, moderate, major flood on each creek/river system.
- The Sub-plan needs to ensure that all potential agencies and service providers know what requirements they may be called upon to provide. Thus, single groups should not be singled out (e.g. Telstra) when there are many others that may be required to respond. The other issue will be underground cabling for enterprises such as the NBN and what steps/actions are highlighted to address such issues, clearly brought into focus by the cable failure near Bundaberg in February 2013.

In regard to the comment on Section 4.12 above, such information should, as much as possible, be composed outside the times of an event so that careful consideration and reflection can be given to the wording to ensure it is clear and unambiguous. Composing detailed messages during an event is both time consuming (when it is precious) and runs the risk of ambiguous or misleading wording when there is little time for review.

5 FLOODPLAIN RISK MANAGEMENT OPTIONS

5.1 GENERAL

There are three generally recognised ways of managing floodplains to minimise the risk to life and to reduce flood losses:

- By modifying the response of the population at risk to better cope with a flood event (Response Modification);
- By modifying the behaviour of the flood itself (Flood Modification); and
- By modifying or removing existing buildings and infrastructure and/or by imposing controls on future property and infrastructure development (Property Modification).

Examples of the various methods are listed in **Error! Reference source not found.** below.

Table 13: Floodplain Management Measures

Response Modification	Flood Modification	Property Modification
Community education	Flood control dams	Land use zoning
Community preparedness	Detention basins	Voluntary purchase
Flood prediction and warning	Channel improvements	Voluntary house raising
Flood Emergency Plans	Levees	Building and development controls
Evacuation arrangements	Bypass floodways	Flood access
Recovery plans	Flood gates	Flood proofing buildings

Flood Modification and Property Modification may also be referred to as "Structural Measures" and Response Modification as "Non-structural Measures" respectively. Including flood preparedness and response measures in an overall Floodplain Risk Management Plan is an effective method of minimising the impact of floods not addressed by other measures and is generally required in any plan as the means of managing any residual risk to personal safety.

A fundamental principle of floodplain risk management is that management measures should not be considered in isolation. Rather, they must be considered collectively on a risk management basis that allows their interactions, their suitability and effectiveness, and their social, ecological and economic impacts to be assessed.

5.2 RESPONSE MODIFICATION MEASURES

Flood response measures encompass various means of modifying the response of the population to the flood threat. Planning for these measures should be incorporated in the MBRC Local Disaster Emergency Management Plan and the Threat Specific Sub-plan – Severe Weather Event for the area. These plans must be complementary to the floodplain risk management plan.

The development and implementation of effective flood response within the community is a means of reducing the damage associated with this risk. Response Modification measures, such as flood warning and evacuation procedures, can be of substantial benefit in their own right. Flood warning and evacuation plans can be very cost effective. In fact, they may, in some cases, be the only economically justifiable risk management measures.

Community education is generally required to maximise the effectiveness of other response modification measures and may also enhance the effectiveness of flood modification or property modification measures.

5.2.1 Local Threat Specific Sub-plans

The MBRC, in association with other relevant agencies and the community, through the LMDG, leads in the development of detailed local plans for areas with significant flood problems. These plans describe the various measures to be undertaken before, during and after a flood, including warning, evacuation, resupply and other procedures.

It is essential that the floodplain management measures adopted in the floodplain management plan are compatible with the relevant Local Disaster Emergency Management Plan and the Local Threat Specific Sub-plan.

Matters that require some actions are set out in Section 4.

5.2.2 Flood Prediction and Warning

The Bureau of Meteorology (BoM) has a system of weather data collection that allows flood levels to be predicted in non-flash flooding catchments. However, the time of concentration in the MBRC catchments is considered flash flooding (less than 6 hours). In the case of catchments affected by flash flooding, it is not possible for the Bureau to provide any prediction and warning, other than a general severe weather warning, because the flood events occur so quickly after the onset of rainfall.

The LDMG has the responsibility to issue flood warnings and add local information to the warnings. This can be based on the MBRC rain/river gauge system currently being installed. The passing on of the consequences of predicted flooding, such as, closing of roads or water entering properties or otherwise affecting human interests and activities, is an essential part of flood warning.

5.2.3 Flood Education

Community engagement and education helps to build resilience to flooding through learning. There are four ways that community education can help communities, including residents and businesses, to improve their flood resilience:

- Learning to prepare for a flood;
- Learning how to respond to a flood;
- Learning how to recover from a flood; and
- Learning how to improve the situation after a flood.

Research shows that there are several psychological factors that must be addressed to increase flood preparedness through learning. These factors include perception of the flood risk, perception of the importance of the risk, whether people believe that they have control over circumstances, their assessment of their resources to enable an action ('self-efficacy') and their capacity for problem solving and to confront challenges. Even with these factors advanced it has been shown that people will only prepare appropriately if they trust the emergency authority (e.g. the SES). A recent flood experience is another factor that may increase people's preparedness activities.

Preparedness covers learning how to prepare for, respond to and recover from a flood. In practice, preparation may involve a range of activities including residents and businesses flood proofing properties and having an emergency kit. Response learning can include how to respond to flood warnings and when and how to evacuate. Recovery learning can include the ways to clean up, resume functions and safety and health precautions.

A method to cover and integrate these preparedness activities is through the development of emergency plans for the different users e.g. residents, businesses, caravan parks, retirement homes, schools. These emergency plans should link to local flood plans.

There are other aspects of resilience-building that can also be assisted through learning. The ability of a community to adapt to a flood event is also dependent on how its capabilities (e.g. leadership, networks) and all its systems (e.g. flood warning systems, recovery systems) operate. Learning can be conducted to further improve capabilities (e.g. training for emergency management volunteers, briefings for community leaders such as councillors) and

systems (e.g. evacuation drills, review of flood warning and communications).

It is important to learn immediately after a flood event to further build resilience to future flood events including by improving preparedness, capabilities and systems. Ways to conduct this learning include through community de-briefs, ongoing discourse (e.g. through the media) and reviews (e.g. by the LDMG).

Community flood education programs should consider all of the above in their design. As a flood can occur at any time, they should be ongoing as learning can be lost rapidly if they are not maintained.

Research has shown that flood education programs are most effective when they:

- Are participatory i.e. not totally consisting of top-down provision of information but where the community has input to the development, implementation and evaluation of education activities;
- Involve a range of learning styles e.g. experiential learning (e.g. field trips, flood commemorations), information provision (e.g. via pamphlets, DVDs, the media), collaborative group learning (e.g. scenario role plays with community groups) and community discourse (e.g. forums, de-briefs).
- Use volunteers to lead informal discussions in the community about flooding
- Are linked with structural and other non-structural floodplain management options (e.g. by encouraging the community having a say in structural infrastructure options, commenting on planning options).
- Are part of Local Disaster Emergency Management Plan and the Local Threat Specific Sub-plan.

5.2.4 Recovery Planning

The floodplain risk management plan needs to recognise that after the flood:

- Council and other authorities will need to restore or clean up their assets;
- Residents and commercial operators will commence clean-up, with the expectation that Council will provide some assistance, even if only in disposing of waste materials and debris, in the residential clean-up after a flood
- Authorities (such as the Department of Communities, Child Safety and Disability Services) may provide some welfare services and assistance payments;
- Meetings to share flood experiences and subsequent problems could include trauma counselling to help people realise they are not alone in the floodplain; and
- The period after the flood is an opportunity to collect data that will help agencies and communities to better deal with the next flood event. This information should include:
  - Water information (levels, rates of rise and fall, velocities, areas inundated);
  - Details of damage;
  - Information which did or did not become available when needed during the flood; and actions which were taken during the flood.

5.3 FLOOD MODIFICATION MEASURES

The purpose of flood modification measures is to modify the behaviour of the flood itself by reducing flood levels or velocities or by excluding floodwaters from areas under threat. It is essential that these measures are assessed, first, on an overall catchment basis, and second, from within the strategic framework of an overall floodplain risk management plan. If assessed individually or in isolation, there is the possibility that future land-use developments may reduce, if not eliminate, present mitigating effects. For example, detention basins must be assessed on a systems basis that incorporates the impact of future development and a range of flooding scenarios.

5.3.1 Flood Mitigation Dams

Flood mitigation dams are designed to reduce downstream flood discharges and are most effective in very large catchment situations. As the flood wave passes through the dam

storage area, the dam is progressively filled to the point of overflow, trapping a portion of the floodwaters. The full dam then provides temporary storage for floodwaters subsequently passing through it. Such structures are extremely expensive and their design usually incorporates irrigation supply or power generation, as well as the flood mitigation aspect.

These structures are not relevant to the MBRC catchments, unless there are moves to upgrade Pine River Dam, and flood mitigation dams are not, therefore, discussed further.

5.3.2 Detention Basins

A detention basin is a small dam that provides temporary storage for floodwaters. Detention basins are used as a means of controlling the peak discharge from urbanised areas. Some of these basins may be quite large, and may be more properly regarded as small dams and have to be designed as such. A detention basin behaves in the same way as a flood mitigation dam, but on a much smaller scale. In urban areas, detention basins are most suitable for small streams that respond quickly to rapidly rising flooding. Detention basins have a number of inherent disadvantages that should be carefully evaluated for each particular situation, for example:

- They require a substantial area to achieve the necessary storage;
- Where they involve multi-purpose uses, safety aspects during flooding need to be addressed;
- Long duration or multi-peak storms (when the basin is filled in the first peak) can increase the likelihood of overtopping (when no alternative is available), or embankment breaching or failure ('dam break'), and the resulting personal danger and damage; and
- They provide little attenuating effect when overtopping occurs.

Consequently, it is important that detention basins are properly designed (including consideration of alternative storm patterns and flood recurrence intervals), constructed and maintained. Risk is reduced by complementary works (bypass spillways) or specific land use planning measures (downstream flowpaths). It is noted that with appropriately designed outlet works, detention basins may act as sediment traps thereby improving urban water quality by reducing the concentration of solids.

In addition to large, community basins, on-site detention (OSD) may be a viable, small-scale flood management option.

OSD is a temporary water storage facility created either as a depression in a paved/landscaped area, an underground tank or a combination of both. This facility detains a volume of water for a short duration during intense storms whilst slowly releasing a portion of this water through a small stormwater outlet.

OSD forms part of an overall site drainage system including gutters, pipes, pits, grates, kerbs, walls, graded surfaces and overland flow paths which assist in directing stormwater runoff to the OSD facility. The design of such drainage systems needs to be prepared by a suitably qualified civil engineer in accordance with specific design requirements established by a council.

The aim of providing on-site detention for new developments or redevelopments is to delay and reduce the stormwater flows (or discharge) from the site to predevelopment levels, thus reducing flood risks caused by stormwater runoff. OSD has been introduced to ensure that no increase in stormwater flows occur from such developments within the local Council area.

5.3.3 Bypass Floodways

Bypass floodways redirect a portion of the floodwaters away from areas under threat from flooding, and so reduce flood levels along the channel downstream of the diversion. Opportunities for the construction of bypass floodways may be limited by existing development, the topography of the area, environmental considerations and the availability of land. Bypass floodways may exacerbate flood problems further downstream and, as they direct flows away from natural paths, may impact on channel form both upstream and downstream of the site of the works. Despite these shortcomings, bypass

floodways can, on occasions, provide a useful management option.

Given the highly built up nature of the MBRC catchments, and their relative flatness in flood affected areas, bypass floodways are considered unviable and will not be discussed further.

5.3.4 Levees

Levees are frequently the most economically attractive measure to protect existing development in flood prone areas. The height or crest level of a levee is determined by a variety of factors that include:

- The economics of the situation (including the nature of development requiring protection);
- The physical limitations of the site;
- The level to which floods can rise relative to the ground levels in the area (important in safety considerations); and
- The visual impact of the levee.

A levee may rarely be called upon to achieve its design requirements. If it fails at this time because of poor design, improper construction or poor maintenance, the money spent on its construction has largely been wasted. Even if design, construction and maintenance are exemplary, all levees will ultimately be overtopped by an 'overwhelming' flood (unless designed for the PMF event). It is not a question of if overtopping will occur, but of when and what the consequences will be. Hence, the importance of plans that address the defence and evacuation of areas protected by levees cannot be overstated (i.e. residual flood risk).

In using levees for flood risk management, in either urban or rural situations, the following precautions need to be noted:

- By excluding floodwaters from one part of the floodplain the levees will increase flooding elsewhere and it is important that the impacts of such increases are significantly less than the damages which are avoided by protecting areas;
- The likelihood and consequences of catastrophic damage and unacceptable personal danger levels when the levee is overtopped;
- Appropriate design of the levee and provision of spillways to avoid uncontrolled high velocity flows or even failure when the levee is overtopped;
- Proper maintenance of the levee crest level, grass cover and spillways and the avoidance of damage from traffic or animals;
- Provision is necessary for local overland flooding/local rainfall within the levee into the main stream. This may require a pumping system and storage basin within the levee, the provision of flap gates on piped systems that pass through the levee or other site specific measures;
- Emergency response plans for levee overtopping and evacuation. The need for such plans is particularly important where escape routes can be severed;
- Analysis of flow conditions that may develop when overtopping occurs and the flood continues to rise. In some situations high hazard conditions can develop in protected areas and unless appropriate restrictions are applied, development and personal safety could be at risk. Such development control measures or restrictions may include buffer zones where development is limited or even prohibited;
- The need for infrastructure management plans to reduce damage to essential services and facilitate rapid recommissioning following flooding is essential;
- On-going community education to ensure that the population is aware of the risk of overtopping, is informed about emergency response plans and does not lapse into the common belief that levees 'provide protection against all floods'; and
- Levees may prevent the flow of water to valuable environmental areas, such as wetlands, and the consequences of this need to be considered especially for threatened species and the ecological community as a whole.

Permanent, carefully designed, constructed and maintained levees are a common and important management measure for existing flood risks. Depending on likely height of levee and population/development being protected,

the levee may best be designed as a small dam. However, they are a partial solution and should be supplemented by comprehensive flood planning and readiness measures.

It is important to bear in mind that a levee, permanent or temporary, is built to provide protection for property and critical infrastructure and should not to be relied on to protect human life. If a levee is part of a comprehensive management plan, its operation and design must conform to an overall flood emergency strategy that also encompasses public information, evacuation and rescue strategies

There are locations, particularly in the Caboolture River catchment, where there are high level cross-flows between sub-catchments, leading to changes in the hydraulic regime of the creeks or rivers. There may be some benefit in exploring options to construct levee-like structures to artificially raise the ridge between the sub-catchments.

5.3.5 Channel Modifications

The hydraulic capacity of a river channel to discharge floodwater can be increased by widening, deepening or re-aligning the channel and by clearing the channel banks and bed of obstructions to flow.

The effectiveness of channel modifications depends upon the characteristics of the river channel and the river valley. In urban situations, channel modifications can provide the community with other positive benefits. In the main, these involve enhanced visual aesthetics by landscaping and the provision of recreation facilities, such as linear parks.

Channel modifications are likely to be most effective (including reducing the need for other structural works) on steeper, smaller streams with overgrown banks and narrow floodplains. Channel modifications are unlikely to have a significant effect in flooding situations where there are extensive areas of overbank flooding or where flooding effects are dominated by increased tide levels.

As a management measure, channel modifications have a number of potential disadvantages. For instance:

- Like bypass floodways, they facilitate the transfer of floodwaters downstream and can accentuate downstream flooding problems;
- The potential impacts of such works on channel bed and bank stability, both upstream and downstream of the site;
- The high cost of maintenance;
- The destruction of riverine habitat; and
- The visual impact of replacing naturally varying channel sections with a section of more uniform geometry.

The use of concrete lined channels to replace natural streams is particularly undesirable from an environmental stand point and should be avoided where possible. Where modifications to natural streams are proposed these should be designed considering guidelines for the rehabilitation and restoration of streams as available through organisations such as the Co-operative Research Centre for Catchment Hydrology.

5.3.6 Floodgates

Floodgates may be used to control flow down a bypass floodway, or to prevent flow along a small creek or drain or other waterway. When used to control flow down a bypass floodway the opening of the floodgates is generally designed to keep the flow in the mainstream until bank full conditions are about to be reached. The gate is then opened to reduce the problems that would occur if there was somewhat uncontrolled overbank flow from the mainstream.

Floodgates may also be used to keep flood waters from backing up a drain or creek. These gates may be designed to be normally open and then closed when there is a flood. They are often used to prevent oceanic inundation. Alternatively, in some situations they may be normally closed and open only when the water level behind the gate is higher than the water level in the stream or estuary.

Floodgates may be designed to open or close automatically, or may require someone to open or close the gate at flood time. The protection of some low-lying urban areas is usually the key function of floodgates. This benefit must

be compared with a range of other adverse environmental impacts of floodgates such as:

- Changes in aquatic ecology;
- Exposure of acid sulfate soils;
- Changes in water quality;
- Drying out of wetlands and change in functionality;
- Potentially altered hydrological regime resulting in changed vegetation species composition; and
- Restriction of fish passage and loss of nursery habitat.

Changes in operation of flood gates, particularly those whose principal purpose was to exclude tidal inundation and backwater flooding, can assist in reducing or rehabilitating these problems. In areas of known acid sulfate soil problems allowing for controlled tidal flushing during non-flood periods can decrease the level of acidity released into an estuary to a more acceptable level. In addition, controlled opening of floodgates can direct additional water to wetlands. This can be accomplished by maintaining some or all gates in an open position during non-flood times and having procedures to have gates closed during flood periods. Closure of gates can be automatic with maintenance ensuring closure has occurred during flood periods.

Maintenance of floodgates is important to ensure that they do close or open satisfactorily when the flood comes and remain closed or open as required during non-flood times.

5.3.7 Temporary Flood Barriers

There are a number of temporary flood barrier systems in use, under test or generally available throughout Australia.

Every system meets a certain demand for flood protection, and may be suitable across a range of conditions, subject to the particular circumstances of a location.

Testing of a broad range of temporary flood barriers under “flood” conditions and with various foundation conditions has been carried out by government/semi-government agencies in the United Kingdom and Switzerland and the individual companies have all established detailed design and application criteria.

Despite the apparent attractiveness of these systems, it is considered that the most appropriate approach to floodplain risk management is a comprehensive scheme that contains elements to control floodwaters (where viable and not detrimental to others), manage land use and planning controls and manage the response to a flood, through the emergency services.

A permanent system should be used to control floodwaters if it is technically, economically, environmentally and socially acceptable, to provide protection to the required level. A permanent system may involve short, specially designed sections that are removable during non-flood times – catering for railway crossings that cannot pass over a permanent structure, major roads, etc.). These are not considered to be temporary flood barriers.

A temporary flood barrier should not be a substitute for a permanent structure, investigated and designed to fully account for all the variability of flooding; it should only be used where the permanent structure is not viable.

Ad-hoc use of temporary flood barriers is not appropriate as adverse impacts may occur to adjacent properties, and the likelihood and consequences of failure are unpredictable. The identification of areas where levees can minimise the consequences of flooding should be established through a flood study process.

Given all these broad-area constraints, consideration could be given to providing temporary flood protection measures, such as the “Floodgate” line of products (named for illustrative purposes only), to permanent commercial structures within the 100 year ARI flood extent. This would have a similar, if potentially better result than sand-bagging and would certainly be significantly less labour intensive. This has been done in places such as Lismore in NSW and may prove a sound interim measure until a comprehensive, strategically based approach is determined.

5.4 PROPERTY MODIFICATION MEASURES

Property Modification measures incorporate modifying or removing existing properties from flood affected areas and/or by imposing controls on future property and infrastructure development. These are aimed at steering inappropriate development away from areas with a high potential for damage and ensuring that potential damage to developments likely to be affected by flooding is limited to acceptable levels by means of minimum floor levels, flood proofing requirements, etc.

In the MBRC situation, it is convenient to divide the measures into Works and Planning, as each sub-category has differing impacts and applications.

5.4.1 Property Modification - Works

Property Modification – Works includes any measure that changes the character of the property or residence, including:

- Voluntary purchase;
- House raising;
- Flood proofing buildings; and
- Flood access.

a) Voluntary Purchase

In certain areas of the floodplain, particularly where all risks may be unacceptable, it may be impractical or uneconomic to mitigate flooding risk to existing properties. In such circumstances, it may be appropriate to cease occupation of such properties in order to free both residents and potential rescuers from the danger and cost of future floods.

This is achieved by the purchase of the properties and their removal or demolition as part of an adopted floodplain risk management plan. Under such circumstances, property should be purchased at an equitable price and only where voluntarily offered. Such areas should ultimately be rezoned to a flood compatible use such as public open space.

b) Voluntary House Raising

Voluntary house raising has long been a traditional response to flooding. Home owners generally have very strong sentimental and emotional attachments to their dwellings, which often also represent a large capital investment. Avoidance of flood damage by house raising achieves the following three important objectives:

- A reduction in personal loss;
- A reduction in risk to personal safety and in the costs of servicing isolated people who remain in their homes to protect possessions; and
- A reduction in stress and post-flood trauma.

In general, voluntary house raising is a suitable management measure only for acceptable or tolerable risk areas of the floodplain. In unacceptable risk areas, either flood modification measures, for example, levees, or voluntary purchase measures are required.

While raising a house may achieve the objectives described previously, care must be exercised in implementing this measure by considering the implications of a slightly higher than design flood. The new construction may be isolated for long periods during floods, necessitating an increased load on emergency services, should they be required. The isolated house would also need to be capable of “self-support” during flooding. This requires, for example, adequate food, water and possibly power supplies.

Thus it is essential that both the benefits of and risks associated with voluntary house raising are considered in the floodplain risk management planning process.

c) Flood Proofing of Buildings

Flood proofing refers to the design and construction of buildings with appropriate water resistant materials and configuration such that flood damage to the building itself (structural damage), fixtures and fitting and possibly its contents, is minimised should the building be inundated.

At best, flood proofing is an adjunct to other management measures. Because of this, the recommendation to adopt flood proofing as a formal management measure can only be made on an objective basis from within the strategic framework of a floodplain risk management plan. Whilst flood proofing can minimise structural and possibly content damages to flood-affected buildings, the occupiers of flood affected buildings still suffer the social and economic disruption of flooding. Thus, councils cannot simply allow development of flood prone land as long as buildings are "flood proofed".

Rather, the social and economic consequence of flooding needs to be assessed for both the "non-flood proofed" and "flood proofed" situations. If the consequences of flooding with flood proofing in place are still unacceptable, other management measures need to be sought such as flood modification (for existing development) or alternative locations or development controls (for new development).

d) Flood Access

Flood access can be partly dealt with as a development control. However, it also needs to be addressed on a broader scale than the layout of new sub-divisions. In the MBRC catchments, where floods rise and fall in hours, complete isolation during a flood may be acceptable. It needs to be remembered, however, that this only applies to smaller floods as larger floods which involve over floor flooding may require evacuation.

In the more usual situation, in which complete isolation during a flood is an unacceptable risk, an access route which is closed in small or large floods may be acceptable, if there is an alternative route available. The alternative route may have significantly lower traffic capacity, but should allow large vehicles through. Hence it should not have extremely steep gradients, tight bends or bridges with load limits.

e) Insurance

Insurance is not strictly a property modification measure but is a means of mitigating the cost of the residual risk to property after all other mitigation measures have been implemented. Insurance can be taken out on private property as well as public infrastructure and buildings. It is available for residential, commercial and industrial property. However, the cost of insurance may be considered unaffordable by those who have to pay for it.

5.4.2 Property Modification - Planning

Property Modification – Planning includes any measure that governs what can be built and any requirements to minimise or negate the impacts of flooding. These measures usually constitute land use planning and development controls.

Land use planning limits and controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately. Effective consideration of future development involves a strategic assessment of flood risk to future development areas to guide councils, in wisely and rationally controlling development to reduce the risk exposure of new development to an acceptable level.

Strategic assessment of flood risk can steer inappropriate development away from areas with a high hazard and/or with the potential to have significant impacts upon flood behaviour in other areas. It can also reduce potential damage to developments likely to be affected by flooding to acceptable levels by means of minimum fill and floor levels and flood proofing requirements, etc.

Specific land use planning measures and controls include:

- Zoning - Appropriate land use control measures are strongly recommended if the rate of growth of future flood damage is to be limited. The most effective way to protect the floodway and prevent development occurring within an area of high hydraulic hazard is by zoning the land appropriately. However, the use of zoning to unjustifiably restrict development simply because land is flood prone is not supported.
- Development Controls are the appropriate means of implementing

detailed aspects of council's floodplain risk management plan, particularly when addressing future flood risk. The suitability and effectiveness of development controls in managing risk needs to be considered within a strategic management framework as part of the management study. The aspects of land use planning and development controls that need to be addressed in detail in the management study with associated recommendations in the management plan should include:

- Access to the Site before, during and after Flood Events;
- Fill or Excavation in the Floodplain;
- Freeboard;
- Floor levels;
- Differences between Land Uses;
- Services;
- Impact on Flood Behaviour;
- Structural Soundness When Flooded;
- Building Materials (see **Error! Reference source not found.**); and
- Fencing.

5.4.3 Designated Flood Event

A key decision in the Floodplain Risk Management Study is the determination of the Designated Flood Event, the Designated Storm Tide Event and the Natural Hazard Management Area. This decision is of prime concern to MBRC and is addressed more fully in Section 6.

6 DFE & DSTE

6.1 DESIGNATED FLOOD EVENT (DFE)

A key decision in the floodplain risk management process is the determination of both the DFE and the NHMA.

As noted in Section 2, the three constituent councils adopted the 100 year Average Recurrence Interval (ARI) as their Designated Flood Event (DFE) flood level.

This 100 year ARI is the most commonly adopted flood both in Australia and internationally as a DFE[1]. It essentially means that flood related development controls, e.g. floor level, building type, are applied to land affected by the estimated 100 year ARI flood event, and that areas above that flood have no controls.

Whether this is really a suitable standard is open to argument as the source of this decision, obscured in the mists of time, appears to have been a need to adopt some probability of flooding that "sounded" unlikely, even though there have been regular occurrences of floods of that nature, or higher, worldwide each year and in many parts of Eastern Australia recent years.

There are strong arguments that the adopted DFE should be a merit based decision, taking into account the full range of flood sizes, up to and including the probable maximum flood (PMF) and the corresponding risks associated with each flood.

While there may be a few exceptions for sensitive uses or critical infrastructure, it is neither feasible nor socially or economically justifiable to adopt the PMF as the DFE. On the other hand, the suggestion that a widely accepted probability of above floor flooding of buildings should be used as the measure of an acceptable probability of all other flood consequences is also not socially or economically justifiable.

[1] UK uses 1 in 75 years, Netherlands 1 in 1250 or rarer.

6.2 DESIGNATED STORM TIDE EVENT (DSTE)

As discussed in Section 2, the previous councils adopted disparate DSTE and corresponding DSTE levels. Similarly, the previous councils adopted different values to add to their DSTE to account for sea level rise.

All three jurisdictions utilised historic or generic data to define the DSTE however there is now mapping and a study that would support more precision in the delineation of the affected areas. There needs to be a consistent, if potentially conservative value adopted for SLR allowance for the 2050 planning horizon.

6.3 NATURAL HAZARD MANAGEMENT AREA

The definition and adoption of the DFE and DSTE will set the Natural Hazard Management Area required under the various State Planning Policies.

As noted in Section 2, the three constituent councils generally adopted the 100 year Average Recurrence Interval (ARI) extent for the fluvial (river and creek) flooding NHMA though providing that information on a planning overlay was only comprehensively done by Pine Rivers and only generally by the other councils. No constituent council really addressed Storm Tide in the NHMA overlays.

6.4 INTERIM RECOMMENDATION

The data that has been collected and generated regarding flooding from all sources in the MBRC region will eventually be invaluable in determining a long-term NHMA and various development controls therein.

Indeed, the early consideration of flood risk in strategic land use planning can result in land use zonings and development controls, within

planning overlays, which support development in consideration of flood risk management. They can reduce the impacts of new development on flooding and the impact of flooding on the new development.

However, all the necessary data and analysis is not available or complete and thus a decision on an interim DFE/DSTE must be made to allow development of land to continue until a final decision is reached.

Usually, such a decision would be based on historical data or decisions, supported by indicators such as an inflection point in a plot of estimated flood damages. Examples of such plots[1] are provided in Figure 1 and Figure 2.

Figure 1 - Above Floor Flooded Properties

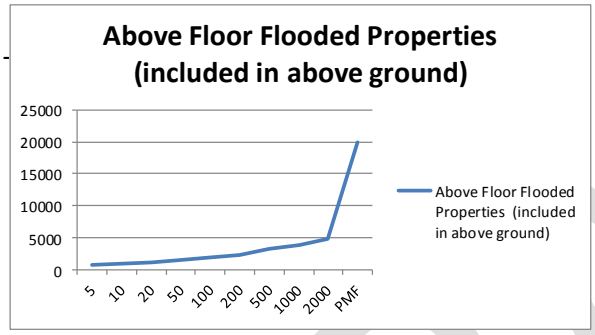
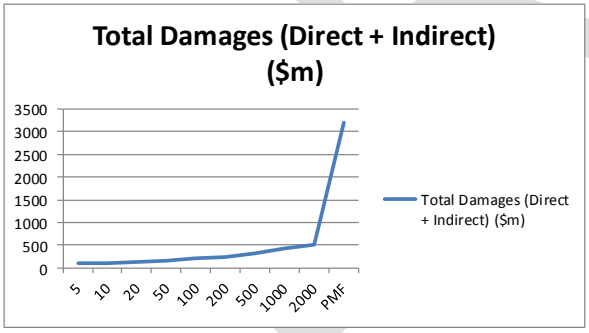


Figure 2 - Residential Direct Damage ($)



As can be seen from these plots, there is a gradually increasing number of properties affected by flooding, with a reflection of that in the increasing damages. The inflection point comes at the point where the data has to extrapolate from the 1 in 2000 year ARI event to the PMF.

This is, in effect, a negative indicator in that it favours no particular flood over any other – the jump to the PMF is more an indicator of the probability applied to the PMF rather than a viable basis for choosing a DFE.

Accordingly, it is recommended that an interim DFE/DSTE should be the 1 in 100 year ARI event. This will generally allow continuity with previous standards and allow time for any risk-based approach to be bedded down and have any technical or cadastral anomalies identified and rectified.

The risk based approach is discussed further in Section **Error! Reference source not found.**.

[1] From Molino Stewart Pty Ltd (2013) MBRC Floodplain Risk Management Study Stage 1 (Draft)

7 FREEBOARD

7.1 BACKGROUND

As noted previously, the three constituent councils in MBRC had different freeboards applied in their affected areas. These are summarised below.

Table 14 - Freeboard Summary

Pine River	Redcliffe	Caboolture
Fluvial 750mm Storm Tide 750mm	Fluvial - 30m buffer and 300mm Storm Tide – 225mm	300mm for both fluvial and storm tide events.

7.2 WHAT IS FREEBOARD?

There is, within MBRC, considerable discussion regarding the level of freeboard that should be applied to new or re-developments. To address this, it is reasonable to discuss what freeboard is and what purpose it fulfils.

Freeboard is the difference between the modelled level of the flood event upon which the DFE/DSTE is based and the surveyed planning level applied to any development, residential or commercial. It aims to provide reasonable certainty that the risk exposure selected in deciding on a DFE / DSTE is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc.

The purpose of freeboard is to provide reasonable certainty that the reduced risk exposure provided by selection of a particular flood as the basis of a DFE / DSTE is actually provided given the following factors:

- Uncertainties in the estimates of flood levels;
- Differences in water levels across the floodplain because of 'local factors' which are not accounted for at the scale of the flood modelling (e.g. water piling up against structures and hydraulic features such as standing waves and eddies);
- Increases in water level as a result of wave action probably not determined in floodplain modelling. This includes wind-induced waves across fetches of open water and waves induced by boats and vehicles moving through flooded areas;
- Changes in rainfall patterns and ocean water levels as a result of climate change though this is better assessed using sensitivity testing of various hydrologic factors in the flood modelling; and
- The cumulative effect of subsequent infill development of existing zoned land.

Freeboard should never be relied on to manage risk in events larger than the flood used to derive the DFE/DSTE. However, freeboard may be different for:

- Different land uses;
- Different parts of the floodplain; and
- Mitigation works of different types.

7.3 WHAT FREEBOARD TO ADOPT?

As noted in Section 7.2, there is discussion within MBRC over the freeboard to be applied in floodplain risk management plans and development controls.

A Council analysis relates the number of properties to the freeboard needed to ensure the incremental flood depth did not exceed the selected freeboard (see Appendix B). Thus the freeboard can vary across the floodplain with the value reflecting both the depth of flooding as well as the ground level.

This approach eliminates any problems that arise from a "one size fits all" approach and does consider, in a limited fashion, the risks associated with the occupation of the floodplain.

Another approach adopted more commonly in Australian usage, as well as in the United Kingdom and the United States, is to apply a fixed freeboard for all flood conditions or for a specific problem. For example, the NSW Government stipulates a 500mm freeboard on

1 in 100 year ARI event for most residential floor levels although many existing planning instruments reflect past practices with freeboards ranging from 0mm to 500mm. The Temporary Local Planning Instrument – 01/12 Brisbane Interim Flood Response specifies a range of freeboards up to 500mm for habitable floors and 300mm for non-habitable areas. Melbourne Water has 600mm on major waterways for a 1 in 100 year ARI event but 300mm on "overland flows" for a 1 in 100 year ARI event. The areas of Victoria covered by the Catchment Management Authorities have a fixed 300mm freeboard for a 1 in 100 year ARI event or the highest recorded flood, if no modelling has been carried out.

So what is the better recommendation – the "high" freeboard of the ex-Pine Rivers Council (750mm) or the "lower" freeboard (300mm) of the others?

As with the determination of the DFE/DTSE, the adoption of a freeboard should be based on a merit approach, rather than a fixed number. That approach is, of course, dependent on having all, or a significant amount, of the data needed to make such a decision.

It is considered that, as an interim measure, the freeboard for new or redevelopment in the areas affected by the 1 in 100 year flood should be a minimum of 500mm. This is a midway point that makes allowance for larger floods and has only limited economic impact on the economics of building a new property. It also is consistent with current recommendations for other major urban areas is Australia.

It is contrary to good practice to allow development to occur in areas of high hazard that may affect people or property. Thus, a rider to this recommendation is that there needs to be a constraint placed on where new development is located and whether re-development should be approved in certain areas. Without full analysis of the risks involved, it is recommended that an interim standard of no new or redevelopment should occur in land affected by the 1 in 20 year ARI flood event. In other words, development should not be permitted on land below the 1 in 20 ARI level even though it may be physically possible to construct a building there with a floor level 500mm above the 1 in 100 year ARI flood event.

The other concern with applying a freeboard is how it is applied – is it done by fill or is the floor level above ground level on piers.

The most important consideration is "will the fill impact on adjoining properties?" This may require a localised study to determine this and it will be up to Council, in the longer term, to determine the controls required for this issue.

However, as an interim measure, it is recommended that no fill should be used to implement freeboard requirements in land affected by the 1 in 100 year ARI flood event. In other words, the land should not be filled to the 1 in 100 year ARI flood level to assist a building to achieve its freeboard requirements but land above the 1 in 100 year ARI flood level can be filled for this purpose.

8 THE INTERIM PLAN

8.1 GENERAL

This Section sets out the Interim Floodplain Risk Management Measures recommended for MBRC.

The longer term measures, needed to produce an operational Floodplain Risk Management Plan are discussed in Section **Error! Reference source not found.**.

8.2 RESPONSE MODIFICATION

A range of reviews and amendments to the MBRC Local Disaster Emergency Management Plan 2011 and the Threat Specific Sub-plan – Severe Weather Event (August 2011) that can be taken immediately include:

- Include as definition of risk - Product of the consequence and probability of a hazardous event or phenomenon.
- Definitions/Glossary should be amended as necessary to refer to AS/NZS ISO 31000:2009 rather than AS/NZS 4360:2004.
- Reorder or possibly recast Section 1.1 "Purpose of Plan" so that the primary function is reducing the impact of a natural disaster on the MBRC region so that the consequences for the community are mitigated/minimised.
- Bring Social data up-to-date with 2011 Census data. Use detailed suburb or division data to highlight potential issues with language, custom, etc.
- Locations of Sensitive Land Uses and Critical Utilities and Uses should be detailed in main plan and sub-plan, including what hazards they face and what measures have been adopted to address these issues?
- Make sure hyperlinks work (e.g. www.disaster.qld.gov.au/publications does not).
- Ensure "Threat Specific Sub-plan" notes that Bureau of Meteorology does not issue site specific flood warnings in the MBRC region and that MBRC has constructed its own network of rain gauges and stream gauges and is preparing a flood warning manual to emulate site specific warnings of the BoM.
- Plans need to promote positive/active approach (will do rather than may do).
- There must be "value adding" to warnings issued by LDMG so that there is both technical (river height, timing) and potential impact (streets flooded or areas cut off) included in the warning. The warning should also give advice as to what measures the persons affected should take, from evacuation now to protection of buildings or contents. These messages should, as much as practical, be composed in non-flood times to ensure clarity of message and minimise any ambiguity.
- Define what is meant by minor, moderate, major flood on each creek/river system.

8.3 FLOOD MODIFICATION

There are no major Flood Modification Measures that can be undertaken under the proposed Interim Floodplain Risk Management Plan.

However, given the potential for backwater flooding in drains that empty to the sea or estuary, consideration could be given to the use of flap-gates or other forms of drainage controls. These structures have the potential to have an immediate benefit in mitigating impacts in known backwater flooding areas.

There are a number of styles of these gates in use across Australia. There is no recommendation for any type in particular as each has benefits and disbenefits and needs to be designed on a case by case basis.

In addition, consideration could be given to providing temporary flood protection measures, such as the "Floodgate" line of products, to permanent commercial structures within the 100 year ARI flood extent.

Major measures are considered in Section **Error! Reference source not found.** that discusses longer term measures.

8.4 PROPERTY MODIFICATION

As interim measures, it is recommended that:

- DFE/DSTE should be the 1 in 100 year ARI event.
- Freeboard for new or redevelopment in the areas affected by the 1 in 100 year flood should be a minimum of 500mm.
- No new or redevelopment should occur in land affected by the 1 in 20 year ARI flood event.
- No fill should be used to implement freeboard requirements in land affected by the 1 in 100 year ARI flood event.

8.5 COSTS, PRIORITIES & IMPLEMENTATION

8.5.1 Costs

There are no major cost items within the interim floodplain risk management measures proposed. Purchase of any temporary flood protection measures, such as the "Floodgate" line of products, should be a matter for consideration by the beneficiaries.

The costs of implementing the Property Modification and Response Modification measures fall within the normal operations of MBRC however there may be a requirement for internal budgetary arrangements to ensure all measures are implemented.

8.5.2 Funding Requirements

As indicated above, the costs of implementing the floodplain management measures fall within the normal operations of MBRC however there may be a requirement for internal budgetary arrangements to ensure all measures are implemented.

There is no State or Federal financial assistance provided for the implementation of the recommended measures.

8.5.3 Priorities

All measures in the Interim Floodplain Risk Management Plan have equal priority and can be implemented over a relatively short time frame.

9 THE FUTURE

9.1 STUDIES

Significant progress has been achieved in the collection and analysis of flood data from creeks, rivers, the ocean and overland stormwater. This data is essential in informing all the decisions relating to the Floodplain Risk Management Plan.

However the data and analysis is not necessarily to the same standard, with issues identified with the storm-tide modelling, the methodology used to estimate runoff in low probability flood events and the generalisations needed to be used in some of the GIS analysis.

These issues do not negate the findings presented in the originating studies; it is just that there is room to improve and update.

The program of studies already developed within MBRC should continue if not increase in pace. Based on investigations to date, the following are recommended as being the highest priority:

- A hydrodynamic model of the storm tide inundation scenarios and processes, especially the active wave zone, be developed and impacts revised to appropriately depict probability assigned to the resulting water levels and velocities;
- A property floor level survey in the storm tide floodplain be undertaken;
- The damages estimates need to be based on a set of consistent stage-damage curves (recommended to use those developed by Molino Stewart 2013);
- Once the storm tide modelling is finalised, the risk analysis for creek & river, storm tide and overland flow should be revised on a consistent basis so that like risk can be compared and contrasted to like risk;
- Once the individual risk assessments have been completed, undertake an analysis that merges risks from all sources and creates an overall risk map for the MBRC region for flooding. (A similar analysis could be undertaken for other natural hazards such as bush fire.)

With this final risk "map" established, the other long term measures can be finalised.

9.2 RESPONSE MODIFICATION MEASURES

For the longer term, the community education and engagement programs discussed in Section 5.2.3 should be developed using experienced practitioners in this specialist area.

A long-term program of activities should be developed and supported by MBRC and other relevant agencies. Too often, experiences learnt in difficult conditions are not recorded and remembered – with the risks of flooding faced by so many members of the community, the need to continue to educate and engage cannot be overlooked.

The MBRC Local Disaster Emergency Management Plan (2011) and the Threat Specific Sub-plan – Severe Weather Event (August 2011) should be reviewed in detail on a, at minimum, basis of once every five years or, should a major event take place, immediately after that event.

These reviews are essential given the changing nature of government in Queensland – changes in legislation, changes in policies and changes in departmental organisations all need to be accurately reflected in the LDEMP and sub-plans.

9.3 FLOOD MODIFICATION MEASURES

As discussed in Section 5.3, there is a range of potential flood modification measures that could be employed to mitigate the impacts of flooding throughout MBRC.

9.3.1 Changes to Infrastructure

Once the composite all-risks mapping is completed, areas where there are indications that existing infrastructure is causing back-ups will become obvious. With this knowledge, specialist flood modelling should be undertaken to assess possible structural changes, e.g. additional waterway area under highways / railways through adding high level culverts, reconstructing existing structures to a higher standard, clearing vegetation, particularly invasive species, from around structures.

9.3.2 Levees / Temporary Flood Barriers

It is appreciated that levees have a certain "flavour of the month" about them in Queensland at present. They can be very effective however the two constraints – their potential to redirect flows and the potential for massive flood damage and even loss of life should a levee be overtopped by a bigger than design flood level – require significant consideration in determining the location and size of any new levee.

A levee, if that measure is adopted, should also be part of a strategically planned series of floodplain risk management measures – a levee is not the panacea for flooding. This applies whether the levee is a permanent structure or a temporary flood barrier, used where constraints may preclude a permanent structure.

9.3.3 Detention Basins

As noted in Section 5.3.2, detention basins may be a viable flood modification measure for overland flows and the development of green-field sites. They may also be used in redevelopment scenarios where there is sufficient open space to construct a suitable basin.

At present, it is understood that the approach taken in MBRC is that it is up to the developer/designer to incorporate a basin into a development to ensure that "flooding is not worse" once the development is implemented. In many cases, the design only considers the 1 in 100 year ARI flood and not lesser or greater floods. This approach can lead to adverse impacts downstream of a basin, including significant erosion of the stream channel.

Accordingly, it is recommended that a detention basin policy be developed for MBRC. This policy should address the full range of floods and should be based, for construction purposes, on the ANCOLD guidelines for the design of small dams. Consideration should also be given to applying on-site detention policies for suitable developments as a method of addressing overland flows.

9.3.4 Channel Modification

Modification to the channels through extensive excavation, dredging or reshaping is not recommended in the MBRC area.

However, consideration needs to be given to clearing the smaller creek systems of overgrowing weeds and other vegetation as well as creating suitable fauna pathways for the easy passage of fauna from urbanised bush settings to more natural bushland, particularly in the lower reaches of the creek / river systems.

While this can be seen as an environmental measure rather than a strictly flood modification measure, various studies (e.g. FloodMit 2012) have found that stream clearing has significantly reduced flooding in relatively narrow creeks. It the creeks and floodplains are cleared of introduced species, the re-establishment of native species has proven to be beneficial for all flood affected areas.

9.4 PROPERTY MODIFICATION MEASURES

The longer term property management measures will revolve around:

- Selection of a DFE/DSTE;
- Determination of a suitable freeboard; and

- Determination of desired zones and development controls.

9.4.1 DFE / DSTE

The selection of the DFE / DSTE should be made in consideration of the full range of flood events.

The DFE / DSTE should:

- Be selected using a risk management approach in light of the ramification of the full range of flood risks; and
- Reflect be an acceptable risk that allows for a reasonable compromise between living on the floodplain and accepting the consequences of this choice.

They are generally used with a freeboard in setting development standards.

The selection of a DFE, even with comprehensive land use zonings, cannot necessarily deal with the flood risk to more vulnerable development. This may require the use of a higher DFE or the use of additional location based development controls to reduce vulnerability at a specific location.

For example, aged care homes and hospitals may have occupants that are particularly vulnerable to flood risks and, what may be acceptable probability of isolation for general residential or commercial development would be an unacceptable risk for these more sensitive developments.

Key infrastructure such as power supplies, communication centres, emergency response headquarters and evacuation centres should also not be located in areas of unacceptable risk. Trying to apply different DFEs to such works would only lead to confusion, as a number of flood planning precincts with location based development controls would be needed.

However, it is considered that the longer-term direction for flood management should be based on risk – is it acceptable, is it tolerable or is it unacceptable – not on a single flood event.

In order to identify areas for freeboard control, the results of the risk assessment need to be overlaid. The worst possible combination of risk is an unacceptable risk to personal safety and an unacceptable risk of isolation on a low flood island[1].

The application of the risk assessment to controls and identification of areas for detailed assessment is under continuing investigation and should be developed further during the development of a detailed floodplain risk management study and final plan.

There will still be a need for a DFE however that event will not determine what and where development can occur, it will determine what controls will be applied to any development that meets the defined risk criteria. The cumulative flood risk will determine where and what level of control is placed on development.

This approach will take some time to fully develop however the data required to support the approach is being gathered / assessed and a suitable Planning Scheme that satisfies the Draft Queensland Planning Provisions (December 2012) based on the risk principles adopted by Council can eventually be established.

9.4.2 Freeboard

As with the DFE/DSTE, it is considered that risk assessment will play a greater role in setting the freeboard requirements than will the selection of a particular flood event. Freeboard setting is not an issue for areas outside flood risk areas.

The appropriate means of determining where and to what level freeboard is applied is considered to require a summation of all assessed flood risks.

In areas where the risks are acceptable, the freeboard could be:

- 300mm above the selected DFE/DSTE where the risks are acceptable (possibly 500mm if development is of a sensitive or critical nature and must be placed in an affected area); and
- 750mm where risks are tolerable.

[1] See MBRC Floodplain Risk Management Study – Stage 1 – Molino Stewart 2013.

No further development should be allowed in areas where the risk in unacceptable, unless the development is compatible with such circumstances, e.g. recreation and open space, environmental management and conservation or tourism/special uses such as boat ramps, small anchorages and associated service buildings.

9.4.3 Zonings Development Controls and Building Controls

Zonings to be developed under the MBRC Planning Scheme that satisfy the eventual Queensland Planning Provisions should restrict activities from areas of unacceptable risk as well as areas that are needed to perform their natural flood functions of flow conveyance and flood storage. This will limit impacts upon existing flood behaviour.

Zonings should also encourage land uses and densities compatible with the varying types and degrees of flood risk.

For example, developments expected to have inhabitants who are more vulnerable (such as aged care homes and hospitals) should be placed in areas where the risk of isolation is acceptable or, even better, at no risk.

Development controls support zonings by reducing risks to acceptable levels. Some controls are related to a particular flood event: for example minimum floor levels and minimum fill levels generally relate to the DFE. However, other controls may relate to a specific area, such as providing adequate infrastructure to facilitate effective emergency management. This illustrates the importance of considering the full range of flood risk in strategic land use planning and the use of location based development controls.

Building controls are not stand-alone solutions to mitigating flood risk. They need to be used in conjunction with strategic land use planning, flood mitigation measures and emergency management planning. Building controls are important in reducing damage to buildings and their contents. Some general controls may include:

- Minimum floor level requirements relative to a DFE where DFEs selected may vary with the type and use of building.
- Requirements for the use of flood resistant materials to reduce the vulnerability of structural and/or non-structural components of the building to inundation. These could be prepared in consultation with the finalisation of the Australian Building Code Board – Construction of Buildings in Flood Hazard Areas (Version 2012.2).

10 REFERENCES

10.1 TECHNICAL

Australian Building Code Board –Construction of Buildings in Flood Hazard Areas (Version 2012.2).

CSIRO (2000) Floodplain management in Australia: best practice principles and guidelines. SCARM Report 73. CSIRO Publishing.

Department of Environment and Climate Change (DECC) (2007). Floodplain Risk Management Guideline: Flood Emergency Response Planning Classification of Communities. NSW Department of Environment and Climate Change

Department of Infrastructure, Planning and Natural Resources (DIPNR) (2005) Floodplain Development Manual: the management of flood liable land. NSW Department of Infrastructure, Planning and Natural Resources. Sydney, NSW.

Engineers Australia (2010) Australian Rainfall and Runoff Revision Project 10: Appropriate Safety Criteria for People and Vehicles.

FloodMit Pty Ltd., Hydraulic Impacts of Vegetation in Creek Corridors, Draft Report for Fairfield City Council, November 2012.

Hawkesbury-Nepean Flood Management Advisory Committee (2006), Managing Flood Risk Through Planning Opportunities: Guidance on Land Use Planning in Flood Prone Areas.

Insurance Council of Australia (2012), Cordell Residential Valuer. Accessed 24/07/2012. < http://www.insurancecouncil.com.au/for-consumers/calculators>

Molino Stewart Pty Ltd (2013) MBRC Floodplain Risk Management Study Stage 1 (Draft)

Moreton Bay Regional Council (MBRC) (2012a) Draft Floodplain Risk Management Strategy.

Moreton Bay Regional Council (MBRC) (2012b) Storm Tide Management Study.

Queensland Government: Natural Resources and Mines (2002) Guidance on the Assessment of Tangible Flood Damages.

Queensland Treasury (2006) Cost Benefit Analysis Guidelines – Achieving Value for Money in Public Infrastructure and Service Delivery.

Water Studies (1992) Forbes Flood Damage Study, August 1990 Flood. Report for the NSW Department of Water Resources by Water Studies Pty Ltd

10.2 PLANNING

Caboolture Shire – Shire Plan Policies, effective October 2011, Shire Plan Supporting Information, Shire Plan Volumes 1 & 2, effective October 2012.

Pine Rivers Planning Scheme

Redcliffe Planning Scheme 2005

Queensland Coastal Plan Coastal Hazards Guideline, 2012

Planning for stronger, more resilient floodplains, QRA 2012

Temporary State Planning Policy 2/11, Planning for stronger, more resilient floodplains, September 2011

Statutory guideline 02/12 Making and amending local planning instruments November 2012

Queensland Floods Commission of Inquiry, March 2012

Queensland Government response to Queensland Floods Commission of Inquiry

APPENDIX A – BUILDING MATERIALS

FLOOD COMPATIBLE MATERIALS[1]

BUILDING COMPONENT	FLOOD COMPATIBLE MATERIAL	BUILDING COMPONENT	FLOOD COMPATIBLE MATERIAL
Flooring and Sub-floor Structure	• concrete slab-on-ground monolith construction • suspension reinforced concrete slab.	Doors	• solid panel with water proof adhesives • flush door with marine ply filled with closed cell foam • painted metal construction • aluminium or galvanised steel frame
Floor Covering	• clay tiles • concrete, precast or in situ • concrete tiles • epoxy, formed-in-place • mastic flooring, formed-inplace • rubber sheets or tiles with chemical-set adhesives • silicone floors formed-inplace • vinyl sheets or tiles with chemical-set adhesive • ceramic tiles, fixed with mortar or chemical-set adhesive • asphalt tiles, fixed with water resistant adhesive	Wall and Ceiling Linings	• fibre-cement board • brick, face or glazed • clay tile glazed in waterproof mortar • concrete • concrete block • steel with waterproof applications • stone, natural solid or veneer, waterproof grout • glass blocks • glass • plastic sheeting or wall with waterproof adhesive
Wall Structure	• solid brickwork, blockwork, reinforced, concrete or mass concrete	Insulation Windows	• foam (closed cell types) • aluminium frame with stainless steel rollers or similar corrosion and water resistant material.
Roofing Structure (for Situations Where the Relevant Flood Level is	• reinforced concrete construction • galvanised metal	Nails, Bolts, Hinges and Fittings	• brass, nylon or stainless steel • removable pin hinges

[1] List based on similar situation in Fairfield City Council in NSW. Subject to finalisation of the Australian Building Code Board – Draft Construction of Buildings in Flood Hazard Areas (Version 2012.1).

Above the Ceiling)	construction		• hot dipped galvanised steel wire, nails or similar.

FLOOD COMPATIBLE BUILDING COMPONENTS[1]

Electrical and Mechanical Equipment For dwellings constructed on land to which this Plan applies, the electrical and mechanical materials, equipment and installation should conform to the following requirements.	**Heating and Air Conditioning Systems** Heating and air conditioning systems should, to the maximum extent possible, be installed in areas and spaces of the house above the relevant flood level. When this is not feasible every precaution should be taken to minimise the damage caused by submersion according to the following guidelines.
Main power supply Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the relevant flood level. Means shall be available to easily disconnect the dwelling from the main power supply.	**Fuel** Heating systems using gas or oil as a fuel should have a manually operated valve located in the fuel supply line to enable fuel cut-off.
Wiring All wiring, power outlets, switches, etc., should, to the maximum extent possible, be located above the relevant flood level. All electrical wiring installed below the relevant flood level should be suitable for	**Installation** The heating equipment and fuel storage tanks should be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage

[1] List based on similar situation in Fairfield City Council in NSW. Subject to finalisation of the Australian Building Code Board – Draft Construction of Buildings in Flood Hazard Areas (Version 2012.1).

continuous submergence in water and should contain no fibrous components. Earth core linkage systems (or safety switches) are to be installed. Only submersible-type splices should be used below the relevant flood level. All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.	the fuel supply line. All storage tanks should be vented to an elevation of 600 millimetres above the relevant flood level.
Equipment - All equipment installed below or partially below the relevant flood level should be capable of disconnection by a single plug and socket assembly.	**Ducting -** All ductwork located below the relevant flood level should be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a water-tight wall or floor below the relevant flood level, the ductwork should be protected by a closure assembly operated from above relevant flood level.
Reconnection - Should any electrical device and/or part of the wiring be flooded it should be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.	**Ancillary Structures (steps, pergolas, etc.) –** Suitable water tolerant materials should be used such as masonry sealed hardwood and corrosive resistant metals. Copper Chrome Arsenate (CCA) treated timber is not a suitable material.

APPENDIX B – FREEBOARD HEIGHT ANALYSIS

Insert pdf document here

This is Steve Roso's freeboard review – not included at this draft stage of the document.

Appendix F: Freeboard Review and Recommendations Report (BMT WBM, 2014)

BMT WBM Pty Ltd
Level 8, 200 Creek Street
Brisbane Qld 4000
Australia
PO Box 203, Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.bmtwbm.com.au

Our Ref: PEH: L.B21092.003.final

11 May 2015

Moreton Bay Regional Council
220 Gympie Road
Strathpine Q 4500

Attention: Anthony Martini

Dear Anthony,

RE: REVIEW OF FREEBOARD PROVISIONS AT MBRC

Thank you for seeking BMT WBM's input regarding the above matter. Outlined in this letter is our advice to the Moreton Bay Regional Council (**MBRC**).

1 Definition and Purpose for Freeboard

There are many definitions of 'freeboard' that are used by various agencies and documented within relevant literature. In the context of flooding and inundation, freeboard is essentially a provision that is over and above a best-estimate of relevant design conditions (e.g. defined flood event levels) to provide a 'factor of safety' when nominating a particular standard for future development. Freeboard therefore is applied to design requirements to help mitigate the consequential impacts of flooding, such as the requirements for floor levels, lot fill levels and flood defence (e.g. levee) levels.

The reason for applying a freeboard is to provide an allowance for circumstances whereby the designated design conditions would be exceeded. As outlined in various literature (see Emergency Management Australia, 1999; ARMCANZ, 2000; NSW Government, 2005; HNFMSC, 2006; DEWS, 2013; Australian Government, 2013), this could occur as a result of various factors, including the following:

- inaccuracies and uncertainties associated with determination of the design conditions;
- unpredictable and indeterminate local flood hydraulic conditions (e.g. afflux, waves etc); and
- possible impacts in the future (e.g. new development, climate change, new design rainfall patterns).

Freeboard is a floodplain management planning tool. It does not influence the determination of design floods or defined flood events (DFEs). 'DFE + Freeboard' is generally considered as the 'Flood Planning Level'.

The Queensland Floods Commission of Inquiry (2012) noted that Councils typically use a freeboard to provide a buffer that allows for uncertainty in estimating flood water heights, as well as the effects of wave action and unforeseen variation in local flood behaviour. The Commission of Inquiry found that it was not mandatory for Councils to set a freeboard level, although most were typically in the range of 300 to 500mm. Higher freeboard was considered necessary where there was a higher level of uncertainty surrounding the estimate of flood level.

Freeboard is used in floodplain management worldwide. For example, the Environment Agency (UK) recommends a 300mm freeboard above the 1 in 200 year flood level for defining residential floor levels, with this value increasing to 600mm if the flood levels have been computed with a low degree of precision. Within Australia, there are a number of national and state-based guidelines and manuals that provide direction regarding freeboard, although all mandatory provisions are generally specified at the local government level through planning schemes and similar instruments.

2 Previous Approach in Prior Planning Schemes

2.1 Caboolture Shire Plan

Freeboard considerations in the former Caboolture Shire Plan are as follows:

Dwelling House Code

S3.1 *For land affected by flood water:*

(a) the floor level of habitable rooms is not lower than the higher of:

(i) 300mm above the highest recorded flood level as determined by Council or 300mm above the calculated 100 year ARI flood level where such a level has been determined by Council, whichever is the greater;

Planning Scheme Policy 4 – Design and Development Manual Part A

8.9 Minimum Flood Immunity Levels

Location	*Minimum Design Allotment Levels for Urban Zones or Level of Flood Free Area in Rural and Residential Zones*
Adjacent to river, creek or waterway	*Calculated 100 year ARI ultimate flood level + 300mm freeboard*
Adjacent to engineered channels	*Calculated 100 year ARI ultimate flood level + 300mm freeboard*
In areas affected by tidal water	*Adopted 100 year ARI storm tide level (RL 2.8AHD) + 300mm freeboard*
Adjacent to roads and overland flow paths	*Calculated 100 year ARI flow depth + 50mm freeboard*

2.2 Pine Rivers Plan

Freeboard considerations in the former Pine Rivers Plan are as follows:

Major Flood Events Overlay Code

AS1.1/PS1.1 *Building floor levels of all habitable rooms are above the DFE flood level by the following heights:*

(a) 750mm – where inundation area is an existing natural watercourse

(b) 500mm – where inundation area is an engineered channel

Other development Codes: Urban Residential Design Code

PS 5 *The residential lots are developed to the following finished surface levels*

Location	*Minimum Development Level Requirements*
Adjacent rivers, creeks and watercourses	*Q100 flood level + 750mm*
Adjacent engineered channels	*Q100 flood level + 500mm*

2.3 Redcliffe City Planning Scheme

Freeboard considerations in the former Redcliffe City Planning Scheme are as follows:

Natural Features or Resources Overlay Code

PS11.2 *Floor levels are located above the Q100 flood level*

3 Approach Used in Neighbouring Local Authorities

3.1 Sunshine Coast Planning Scheme

Freeboard considerations in the Sunshine Coast Planning Scheme are as follows:

Flood Hazard Overlay Code

Table 8.2.7.3.1 – Dual occupancy & Dwelling house AO1 *The finished floor level of all habitable rooms is at least 500mm above the DFE and DSTE*

OR

Where the DFE and DSTE has not been modelled for the area, the finished floor level of all habitable rooms is at least 600mm above the highest recorded flood or storm tide inundation level

Table 8.2.7.3.2 – All other development AO3.1 *Finished surface and floor levels of urban lots, and buildings and infrastructure comply with the flood immunity requirements specified in Table 8.2.7.3.3 (Flood levels and flood immunity requirements for development and infrastructure)*[1]*.*

3.2 Brisbane City Plan

Freeboard considerations in the Brisbane City Plan are as follows:

Flood Overlay Code

Table 8.2.11.3.B

Flooding source	*Minimum habitable floor level*
Brisbane River	*RFL + 500mm*
Creek/waterway	*1% AEP flood level + 500mm*
Overland flow	*2% AEP flood level + 500mm*
	Note – where no detailed flood level information is available from Council such as an overland flow path, a RPEQ with expertise in flood studies is to derive the relevant flood level and certify that the development level for the dwelling house, including any secondary dwelling, meets the required immunity standards.

[1] Table 8.2.7.3.3 provides minimum design levels for lot surface and building floors for all land use types. The DFE and DSTE are the respective 1% AEP at the year 2100. Generally, the freeboard allowance for floor levels of buildings of most development types is 0.5m, or 0.6m where there is no DFGE/DSTE available (i.e. where a historical level is utilised). 1m freeboard is required for community infrastructure, utilities and hazardous and other materials in areas with only historical levels.

Coastal Hazard Overlay Code

Table 8.2.6.3.B – Flood planning levels for a dwelling house

Flooding source	*Minimum ground level for house pad after filling (where filling permitted)*	*Minimum habitable floor level*	*Minimum non-habitable floor level – utility areas, garage, laundry and storage room*
Storm-tide flooding within the: *High storm-tide inundation area sub-category; or* *Medium storm-tide inundation area sub-category*	*2.5m AHD* *(1% AEP)*	*2.5m AHD + 500mm* *(1% AEP + 0.5m)*	*2.5m AHD + 300mm* *(1% AEP + 0.3m)*

Table 8.2.6.3.C – Categories of flood planning levels

Flooding source	*Minimum design floor or pavement levels (m, AHD)*				
	Category A (i.e. habitable room) *(For development other than a dwelling house)*	*Category B*	*Category C*	*Category D*	*Category E*
Storm-tide flooding within the: *High storm-tide inundation area sub-category; or* *Medium storm-tide inundation area sub-category*	*3.1m AHD + 0.5m (1% AEP level at 2100 + 0.5m)*	*3.1m AHD + 0.3m* *(1% AEP level at 2100 +0.3m)*	*3.1m AHD (1% AEP level at 2100)*	*2% AEP level*	*2% AEP level*

Table 8.2.6.3.D - Flood planning level categories for development types[2]

BCA Building Classification	*Development types and design levels, assigned design floor or pavement levels*	*Category* *refer to Table 8.2.6.3.C*
Class 1-4	*Habitable room*	*Category A*
	Non-habitable room *including patio and courtyard*	*Category B*
	Non-habitable part of a Class 2 or Class 3 building excluding the essential services control room	*Category B*
	Parking located in the building undercroft of a multiple dwelling	*Category C*
	Carport; unroofed car park; vehicular manoeuvring area	*Category D*
	Essential electrical services of a Class 2 or Class 3 building only	*Category A*
	Basement parking entry	*Category C + 300mm*
Class 5, Class 6, or *Class 8*	*Building floor level*	*Category C*
	Garage or car park located in the building undercroft	*Category C*
	Carport or unroofed car park	*Category D*
	Vehicular access and manoeuvring area	*Category D*

[2] This table is a reproduction of that provided in the Brisbane City Plan. The original table includes a range of notations that for brevity have been removed from this reproduction. Please refer to the Brisbane City Plan for the original table.

	Basement parking entry	*Category C*
	Essential electrical services	*Class 8 – Category C* *Class 5 and 6 – Category A*
Class 7a	*Refer to the relevant building class specified in this table*	
Class 7b	*Building floor level*	*Category C*
	Vehicular access and manoeuvring area	*Category D*
	Essential electrical services	*Category C*
Class 9	*Building floor level*	*Category C*
	Vehicular access and manoeuvring area	*Category D*
	Essential electrical services	*Category C*
	Building floor level	*Category C*
	Vehicular access and manoeuvring area	*Category D*
	Essential electrical services	*Category C*
Class 10a	*Car parking facility*	*Refer to the relevant building class specified in this table*
	Shed or the like	*Category D*
Class 10b	*Swimming pool*	*Category E*
	Associated mechanical and electrical pool equipment	*Category C*
	Other structures	*Flood planning levels do not apply*

3.3 Gold Coast Planning Scheme

Freeboard considerations in the Gold Coast Planning Scheme are as follows:

Constraint Codes: Flood Affected Areas

AS2.1.1 *An allowance of at least 300mm is added to the Designated Flood Level for habitable rooms, or other allowance amount specified in a Local Area Plan*

Within the new Gold Coast Draft City Plan, freeboard considerations are proposed as follows:

Flood overlay code

AO2.1 *An allowance of at least 300mm is added to the Designated Flood Level for habitable rooms, or other allowance amount specified in a Precinct*

3.4 Logan Planning Scheme

Freeboard considerations in the Logan Planning Scheme are as follows:

Floodplain Management Area Code

S1.1 *The ground level of the site and any access to the development is above the level of the defined flood event applicable to the premises*

O2 *Development for a residential use is constructed on fill which is above the level of the defined flood event except where the site is classified as a low flood hazard*

Planning Scheme Policy 6 – Standards for Flood Plain Management Area

***2.1.4** Design floor level for the prescribed flood district is the 100 year ARI statistical flood plus 300mm*

Within the draft Logan Planning Scheme, the following freeboard provisions are proposed:

Flood hazard overlay code

***AO1** A building has a finished habitable floor level a minimum of 500mm above the defined flood event*

4 Relevant Legislation and Regulations

4.1 State Planning Policy

The State Planning Policy (SPP) does not prescribe specific freeboard requirements. Rather Part E of the SPP requires development to avoid natural hazard areas or to mitigate the risks of the natural hazard to an acceptable or tolerable level. The SPP guideline notes that this requirement can be met where 'development does not involve land uses that create an intolerable risk to people and property. Development is located and designed to avoid or mitigate the risk to people, property and infrastructure to an acceptable or tolerable level.'

The example code for flood hazards presented in the guideline presents a freeboard requirement of 300mm *above the highest known flood level*. This is not binding and is presented purely as an example, however, it signifies a possible standard that State Government may consider in the drafting of a local government planning scheme.

4.2 Sustainable Planning Act 2009 and Regulation

The *Sustainable Planning Act 2009* establishes a framework for development assessment but does not set standards against which applications should be assessed. There are also no specific requirements provided under the State Development Assessment Provisions.

The *Sustainable Planning Regulation 2009* provides referral jurisdiction to local governments for buildings proposed in flood hazard areas where the proposed flood level is below that declared by the local government under the *Building Regulation 2006*. This jurisdiction involves assessment as to the appropriateness of the proposed flood level by reference to flood modelling, recorded flood levels in the area, and any other matter the local government considers relevant.

4.3 Queensland Building Regulations

In response to the recent floods, and as highlighted through the subsequent Commission of Inquiry, the Queensland Government has introduced new mandatory requirements for freeboard through the Queensland Development Code (QDC) Mandatory Part 3.5 - Construction of buildings in flood hazard areas, which commenced on 26 October 2012. Changes were also made to the *Building Regulation 2006* under the *Building Act 1975* on 20 December 2013. The *Building Regulation 2006* now sets a minimum freeboard of 300 millimetres.

4.4 Building Code of Australia 2013

With respect to freeboard, the Building Code of Australia (BCA) standard for construction of buildings in flood hazard areas (ABCB, 2013) quotes (p.13) “Freeboard for residential buildings would typically be a maximum of 0.5m unless the specific exposure factors at the location require a higher value. In shallow depths of local overland flow, often resulting from urban piped drainage system bypass, a smaller minimum freeboard of 0.3m is typically used.” It is noted that the BCA allows for up to 1.0m depth of flooding over non-habitable floor levels during the flood used for planning purposes (what is referred to as the flood hazard level, or DFE in Queensland context).

5 Current National Best Practice

5.1 NSW Floodplain Development Manual (NSW Government, 2005)

In NSW, Councils have a statutory responsibility for managing floodplains. The NSW Government has prepared a guideline document, the Floodplain Development Manual (FDM) (2005) for assisting Councils in this regard. Importantly, under the provisions of s733 of the NSW *Local Government Act 1993*, Councils have been considered to have acted in ‘good faith’ and thenceforth are indemnified from liability with respect to matters involving flooding if they follow the floodplain management procedures set out in this guideline document.

The FDM (Appendix K) states that the purpose of freeboard is to provide reasonable certainty that the reduced risk exposure provided by selection of a particular flood as the basis of a flood planning level (FPL) is actually provided, given uncertainties relating to a number of factors. These factors include the following:

- uncertainties in the estimates of flood levels;
- ‘local factors’ influencing water surfaces;
- wave action, from wind as well as from boats and vehicles moving through flooded areas;
- changes in rainfall patterns and ocean water levels as a result of climate change; and
- cumulative effect of future infill development (especially on existing zoned land).

Whilst not a mandatory requirement, there is considerable support throughout the document for adopting an FPL of 1% AEP plus a freeboard of 500mm (for residential development). This provision is adopted almost exclusively within NSW, however, the FDM acknowledges that freeboard provisions may differ based on the following:

- landuse type;
- location within the floodplain; and
- presence of mitigation works (may need additional freeboard to accommodate future changes, such as post-construction settlement of a levee).

5.2 Guidelines for Development in Flood-prone Areas (Melbourne Water, 2007)

Under the *Victorian Building Regulations 2005*, floor level heights for buildings should be set a minimum 300mm above the applicable flood level, or as otherwise determined by the relevant floodplain management authority.

Melbourne Water, as the lead floodplain management authority within the Greater Melbourne area distinguishes between flooding from riverine/creek system and flooding from overland flowpaths. For riverine floodplains, Melbourne Water specifies that building floor levels should be at least 600mm above the 1% AEP flood level, while associated outbuildings are to be 300mm above the 1% AEP. These freeboard requirements are defended on the following basis:

- flood levels can surge or fluctuate due to wave action or other wind effects or tidal influences; or
- floods bigger than the 1% AEP flood would cause significant increases in flood level; or
- the estimated 1% AEP flood level is based on approximations or interpolations that reduce confidence in the absolute accuracy; or
- essential services or other particularly sensitive activities or assets are to be incorporated on a site.

By way of comparison, freeboard provisions specified by Melbourne Water for overland flows are 300mm for buildings and 150mm for outbuildings, above the 1% AEP flood level.

5.3 Managing the Floodplain: a Guide to Best Practice in Flood Risk Management in Australia – Australian Emergency Management Handbook 7 (Australian Government, 2013)

The new Australian Emergency Handbook 7 (Handbook) acknowledges the purpose of freeboard is to provide certainty of achieving a desired level of service for a designated flood standard (i.e. DFE). The freeboard is to account for potential increases in flood level during the designated event as a result of various factors including uncertainties in the estimates of flood levels, local differences in water level, wave action, future development and future climate change. Importantly, the Handbook states that freeboard should not be considered to provide additional protection beyond the DFE.

The Handbook indicates that there are many circumstances where a freeboard of 300mm to 600mm may be considered acceptable. Lower freeboards would generally be acceptable for shallow water conditions, where the potential for higher levels would be limited. Higher freeboards would be more applicable for deeper flooding and where estimated design flood levels are less certain, or are particularly sensitive to modelling assumptions.

To assist in selecting appropriate freeboard, the Handbook recognises the need for computational flood studies to identify numerical uncertainties and to quantify the implications of these uncertainties through sensitivity analyses.

The Handbook essentially replaces previous SCARM Report No. 73 Floodplain Management in Australia: Best Practice Principles and Guidelines (ARMCANZ, 2000). The SCARM Report noted that a freeboard of 300 – 500mm is commonly applied by many local agencies across Australia when defining minimum floor levels. Added protection to properties above the DFE as a result of the freeboard (if the factors that potentially increase flood levels do not transpire), is considered a ‘bonus’, not a guarantee.

5.4 Managing Flood Risk through Planning Opportunities: Guidance on Land use planning in flood prone areas (HNFMSC, 2006)

Within the series of documents prepared by the Hawkesbury-Nepean Floodplain Management Steering Committee (HNFMSC, 2006), freeboard is again recognised as an important floodplain management tool

that compensates for uncertainties associated with flood model estimation/confidence, including wave action, afflux and climate change. This is required because of the impossibility of quantifying either the increase in flood levels associated with these factors, or the likely consequence of two or more factors occurring simultaneously. Provision of a freeboard therefore negates the need to undertake rigorous review of these factors.

While most freeboard provisions across NSW are defined as 500mm, the guidelines state that freeboard higher than 500mm can be justified through a cost-benefit analysis, which would be carried out as part of a floodplain risk management study.

Given that flood planning levels (or DFEs) rely on the application of computational flood models, which are based on limited data (in terms of catchment flows, floodplain topography, flood frequency analysis, historical flood event information, etc), it becomes necessary to understand the broader uncertainties of the model results, as well as more site-specific uncertainties across the floodplain.

5.5 Queensland Urban Drainage Manual (DEWS, 2013)

The Queensland Urban Drainage Manual (QUDM) notes that water surfaces during flood events and overland flows are rarely smooth and level. Therefore, the primary purpose of freeboard is to provide protection of buildings from flood inundation resulting from a DFE above the 'theoretical' flood level. Factors potentially influencing water levels that may be higher than the theoretical flood level include uncertainties in flood level prediction, variations in structure blockage, variations in water level across the floodplain (e.g. superelevation), conversion of water's kinetic energy (velocity head) into potential energy (i.e. afflux), the effects of wave action, and the risk of future building works within the floodplain.

In coastal regions, QUDM notes that higher freeboards are often recommended. Also, local governments may choose a major design storm standard less than the 1% AEP but may combine this with higher freeboard requirements.

QUDM recommends a minimum of 300m for freeboard to account for variables that potentially influence the DFE.

6 Draft MBRC Planning Scheme Provisions

The freeboard requirements proposed in the draft MBRC planning scheme (July 2014) were as follows:

- 750mm above the DFE for all building habitable floor levels;
- 750mm above the DFE for all non-residential building floor levels; and
- 500mm above DFE for minimum ground levels.

For the above conditions, the DFE is defined as the 1% AEP flood event for the fully developed catchment including an allowance for greenhouse climate change and general sea level rise to the planning horizon year 2100 (discussed further below).

Whilst the freeboard requirement is consistent across the flood planning area, the draft planning scheme provides different provisions for areas identified as low, medium and high risk within the flood planning area. The categorisation of risk is based on a combination of flood likelihood and consequence, where the consequence is based on hazard. Categorisation of hazard is a function of flood depth and flood velocity for events of particular frequency (refer Figure 1).

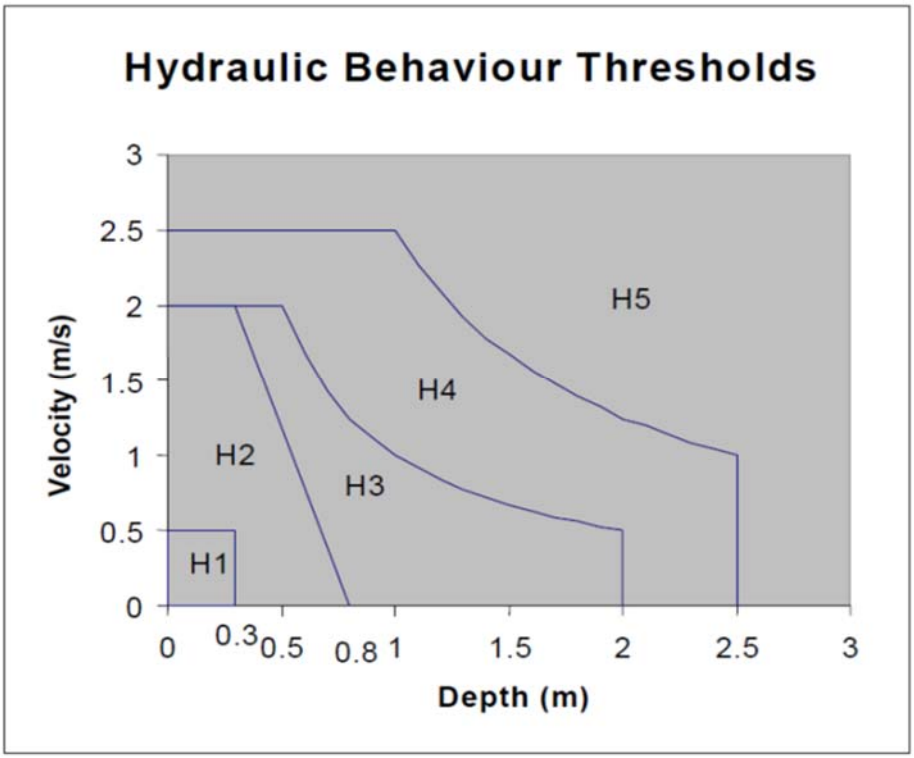


Figure 1 Flood Hazard Relationship Between Velocity and Depth (from Newcastle LGA)

Generally, conditions that result in a H4 or H5 category (see Figure 1) are associated with high risk, while H1, H2 and H3 areas are associated with medium risk. Low risk areas are those areas outside the extent of the high and medium risk areas and are generally only inundated very infrequently.

7 Current MBRC Estimates of Inundation and DFE

7.1 Defining the DFE

MBRC has undertaken a comprehensive program of catchment modelling and floodplain mapping across all minor basins within the MBRC local government area in order to characterise flood behaviour. This information has formed the Regional Flood Database and covers the following minor basins:

- Brisbane Coastal Creeks;
- Bribie Island;
- Burpengary Creek;
- Byron Creek;
- Caboolture River;
- Hays Inlet;
- Lower Pine River;
- Mary River;

- Neurum Creek;
- Pumicestone Passage;
- Redcliffe;
- Sideling Creek;
- Stanley River; and
- Upper Pine River.

Additionally, MBRC has undertaken a Storm-tide Inundation Study. This study provides information about potential oceanic flooding along the coastal region within the MBRC local government area.

The DFE is applicable to areas affected by both stormtide inundation and riverine flooding.

For stormtide inundation areas the DFE comprises a 1% AEP stormtide with allowance for higher sea levels and increased cyclonic wind speeds as is predicted to occur in the year 2100. We also understand from discussions with MBRC officers that the Defined Flood Event (DFE) for riverine areas is based on the 1% AEP event combined with a number of measurable uncertainties, as follows:

- 1% AEP; plus
- future conditions (increased rainfall and higher sea levels as at year 2100); plus
- future development; plus
- blockage of structures; plus
- roughened floodplain; plus
- coincident future stormtide.

It is noted that for model efficiency, the DFE rainfall adopts a synthesised rainfall pattern (known as the Moreton Bay Design Storm) rather than the 1987 AR&R temporal patterns. This emulates the AR&R rainfall burst as a single storm of duration 270 minutes.

7.2 Reliability of modelling against the January 2011 Floods

Five (5) catchments were modelled for the January 2011 event, and results compared against observed flood records. The five catchments were:

- Burpengary Creek (BUR);
- Caboolture River (CAB);
- Stanley River (STA);
- Upper Pine River (UPR); and
- Lower Pine River (LPR).

A total of 276 observations of flood level were recorded for the January 2011 event, however, based on closer review of these, 28 were discounted due to insufficient rainfall data (7 observations), failed rain gauge (3 observations), possible human error in identification of flood level (8 observations), edge of flood extents (8 observations) and infrastructure not explicitly included in the model (2 observations). For the remaining

248 observations, the recorded levels were compared with the model results for the 2011 event (refer Figure 2). The results show that there was quite a large range in difference between observed and modelled results. Approximately 55% of observations were higher than modelled levels. The roughly normal distribution of the data, with approximately equal number of observation higher and lower than modelled levels suggests that the major factor contributing to the difference is the inherent inaccuracy associated with modelling assumptions and numerical estimations rather than other local floodplain components that would generally create higher than modelled levels, such as wave action and local afflux effects.

The distribution of observations above modelled predictions for the January 2011 event are presented in Table 1.

Table 1 Distribution of observations greater than modelled for January 2011 event

Observed greater than Modelled	Percentage of total observations for the event	Number of observations
0mm	54.8%	136
150mm	32.3%	80
300mm	16.1%	40
500mm	5.6%	14
600mm	3.2%	8
750mm	0.4%	1

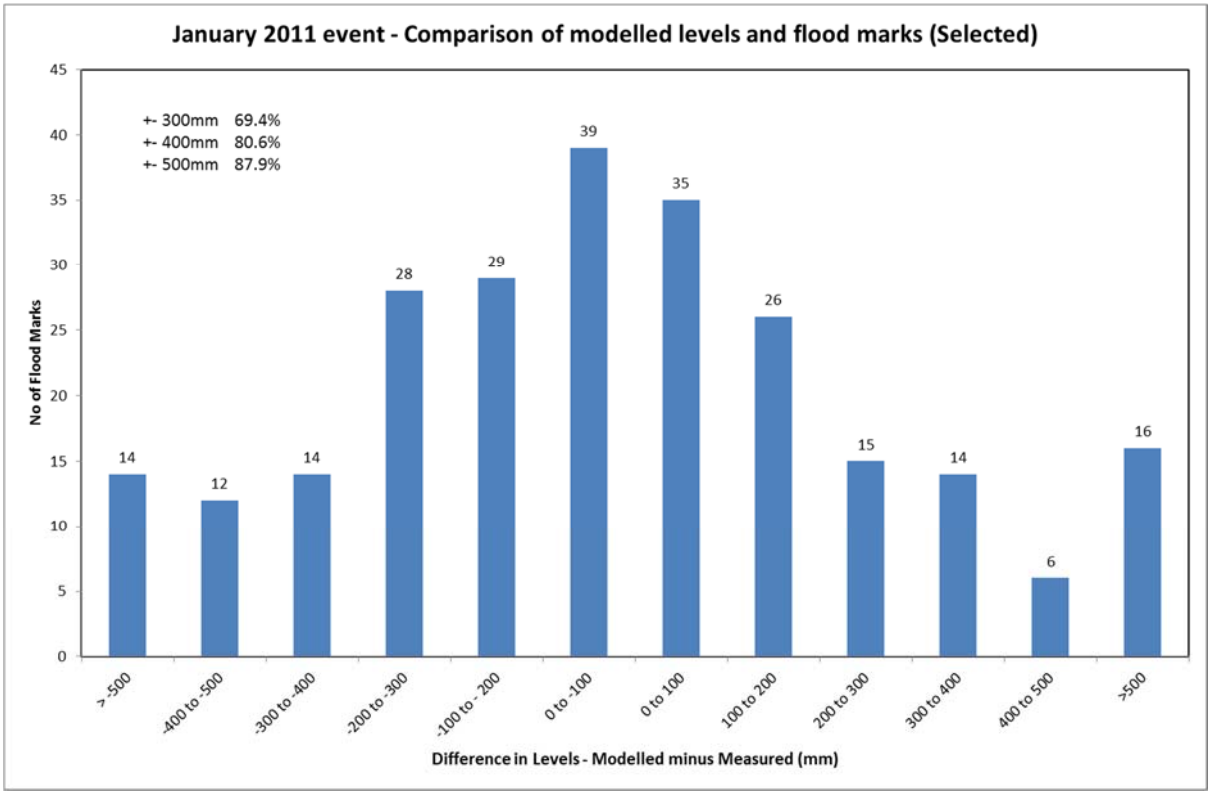


Figure 2 Comparison between observed and modelled results for January 2011 event

Of the 14 observations (5.6%) greater than 500mm, none are located east of the Bruce Highway, well away from the coastal planning area, while of the 40 observations (16.1%) greater than 300mm, only two are located east of the Bruce Highway (one in Burpengary catchment and one in Caboolture catchment) (refer Figure 3).

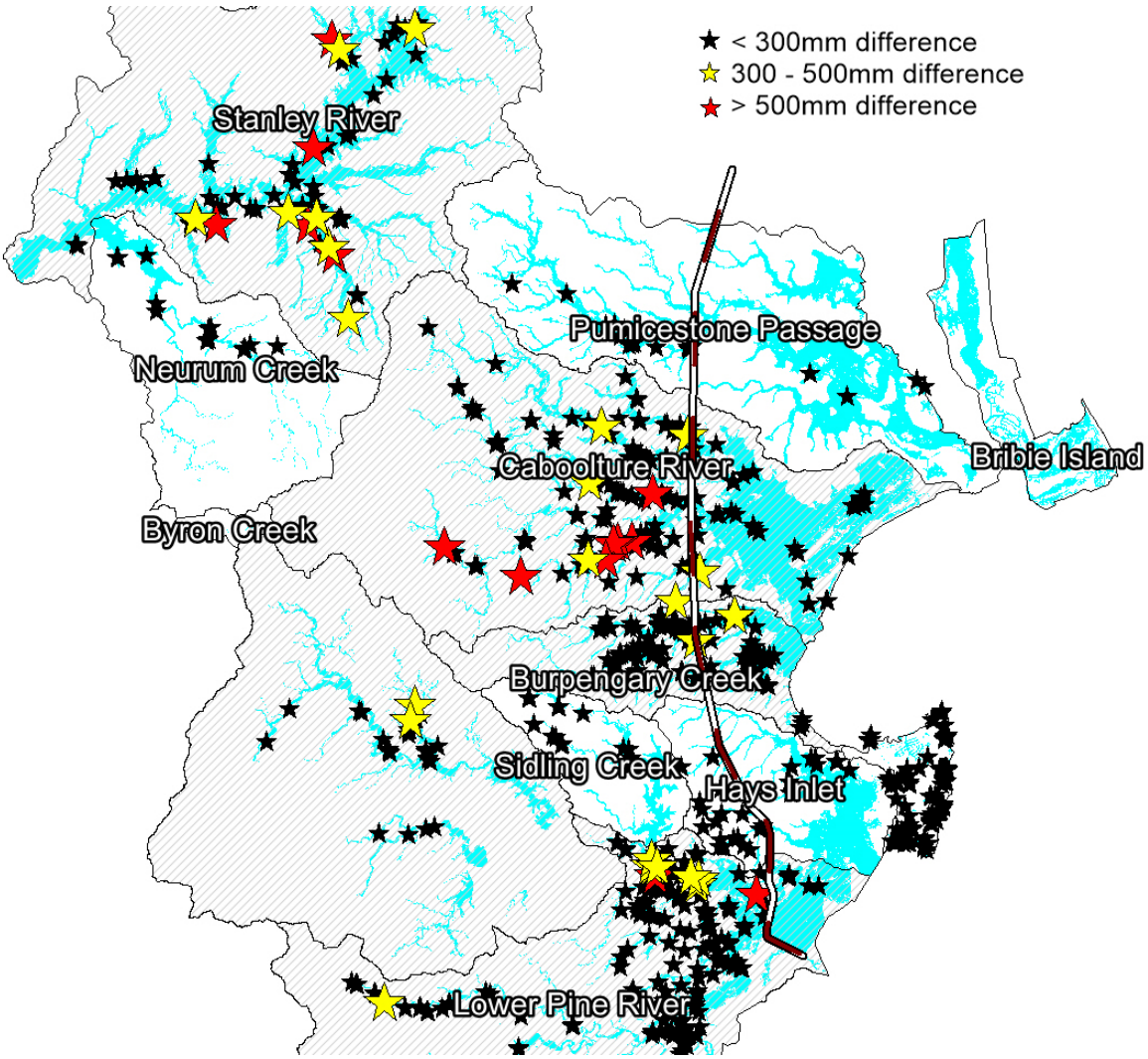


Figure 3 Observations for January 2011 event

7.3 May 2015 Floods

Another very significant rainfall event was experienced across the Moreton Bay region during the afternoon of 1 May, 2015. While analysis of this event is still underway, preliminary findings suggest that in some parts of the Moreton Bay local government area, the rainfall intensity exceeded the 1% AEP conditions. Approximately 330 flood marks across the local government area were captured and surveyed by Council for this event. It is anticipated that the observed data associated with the 1 May 2015 event (measured rainfall, river levels and flood marks) will be used in the near future as part of the on-going review, update and validation of Council's existing flood modelling suite.

8 Broad assessment of flood mapping results

8.1 Flooding extents

The topography of the MBRC local government area comprises generally flat coastal plain backed by steeper terrain with incised valleys. The Bruce Highway is approximately located at the interface between the coastal plain and the steeper upper catchment areas. Mapping shows that the areal flood extents are not significantly different for the 1% AEP and 0.1% AEP events, while the extent of the PMF event is also not significantly larger than the 0.1% AEP event. This means that there is generally not a dramatic increase in properties affected as floods increase towards extreme conditions. Notwithstanding, it is expected that the depths of flooding for these more extreme events would be notably larger.

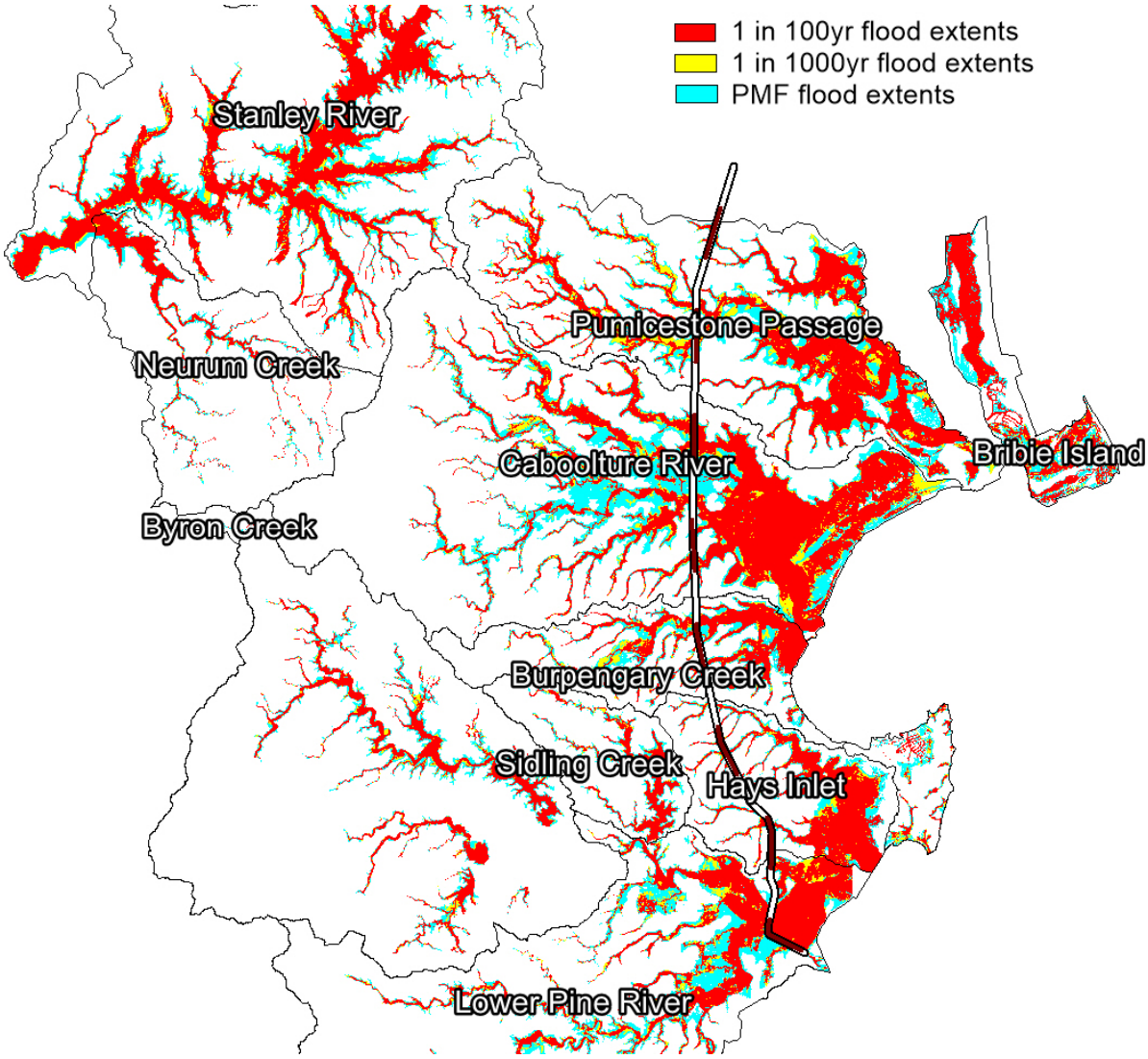


Figure 4 Flood extents for 1 in 100yr, 1 in 1000yr and PMF

8.2 1% and 0.1% AEP Comparison

Comparison between the 1% and 0.1% AEP events highlights locations within the MBRC local government area where flood level is particularly sensitive to the magnitude of flow. Areas of greatest difference (generally more than 1 metre) are mostly located along the major tributaries to the west of the Bruce Highway within the steeper sections of the catchment. An area east of the Bruce Highway within the Pumicestone Passage catchment is also sensitive to flow with a larger difference between 1% and 0.1% AEP flood levels.

Smaller differences in level between the 1% and 0.1% AEP (i.e. less than 300mm) include many of the upper catchment streams as well as areas within the immediate coastal fringe. The area considered to be within the transition between riverine and coastal flooding mostly has a difference of approximately 500mm.

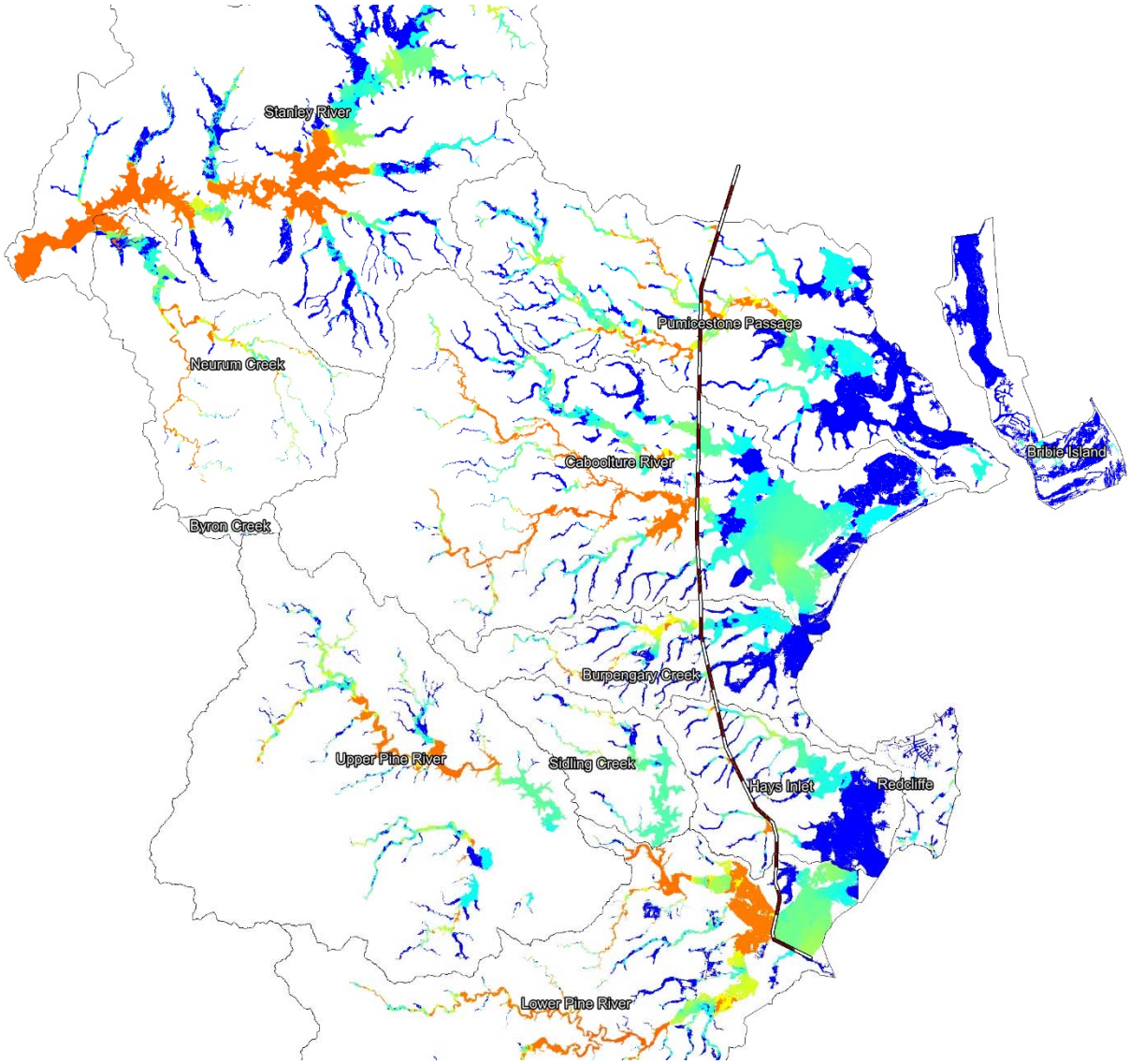


Figure 5 Difference in flood depths between 1 in 1000yr and 1 in 100yr

8.3 DFE and 1% Comparison

A comparison between the mapped DFE and the current day 1% AEP flood levels highlights the locations across the catchments where the 'measurable uncertainties' included in the DFE have the greatest effect. The difference between the DFE and the 1% AEP is mostly less than 300mm, with the exception of some upper reaches of the major tributaries, where the difference can be well over 500mm (ranging from 700mm to 2m in Lower and Upper Pine Rivers, upper Caboolture and behind some critical culverts in Upper Pumicestone). It is noted that the difference in the Stanley River is up to 7m, which we understand is due to particular assumed tailwater conditions associated with Somerset Dam.

In some areas, a significant increase is noted immediately upstream of a road crossing (e.g. the Bruce Highway), and as such would be the result of an assumed blockage of the structure (with localised impacts of 200mm or more). However, in other areas, the driving factor for the increase in flood levels to the DFE level is not immediately apparent and could be the result of a combination of factors. We also understand from discussions with MBRC officers that some of this effect may be due to the use of less detailed topographic resolution for model scenarios that contribute to the DFE. This effect is limited to the larger modelled catchments such as the Lower Pine River where model run-times were significant, necessitating a less detailed topographic resolution.

In the coastal areas, comparison of the DFE (with stormtide) to the 1% AEP riverine flood levels highlights the significance of the stormtide component of the DFE. The stormtide inundation is limited to the area downstream (east) of the Bruce Highway.

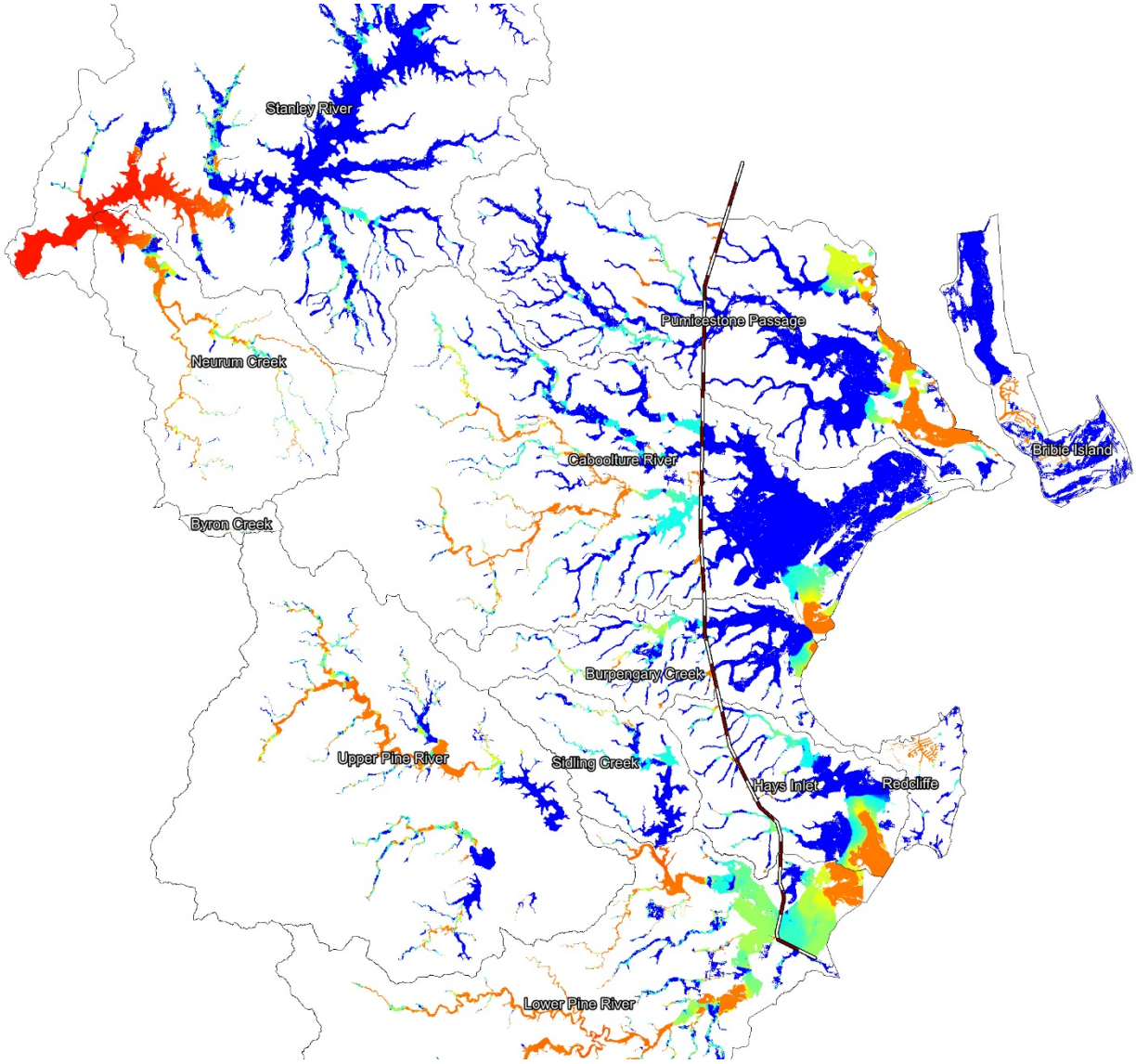


Figure 6 Difference in flood depths between DFE and 1% AEP (excluding stormtide)

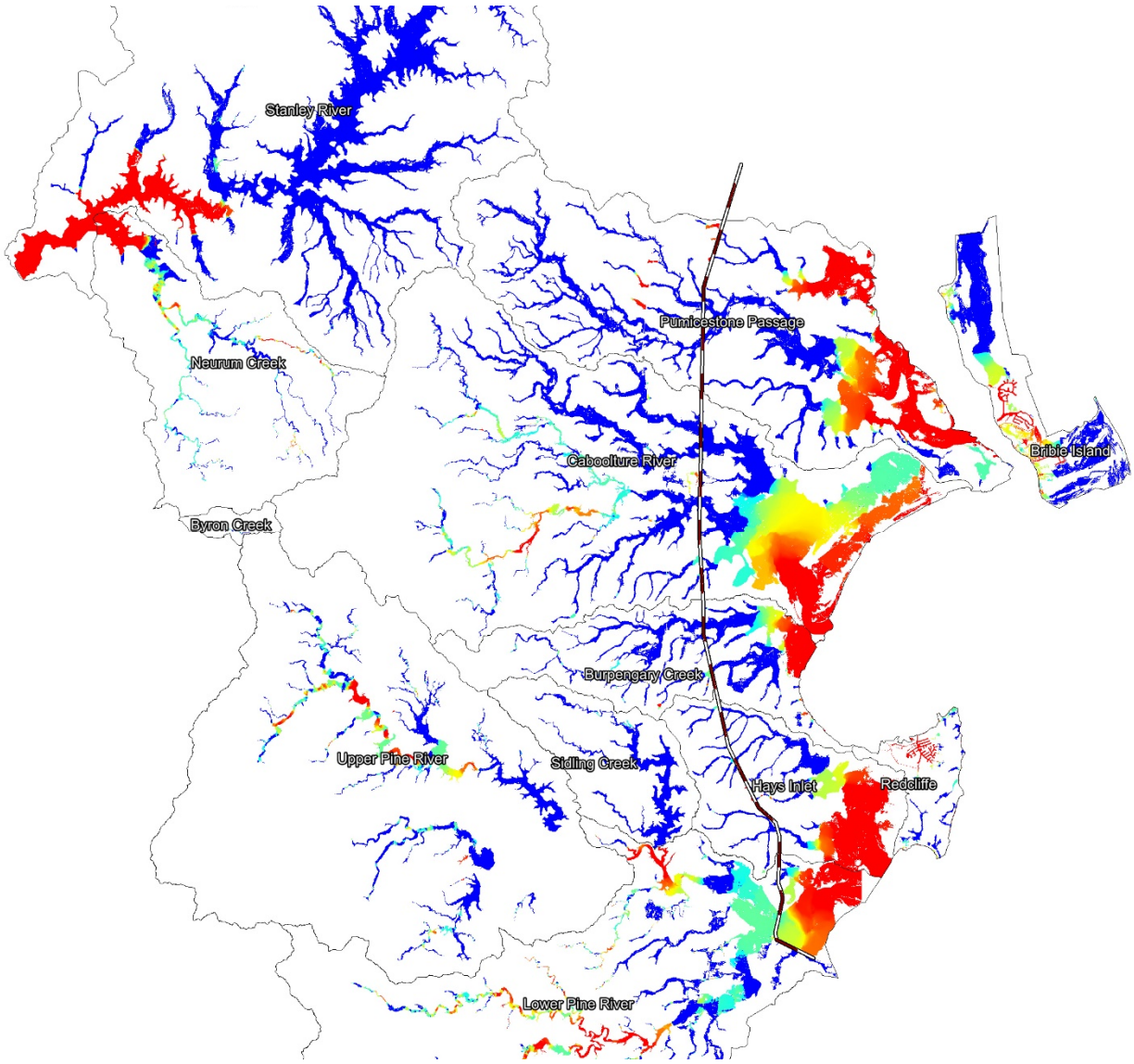


Figure 7 Difference in flood depths between DFE and 1% AEP (including stormtide) (note different gradient scale to Figure 6 has been adopted to highlight stormtide impacts)

9 Factors to Consider in Setting Freeboard for MBRC Area

As outlined previously, there are a number of factors that are generally considered by authorities when calculating appropriate freeboard requirements. These are discussed briefly below in the context of MBRC modelling and the adopted DFE.

9.1 Uncertainties in modelling

Computational modelling is used to provide best-estimates of flood inundation and flood behaviour. The accuracy of the modelling relates to the accuracy of the data used to construct the model and the information used to calibrate and validate the results. Parameters within the model are typically chosen on the basis of matching model results to actual observations for specific flood event (i.e. model calibration).

However, if there is not many reliable observations, and if observed events do not cover a reasonable spectrum of events, then the suitability of parameters can be limited. Potential uncertainties arising from the computational predictions of flood levels can be established through sensitivity testing of the flood model, targeting variations in critical parameters such as discharge, floodplain roughness (vegetation), topography, grid size, boundary conditions, structure details and so on.

There are a number of modelling assumptions related to design flood event predictions, including temporal rainfall pattern, the spatial distribution of rainfall across catchment, antecedent conditions and initial levels of storages, rainwater tanks and detention basins.

The accuracy of the modelling also relates to the robustness of the methods undertaken. This is related to the financial investment made in development of the model, as well as the experience and expertise of the practitioners responsible for the build, and the type of model used. It is common practice in Australia and overseas to adopt a higher freeboard for circumstances where the reliability of flood model predictions is considered to be low.

For MBRC flood models, the comparison of observed and modelled results for the January 2011 event provided an indication of expected level of uncertainty in the modelling. Almost 70% of observed records for this event were within 300mm of the predicted level, and almost 88% were within 500mm. Of note is the fact that the locations of larger differences between observed and modelled results were mostly in the steeper parts of the catchments, away from the coastal floodplain, to the west of the Bruce Highway. Also, the results of the comparison between the 1% and 0.1% AEP flood levels indicated that the non-coastal reaches, to the west of the Bruce Highway, have the larger sensitivity to flow.

The DFE adopted by MBRC incorporates provisions for some modelling uncertainties, including a rougher floodplain and increased blockage at structures.

9.2 Unpredictable flood behaviour

During floods, water levels are rarely smooth and even across a floodplain. Therefore, there is often a notable difference between the ‘theoretical’ flood level and the actual water surface during a flood event. Localised blockages can occur within flowpaths. This creates affluxes, where the water surface is increased locally on the upstream side of the blockage. Examples of blockage of a flowpath can include buildings, fences, dense vegetation, embankments, debris build-up and siltation. Areas of concentrated flow are particularly susceptible to blockage, such as culverts and bridge openings. Once blocked, alternative flowpaths are required, which may result in overtopping of road deck levels, engagement of secondary floodways etc.

For areas where floodwaters flow rapidly, large scale standing waves can be generated (as occurred through Toowoomba in January 2011). Flood levels around floodplain edges can also be ‘set-up’ due to wind effects, while wind waves may also create surface turbulence and affect localised flood levels. Given that rainfall is generated from an intense storm event, the occurrence of high winds would be highly likely.

Localised waves can also be generated by boats travelling on the floodwaters, or more likely, vehicles driving through floodwaters. Larger vehicles (such as 4WDs) travelling at moderate speed (~20km/hr) can generate reasonable size bow waves (in the order of 200mm or more).

There is generally a higher degree of unpredictable behaviour in areas of steeper flood gradient (such as the reaches to the west of the Bruce Highway) and where flows change direction (sharp bends). Also,

these environments may contain more complex three-dimensional flow patterns that are not adequately represented by the modelling.

While the MBRC adoption of the DFE incorporates provision for blockage of structures, there is generally little provision made for other unpredictable hydraulic conditions.

9.3 Allowance for future conditions

It is possible that future conditions will involve more development within the flood planning area. As a minimum, development within the extents of existing zonings would be expected. An increase in the amount of development within the floodplain, and more broadly across the catchment, can introduce the following:

- changes to catchment parameters associated with urbanisation;
- changes to roughness associated with vegetation change;
- infilling of floodplain storage due to development (linear infrastructure as well as land development especially within existing zonings); and
- future flood mitigation works (i.e. improvements in some areas, but possibly worsen in other areas, such as impacts of larger culverts or bridge openings).

As well as future development, there is a high likelihood that the future climate will be different, which may change the frequency and behaviour of future floods. This could include for example changes to rainfall (intensities, storm behaviour, seasonal trends), changes to coastal storms (driving stormtide inundation), and increases to mean sea level. While design conditions, such as the DFE, generally include a specific provision for future climate conditions, which has been quantified separately, freeboard can be used to accommodate some of the uncertainty around best estimates for future projections (including rainfall and sea level rise projections). DECCW (2010) note that the standard freeboard of 500mm applied broadly across NSW includes a small allowance for addressing some of the uncertainty associated with estimating climate change impacts.

Additionally, as more rainfall data is collected in the future, it is possible that intensity-frequency-duration (IFD) rainfall conditions for the MBRC area will be redefined.

The DFE adopted by MBRC includes a range of future conditions. Specifically, the DFE includes an allowance for future development within the floodplain and the catchment, and also future climate conditions, including more intense rainfall and higher sea level rise (an increase of 0.8m above 1990 levels).

9.4 Coastal processes

The MBRC DFE for stormtide inundation adopts a ‘bath-tub’ approach based on peak stormtide levels at the coastline, including allowance of wave set-up. Stormtide level would be attenuated as it migrates inland through coastal entrances and over low-lying frontal dunes and foreshores.

The DFE for stormtide inundation does not include any provisions for coastal processes, such as surface wave run-up and overtopping of dunal barriers and coastal foreshores. Without detailed hydrodynamic and wave modelling or calculations of overtopping rates (e.g. EUROTOP methods) it is not possible to determine the potential impacts of these processes on floodplain conditions behind the coastline. Notwithstanding, impacts would be expected to reduce relatively quickly with distance away from the

coastline and open estuary foreshores. Full attenuation of storm-generated surface waves would be expected within about 100 – 300 metres from the coastline.

With respect to inundation levels in the immediate coastal zone, additional provision can be applied to the freeboard to increase the factor of safety for future development to accommodate such conditions. Future development in areas subject to direct wave impacts should also be subject to more detailed coastal engineering reports to ensure that works are appropriately located and designed to mitigate coastal risks.

9.5 Variable freeboard

While there is considerable merit in maintaining a consistent freeboard for all future development within the MBRC local government area, risk-based management approaches are often used to provide more customised solutions. The DFE and/or the freeboard requirements may differ across the flood planning area depending on the following:

- the proposed landuse (e.g. residential, commercial, industrial, recreational);
- the location within the flood planning area (e.g. high, medium and low risk areas; coastal plains versus steeper catchments); and
- the specifics of the development (e.g. function, serviceability, life expectancy, future expansion).

In many locations freeboard differs based on the land use or development type. This inherently relates to the level of risk considered acceptable for the particular use of the land. For example, it is common for non-habitable rooms to have a lower (or even nil) freeboard provisions compared to habitable rooms. Similarly, some planning schemes (e.g. former Ipswich scheme, prior to the TLPI) allow different freeboard requirements for different land use, such as industrial and recreational lands (and sometimes also a different DFE compared to residential and commercial development). As was the case for the former Ipswich scheme, other provisions may need to be applied though to help minimise flood-related damages, including the use of flood resistant materials.

For the purposes of this assessment, a standard residential development is considered as a base case. MBRC may wish to adjust freeboard requirements for other landuse or development types.

10 Minimum freeboard requirements

In accordance the recent revisions to the Queensland Building Code, minimum freeboard requirement for residential development should be 300mm above the DFE.

11 Freeboard options assessment

11.1 Formulation of options

Two elements need to be considered in formulating options for freeboard: what values to adopt, and what areas do they apply to. With respect to values, the minimum requirement is 300mm. Other Councils and authorities apply values between 300mm and 600mm, while in some parts of the MBRC local government area 750mm has been used historically (in Pine Rivers). With respect to location, the simplest approach is to have a single value that is applied uniformly across the catchment. Based on the catchment characteristics of the MBRC local government area, however, there is justification to consider differentiation between the coastal floodplains (which are generally flat and influenced by stormtide) and the steeper upper

slopes of the catchments. As a way of simplifying this differentiation, the freeboard requirements could be defined based on the location relative to the Bruce Highway (which conveniently traverses the MBRC local government area approximately at the interface between the coastal plains and the steeper catchment).

Recognising the added impacts of coastal processes, a supplementary provision could be considered within the area directly affected. In the absence of a better defined coastal impact zone, the existing Erosion Prone Area (State Planning Policy) can be used to define a zone where additional freeboard requirements can be imposed to better accommodate direct coastal processes.

Options have therefore been considered based on the following matrix (Table 2).

Table 2 Freeboard Options

Increasing complexity in spatial definition

Increasing provision for uncertainty

Uniform	East / West of Hwy (1)	Coastal / Upper slopes (1)
300mm	300mm / 500mm	300mm / 500mm
500mm	300mm / 600mm	300mm / 600mm
600mm	300mm / 750mm	300mm / 750mm
750mm	500mm / 750mm	500mm / 750mm

(1) Excluding the area impacted by coastal processes

11.2 Qualitative assessment of options

11.2.1 Spatial Definition

As outlined in this report, there appears to be a degree of uncertainty attributed to the steeper parts of the minor basins. This is evidenced through the comparison of observed and modelled results for the January 2011 flood as well as the greater sensitivity to flows (as indicated by the generally larger difference between 1% and 0.1% AEP levels). However, the lower lying coastal floodplains are considered to be more susceptible to the potential impacts of future sea level rise.

A qualitative assessment of the options for spatial definition of freeboard, with pros and cons, is provided in Table 3.

Table 3 Qualitative Assessment of Spatial Definition of Freeboard

	Pros	Cons
Uniform	Convenience and simplicity of understanding by community	Does not match the expected difference in uncertainty in DFE levels based on location within the catchment
East / West of Highway	Is mostly convenient for defining a boundary between freeboard requirements and can be easily	A small section of upper Pumicestone Passage basin on the eastern side of the highway may be

	Pros	Cons
	understood by community. Unlikely to have future development that straddles the Highway boundary. Mostly accounts for the expected difference in sources of uncertainty between coastal plains and the steeper parts of the catchment.	under-provided compared to other similar environments across the MBRC local government area. It is noted, however, that this section of catchment is mostly within a State Forest area and therefore implications would be minimal.
Coastal / Upper slopes	Appropriately accounts for the expected difference in sources of uncertainty in DFE levels within the catchment	May be difficult to define boundaries between freeboard requirements. Could introduce complications for developments on or close to boundaries.

On balance, we consider that the East / West of Highway compartmentalisation of the flood planning area would be most appropriate for MBRC.

11.2.2 Freeboard Values

East of Bruce Highway

East of the Bruce Highway, there was only 2 out of 40 observations during the January 2011 floods that were higher than modelled levels by more than 300mm. The difference between the 1% and 0.1% AEP flood levels east of the Bruce Highway is mostly less than about 500mm. The DFE levels generally exceed the 0.1% AEP levels east of Bruce Highway, and include provisions for future (2100) stormtide conditions.

A qualitative assessment of the freeboard value options east of the Bruce Highway, with pros and cons, is provided in Table 4.

Table 4 Qualitative Assessment of Freeboard Value: East of Bruce Highway

	Pros	Cons
300mm	Generally matches the level of accuracy of modelling for this section of the floodplain. Provisions for sea level rise and future storm conditions are already incorporated into the DFE. 300mm on top of 0.8m SLR is consistent with upper limits of alternative SLR estimates. Consistent with previous freeboard provisions in Logan, and the former Caboolture Shire. Lower than freeboard provisions in the immediately adjacent Sunshine Coast and Brisbane City local governments, due to the level of modelling accuracy for this section of the floodplain	Is considered a minimum level. A small section of upper Pumicestone Passage basin on the eastern side of the highway may be under-provided compared to other similar environments across the MBRC local government area. It is noted, however, that this section of catchment is mostly within a State Forest area and therefore implications would be minimal. Provides little allowance for coastal processes such as wave overtopping effects behind the foreshore area.

	Pros	Cons
500mm	Provides added protection against uncertainties in modelling and future conditions compared to the 300mm freeboard, including additional provision associated with coastal processes. Consistent with the Building Code of Australia, the freeboard provisions used broadly across NSW and immediately adjacent local government areas of Sunshine Coast and Brisbane.	May be considered conservative away from the foreshore area given that the DFE already contains significant provisions for future conditions (including SLR), which are in excess of provisions in adjacent local government areas (i.e. DSTE is 2.9 – 3.6m AHD compared to Brisbane DSTE of 3.1m AHD). May require additional filling within the floodplain to meet requirements, or preclude reasonable development.
600mm	Not considered in detail. Additional factor of safety compared to 500mm.	
750mm	Not considered. As above.	

West of Bruce Highway

The flood planning area west of the Bruce Highway is mostly characterised by narrow incised valleys. The relatively steep sides of the valleys mean that the lateral extent of flooding is not significantly different between the 1% AEP, 0.1% AEP and the PMF. Depths of flooding, however, can be quite different within these areas, with the 0.1% AEP broadly about 500mm higher than the 1% AEP level. The accuracy of the modelling has been estimated by comparing the observed and modelled levels for the January 2011 event. For this event, the difference was less than 300mm for approximately 70% of locations, and was less than 500mm for 88% of locations. Only 5.6% of observed levels were higher than modelled levels by more than 500mm, 3.2% by more than 600mm, and 0.4% by more than 750mm.

The adopted DFE is generally about 200mm to 300mm higher than the 1% AEP level, although in some isolated locations, it is up to about 2m higher (for example in the Upper and Lower Pine River basins and the upper reaches of the Caboolture River basin) presumably due to site specific factors. For the purposes of this assessment, the conditions assumed for the DFE in the lower Stanley River have been ignored, as they are site specific to assumed Somerset Dam conditions.

A qualitative assessment of the freeboard value options west of the Bruce Highway, with pros and cons, is provided in Table 5.

Table 5 Qualitative Assessment of Freeboard Value: West of Bruce Highway

	Pros	Cons
300mm	Not considered as already established that freeboard requirements west of Bruce Highway should be greater than east of the highway.	
500mm	Potentially captures up to 95% of variability due to modelling uncertainties. Consistent with the Building Code of Australia, the freeboard provisions used broadly across NSW and other local government areas including Sunshine Coast and Brisbane.	May be insufficient for coincidence of inaccurate modelling as well as localised water disturbances (afflux and waves), which could be significant in fast-flowing waterways with tight bends.

	Pros	Cons
600mm	Potentially captures up to 98% of variability due to modelling uncertainties, or may allow for some localised water disturbance on top of reasonable model uncertainties. Consistent with freeboard provisions in Melbourne and the UK	As above, but to a lesser degree. May require additional filling within the floodplain to meet requirements, or preclude reasonable development.
750mm	Potentially captures up to 99.5% of variability due to modelling uncertainties, or may allow for reasonable localised water disturbance on top of model uncertainties. Consistent with freeboard provisions in former Pine Rivers Plan. Consistent with the draft planning scheme provisions as exhibited earlier this year.	May require additional filling within the floodplain to meet requirements, or preclude reasonable development

12 Recommendations for Freeboard Provisions

Given the options assessment above, particularly considering the need to incorporate extra allowance for direct coastal processes, and to achieve an element of consistency with adjacent local government areas, we consider that:

- **500mm** freeboard is required within the entire Erosion Prone Area (State Planning Policy);
- **300mm** freeboard is required within the flood planning area to the east of Bruce Highway but outside the Erosion Prone Area (State Planning Policy); and
- **750mm** freeboard is required within the flood planning area to the west of Bruce Highway.

All freeboards are to apply to relevant DFE levels. It is expected that as the Erosion Prone Area (State Planning Policy) is updated and re-mapped in the future, the freeboard provisions would also extend to the updated areas.

13 Definition of Flood Planning Area

It will be important for MBRC to define the relevant flood planning area of the lateral extents of the DFE plus the relevant freeboard provisions. Unless this is adopted, there will be the potential for inconsistency on the fringe of the flood planning area, where properties just inside the area are required to add a freeboard, while the adjacent properties just outside the area would not.

Consideration should also be given to defining the flood planning area based on more extreme event conditions (e.g. 0.1%, 0.01% or PMF, depending on availability of mapping) to ensure that there is transparency to the community regarding the potential for flooding, and also to capture the need for

development controls on specific development types, such as hospitals or other emergency services, which would require a higher level of certainty for avoiding potential flood impacts.

14 Limitation of Assessment

This assessment has been carried out based on information made available by MBRC or readily available on public web-sites. BMT WBM takes no responsibility for the accuracy of the data used. The outcomes of this freeboard review may need to be revisited if any future review of MBRC's regional flood database identifies significant uncertainties and limitations of MBRC's current flood modelling.

We understand that the resolution of modelling differs between minor basins and also for different design event conditions, including the DFE. No assessment has been made on the potential variances in model predictions associated with the different resolutions.

This assessment does not consider in detail coastal erosion issues and coastal processes that may necessitate further consideration for beachfront properties. A nominal allowance for some wave overtopping of dunes and foreshores has been included within our freeboard recommendation.

If you require any further information regarding this matter, please do not hesitate to contact the undersigned.

Yours Faithfully
BMT WBM

Dr Philip Haines
Operations Director, Water and Environment

Appendix G: Draft Coastal Hazard Overlay Code and Flood Hazard Overlay Code

5.10 Levels of assessment—Overlays

The following tables identify where an overlay changes the level of assessment from that stated in a zone or local plan and the relevant assessment criteria.

Note—Where development is proposed on land that is included in more than one overlay that changes the level of assessment, or subject to more than one sub-category within an overlay that changes the level of assessment, the highest level of assessment applies.

Table 5.10.1.1 Levels of assessment and assessment criteria for Coastal hazard overlay

Development	Level of assessment	Assessment criteria
All aspects of development		
Material change of use, reconfiguring a lot, building work or operational work	**Exempt**	
	If complying with the circumstances for exempt development in Table 1.7.7.1 'Exempt development'.	None
Material change of use, reconfiguring a lot, building work or operational work for Park	**No change**	
	In all instances	If self-assessment – the relevant self-assessment outcomes in Table 8.2.1.1 of the 8.2.1 'Coastal hazard overlay code' If code assessment – the 8.2.1 'Coastal hazard overlay code' If impact assessment – the planning scheme.
Material change of use, reconfiguring a lot for creating lots by subdividing another lot, building work or operational work in Erosion prone area (State Planning Policy)	**Impact assessment**	
	In all instances	The planning scheme.
Material change of use for a use that is in the retail and commercial activities defined activities group or low impact industry activities defined activity group		
Material change of use	**No change**	
	If : a. not in the Limited development zone; b. using an existing building; c. not increasing gross floor area by more than 80m^2; d. complying with the relevant criteria for self-assessable	If self-assessment - the relevant self-assessment outcomes in Part A of Table 8.2.1.1 of the 8.2.1 'Coastal hazard overlay code'.

Development	Level of assessment	Assessment criteria
	development.	
All other material change of use (MCU)		
Material change of use in the High risk storm tide inundation area	**Code assessment**	
	If for the following: a. Dwelling house where not included in the Limited development zone; or b. Outdoor sport and recreation; or c. Permanent plantation; or d. Cropping (where involving forestry for wood production); or e. Tourist park where not included in the Limited development zone; or f. Home based business where not included in the Limited development zone. Note: If the MCU is impact assessable in the zone or local plan, then the level of assessment is not lowered to code assessment.	8.2.1 'Coastal hazard overlay code'
	Impact assessment	
	If not code assessment	The planning scheme.
Material change of use in the Medium risk storm tide inundation area	**No change**	
	If not code assessment or impact assessment as identified below.	If self-assessment – the relevant self-assessment outcomes in Table 8.2.1.1 of the 8.2.1 'Coastal hazard overlay code' If code assessment – the 8.2.1 'Coastal hazard overlay code' If impact assessment – the planning scheme.
	Code assessment	
	If for a residential accommodation building (including a dwelling house) where not involving vulnerable land	8.2.1 'Coastal hazard overlay code'

Development	Level of assessment	Assessment criteria
	use (flood and coastal) Note: If the MCU is impact assessable in the zone or local plan, then the level of assessment is not lowered to code assessment.	
	Impact assessment	
	If for a vulnerable land use (flood and coastal).	The planning scheme.
Material change of use in the Balance coastal planning area	**No change**	
	In all instances	If self-assessment – the relevant self-assessment outcomes in Table 8.2.1.1 of the 8.2.1 'Coastal hazard overlay code' If code assessment - the 8.2.1 'Coastal hazard overlay code' If impact assessment – the planning scheme.
Reconfiguring a lot		
Reconfiguring a lot for creating lots by subdividing another lot	**No change**	
	If in the Balance coastal planning area.	If code assessment – the 8.2.1 'Coastal hazard overlay code' If impact assessment – the planning scheme.
	Code assessment	
	If in the Medium risk storm tide inundation area where for a lot on a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act 1997* and is associated with a material of use. Note: If the MCU is impact assessable in the zone or local plan, then the level of assessment is not lowered to code assessment.	8.2.1 'Coastal hazard overlay code'
	Impact assessment	
	If in the following: a. High risk storm tide	The planning scheme.

Development	Level of assessment	Assessment criteria
	inundation area; or b. Medium risk storm tide inundation area where not for a lot on a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act 1997* and is associated with a material change of use.	
Reconfiguring a lot for boundary realignment	**Exempt**	
	If in the Balance coastal planning area	None
	Code assessment	
	If in the following: a. High risk storm tide inundation area; or b. Erosion prone area (State planning policy); or c. Medium risk storm tide inundation area.	8.2.1 'Coastal hazard overlay code'
Operational Work		
Operational work for filling or excavation	**Code assessment**	
	If in the following: a. General residential zone; or b. Centre zone; or c. Community facilities zone; or d. Recreation and Open Space Zone; or e. Industry zone; or f. Township zone; or g. Emerging community zone. Note: If the operational work is	8.2.1 'Coastal hazard overlay code'

Development	Level of assessment	Assessment criteria
	impact assessable in the zone or local plan, then the level of assessment is not lowered to code assessable.	
	Impact assessment	
	If in other zones.	The planning scheme.
Building Work		
Building work not associated with a material change of use	**Self-assessment**	
	If: a. in the Balance coastal planning area; b. complying with all self-assessment outcomes. Note: If the building work is code or impact assessable in the zone or local plan, then the level of assessment is not lowered to self-assessable.	The relevant self-assessment outcomes in Table 8.2.1.1 of the 8.2.1 'Coastal hazard overlay code'
	Code assessment	
	If: a. self-assessment where not complying with the self-assessment outcomes; or b. in the following: i. High risk storm tide inundation area not included in the Limited development zone; or ii. Medium risk storm tide inundation area. Note: If the building work is impact assessable in the zone or local plan, then the level of assessment is not lowered to code assessable.	8.2.1 'Coastal hazard overlay code'
	Impact assessment	
	If in the High risk storm tide inundation area included in the Limited development zone	The planning scheme.

5.10.2 Flood hazard overlay

Table 5.10.2.1 Levels of assessment and assessment criteria for Flood hazard overlay

Development	Level of assessment	Assessment criteria
All aspects of development		
Material Change of use, Reconfiguring a lot, building work or operational work	**Exempt**	
	If complying with the circumstances for exempt development in 1.7 'Local government administrative matters'.	None
Material Change of use, Reconfiguring a lot, building work or operational work for Park	**No change**	
	In all instances	If self-assessment – the relevant self-assessment outcomes in Table 8.2.2.1 of the 8.2.2 'Flood hazard overlay code'. If code assessment – the 8.2.2 'Flood hazard overlay code'. If impact assessment – the Planning Scheme
Material change of use for a use that is in the retail and commercial activities defined activities group or low impact industry activities defined activity group		
Material change of use	**No Change**	
	If : a. not in the Limited development zone; b. using an existing building; c. not increasing gross floor area by more than 80m^2; d. complying with the relevant criteria for self-assessable development.	If self-assessment - the relevant self-assessment outcomes in Part A of Table 8.2.2.1 of the 8.2.2 'Flood hazard overlay code'.
All other material change of use (MCU)		
Material change of use	**No change**	

Development	Level of assessment	Assessment criteria
in the Balance flood planning area	In all instances.	If self-assessment – the relevant self-assessment outcomes in Table 8.2.2.1 of the 8.2.2 'Flood hazard overlay code'. If code assessment – the 8.2.2 'Flood hazard overlay code'. If impact assessment - the Planning Scheme
Material change of use in the High risk area	**Code assessment**	
	If for the following: a. Dwelling house where not included in the Limited Development Zone; or b. Outdoor sport and recreation; or c. Permanent plantation; or d. Cropping (where involving forestry and wood production); or e. Tourist park where not included in the Limited development zone; or f. Home based business where not included in the Limited development zone. Note: If the MCU is impact assessment in the zone or local plan, then the level of assessment is not lowered to code assessment.	8.2.2 'Flood hazard overlay code'.
	Impact assessment	
	If not code assessment	The Planning Scheme
Material change of use in the Medium risk area	**Code assessment**	
	If for the following: a. Dwelling house; or b. Outdoor sport and recreation; or	The 8.2.2 'Flood hazard overlay code'

Development	Level of assessment	Assessment criteria
	c. Permanent plantation; or d. Cropping (where involving forestry and wood production); or e. Tourist park; or f. Home based business. Note: If the MCU is impact assessment in the zone or local plan, then the level of assessment is not lowered to code assessment.	
	Impact assessment	
	If not code assessment	The Planning Scheme
Material Change of Use in a Drainage investigation area identified on Figure 8.3.1 of the 8.2.2 'Flood hazard overlay code'	**Code assessment**	
	If for a Dwelling house Note: If the MCU is impact assessment in the zone or local plan, then the level of assessment is not lowered to code assessment.	8.2.2 'Flood hazard overlay code'
	Impact assessment	
	If not code assessment	The Planning Scheme
Reconfiguring a lot		
Reconfiguring a lot for boundary realignment	**Exempt**	
	Where not in the following: a. High risk area; b. Medium risk area; c. a Drainage investigation area identified on Figures 8.2.2.1 to 8.2.2.9 of the 8.2.2 'Flood hazard overlay code'.	None
	Code assessment	
	If not exempt or impact assessment	8.2.2 'Flood hazard overlay code'
	Impact assessment	
	If in a Drainage investigation area	The planning scheme

Development	Level of assessment	Assessment criteria
	identified on Figures 8.2.2.1 to 8.2.2.9 of the 8.2.2 'Flood hazard overlay code'	
Reconfiguring a lot for creating lots by subdividing another lot	**No change**	
	If in the Balance flood planning area.	If code assessment – 8.2.2 'Flood hazard overlay code' If impact assessment - the Planning Scheme.
	Code assessment	
	If: a. in the Medium risk area; b. in the Medium risk storm tide inundation area of the Coastal planning area or the Balance coastal planning area of the Coastal planning area; c. for creating lots by subdividing another lot where for a lot on a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act* 1997 and is associated with a material of use; and d. associated with a material change of use. Note: If the RaL is impact assessment in the zone or local plan, then the level of assessment is not lowered to code assessment.	8.2.2 'Flood hazard overlay code'
	Impact assessment	
	If not code assessment.	The Planning Scheme
Operational Work (filling or excavation only)		

Development	Level of assessment	Assessment criteria
Operational Work	**Impact assessment**	
	If in the following: a. part of the Flood planning area not in the Coastal planning area; or b. a Drainage investigation area identified on Figures 8.2.2.1 to 8.2.2.9 of the 8.2.2 'Flood hazard overlay code'; or c. High risk area included in the Limited development zone.	The Planning Scheme
	Code assessment	
	If not impact assessment	8.2.2 'Flood hazard overlay code'
Building Work		
Building work not associated with a material change of use	**Self-assessment**	
	If: a. in the Balance flood planning area; b. complying with all self-assessment outcomes. Note: If the building work is code or impact assessment in the zone or local plan, then the level of assessment is not lowered to self-assessment.	The relevant self-assessment outcomes in Table 8.2.2.1 of the 8.2.2 'Flood hazard overlay code'.
	Code assessment	
	If: a. self-assessment where not complying with all self-assessment outcomes; or b. in the following: i. High risk area not included in the Limited development zone;	8.2.2 'Flood hazard overlay code'

Development	Level of assessment	Assessment criteria
	ii. Medium risk area; iii. a Drainage investigation area identified on Figure 8.2.2.1 to 8.2.2.9 of the 8.2.2 'Flood hazard overlay code'. Note: If the building work is impact assessment in the zone or local plan, then the level of assessment is not lowered to code assessment.	
	Impact assessment	
	If in the High risk area included in the Limited development zone.	The Planning Scheme.

8 Overlays

8.1 Preliminary

1. Overlays identify areas within the planning scheme that reflect distinct themes that may include all or one of the following:

    a. sensitive to the effects of development;
    b. constrain land or development;
    c. subject to valuable resources;
    d. present opportunities for development.

2. Overlays are mapped and included in Schedule 2.

3. The changed levels of assessment, if applicable, for development affected by an overlay are in Part 5.

4. Some overlays may be included for information purposes only. This may result in no change to the level of assessment or no additional assessment criteria.

5. Assessment criteria for an overlay may be contained in one or both of the following:

    a. a map for an overlay;
    b. a zone code contained in Part 6;
    c. a local plan code contained in Part 7;
    d. an overlay code contained in Part 8;
    e. a development code contained in Part 10.

6. Where development is proposed on premises partly affected by an overlay, the assessment criteria for the overlay only relates to the part of the premises affected by the overlay.

7. The following overlays for the planning scheme with a code are:

    a. Coastal hazard overlay;
    b. Flood hazard overlay;

8. The following overlays for the planning scheme without an overlay code(s) are:

    a. Acid sulphate soils;
    b. Active transport
    c. Building heights;
    d. Bushfire prone areas;
    e. Centre walking distances;
    f. Community activities and neighbourhood hubs;
    g. Environmental areas and corridors;
    h. Extractive resources;
    i. Heritage and landscape character;
    j. Landslide hazard;
    k. Major infrastructure buffers;
    l. Overland flow path
    m. Road hierarchy;
    n. Rural residential zone lot sizes;
    o. Scenic amenity areas;
    p. Stormwater catchments.

9. The following overlay for the planning scheme is for information purposes only:

   a. Transport noise corridors.

Editor's note - Interested persons may obtain details about the transport noise corridor and the levels of noise from the local government or www.hpw.qld.gov.au/construction/BuildingPlumbing/Building/TransportNoiseCorridors.

Note – Not all overlay maps have overlay codes or use overlays to change levels of assessment, accordingly Part 5, section 5.10 Levels of assessment - Overlays and Part 8, section 8.2 Overlay codes do not contain the full suite of provisions that may apply for all overlays. Additional assessment criteria for the part of the premises affected by an overlay may be contained within the relevant zone, local plan and development codes.

8.2 Overlay codes

8.2.1 Coastal hazard overlay code

8.2.1.1 Application - Coastal hazard overlay

1. This code applies to assessing development in the Coastal hazard overlay, if:

    a. self-assessable or assessable development where this code is an applicable code identified in the assessment criteria column of a table of assessment for an overlay (section 5.10);
    b. impact assessable development.

2. The Coastal hazard overlay code applies to land in the Coastal planning area identified on a Coastal hazard overlay map which includes land in the Coastal planning area in the following sub-categories:

    a. High risk area, comprising the land in the following:

        i. Erosion prone area (State Planning Policy);
        ii. High risk storm tide inundation area;

    b. Medium risk area, comprising land in the Medium risk storm tide inundation area;

    c. Balance coastal planning area.

3. When using this code, reference should be made to section 5.3.2 and, where applicable, section 5.3.3, in Part 5.

8.2.1.2 Purpose – Coastal hazard overlay

1. The purpose of the Coastal hazard overlay code is to:

    a. identify whether an area is subject to a coastal hazard;
    b. minimise the risk to life, property, community, economic development and the environment from the coastal hazard by:

        i. limiting development in an area of intolerable risk of coastal hazard to avoid the risk of the coastal hazard;
        ii. managing development in an area of tolerable risk of coastal hazard to mitigate the risk of the coastal hazard;

    c. ensure that development does not increase the potential for adverse impacts on the premises or other premises, public lands, watercourses, roads or infrastructure without appropriate mitigation.

2. The purpose of the Coastal hazard overlay code will be achieved through the following overall outcomes:

    a. Development in the Erosion prone area (State Planning Policy) avoids the intolerable risk of the coastal hazard by ensuring that:

        i. a material change of use is only for a use which:

            A. avoids the coastal erosion risk; or
            B. manages the coastal erosion risk through a strategy of planned retreat; or
            C. mitigates the coastal erosion risk if there are no adverse local drainage impacts, flooding and coastal impacts on other premises,

public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times;

ii. reconfiguring a lot for boundary realignment only occurs if the intolerable risk of coastal hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the intolerable risk of coastal hazard for future occupants is mitigated;
iii. reconfiguring a lot for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation;
iv. building work complies with the flood planning level, engineering design and resilient materials requirements;
v. operational work for filling or excavation does not occur.

b. Development in the High risk storm tide inundation area included in the Limited Development Zone avoids the extremely unacceptable intolerable risk of the coastal hazard by ensuring that:

i. a material change of use is only for the following uses if the intolerable risk of coastal hazard to people, property and infrastructure located on the premises and other premises is avoided:

A. Outdoor sport and recreation; or
B. Park; or
C. Permanent plantation; or
D. Cropping (where involving forestry for wood production);

ii. reconfiguring a lot for boundary realignment only occurs if the intolerable risk of coastal hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the intolerable risk of coastal hazard for future occupants is mitigated;
iii. reconfiguring a lot for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation;
iv. building work is less than $50m^2$ in area and associated with a use in paragraph (i);
v. operational work for filling or excavation does not occur.

c. Development in the High risk storm tide inundation area not included in the Limited Development) Zone, avoids the unacceptable intolerable risk of the coastal hazard by ensuring that:

i. a material change of use is only for the following uses if consistent with the overall outcomes of the applicable zone and precinct and the intolerable risk of coastal hazard to people, property and infrastructure located on the premises and other premises is avoided:

A. Dwelling house; or
B. Outdoor sport and recreation; or
C. Park; or
D. Permanent plantation; or
E. Cropping (where involving forestry for wood production); or
F. Tourist park; or
G. Home based business;

ii. reconfiguring a lot for boundary realignment only occurs if the intolerable risk of coastal hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the intolerable risk of coastal hazard for future occupants is mitigated;
iii. reconfiguring a lot for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation;

iv. building work complies with the flood planning level, engineering design and resilient materials requirements;
v. filing or excavation only occurs if:

A. in the General residential zone, Centre zone; Community facilities zone, Recreation and open space zone, Industry zone, Township zone or Emerging community zone;
B. any filling is limited to raising the ground level to the Year 2100 Highest Astronomical Tide level;[1]
C. there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times.

d. Development in the Medium risk storm tide inundation area manages and mitigates the tolerable risk of the coastal hazard by ensuring that:

i. a material change of use is only for uses consistent with the overall outcomes of the applicable zone and precinct if the use is not a vulnerable land use (flood and coastal) and the risk to people, property and infrastructure located on the premises and other premises is avoided or mitigated;
ii. reconfiguring a lot is only for the following:

A. creating lots by subdividing another lot for a lot on a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act 1997* and is associated with a material change of use; or
B. reconfiguring a lot for boundary realignment only occurs if the risk of coastal hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the risk of coastal hazard for future occupants is mitigated;
C. the purposes of Park or Permanent plantation;

iii. building work complies with the flood planning level, engineering design and resilient materials requirements;
iv. operational work for filling or excavation only occurs if:

A. in the General residential zone, Centre zone, Community facilities zone, Recreation and open space zone, Industry zone, Township zone or Emerging community zone;
B. any filling is limited to raising the ground level to as a minimum the Year 2100 Highest Astronomical Tide level[2] and as a maximum the level of the Defined Flood Event;
C. there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times.

f. Development in the Balance coastal planning area manages and mitigates the tolerable risk of the coastal hazard by ensuring that:

i. a material change of use is only for uses consistent with the overall outcomes of the applicable zone and precinct if the risk to people, property and infrastructure located on the premises and other premises is avoided or mitigated;

[1] The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.
[2] The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.

ii. reconfiguring a lot is consistent with the overall outcomes of the applicable zone and precinct;
iii. building work complies with the flood planning level and resilient material requirements;
iv. operational work for filing or excavation only occurs if:

A. in the General residential zone, Centre zone, Community facilities zone, Recreation and open space zone, Industry zone, Township zone or Emerging community zone;
B. any filling is limited to raising the ground level to as a minimum the Year 2100 Highest Astronomical Tide level[3] or as a maximum the level of the Defined Flood Event;
C. there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times.

e. Development in the Coastal planning area:

i. supports and does not unduly burden the disaster management response and recovery capacity and capabilities during and after a significant coastal hazard event;
ii. provides for efficient evacuation of on-site persons and facilitates direct and simple access for evacuation personnel and resources during a coastal hazard event, while ensuring development does not hinder or place additional complexities upon evacuation activities for other premises;
iii. avoids isolation of persons during a coastal hazard event up to and including the Defined Flood Event;
iv. adopts siting, built form, layout, and access (including evacuation access) arrangements that respond to the risk of the coastal hazard and minimise risk to personal safety in all coastal hazard events up to and including the Defined Flood Event;
v. is resilient to a coastal hazard event by ensuring the siting and design of development accounts for the potential risks to property associated with the coastal hazard event;
vi. directly, indirectly and cumulatively avoids an increase in the severity of a coastal hazard event and potential for damage on the premises or to other premises;
vii. involving essential community infrastructure remains functional during and immediately after a coastal hazard event up to and including the Defined Flood Event;
viii. ensures that essential building services or services essential for the development are designed, located and operated to minimise the risk of the coastal hazard to people, damage to property, disruption to building function and the re-establishment time after a coastal hazard event;
ix. avoids the accidental release of hazardous materials as a result of a coastal hazard event;
x. maintains natural processes and the protective function of landforms and vegetation;
xi. does not impact adversely on the ability for future coastal hazard mitigation measures to be implemented on other premises.

8.2.1.3 Criteria for assessment

To determine if development is self-assessable, development is to comply with the self-assessable acceptable outcomes set out in Part A, Table 8.2.1.1. Where development does not meet a self-assessable acceptable outcome (SAO) of the relevant criteria Part A, Table 8.2.1.1, assessment is against the corresponding performance outcome (PO) identified in the table

[3] The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.

below. This only occurs whenever a SAO is not met, and is therefore limited to the subject matter of the SAOs that are not complied with. To remove any doubt, for those SAOs that are complied with, there is no need for assessment against the corresponding PO.

Self-assessable acceptable outcomes	Corresponding performance outcomes
SAO1	PO8 (if in the Balance coastal planning area) PO13 (if not in the Balance coastal planning area)
SAO2 (for MCU or building work for dwelling house)	PO3
SAO2 (for all other development)	PO8 (if in the Balance coastal planning area) PO13 (if not in the Balance coastal planning area)
SAO3	PO8 (if in the Balance coastal planning area) PO13 (if not in the Balance coastal planning area)
SAO4 (for MCU or building work for dwelling house)	PO3
SAO4 (for all other development)	PO8 (if in the Balance coastal planning area) PO13 (if not in the Balance coastal planning area)
SAO5 (for MCU or building work for dwelling house)	PO6
SAO5 (for all other development)	PO8 (if in the Balance coastal planning area) PO13 (if not in the Balance coastal planning area)
SAO6	PO26
SAO7	PO31
SAO8 (for MCU or building work for dwelling house)	PO7
SAO8 (for all other development)	PO17 (if not in the Balance coastal planning area)

Part A – Criteria for self-assessable development – Coastal hazard overlay

Table 8.2.1.1 Self-assessable development – Coastal hazard overlay

Self-assessable acceptable outcomes	
Section A – If for self-assessable development for material change of use in an existing building	
SAO1	Development ensures that new building materials utilised as a consequence of the change of use for habitable and non-habitable rooms below the flood planning level in Table 8.2.1.3 have a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques.[4].
Section B – If for self-assessable development other than a material change of use in an existing building	
SAO2	Development ensures that a habitable floor level that is the subject of the development is located, designed and constructed to the flood planning level in Table 8.2.1.3.

[4] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

SAO3	Development for a non-residential building ensures that a finished floor level the subject of the development is located, designed and constructed to the flood planning level in Table 8.2.1.3.
SAO4	Development ensures that building materials for non-habitable rooms below the flood planning level in Table 8.2.1.3 have a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques.[5]
SAO5	Development on land below the level of the Defined Flood Event involving operational work for filling or excavation complies with the requirements of Table 8.2.1.4 and does not increase the potential for erosion, scour or flood damage either on the premises or on other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain. Note: Prior to development occurring, an investigation into the potential impacts of earthworks should be undertaken by a suitably qualified person so that a prospective developer can satisfy themselves the development meets this SAO. Guidance on the matters to be addressed is provided in Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.
SAO6	Development that involves hazardous chemicals ensures the hazardous chemicals are located and stored at or above the flood planning level in Table 8.2.1.3.
SAO7	Development for a Park ensures works are provided in accordance with the requirements set out in Appendix B of the Planning scheme policy - Integrated design.
SAO8	Development ensures that an essential electrical service is located above the flood planning level in Table 8.2.1.3. Note: An essential electrical service includes services defined as utilities and customer dedicated substation in *Mandatory Part 3.5 – Construction of buildings in flood hazard areas* of the *Queensland Development Code*.

Part B – Criteria for assessable development – Coastal hazard overlay

Where development is impact assessable, the assessment criteria becomes the whole of the planning scheme.

Table 8.2.1.2 Assessable development – Coastal hazard overlay

Performance outcomes	Acceptable outcomes
Material change of use or building work for a dwelling house	
PO1 Development in the High risk storm tide inundation area included in the Limited Development Zone for: a. a material change of use and associated building work for a dwelling house does not occur; b. building work not associated with a material change of use for a dwelling house only occurs for an existing lawful use.	No acceptable outcome provided.

[5] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

Performance outcomes	Acceptable outcomes
PO2 Development in the Erosion Prone Area (State Planning Policy): a. avoids the coastal erosion risk; or b. manages the coastal erosion risk through a strategy of planned retreat; or c. mitigates the coastal erosion risk such that there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times.	No acceptable outcome provided.
PO3 Development is resilient to a coastal hazard event by ensuring the design and built form account for the potential risks of flooding. Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazard(s) to which the building will be subject, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the coastal hazard and the structural approach to be utilised[6]. Information on the risk of a coastal hazard for premises in the Coastal planning area is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/..[7]	**AO3.1** Development is in accordance with the following: a. a site based coastal engineering report from a suitability qualified Registered Professional Engineer Queensland which identifies the coastal hazard and the structural approach to be utilised for the building work;[8] b. a structural engineering design which ensures that the building work and any associated earthworks are capable of withstanding the nature of the coastal hazard event to which the building will be subject.[9] Note - New buildings will require a structural engineering design capable of withstanding the nature of the hazard(s) to which the building will be subject, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the coastal hazard and the structural approach to be utilised. Information on the risk of a coastal hazard for premises in the Coastal planning area is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/. Note – Reporting to be prepared in accordance with Planning scheme policy – Flood hazard, Coastal hazard and Overland flow. **AO3.2** Development ensures that a habitable floor is located, designed and constructed to at least the flood planning level in Table 8.2.1.3. **AO3.3** Development ensures that building work for a non-habitable room below the flood planning level in Table 8.2.1.3 has a high water

[6] Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.
[7] Available at https://www.moretonbay.qld.gov.au/floodcheck/.
[8] Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.
[9] Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

Performance outcomes	Acceptable outcomes
	resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques.[10] *Development involving building work in the High risk storm tide inundation area or Medium risk storm tide inundation area* **AO3.4** Development ensures that a fence is at least 50% permeable.
PO4 Development ensures that where operational work for filling alone cannot ensure the development achieves the flood planning level in Table 8.2.1.3, a building is designed and constructed using pier and pole construction to achieve the required storm tide immunity in the Defined Flood Event.	No acceptable outcome provided.
PO5 Development maintains a functional and attractive relationship with the adjacent street frontage.[11] Note – This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain and attractive presentation to the street.	**AO5** Development for a residential dwelling where pier and pole construction is utilised: a. uses screening around the understorey of the dwelling to ensure the understorey is not visible from the street; b. allows for the flow of flood water through the understorey.
PO6 Development does not increase the potential for erosion, scour or flood damage either on the premises or on other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	No acceptable outcomes provided.
PO7 Development ensures that an essential electrical service is located to achieve the required storm tide immunity in the Defined Flood Event and maintain public safety at all times. Note: An essential electrical service includes services defined as utilities and customer dedicated substation in *Mandatory Part 3.5 – Construction of buildings in flood hazard areas* of the *Queensland Development Code*.	**AO7** Development ensures that an essential electrical service is located above the flood planning level in Table 8.2.1.3. Note: An essential electrical service includes services defined as utilities and customer dedicated substation in *Mandatory Part 3.5 – Construction of buildings in flood hazard areas* of the *Queensland Development Code*.

[10] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

[11] This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.

Performance outcomes	Acceptable outcomes
Material change of use or building work for all other land uses (other than a dwelling house) in the Balance coastal planning area	
PO8 Development is resilient to a coastal hazard event by ensuring design and built form account for the potential risks of flooding.	*Development involving building work for a residential use* **AO8.1** Development ensures that a habitable floor is located, designed and constructed to at least the flood planning level in Table 8.2.1.3. **AO8.2** Development ensures that a non-habitable room below the flood planning level in Table 8.2.1.3 has a high water resistance. Note: The Queensland Government Fact Sheet '*Rebuilding after a flood*' provides information about water resilient products and building techniques.[12] *Development involving building work for a non-residential use* **AO8.3** Development ensures that the finished floor level is located, designed and constructed to at least the flood planning level in Table 8.2.1.3. **AO8.4** Development ensures that a non-habitable room below the flood planning level in Table 8.2.1.3 has a high water resistance.
PO9 Development ensures that a use which requires an interface with the public realm (including a commercial and residential use) maintains a functional and attractive relationship with the adjacent street frontage.[13] Note - This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.	**AO9.1** Development for a residential use where pier and pole construction is utilised: a. uses screening around the understorey of the dwelling b. allows for the flow of flood water through the understorey. **AO9.2** Development for a commercial building or structure maintains an active street frontage through:

[12] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

[13] This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.

Performance outcomes	Acceptable outcomes
	a. providing clear pedestrian access from any adjacent footpath to the floor level of the commercial activity; b. providing a retail or food and beverage use, if consistent with the overall outcomes of the applicable zone and precinct, which interface with and overlook the street; or c. urban design treatments which screen the understorey of the building from view from the adjacent street frontage but must not impede storm tide flow.
PO10 Development ensures that public safety and risk to the environment are not adversely affected by a detrimental impact of floodwaters up to the Defined Flood Event on a hazardous chemical located or stored on the premises.	**AO10** Development ensures that a hazardous chemical is located or stored at least above the flood planning level in Table 8.2.1.3. Note: Refer to the *Work Health and Safety Act 2011* and associated Regulation and Guidelines, the *Environmental Protection Act 1994* and the relevant building assessment provisions under the *Building Act 1975* for requirements related to the manufacture and storage of hazardous substances.
Material change of use or building work for all other land uses (other than a dwelling house) in the Erosion prone area (State Planning Policy), High risk storm tide inundation area and Medium risk storm tide inundation area	
PO11 Development is: a. limited in the Erosion prone area (State Planning Policy) and High risk storm tide inundation area to avoid the intolerable risk of the coastal hazard; b. managed in the Medium risk storm tide inundation area to mitigate the tolerable risk of the coastal hazard. Note: The overall outcomes of this code identify the development outcomes which are intended so as to avoid the intolerable or tolerable risk of the coastal hazard applicable to the premises in the relevant sub-categories of the Coastal planning area.	No acceptable outcome provided.
PO12 Development maintains personal safety at all times, such that: a. a vulnerable land use (flood and coastal) is not located in the Erosion prone area (State Planning Policy), High risk storm tide inundation area or the Medium risk storm tide inundation area; b. new buildings are not located in the High risk storm tide inundation area included in the Limited Development Zone; c. evacuation capability from the development or other premises is not hindered or made more complicated and there is no significant additional burden placed on emergency services personnel;	No acceptable outcome provided.

Performance outcomes	Acceptable outcomes
d. the isolation of persons in the Defined Flood Event is avoided.	
PO13 Development is resilient to a coastal hazard event by ensuring design and built form account for the potential risks of the coastal hazard event (including storm tide inundation, wave action and coastal erosion). Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazards to which the building will be subject, to be supported a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the coastal hazard and the structural approach to be utilised.[14] Information on the risk of a coastal hazard for premises in the Coastal planning area is available on Council's Flood Check website.[15] Note - Reporting to be prepared in accordance with Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	**AO13.1** Development in the Erosion prone area (State Planning Policy), High risk storm tide inundation area and Medium risk storm tide inundation area is in accordance with the following: a. a site based coastal engineering report from a suitability qualified Registered Professional Engineer Queensland which identifies the coastal hazard and the structural approach to be utilised for the building work;[16] b. a structural engineering design which ensures that the building work and any associated earthworks are capable of withstanding the nature of the coastal hazard event to which the building will be subject. Note - New buildings will require a structural engineering design capable of withstanding the nature of the hazard(s) to which the building will be subject, to be supported a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the coastal hazard and the structural approach to be utilised. Information on the risk of a coastal hazard for premises in the Coastal planning area is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/. Note - Reporting to be prepared in accordance with Planning scheme policy - Flood hazard, Coastal hazard and Overland flow. *Development involving building work for a residential use* **AO13.2** Development ensures that a habitable floor is located, designed and constructed to at least the flood planning level in Table 8.2.1.3.

[14] Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.
[15] Available at https://www.moretonbay.qld.gov.au/floodcheck/.
[16] Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

Performance outcomes	Acceptable outcomes
	Development involving building work for a non-residential use **AO13.3** Development ensures that the finished floor level is located, designed and constructed to at least the flood planning level in Table 8.2.1.3. *Development involving building work for all uses* **AO13.4** Development ensures that a fence is at least 50% permeable. **AO13.5** Development ensures that building work for a non-habitable room located below the flood planning level in Table 8.2.1.3 has a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques.[17]
PO14 Development ensures that where operational work for filling alone cannot ensure the development achieves the flood planning level in Table 8.2.1.3, a building is designed and constructed using pier and pole construction to achieve the required storm tide immunity in the Defined Flood Event.	No acceptable outcome provided.
PO15 Development does not: a. directly, indirectly and cumulatively cause any increase in water flow velocity or level; b. does not increase the potential for erosion, scour or flood damage either on-site or on a surrounding property, public land, watercourse, road or infrastructure or elsewhere in the floodplain. Note - To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	No acceptable outcome provided.
PO16 Development supports, and does not unduly burden, disaster management responses and recovery capacity and capabilities for a coastal hazard event up to and including the Defined Flood Event.	No acceptable outcome provided.

[17] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf.

Performance outcomes	Acceptable outcomes
PO17 Development ensures that an essential electrical service is located to achieve the required storm tide immunity in the Defined Flood Event and maintain public safety at all times. Note: An essential electrical service includes services defined as utilities and customer dedicated substation in *Mandatory Part 3.5 – Construction of buildings in flood hazard areas* of the *Queensland Development Code*.	**AO17** Development ensures that an essential electrical service is located above the flood planning level in Table 8.2.1.3. Note - An essential electrical service includes services defined as utilities and customer dedicated substation in *Mandatory Part 3.5 – Construction of buildings in flood hazard areas* of the *Queensland Development Code*.
PO18 Development has access which, having regard to the hydraulic hazard, provides for safe vehicular and pedestrian movement and emergency services access.	No acceptable outcome provided.
PO19 Development ensures that a use which requires an interface with the public realm (including a commercial and residential use) maintains a functional and attractive relationship with the adjacent street frontage.[18] Note - This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.	**AO19.1** Development for a residential dwelling where pier and pole construction is utilised: a. uses screening around the understorey of the dwelling that is a minimum of 50% permeable to ensure the understorey is not visible from the street; b. allows for the flow of storm tide water through the understorey. **AO19.2** Development for a commercial building or structure maintains an active street frontage through: a. providing clear pedestrian access from any adjacent footpath to the floor level of the commercial activity; b. providing a retail or food and beverage use, if consistent with the overall outcomes of the applicable zone and precinct, which interfaces with and overlooks the street; c. urban design treatments which screen the understorey of the building from view from the adjacent street frontage but do not impede storm tide flow.

[18] This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.

Performance outcomes	Acceptable outcomes
Additional criteria for reconfiguring a lot (boundary realignment)	
PO20 Development is designed to: a. ensure personal safety at all times; b. not increase the potential for erosion, scour or flood damage either on the premises or other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain; c. not increase the risk to people, property and infrastructure located on the premises and other premises and where applicable the risk for future occupants is mitigated. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	**AO20.1** Development ensures that the building envelope is located in an area other than a High risk storm tide inundation area or Erosion prone area (State Planning Policy). **AO20.2** Development ensures that the entry points into the development are located to provide a safe and clear evacuation route path.
Additional criteria for reconfiguring a lot (other than by boundary realignment)	
PO21 Development is compatible with the intolerable or tolerable level of risk of the coastal hazard applicable to the premises such that reconfiguring a lot: a. either in the Erosion prone area (State Planning Policy),or High risk storm tide inundation area for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation; b. in the Medium risk storm tide inundation area for creating lots by subdividing another lot is only for a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act 1997* and also associated with a material change of use or for the purposes of Park or Permanent plantation; c. in the Balance coastal planning area is consistent with the overall outcomes of the applicable zone and precinct. Note: The overall outcomes of this code identify the development outcomes which are intended so as to avoid the intolerable or tolerable risk of the coastal hazard applicable to the premises in the relevant sub-categories of the Coastal planning area.	No acceptable outcome provided.

Performance outcomes	Acceptable outcomes
PO22 Development is designed to ensure personal safety at all times such that: a. storm tide immunity up to the Defined Flood Event is achieved; b. the road layout avoids isolation in a coastal hazard event and does not impede evacuation; c. signage is utilised to ensure that community members have a clear understanding of the nature of the risk of storm tide inundation in the area.	*If in the Balance coastal planning area* **AO22.1** Development ensures that the finished ground level for all additional lots, excluding a Park, complies with the requirements of Table 8.2.1.4. **AO22.2** Development ensures that the road and pathway[19] layout: a. ensures residents are not physically isolated from an adjacent storm tide inundation free urban area;[20] b. provides a safe and clear evacuation route path by: i. locating entry points into the development above the requirements set out in Appendix C of the Planning scheme policy - Integrated design and avoiding cul-de-sac or other non-permeable layouts; ii. direct and simple routes to a main carriageway. Note - 'Pathway' in this instance relates to pedestrian and non-pedestrian routes internal to a development site that are not specifically roads – for example, pedestrian pathways within a hotel development or internal roads in a large townhouse development. Note - It is important to ensure that new reconfigurations are not isolated from other urban areas in the event of a flood. **AO22.3** Development ensures that a new road and development access are provided in accordance with the requirements set out in Appendix C of the Planning scheme policy - Integrated design. **AO22.4** Development ensures that: a. signage is provided on a road or pathway[21] indicating the position and path of all safe evacuation routes off the premises; and b. if the premises contains or is within 100m of an area subject to the Defined

[19] 'Pathway' in this instance relates to pedestrian and non-pedestrian routes internal to a development site that are not specifically roads – for example, pedestrian pathways within a hotel development or internal roads in a large townhouse development.

[20] It is important to ensure that new reconfigurations are not isolated from other urban areas in the event of a flood.

[21] 'Pathway' in this instance relates to pedestrian and non-pedestrian routes internal to a development site that are not specifically roads – for example, pedestrian pathways within a hotel development or internal roads in a large townhouse development.

Performance outcomes	Acceptable outcomes
	Flood Event, hazard warning signage and depth indicators are provided at each key hazard point, such as at a waterway crossing or an entrance to a low-lying reserve. Note - 'Pathway' in this instance relates to pedestrian and non-pedestrian routes internal to a development site that are not specifically roads – for example, pedestrian pathways within a hotel development or internal roads in a large townhouse development. *If in the Erosion prone area (State Planning Policy), High risk storm tide inundation area or Medium risk storm tide inundation area* No acceptable outcome provided.
PO23 Development ensures that infrastructure excluding a road: a. is located outside of the Erosion prone area (State Planning Policy), High risk storm tide inundation area and Medium risk storm tide inundation area; or b. is otherwise located in the Erosion prone area (State Planning Policy), High risk storm tide inundation area or Medium risk storm tide inundation area to function during and after all coastal hazard events up to and including the Defined Flood Event.	*If in the Balance coastal planning area* **AO23** Development ensures that: a. any component of infrastructure which is likely to fail to function or may result in contamination when inundated by storm tide is located above the Defined Flood Event; or b. infrastructure is designed, located and constructed to resist the hydrostatic and hydrodynamic forces as a result of inundation by the Defined Flood Event. *If in the Erosion prone area (State Planning Policy), High risk storm tide inundation area or Medium risk storm tide inundation area* No acceptable outcome provided.
Additional criteria for operational work for filling or excavation whether or not associated with a material change of use, building work or reconfiguring a lot	
PO24 Development ensures that filling complies with the requirements of Table 8.2.1.4.	No acceptable outcome provided.
PO25 Development does not: a. directly, indirectly and cumulatively cause any increase in water flow velocity or level; b. increase the potential for erosion, scour or flood damage either on the premises or other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain; c. change the timing of the flood wave or impact on flood warning times. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a	No acceptable outcome provided.

Performance outcomes	Acceptable outcomes
suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood Hazard, Coastal Hazard and Overland Flow.	
Additional criteria for development involving hazardous chemicals	
PO26 Development ensures that hazardous chemicals are not located or stored in the Erosion prone area (State Planning Policy) or High risk storm tide inundation area.	No acceptable outcome specified.
PO27 Development in the Medium risk storm tide inundation area and Balance coastal planning area ensures that public safety and risk to the environment are not adversely affected by a detrimental impact of a coastal hazard event on a hazardous chemical located or stored on the premises.	**AO27** Development ensures that a hazardous chemical is located or stored at least above the flood planning level in Table 8.2.1.3. Note: Refer to the *Work Health and Safety Act 2011* and associated Regulation and Guidelines, the *Environmental Protection Act 1994* and the relevant building assessment provisions under the *Building Act 1975* for requirements related to the manufacture and storage of hazardous substances.
Additional criteria for development for community infrastructure	
PO28 Development for community infrastructure is not located in the Erosion prone area (State Planning Policy) or High risk storm tide inundation area.	No acceptable outcome provided.
PO29 Development for community infrastructure in the Medium risk storm tide inundation area or the Balance coastal planning area: a. remains functional to serve community needs during and immediately after the Defined Flood Event; b. is designed, sited and operated to avoid adverse impacts on the community or the environment due to the impacts of storm tide inundation on infrastructure, facilities or access and egress routes; c. retains essential site access during the Defined Flood Event; d. is able to remain functional even when other infrastructure or services may be compromised in the Defined Flood Event.	No acceptable outcome specified

Performance outcomes	Acceptable outcomes
Additional criteria for development in the Erosion prone area (State Planning Policy)	
PO30 Development is undertaken only for the purpose of the redevelopment of an existing lawful use in a manner that: a. accommodates natural coastal processes, including climate change and sea level rise; b. achieves the following: i. avoids coastal erosion risks; or ii. manages coastal erosion risks through a strategy of planned retreat; or iii. mitigates coastal erosion risks if there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	**AO30** Development: a. constitutes or includes temporary or relocatable structures, and these structures and the ongoing use of the premises are subject to the natural processes affecting the site; or b. installs and maintains coastal protection works to mitigate adverse impacts to people and property from coastal erosion within the premises in a manner which accommodates natural coastal processes without detrimental impacts on other premises; or c. is located, designed and constructed to withstand the expected coastal erosion impacts.
Additional criteria for development for a Park	
PO31 Development for a Park ensures that the design and layout responds to the nature of the coastal hazard affecting the premises in order to: a. maximise public benefit and enjoyment; b. minimise impacts on the asset life and integrity of park structures; c. minimise maintenance and replacement costs.	**AO31** Development for a Park ensures works are provided in accordance with the requirements set out in Appendix B of the Planning scheme policy - Integrated design.

Table 8.2.1.3 Flood planning level for a habitable floor (residential development) and a non-habitable floor (non-residential development) and levels for hazardous chemicals

Coastal planning area	Defined freeboard	Flood planning level
Land in the Coastal planning area which is outside the Erosion prone area (State Planning Policy)	300mm	Defined Flood Event + 300mm
Land in the Coastal planning area which is in the Erosion prone area (State Planning Policy)	500mm	Defined Flood Event + 500mm

Note: If the premises is subject to another overlay which states a flood planning level, the flood planning level that provides the highest level of immunity applies.

Table 8.2.1.4 Fill requirements

Coastal planning area	Fill level
Land in the Erosion prone area (State Planning Policy).	No filling permitted.
Land in the High risk storm tide inundation area included in the Limited development zone	No filling permitted.
Land in the High risk storm tide inundation area not included in the Limited development zone	Filling permitted to the Year 2100 Highest Astronomical Tide level[22].
Land in the Medium risk storm tide inundation area.	Filling permitted as a minimum to the Year 2100 Highest Astronomical Tide level[23] and as a maximum to the level of the Defined Flood Event
Land in the Balance coastal planning area.	Filling permitted as a minimum to the Year 2100 Highest Astronomical Tide level[24] and as a maximum to the level of the Defined Flood Event

[22] The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.
[23] The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.
[24] The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.

8.2.2 Flood hazard overlay code

8.2.2.1 Application - Flood hazard overlay

1. This code applies to assessing development in the Flood hazard overlay, if:

    a. self-assessable or assessable development where this code is an applicable code identified in the assessment criteria column of a table of assessment for an overlay (section 5.10);
    b. impact assessable development (section 5.3)

2. The Flood hazard overlay code applies to land in the Flood planning area identified on a Flood hazard overlay map and includes land in the Flood planning area in the following sub-categories:

    a. High risk area;
    b. Medium risk area;
    c. Balance flood planning area.

3. When using this code, reference should be made to section 5.3.2 and, where applicable, section 5.3.3, in Part 5.

8.2.2.2 Purpose – Flood hazard overlay

1. The purpose of the Flood hazard overlay code is to:

    a. identify whether an area is subject to a flood hazard;
    b. minimise the risk to life, property, community, economic development and the environment from the flood hazard by:

        i. limiting development in an area of extremely unacceptable intolerable risk of flood hazard to avoid the risk of the flood hazard;
        ii. managing development in an area of unacceptable intolerable risk and tolerable risk of flood hazard to mitigate the risk of the flood hazard;

    c. ensure that development does not increase the potential for adverse impacts on the premises or other premises, public lands, watercourses, roads or infrastructure without appropriate mitigation.

2. The purpose of the Flood hazard overlay code will be achieved through the following overall outcomes:

    a. Development in the High risk area included in the Limited Development Zone, avoids the extremely unacceptable intolerable risk of the flood hazard by ensuring that:

        i. a material change of use is only for the following uses if the intolerable risk of flood hazard to people, property and infrastructure located on the premises and other premises is avoided:

            A. Outdoor sport and recreation; or
            B. Park; or
            C. Permanent plantation; or
            D. Cropping (where involving forestry for wood production);

        ii. reconfiguring a lot for boundary realignment only occurs if the intolerable risk of flood hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the intolerable risk of flood hazard for future occupants is mitigated;

iii. reconfiguring a lot for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation;
iv. building work is less than $50m^2$ in area and associated with a use in paragraph (i);
v. operational work for filling or excavation does not occur.

b. Development in the High risk area not included in the Limited Development Zone, manages and mitigates the unacceptable intolerable risk of the flood hazard by ensuring that:

i. a material change of use is only for the following uses if consistent with the overall outcomes of the applicable zone and precinct and the intolerable risk of flood hazard to people, property and infrastructure located on the premises and other premises is avoided:

A. Dwelling house; or
B. Outdoor sport and recreation; or
C. Park; or
D. Permanent plantation; or
E. Cropping (where involving forestry for wood production); or
F. Tourist park; or
G. Home based business;

ii. reconfiguring a lot for boundary realignment only occurs if the intolerable risk of flood hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the intolerable risk of flood hazard for future occupants is mitigated;
iii. reconfiguring a lot for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation;
iv. building work complies with the flood planning level, engineering design and resilient materials requirements;
v. operational work for filling or excavation does not occur.

c. Development in the Medium risk area manages and mitigates the tolerable risk of the flood hazard by ensuring that:

i. a material change of use is only for the following uses if consistent with the overall outcomes of the applicable zone and precinct and the risk to people, property and infrastructure located on the premises and other premises is avoided or mitigated:

A. Dwelling house; or
B. Outdoor sport and recreation; or
C. Park; or
D. Permanent plantation; or
E. Cropping (where involving forestry for wood production); or
F. Tourist park; or
G. Home based business; or
H. Non-residential uses where not involving a vulnerable land use (flood and coastal);

ii. reconfiguring a lot for boundary realignment only occurs if the risk of flood hazard to people, property and infrastructure located on the premises and other premises is not increased and where practicable the risk of flood hazard for future occupants is mitigated;
iii. reconfiguring a lot for creating lots by subdividing another lot is only for the following:

A. in the Balance coastal planning area of the Coastal planning area, if consistent with the overall outcomes of the applicable zone and precinct;
B. in the Medium risk storm tide inundation area of the Coastal planning area, if a lot on a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act 1997* and is associated with a material of use*;*
C. in the High risk storm tide inundation area of the Coastal planning area or outside the Coastal planning area, if for the purposes of Park or Permanent plantation;

iv. building work complies with the flood planning level, engineering design and resilient materials requirements;

v. operational work for filling or excavation only occurs if:

A. in the Balance coastal planning area of the Coastal planning area or in the Medium risk storm tide inundation area of the Coastal planning area where in the General Residential Zone, Centre Zone, Community Facilities Zone, Recreation and Open Space Zone or Industry Zone;
B. any filling is limited to raising the ground level to as a minimum the Year 2100 Highest Astronomical Tide level[1] or as a maximum the level of the Defined Flood Event;
C. there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times.

d. Development of premises subject to a drainage master plan[2] manages and mitigates the risk of the flood hazard and any coastal hazard in this area, such that:

i. a drainage master plan for the relevant Drainage investigation area demonstrates that the development:

A adequately addresses the significant existing and future flood hazards and any coastal hazards affecting the Drainage investigation area without cost to the local government;
B. adequately addresses the significant infrastructure limitations of the Drainage investigation area without cost to the local government;
C. does not result in adverse local drainage impacts, flooding impacts on other premises, public land, watercourses, roads or infrastructure, or impacts on natural riverine and coastal processes or flood warning times;

ii. where it is demonstrated by an approved drainage master plan that the risk to people, property and infrastructure located on the premises and other premises is avoided or mitigated:

A. a material change of use is limited to uses consistent with the overall outcomes of the applicable zone and precinct and complies with the approved Drainage master plan;
B. reconfiguring a lot is consistent with the overall outcomes of the applicable zone and precinct and complies with the approved Drainage master plan;

---

1 The Year 2100 Highest Astronomical Tide level is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.

2 The premises subject to a drainage master plan are the premises included in the General residential zone - Next generation neighbourhood precinct or General residential zone - Urban neighbourhood precinct located in a Drainage investigation area identified on Figures 8.2.2.1 - 8.2.2.9.

C. building work complies with the approved drainage master plan;
D. operational work for filling or excavation complies with the approved drainage master plan.

iii. where it is not demonstrated by an approved drainage master plan that the risk to people, property and infrastructure located on the premises and on other premises is avoided or mitigated development is required to comply with the overall outcomes of the relevant sub-categories of the Flood planning area.

e. Development in the Balance flood planning area manages and mitigates the tolerable risk of the flood hazard by ensuring that:

i. a material change of use is only for uses consistent with the overall outcomes of the applicable zone and precinct if the risk to people, property and infrastructure located on the premises and other premises is avoided or mitigated;
ii. reconfiguring a lot is consistent with the overall outcomes of the applicable zone and precinct;
iii. building work complies with the flood planning level and resilient materials requirements;
iv. operational work for filling or excavation only occurs, if:

A. the land is currently above the 1% AEP 2014;[3]
B. the filling is limited to raising the ground level to the level of the Defined Flood Event;
C. there are no adverse local drainage impacts, flooding and coastal impacts on other premises, public land, watercourses, roads or infrastructure or impacts on natural riverine and coastal processes or flood warning times.

f. Development in the Flood planning area:

i. supports, and does not unduly burden the disaster management response and recovery capacity and capabilities during and after significant flood events;
ii. provides for efficient evacuation of on-site persons and facilitates direct and simple access for evacuation personnel and resources during flood events, while ensuring development does not hinder or place additional complexities upon evacuation activities for other premises;
iii. avoids isolation of persons for flood events up to and including the Defined Flood Event;
iv. provides for siting, built form, layout, and access (including evacuation access) which responds to the risk of the flood hazard and minimises risk to personal safety in all flood hazard events up to and including the Defined Flood Event;
v. is resilient to flood events by ensuring the siting and design of development accounts for the potential risks to property associated with flood hazards;
vi. directly, indirectly and cumulatively avoids an increase in the severity of flood hazards and potential for damage on the premises or to other premises or elsewhere in the floodplain;
vii. involving essential community infrastructure remains functional during and immediately after a flood event up to and including the Defined Flood Event;
viii. avoids the accidental release of hazardous materials as a result of a flood event;
ix. maintains natural processes and the protective function of landforms and vegetation;
x. does not impact adversely on the ability for future flood hazard mitigation measures to be implemented on other premises.

[3] The 1% AEP 2014 is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.

8.2.2.3 Criteria for assessment

To determine if development is self-assessable, development is to comply with the self-assessable acceptable outcomes set out in Part A, Table 8.2.2.1. Where development does not meet a self-assessable acceptable solution (SAO) of the relevant criteria Part A Table 8.2.2.1, assessment is against the corresponding performance outcome (PO) identified in the table below. This only occurs whenever a SAO is not met, and is therefore limited to the subject matter of the SAOs that are not complied with. To remove any doubt, for those SAOs that are complied with, there is no need for assessment against the corresponding PO.

Self-assessable acceptable outcomes	Corresponding performance outcomes
SAO1	PO6 (if in the Balance flood planning area) PO15 (if in the High risk area or Medium risk area)
SAO2 (for MCU or building work for dwelling house)	PO2
SAO2 (for all other development)	PO6 (if in the Balance flood planning area) PO15 (if in the High risk area or Medium risk area)
SAO3	PO6 (if in the Balance flood planning area) PO15 (if in the High risk area or Medium risk area)
SAO4 (for MCU or building work for dwelling house)	PO2
SAO4 (for all other development)	PO6 (if in the Balance flood planning area) PO15 (if in the High risk area or Medium risk area)
SAO5 (for MCU or building work for dwelling house)	PO5
SAO5 (for all other development)	PO7 and PO11 (if in the Balance coastal planning area) PO17 and PO26 (if not in the Balance coastal planning area)
SAO6	PO27
SAO7	PO32
SAO8 (for all other development)	

Part A - Criteria for self-assessable development - Flood hazard overlay

Table 8.2.2.1 Self-assessable development – Flood hazard overlay

Self-assessable acceptable outcomes	
Section A – If for self-assessable development for material change of use in an existing building	
SAO1	Development ensures that new building materials utilised as a consequence of the change of use for habitable and non-habitable rooms below the flood planning level in Table 8.2.2.3 have a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques.[4].
Section B – If for self-assessable development other than a material change of use in an existing building	

[4] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

SAO2	Development ensures that a habitable floor level that is the subject of the development is located, designed and constructed to the flood planning level in Table 8.2.2.3.
SAO3	Development ensures that a finished floor level the subject of the development is located, designed and constructed to the flood planning level in Table 8.2.2.3.
SAO4	Development ensures that building materials for non-habitable rooms below the flood planning level in Table 8.2.2.3 have a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques.[5]
SAO5	Development on land below the level of the Defined Flood Event involving operational works for filling or excavation complies with the requirements of Table 8.2.2.4 and does not increase the potential for erosion, scour or flood damage either on the premises or on other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain. Note: Prior to development occurring, an investigation into the potential impacts of earthworks should be undertaken by a suitably qualified person so that a prospective developer can satisfy themselves the development meets this SAO. Guidance on the matters to be addressed is provided in Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.
SAO6	Development that involves a hazardous chemical ensures the hazardous chemical is located and stored at or above the flood planning level in Table 8.2.2.3.
SAO7	Development for a Park ensures works are provided in accordance with the requirements set out in Appendix B of the Planning scheme policy - Integrated design.
SAO8	Development ensures that an essential electrical service is located above the flood planning level in Table 8.2.1.3. Note: An essential electrical service includes services defined as utilities and customer dedicated substation in *Mandatory Part 3.5 – Construction of buildings in flood hazard areas* of the *Queensland Development Code*.

[5] Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

Part B - Criteria for assessable development - Flood hazard overlay

Where development is impact assessable, the assessment criteria becomes the whole of the planning scheme.

Table 8.2.2.2 Assessable development – Flood hazard overlay

Performance outcomes	Acceptable outcomes
Material change of use or building work for a dwelling house	
PO1 Development in the High risk area included in the Limited Development Zone for: a. a material change of use and associated building work for a Dwelling house does not occur; b. building work not associated with a material change of use for a Dwelling house only occurs for an existing lawful use.	No acceptable outcome provided.
PO2 Development is resilient to flood events by ensuring design and built form account for the potential risks of flooding. Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazard(s) to which the building will be subject consistent with the requirements of the relevant building assessment provisions, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the flood hazard and the structural approach to be utilised[6]. Information on the flood hazard for individual sites is available on Council's Floodcheck website.[7] Note – Reporting to be prepared in accordance with Planning scheme policy – Flood hazard, Coastal hazard and Overland flow.	**AO2.1** Development ensures that a habitable floor is located, designed and constructed to at least the flood planning level in Table 8.2.2.3. Note: The highset 'Queenslander' style house is a resilient low-density housing solution. Higher density residential development should also ensure only non-habitable rooms (e.g. garages) are located on the ground floor. **AO2.2** Development ensures that building work for non-habitable rooms below the flood planning level in Table 8.2.2.3 has a high water resistance. Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazard(s) to which the building will be subject consistent with the requirements of the relevant building assessment provisions, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the flood hazard and the structural approach to be utilised[8]. Information on the flood hazard for individual sites is available on Council's Floodcheck website/. Note – Reporting to be prepared in accordance with Planning scheme policy – Flood hazard, Coastal hazard and Overland flow. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques[9]. *Development in the High risk area or Medium*

6 Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

7 Available at https://www.moretonbay.qld.gov.au/floodcheck/.

8 Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

9 Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

Performance outcomes	Acceptable outcomes
	risk area **AO2.3** Development ensures that a fence is at least 50% permeable.
PO3 Development ensures that where operational work for filling alone cannot ensure the development achieves the flood planning level in Table 8.2.2.3, a building is designed and constructed using pier and pole construction to achieve the required flood immunity in the Defined Flood Event.	No acceptable outcome provided.
PO4 Development maintains a functional and attractive relationship with the adjacent street frontage[10].	**AO4** Development for a residential dwelling where pier and pole construction is utilised: a. uses screening around the understorey of the dwelling to ensure the understorey is not visible from the street; b. allows for the flow of flood water through the understorey.
PO5 Development does not increase the potential for erosion, scour or flood damage either on the premises or on other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	No acceptable outcome provided.
For material change of use or building work (excluding material change of use or building work for a dwelling house) in the Balance flood planning area	
PO6 Development is resilient to a flood hazard event by ensuring design and built form account for the potential risks of flooding. Note - New buildings will require a structural engineering design capable of withstanding the nature of the hazards to which the building will be subject consistent with the requirements of the relevant building assessment provisions, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer	*Development involving building work for a residential use* **AO6.1** Development ensures that a habitable floor is located, designed and constructed to at least the flood planning level in Table 8.2.2.3. *Development involving building work for a non-residential use*

[10] This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.

Performance outcomes	Acceptable outcomes
Queensland that identifies the flood hazard and the structural approach to be utilised[11]. Information on the flood hazard for individual sites is available on Council's Floodcheck website.[12]	**AO6.2** Development ensures that the finished floor level is located, designed and constructed to at least the flood planning level in Table 8.2.2.3. **AO6.3** Development ensures that a non-habitable room below the flood planning level in Table 8.2.2.3 has a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques[13]. Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazard(s) to which the building will be subject consistent with the requirements of the relevant building assessment provisions, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the flood hazard and the structural approach to be utilised[14]. Information on the flood hazard for individual sites is available on Council's Floodcheck website/. Note – Reporting to be prepared in accordance with Planning scheme policy – Flood hazard, Coastal hazard and Overland flow.
PO7 Development does not: a. directly, indirectly and cumulatively cause any increase in water flow velocity or level; b. increase the potential for erosion, scour or flood damage either on the premises or other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain; c. change the timing of the flood wave or impact on flood warning times. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy Flood hazard, Coastal hazard and Overland flow.	No acceptable outcome specified.

11 Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

12 Available at https://www.moretonbay.qld.gov.au/floodcheck/.

13 Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

14 Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

Performance outcomes	Acceptable outcomes
PO8 Development ensures that a use which requires an interface with the public realm, including a commercial and residential use, maintains a functional and attractive relationship with the adjacent street frontage[15].	**AO8.1** Development for a residential use where pier and pole construction is utilised: a. uses screening around the understorey of the dwelling that is a minimum of 50% permeable to ensure the understorey is not visible from the street; b. allows for the flow of flood water through the understorey. **AO8.2** Development for a commercial building or structure maintains an active street frontage through: a. providing clear pedestrian access from any adjacent footpath to the floor level of the commercial activity; b. providing a retail or food and beverage use, if consistent with the overall outcomes of the applicable zone and precinct, which interfaces with and overlooks the street; c. urban design treatments which screen the understorey of the building from view from the adjacent street frontage but do not impede flood flow.
PO9 Development ensures that public safety and risk to the environment are not adversely affected by a detrimental impact of floodwaters up to the Defined Flood Event on a hazardous chemical located or stored on the premises.	**AO9** Development ensures that a hazardous chemical is located or stored at least above the flood planning level in Table 8.2.2.3. Note: Refer to the *Work Health and Safety Act 2011* and associated Regulation and Guidelines, *the Environmental Protection Act 1994* and the relevant building assessment provisions under the *Building Act 1975* for requirements related to the manufacture and storage of hazardous substances.
For operational work for filling or excavation where associated with a material change of use, building work or reconfiguring a lot if in the Balance flood planning area	
PO10 Development occurs on land currently above the 1% AEP 2014.	No acceptable outcome provided.
PO11 Development does not: a. directly, indirectly and cumulatively cause any increase in water flow velocity or level; b. increase the potential for erosion, scour or flood damage either on the premises or other premises, public land, watercourses, roads or infrastructure or elsewhere in the	No acceptable outcome provided.

[15] This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.

Performance outcomes	Acceptable outcomes
floodplain; c. change the timing of the flood wave or impact on flood warning times. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy Flood Hazard, Coastal Hazard and Overland Flow.	
PO12 Development ensures that filling complies with the requirements of Table 8.2.2.4.	No acceptable outcome provided.
For all other development	
PO13 Development is: a. limited in the High risk area included in the Limited Development Zone to avoid the extremely unacceptable intolerable risk of the flood hazard; b. managed in the High risk area not included in the Limited Development Zone to mitigate the unacceptable intolerable risk of the flood hazard; c. managed in the other sub-categories of the Flood planning area to mitigate the tolerable risk of the flood hazard. Note: The overall outcomes of this code identify the development outcomes which are intended so as to avoid or mitigate the intolerable or tolerable risk of the flood hazard applicable to the premises in the relevant sub-categories of the Flood planning area.	No acceptable outcome provided.
PO14 Development maintains personal safety at all times, such that: a. a vulnerable land use (flood and coastal) is not located in the High risk area or Medium risk area; b. new buildings are not located in the High risk area included in the Limited Development Zone; c. a residential accommodation building is located in the following: i. Balance flood planning area; or ii. the Medium risk area where located in the Medium risk storm tide inundation area of the Coastal hazard overlay or Balance coastal planning area of the Coastal hazard overlay ; d. evacuation capability from the development or other premises is not hindered or made more complicated and there is no significant additional burden placed on emergency services	No acceptable outcome provided.

Performance outcomes	Acceptable outcomes
personnel; e. the isolation of persons in the Defined Flood Event is avoided.	
PO15 Development is resilient to a flood hazard event by ensuring design and built form account for the potential risks of the flood hazard event. Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazards to which the building will be subject consistent with the requirements of the relevant building assessment provisions, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the flood hazard and the structural approach to be utilised[16]. Information on the flood hazard for individual sites is available on Council's Floodcheck website.[17] Note – Reporting to be prepared in accordance with Planning scheme policy – Flood hazard, Coastal hazard and Overland flow.	*Development involving building work for a residential use* **AO15.1** Development ensures that a habitable floor is located, designed and constructed to at least the flood planning level in Table 8.2.2.3. *Development involving building work for a non-residential use* **AO15.2** Development ensures that the finished floor level is located, designed and constructed to at least the flood planning level in Table 8.2.2.3. *Development involving building work for all uses* **AO15.3** Development ensures that a fence is at least 50% permeable. **AO15.4** Development ensures that building work for non-habitable rooms below the flood planning level in Table 8.2.2.3 has a high water resistance. Note: The Queensland Government Fact Sheet 'Rebuilding after a flood' provides information about water resilient products and building techniques[18]. Note: New buildings will require a structural engineering design capable of withstanding the nature of the hazards to which the building will be subject consistent with the requirements of the relevant building assessment provisions, to be supported by a report (or multiple reports) prepared by a Registered Professional Engineer Queensland that identifies the flood hazard and the structural approach to be utilised[19]. Information on the flood hazard for individual sites is available on Council's Floodcheck website.[20] Note – Reporting to be prepared in accordance with Planning scheme policy – Flood hazard, Coastal hazard and Overland flow.

16 Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

17 Available at https://www.moretonbay.qld.gov.au/floodcheck/.

18 Available at http://www.hpw.qld.gov.au/SiteCollectionDocuments/WaterResilientProductsAndBuildingTechniquesForRebuildingAfterAFlood.pdf

19 Reporting to be prepared in accordance with the Flood Hazard, Coastal Hazard and Overland Flow planning scheme policy.

20 Available at https://www.moretonbay.qld.gov.au/floodcheck/.

Performance outcomes	Acceptable outcomes
PO16 Development ensures that where operational work for filling alone cannot ensure the development achieves the flood planning level in Table 8.2.2.3, a building is designed and constructed using pier and pole construction to achieve the required flood immunity in the Defined Flood Event.	No acceptable outcome specified.
PO17 Development does not: a. directly, indirectly and cumulatively cause any increase in water flow velocity or level; b. increase the potential for erosion, scour or flood damage either on the premises or on other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain; c. change the timing of the flood wave or impact on flood warning times. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	No acceptable outcome provided.
PO18 Development supports and does not unduly burden, disaster management responses and recovery capacity and capabilities for a flood hazard event up to and including the Defined Flood Event.	No acceptable outcome provided.
PO19 Development has access which, having regard to the hydraulic hazard, provides for safe vehicular and pedestrian movement and emergency services access.	No acceptable outcome provided.
PO20 Development ensures that a use which requires an interface with the public realm, including a commercial and residential use, maintains a functional and attractive relationship with the adjacent street frontage[21].	**AO20.1** Development for a residential dwelling where pier and pole construction is utilised: a. uses screening around the understorey of the dwelling that is a minimum of 50% permeable to ensure the understorey is not visible from the street; b. allows for the flow of flood water through the understorey. **AO20.2** Development for a commercial building or structure maintains an active street frontage through:

[21] This is particularly relevant for commercial uses in centres with a strong 'town-centre' pedestrian realm that also may be affected by flood, or for residential uses to maintain an attractive presentation to the street.

Performance outcomes	Acceptable outcomes
	a. providing clear pedestrian access from any adjacent footpath to the floor level of the commercial activity; b. providing a retail or food and beverage use, if consistent with the overall outcomes of the applicable zone and precinct, which interfaces with and overlooks the street; c. urban design treatments which screen the understorey of the building from view from the adjacent street frontage but do not impede flood flow.
Additional criteria for reconfiguring a lot (boundary realignment)	
PO21 Development is designed to: a. ensure personal safety at all times; b. not increase the potential for erosion, scour or flood damage either on the premises or other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain; c. not increase the risk to people, property and infrastructure located on the premises and other premises and where applicable the risk for future occupants is mitigated.	**AO21.1** Development ensures that the building envelope is located in an area other than a High risk area. **AO21.2** Development ensures that the entry points into the development are located to provide a safe and clear evacuation route path. *If in the Drainage investigation area* **AO19.3** Development occurs in accordance with a drainage master plan for the Drainage investigation area.
Additional criteria for reconfiguring a lot (other than boundary realignment)	
PO22 Development is compatible with the intolerable or tolerable level of risk of the flood hazard applicable to the premises such that reconfiguring a lot: a. in the High risk area, for creating lots by subdividing another lot is only for the purposes of Park or Permanent plantation; b. in the Medium risk area for creating lots by subdividing another lot in the following: i. Balance coastal planning area of the Coastal planning area is consistent with the overall outcomes of the applicable zone and precinct; ii. Medium risk storm tide inundation area of the Coastal planning area is only for a lot on a building format plan under the *Land Title Act 1994* which is subject to a community titles scheme under the *Body Corporate and Community Management Act 1997* and is associated with a	No acceptable outcome provided.

Performance outcomes	Acceptable outcomes
material of use; iii. Erosion prone area (State Planning Policy) or High risk storm tide inundation area of the Coastal planning area or outside of the Coastal planning area, is only for the purposes of Park or Permanent plantation; c. Balance flood planning area, is consistent with the overall outcomes of the applicable zone and precinct. Note: The overall outcomes of this code identify the development outcomes which are intended so as to avoid or mitigate the intolerable or tolerable risk of the flood hazard applicable to premises in the relevant sub-categories of the Flood planning area.	
PO23 Development is designed to ensure personal safety at all times such that: a. flood immunity up to the Defined Flood Event is achieved; b. the road layout avoids isolation in a flood hazard event and does not impede evacuation; c. signage is utilised to ensure that community members have a clear understanding of the nature of the flood risk in the area.	*If the ground level is to be filled to the level of the Defined Flood Event as permitted by Table 8.2.2.4* **AO23.1** Development ensures that the finished ground level for all additional lots (excluding a Park) complies with the requirements of Table 8.2.2.4. **AO23.2** Development ensures that the road and pathway[22] layout: a. ensures residents are not physically isolated from an adjacent flood-free urban area;[23] b. provides a safe and clear evacuation route path by: i. locating entry points into the development above the requirements set out in Appendix C of the Planning scheme policy - Integrated design and avoiding cul-de-sac or other non-permeable layouts; ii. direct and simple routes to a main carriageway. **AO23.3** Development in a greenfield area protects a flood conveyance area by providing an easement or reserve over the area of the premises up to the Defined Flood Event. **AO23.4**

[22] 'Pathway' in this instance relates to pedestrian and non-pedestrian routes internal to a development site that are not specifically roads – for example, pedestrian pathways within a hotel development or internal roads in a large townhouse development.

[23] It is important to ensure that new reconfigurations are not isolated from other urban areas in the event of a flood.

Performance outcomes	Acceptable outcomes
	Development ensures that a new road and development access are provided in accordance with the requirements set out in Appendix C of the Planning scheme policy - Integrated design. **AO23.5** Development ensures that: a. signage is provided on a road or pathway[24] indicating the position and path of all safe evacuation routes off the premises; b. if the premises contains or is within 100m of a waterway, hazard warning signage and depth indicators are provided at each key hazard point, such as at a waterway crossing or an entrance to a low-lying reserve. *If the ground level is to be filled other than as permitted by Table 8.2.2.4* No acceptable outcome specified.
PO24 Development ensures that infrastructure (excluding a road): a. is located outside of the High risk area and Medium risk area; or b. is otherwise located in the High risk area or Medium risk area to function during and after all flood hazard events up to and including the Defined Flood Event.	*If in the Balance flood planning area* **AO24** Development ensures that: a. any component of infrastructure which is likely to fail to function or may result in contamination when inundated by flood is located above the Defined Flood Event; or b. infrastructure is designed, located and constructed to resist the hydrostatic and hydrodynamic forces as a result of inundation by the Defined Flood Event. *If in the High risk area or Medium risk area* No acceptable outcome provided.
PO25 Reconfiguring a lot does not result in: a. adverse impacts on the local drainage and the flood conveyance of a waterway; b. increased flood inundation of surrounding properties; c. any reduction in the flood storage capacity of the floodplain and any clearing of native vegetation. Note: To demonstrate achievement of the performance	*If in the Balance flood planning area* **AO25.1** All earthworks are undertaken outside of the defined flood event. **AO25.2** Earthworks required to regularise allotment shape is undertaken in accordance with Planning scheme policy – Compensatory earthworks. *If in the High risk area or Medium risk area*

[24] 'Pathway' in this instance relates to pedestrian and non-pedestrian routes internal to a development site that are not specifically roads – for example, pedestrian pathways within a hotel development or internal roads in a large townhouse development.

Performance outcomes	Acceptable outcomes
outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy Flood hazard, Coastal hazard and Overland flow.	No acceptable outcome provided.
Additional criteria for operational work for filling or excavation whether or not associated with a material change of use, building work or reconfiguring a lot	
PO26 Development ensures that filling complies with the requirements of Table 8.2.2.4.	No acceptable outcome provided.
Additional criteria for development involving hazardous chemicals	
PO27 Development ensures that hazardous chemicals are not located or stored in the High risk area.	No acceptable outcome provided.
PO28 Development not in the High risk area ensures that public safety and risk to the environment are not adversely affected by a detrimental impact of floodwaters up to the Defined Flood Event on a hazardous chemical located or stored on the premises.	**AO28** Development ensures that a hazardous chemical is located or stored at least above the flood planning level in Table 8.2.2.3. Note: Refer to the *Work Health and Safety Act 2011* and associated Regulation and Guidelines, the *Environmental Protection Act 1994* and the relevant building assessment provisions under the *Building Act 1975* for requirements related to the manufacture and storage of hazardous substances.
Additional criteria for development for community infrastructure	
PO29 Development for community infrastructure is not located in the High risk area or Medium risk area.	No acceptable outcome provided.
PO30 Development for community infrastructure not located in the High risk area or Medium risk area: a. remains functional to serve community needs during and immediately after the Defined Flood Event; b. is designed, sited and operated to avoid adverse impacts on the community or the environment due to the impacts of flood inundation on infrastructure, facilities or access and egress routes; c. retains essential site access during the Defined Flood Event; d. is able to remain functional even when other infrastructure or services may be compromised in the Defined Flood Event.	No acceptable outcome provided.
Additional criteria for development of premises subject to a drainage master plan	
PO31 Development of premises included in the	*If the Council has an adopted a drainage master plan for the Drainage investigation*

Performance outcomes	Acceptable outcomes
General residential zone – Next generation neighbourhood precinct or General residential zone – Urban neighbourhood precinct located in a Drainage investigation area identified on Figures 8.2.2.1 to 8.2.2.10 is supported by drainage works and specific building design responses to mitigate the risk posed by the flood hazard. Note: Planning scheme policy - Flood hazard, Coastal hazard and Overland flow provides direction on the preparation of a drainage master plan.	*area* **AO31.1** Development: a. undertakes identified works, internal and external, or transfers land as required to mitigate the impact of the flood hazard and any coastal hazard; b. is designed to mitigate the impact of the flood hazard and any coastal hazard in accordance with the design standards identified in the drainage master plan in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow. *If the Council does not have an adopted drainage master plan for the Drainage investigation area* **AO31.2** Development: a. occurs in accordance with a drainage master plan prepared by an applicant and approved by the Council; b. undertakes identified works, internal and external, or transfers land as required to mitigate the impact of the flood hazard and any coastal hazard; c. is designed to mitigate the impact of the flood hazard and any coastal hazard in accordance with the design standards identified in the approved drainage master plan. Note: Planning scheme policy - Flood hazard, Coastal hazard and Overland flow provides direction on the preparation of a drainage master plan.
PO32 Development of premises included in General residential zone – Next generation neighbourhood precinct or General residential zone – Urban neighbourhood precinct located in a Drainage investigation area identified on Figures 8.2.2.1 to 8.2.2.10 must ensure that the land is filled: a. where there is an adopted drainage master plan, in accordance with the levels in the drainage master plan; b. where there is no adopted drainage master plan, in accordance with the fill requirements in Table 8.2.2.4 or . such that the filling of the land does not: i. directly, indirectly and	**AO32** No acceptable outcome provided.

Performance outcomes	Acceptable outcomes
cumulatively cause any increase in water flow velocity or level; ii. increase the potential for erosion, scour or flood damage either on the premises or other premises, public land, watercourses, roads or infrastructure or elsewhere in the floodplain. Note: To demonstrate achievement of the performance outcome, an engineering report is to be prepared by a suitably qualified person. Guidance on the matters to be addressed in the report is provided in the Planning scheme policy - Flood hazard, Coastal hazard and Overland flow.	
Additional criteria for development for a Park	
PO33 Development for a Park ensures that the design and layout responds to the nature of the flood hazard affecting the premises in order to: a. maximise public benefit and enjoyment; b. minimise impacts on the asset life and integrity of park structures; c. minimise maintenance and replacement costs.	**AO33** Development for a Park ensures works are provided in accordance with the requirements set out in Appendix B of the Planning scheme policy - Integrated design.
Additional criteria for material change of use for permanent plantation or cropping (where involving forestry for wood production)	
PO34 Development: a. adopts management practices to minimise release of woody debris load into floodwaters during flood events up to the Defined Flood Event; b. complies with other relevant environmental setbacks and requirements.	No acceptable outcome provided.

Table 8.2.2.3 Flood planning level for a habitable floor (residential development) and a non-habitable floor (non-residential development) and levels for hazardous chemicals

Flood planning area	Defined freeboard	Flood planning level
Flood planning area (east of the Bruce Highway and inside the Erosion prone area (State Planning Policy) in the Coastal hazard overlay)	500mm	Defined Flood Event + 500mm
Flood planning area (east of the Bruce Highway and outside the Erosion prone area (State Planning Policy) in the Coastal hazard overlay)	300mm	Defined Flood Event + 300mm

Flood planning area	Defined freeboard	Flood planning level
Flood planning area (west of the Bruce Highway)	750mm	Defined Flood Event + 750mm

Note: If the premise is subject to another overlay which states a flood planning level, the flood planning level that provides the highest level of immunity applies.

Table 8.2.2.4 Fill requirements

Flood planning area	Fill level
Land in the High risk area	No filling permitted
Land in the Medium risk area and not located in a Drainage investigation area. *Note - Where also located in the Balance coastal planning area or Medium risk storm tide inundation area of the Coastal hazard overlay, filling is permitted in accordance with Table 8.2.1.4 of the Coastal hazard overlay code.*	No filling permitted
Land in the Medium risk area and in the Balance coastal planning area or Medium risk storm tide inundation area of the Coastal hazard overlay.	As per Table 8.2.1.4 of the Coastal hazard overlay code.
Land located in a Drainage investigation area identified on Figure 8.2.2.1 to 8.2.2.10.	Filling in accordance with the relevant adopted Drainage master plan
Land in the Balance flood planning area	No filling permitted if land below the level of the 1% AEP 2014[25] Filling permitted to the level of the Defined Flood Event if land above the level of the 1% AEP 2014[26]

[25] The 1% AEP 2014 is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.
[26] The 1% AEP 2014 is available on Council's Flood Check website via https://www.moretonbay.qld.gov.au/floodcheck/.

Figure 8.2.2.1 – Albany Creek

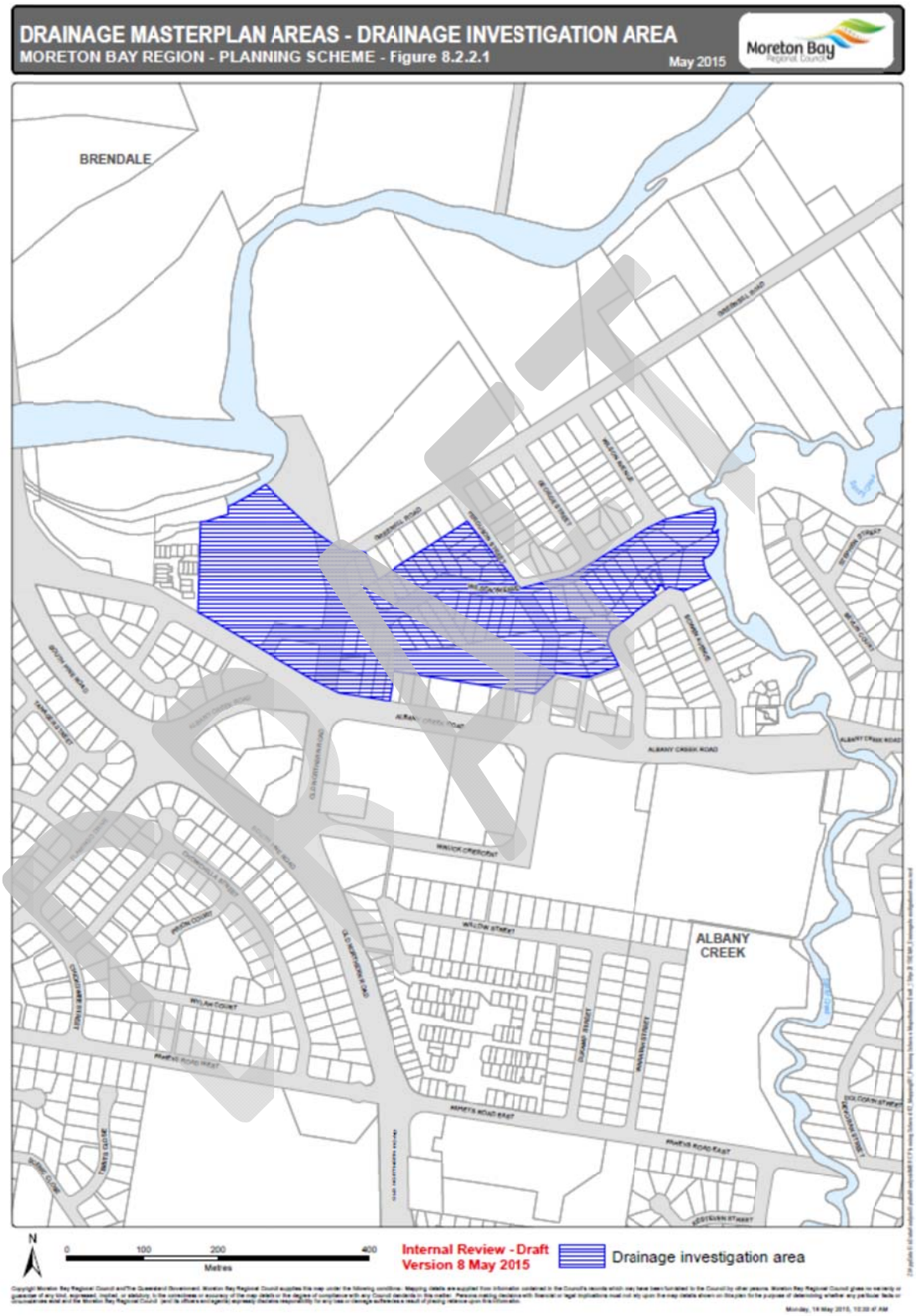


Figure 8.2.2.2 – Clontarf

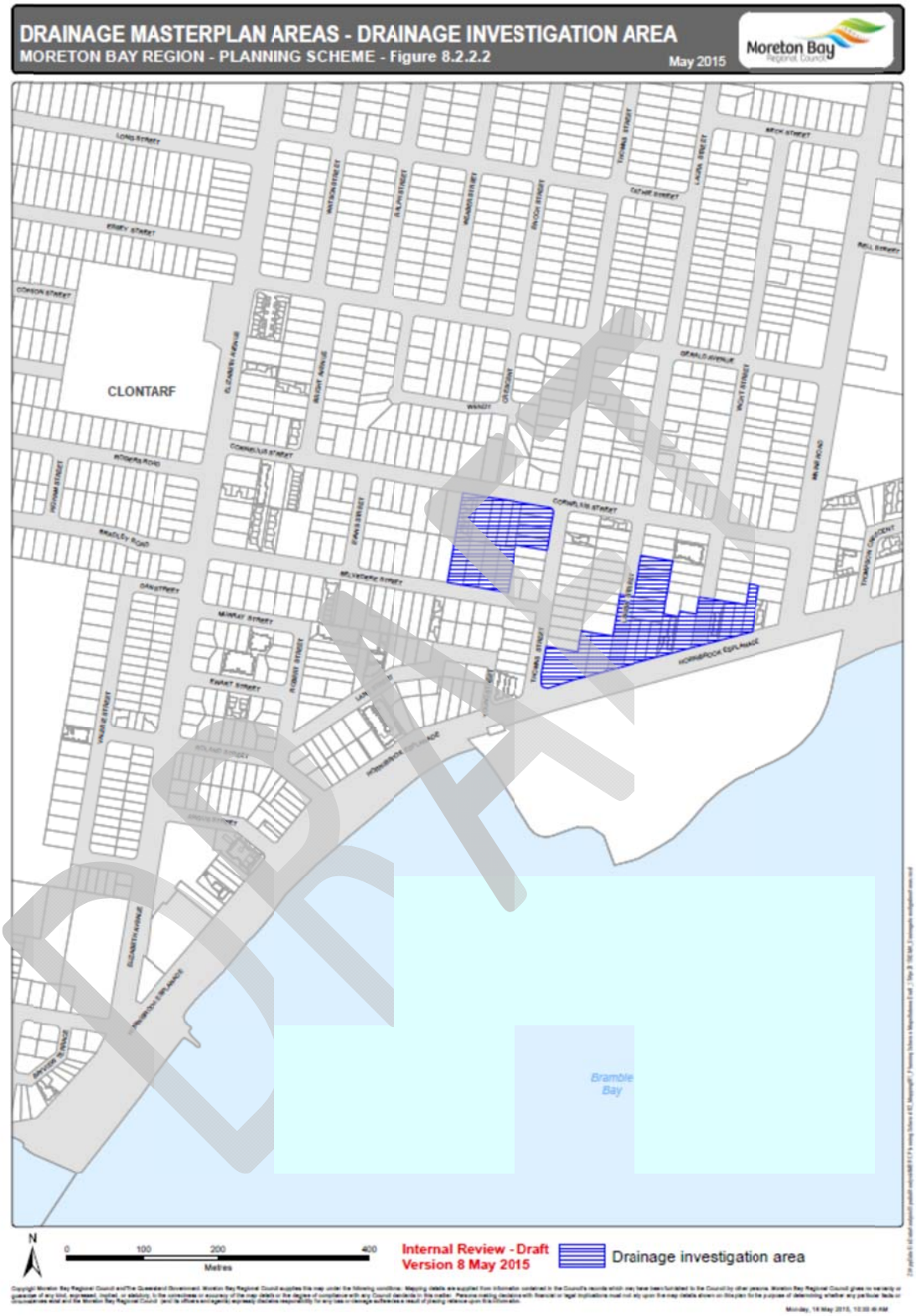


Figure 8.2.2.3 – Woody Point

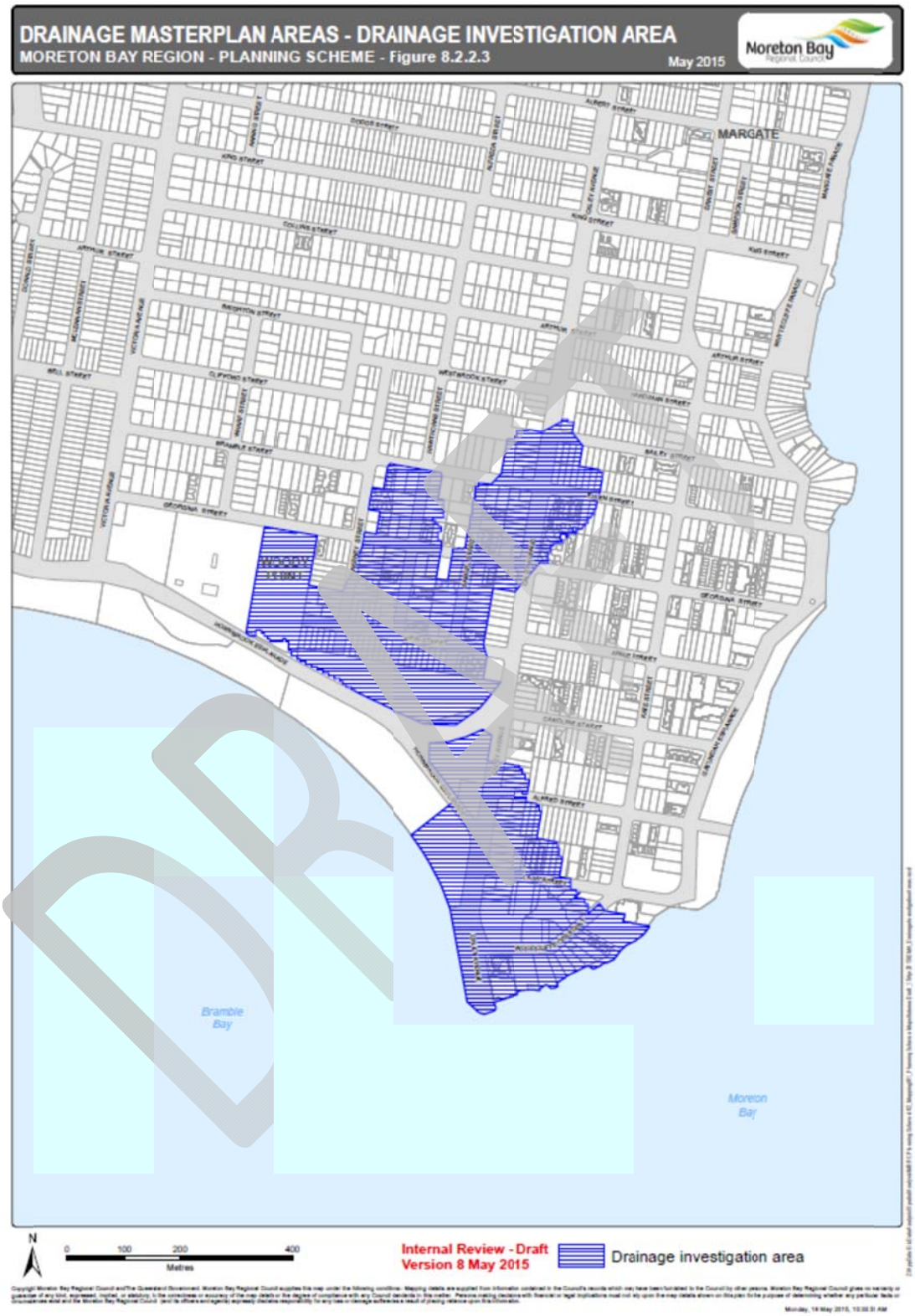


Figure 8.2.2.4 - Margate

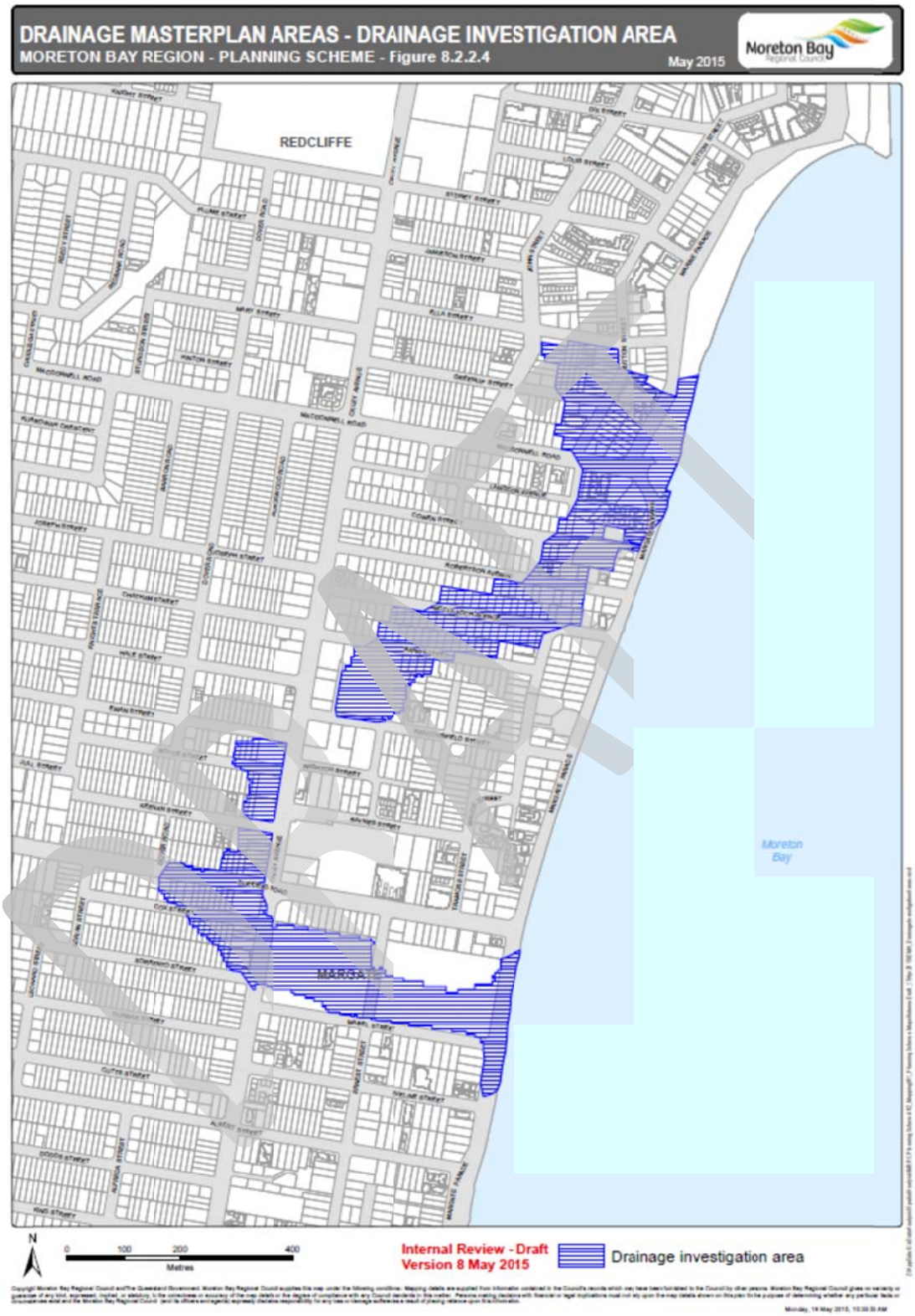


Figure 8.2.2.5 – Redcliffe - Scarborough

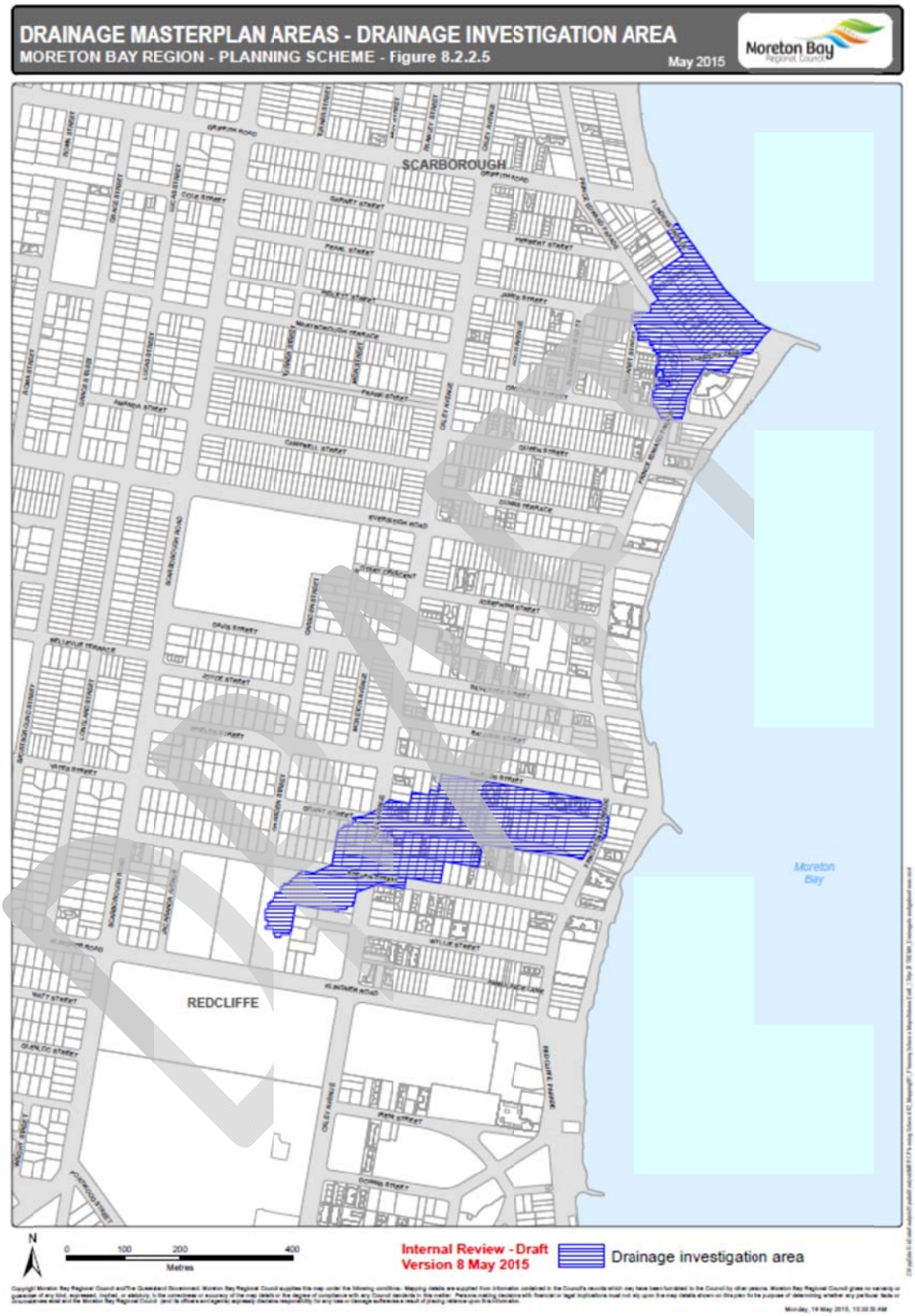


Figure 8.2.2.6 – Scarborough

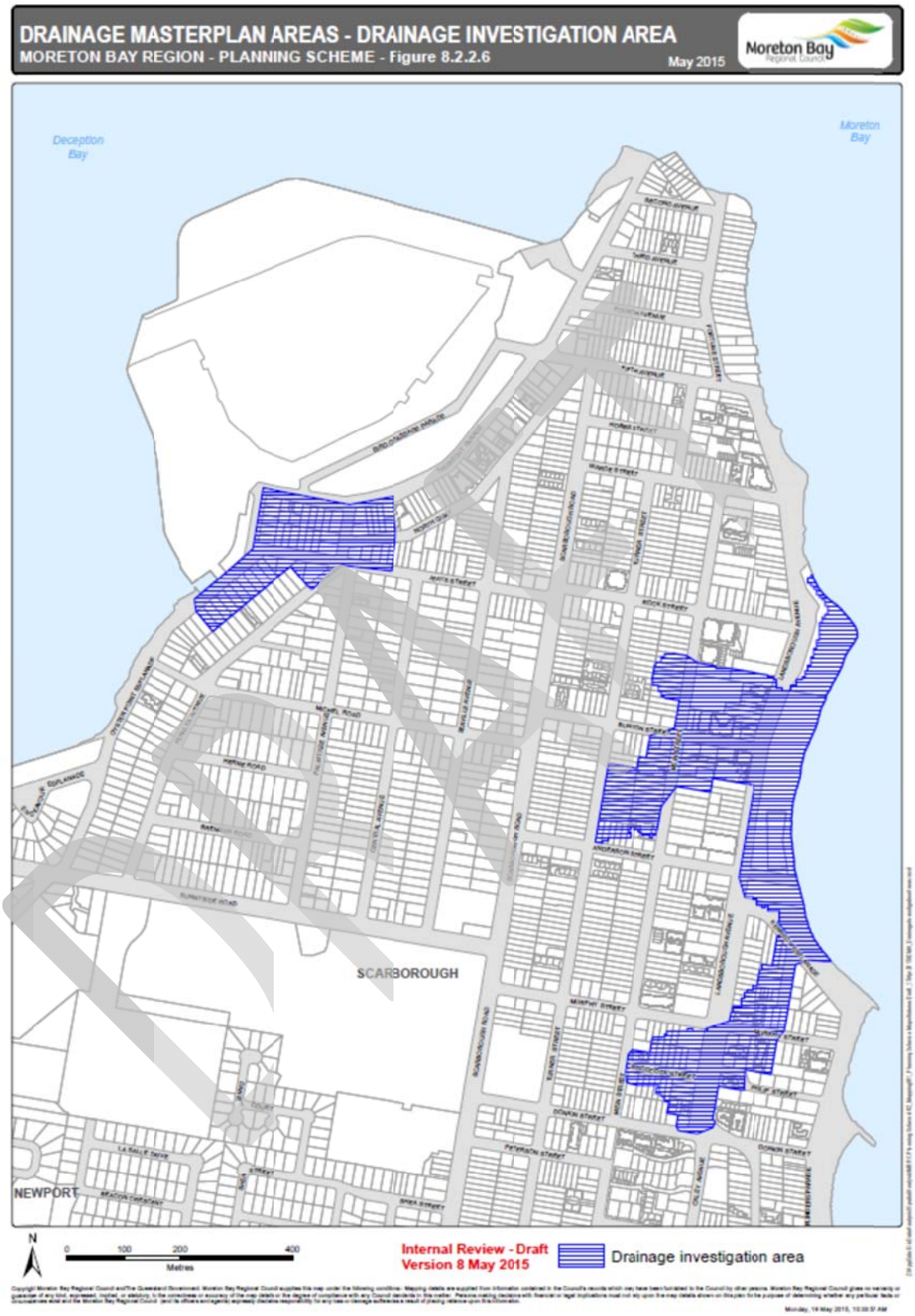


Figure 8.2.2.7 – Rothwell

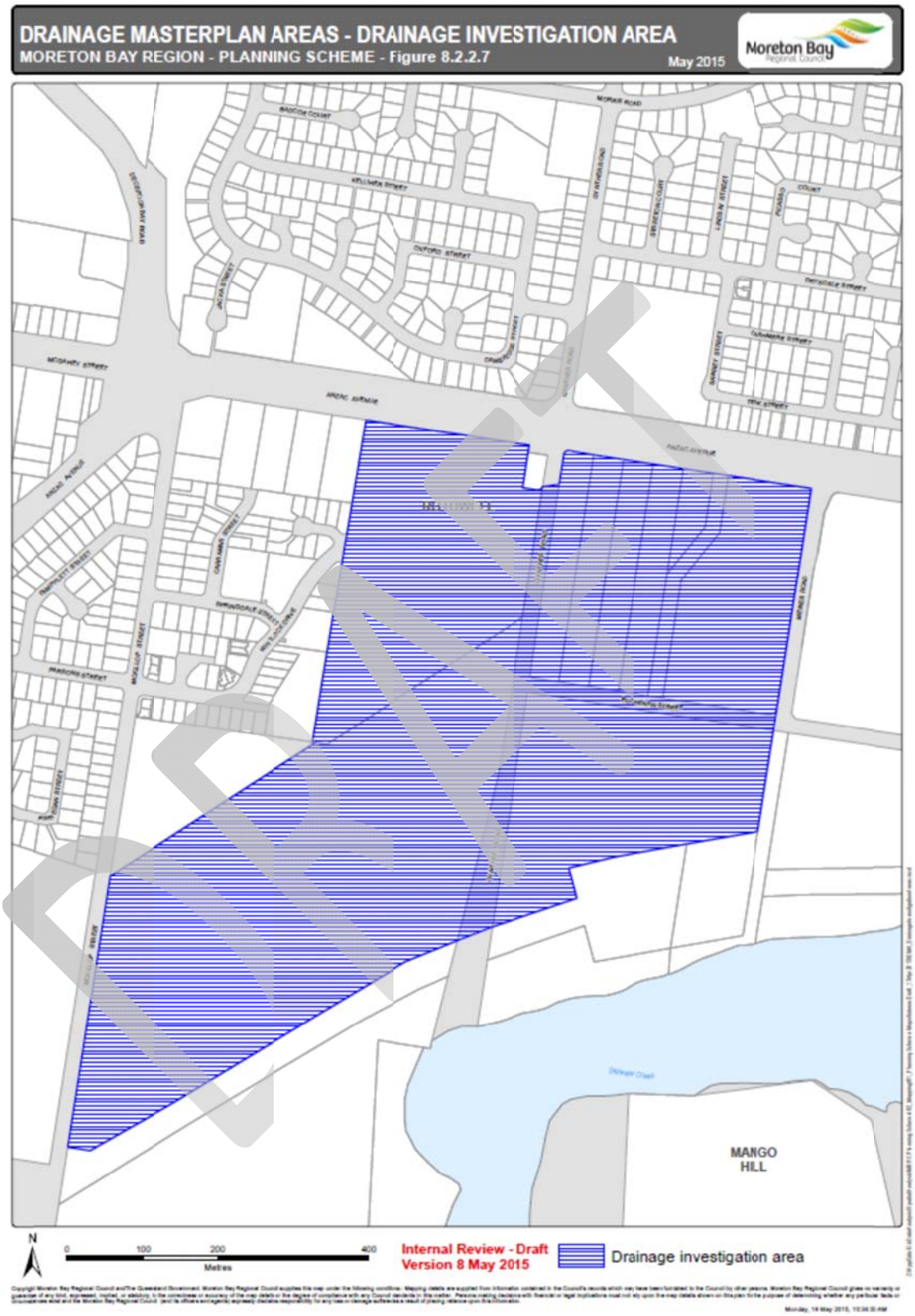


Figure 8.2.2.8 – Deception Bay

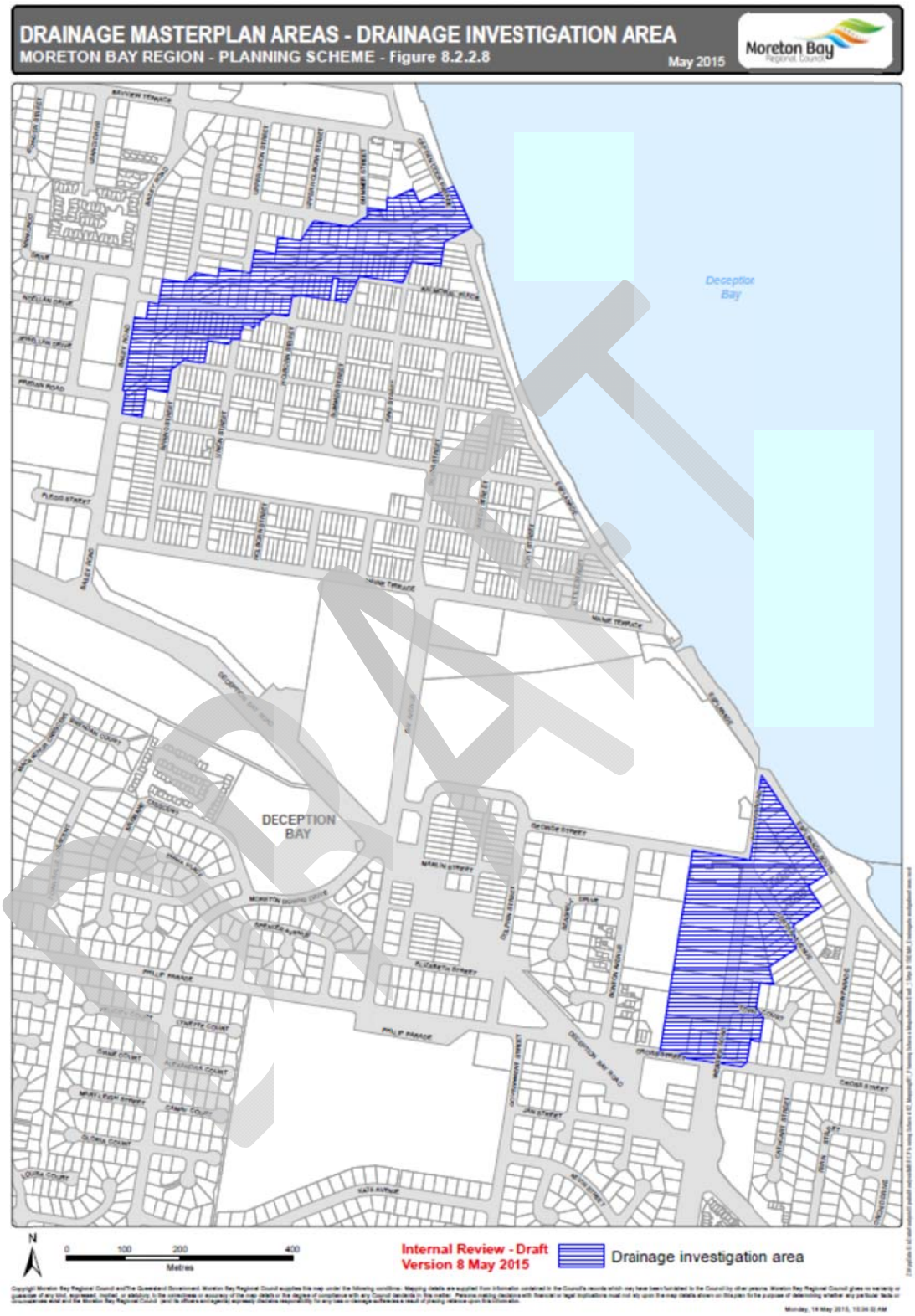


Figure 8.2.2.9 – Burpengary

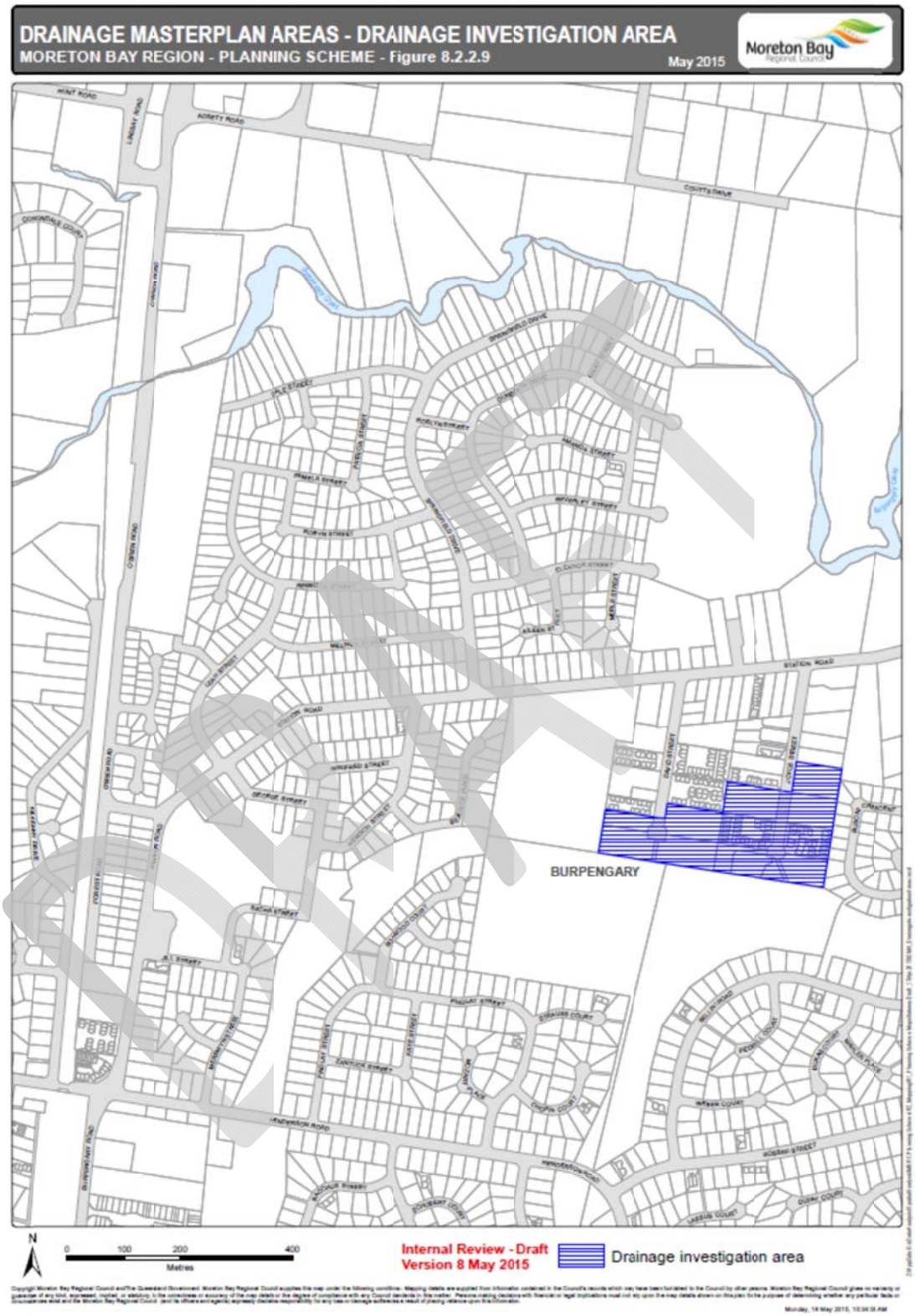
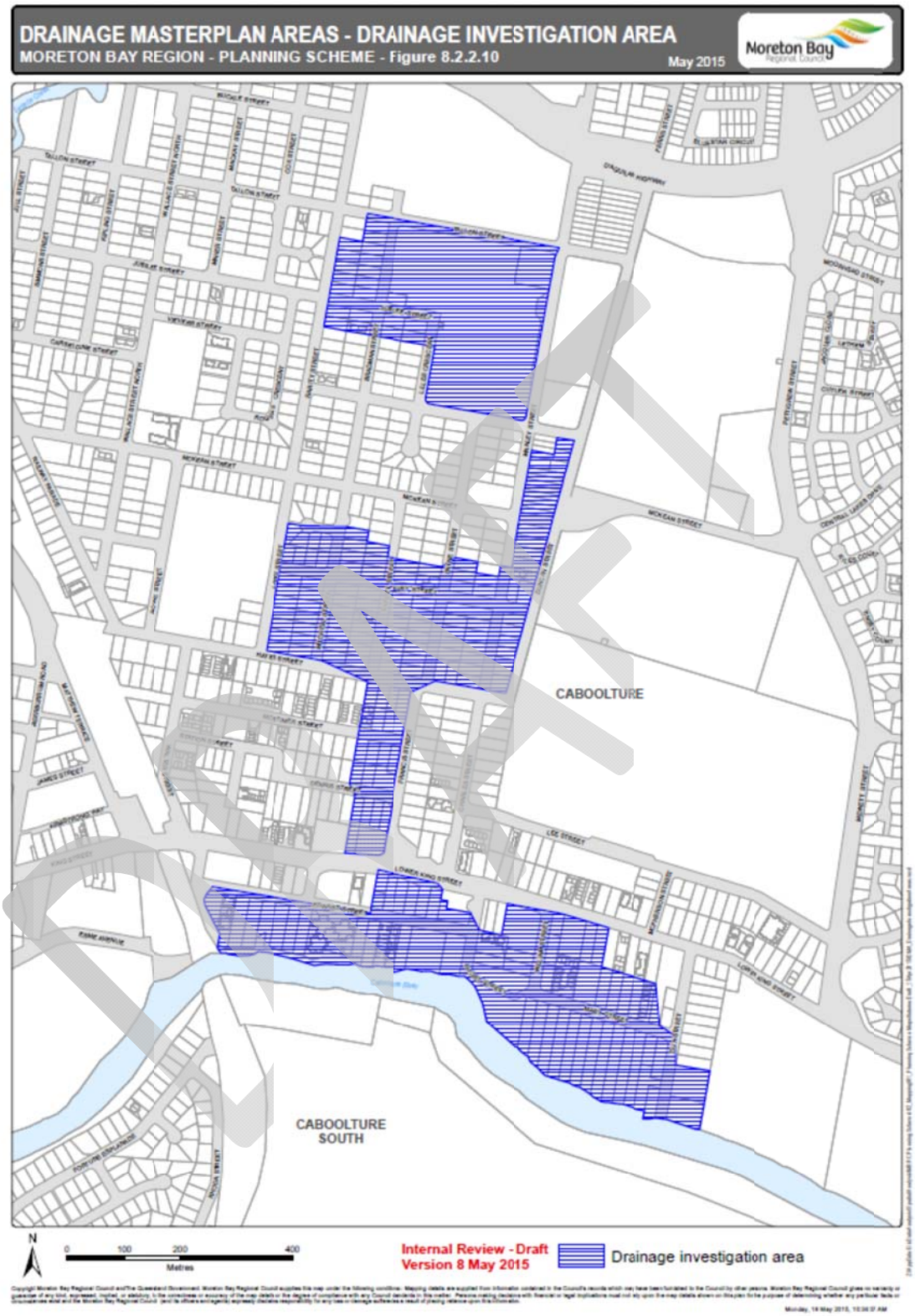


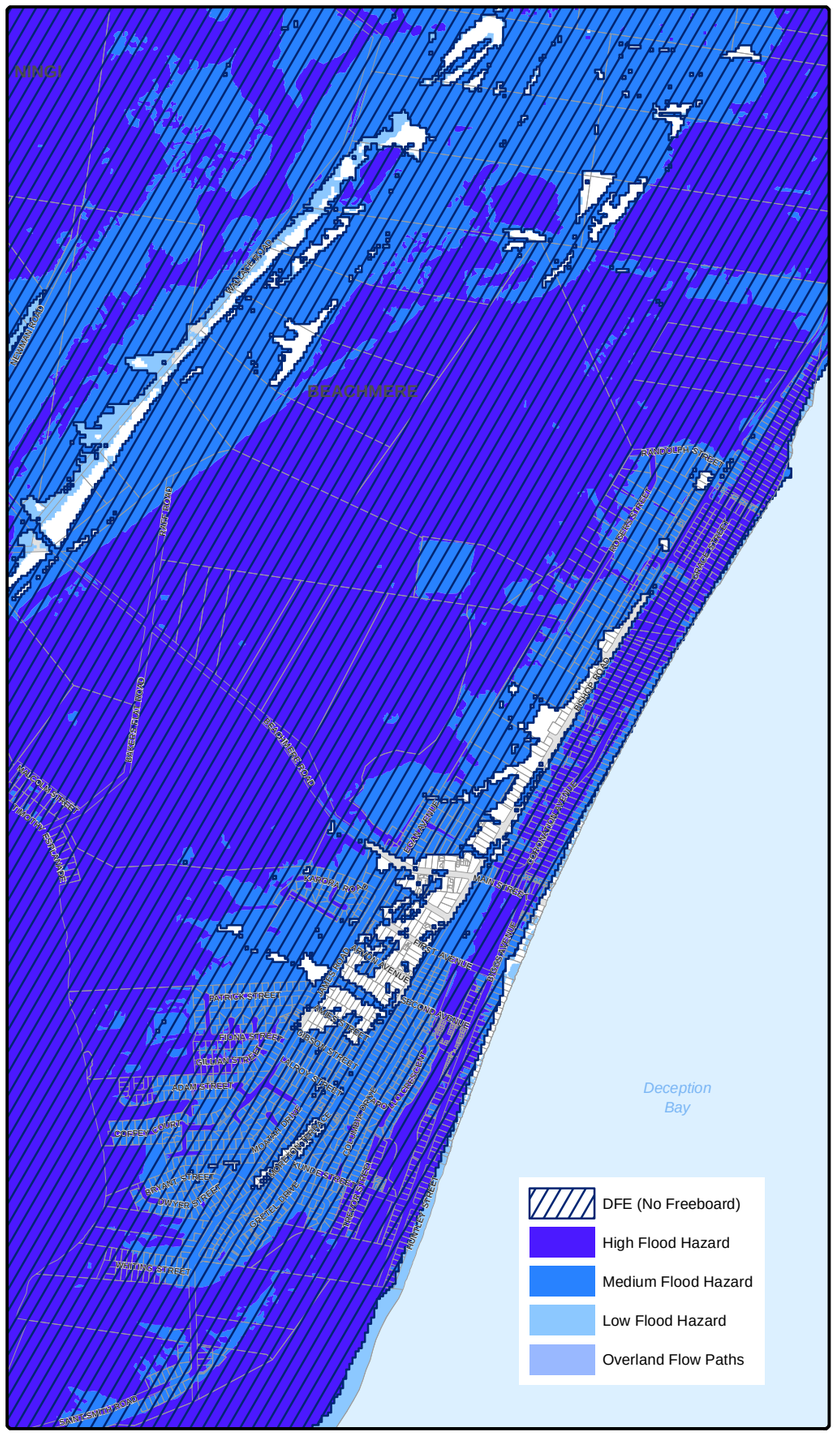
Figure 8.2.2.10 – Caboolture



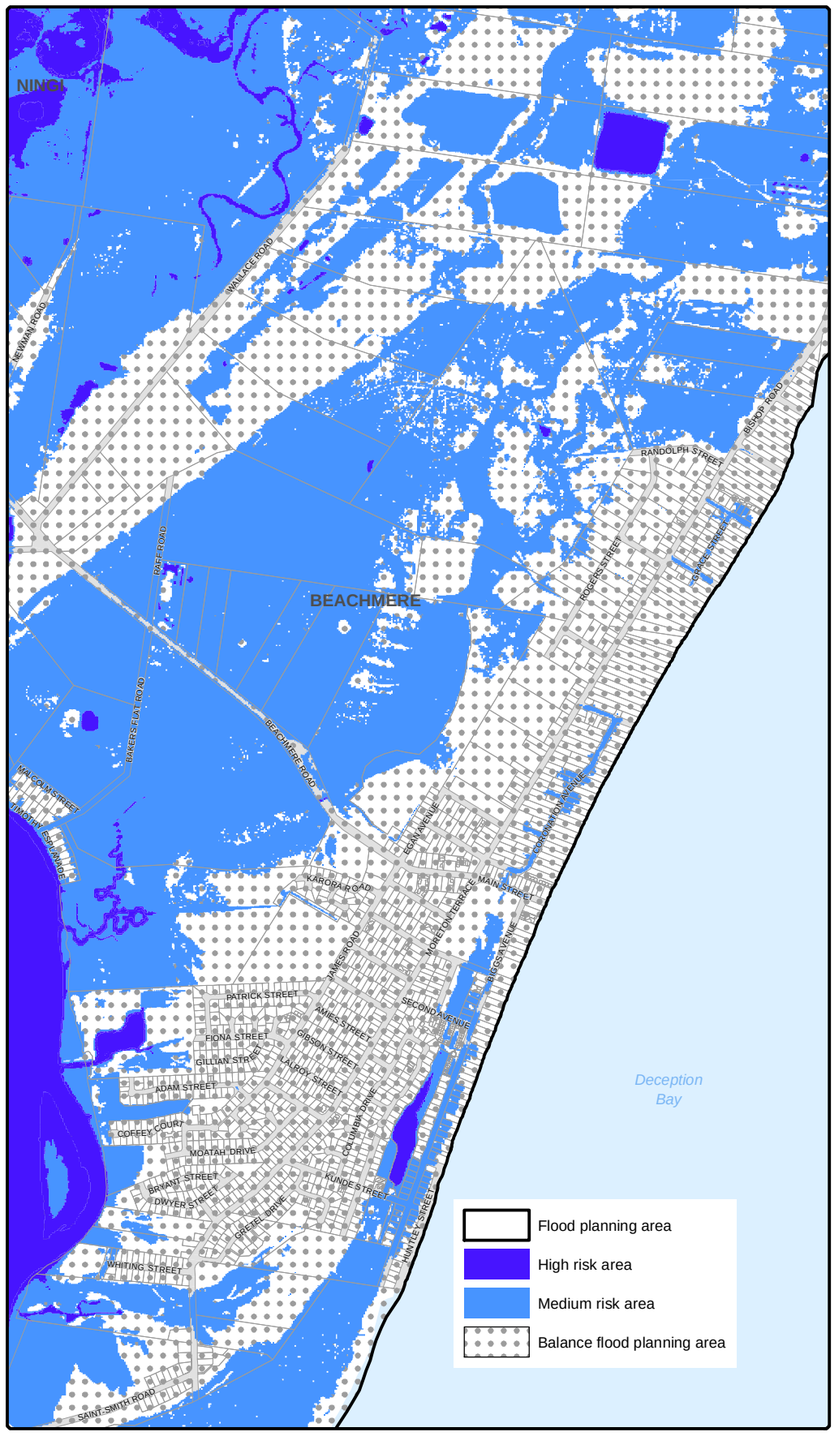
Appendix H: Mapping Differences between Draft and Revised Draft Planning Scheme

Appendix H - Example Maps - Beachmere

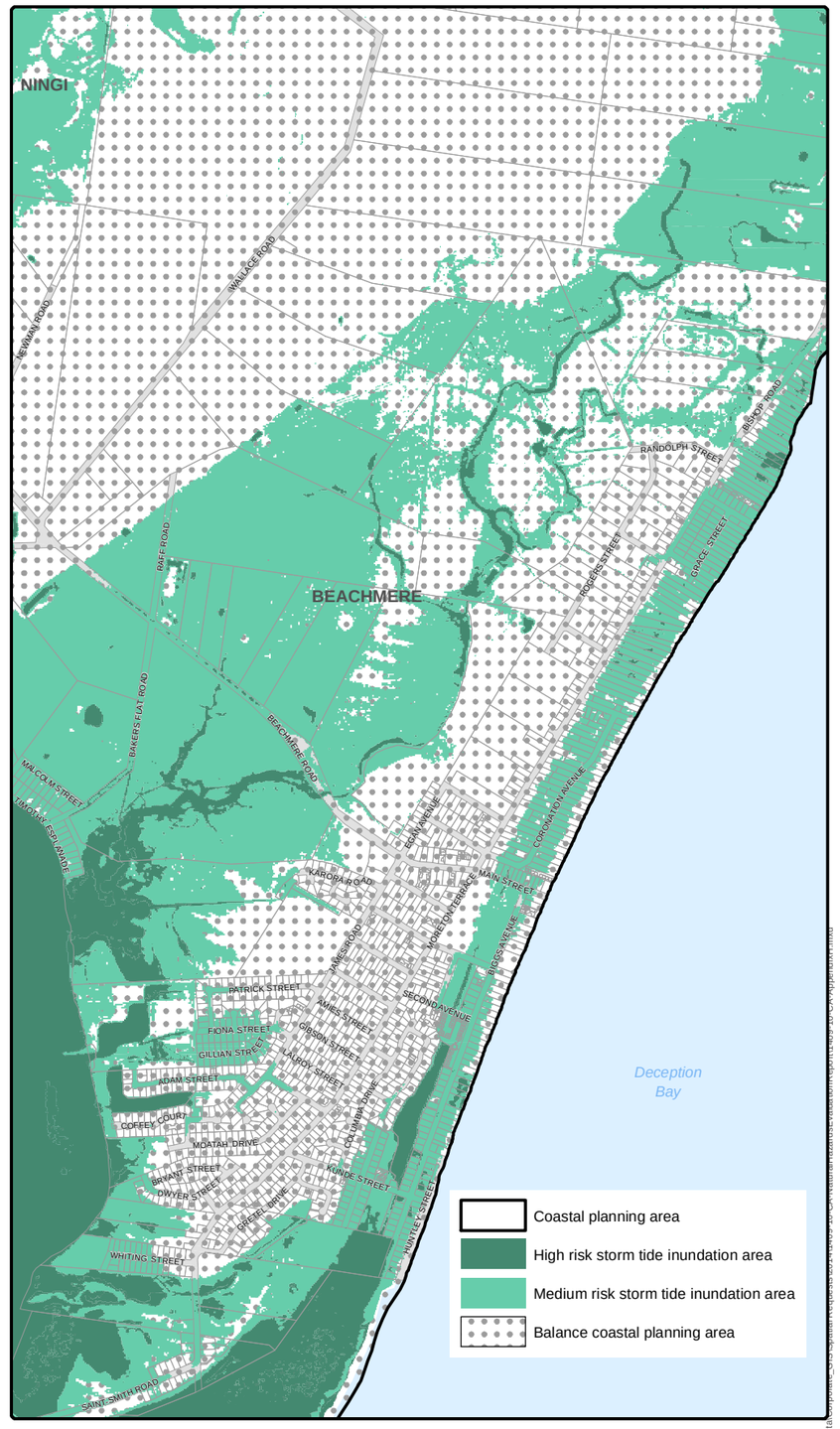
Advertised Flood Hazard (04 July 2014)



New Flood Hazard (Jun 2015)



New Coastal Hazard (Jun 2015)



Geographical Information Services
Moreton Bay Regional Council
PO Box 159,
CABOOLTURE QLD 4510
Ph: (07) 3205 0555
Fax: (07) 3205 0599
Email: gis@moretonbay.qld.gov.au
Web: www.moretonbay.qld.gov.au

N W E S

0 100 200 400 600 800
Metres

SCALE (A3) 1:20,000

Ref: 1409-10-CA

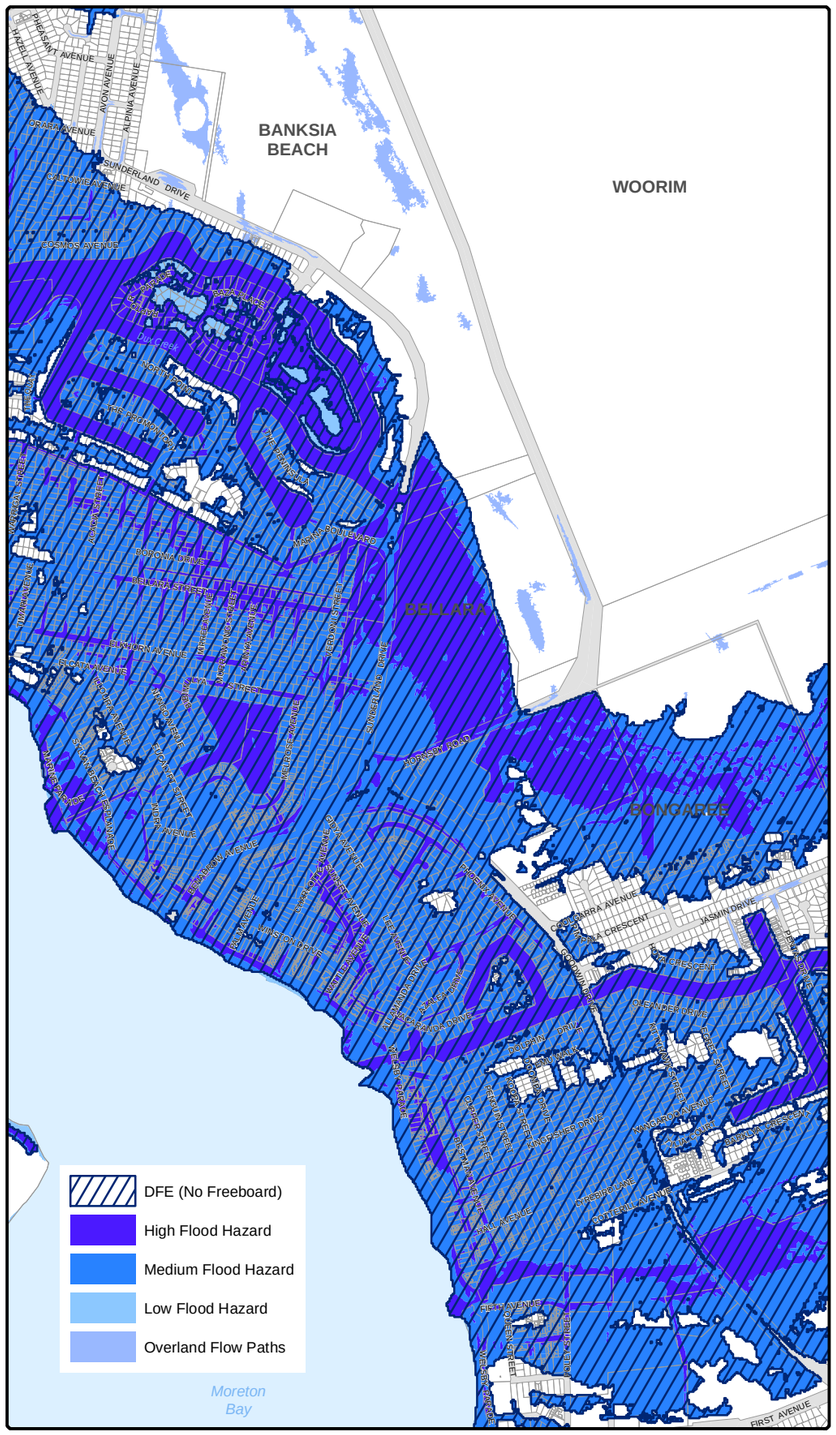
15 June 2015

Z:\AppData\GisData\Templates\A3Lm_Side Template A3Lm_Side Template.mxd

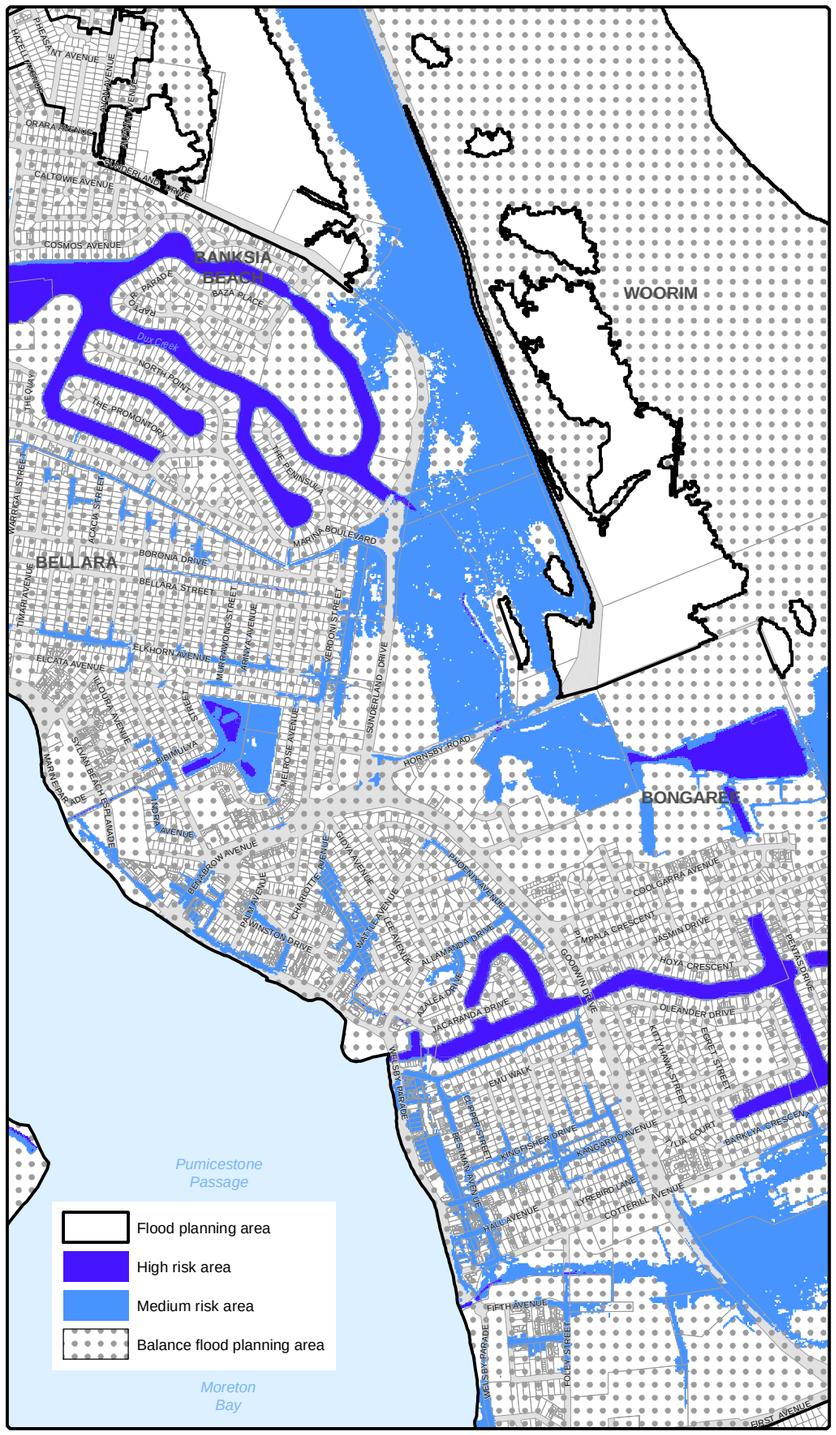
SimonHill

Appendix H - Example Maps - Bribie

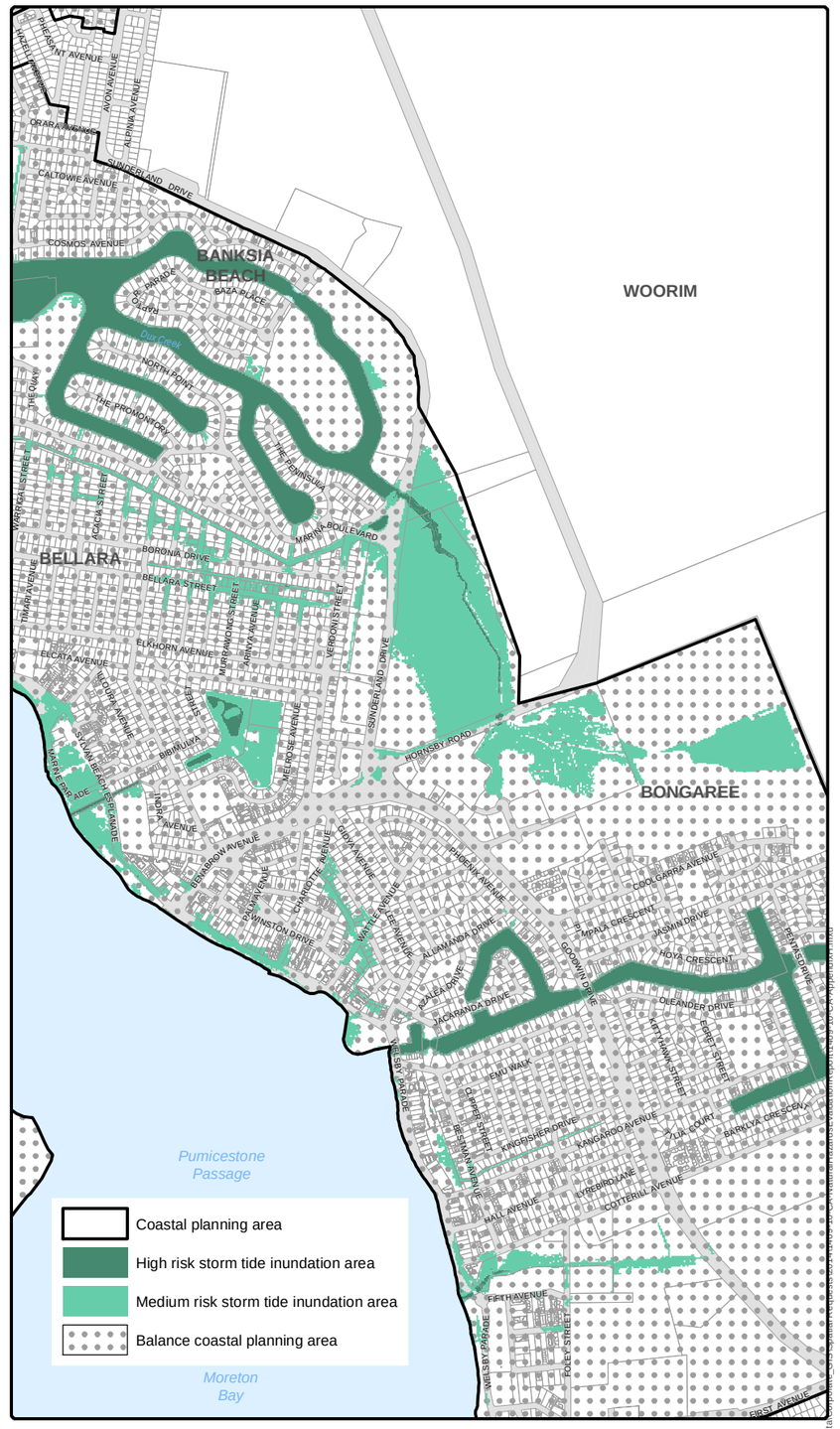
Advertised Flood Hazard (04 July 2014)



New Flood Hazard (Jun 2015)



New Coastal Hazard (Jun 2015)



Geographical Information Services
Moreton Bay Regional Council
PO Box 159,
CABOOLTURE QLD 4510
Ph: (07) 3205 0555
Fax: (07) 3205 0599
Email: gis@moretonbay.qld.gov.au
Web: www.moretonbay.qld.gov.au

N W E S

0 100 200 400 600 800
Metres

SCALE (A3) 1:20,000

Ref: 1409-10-CA

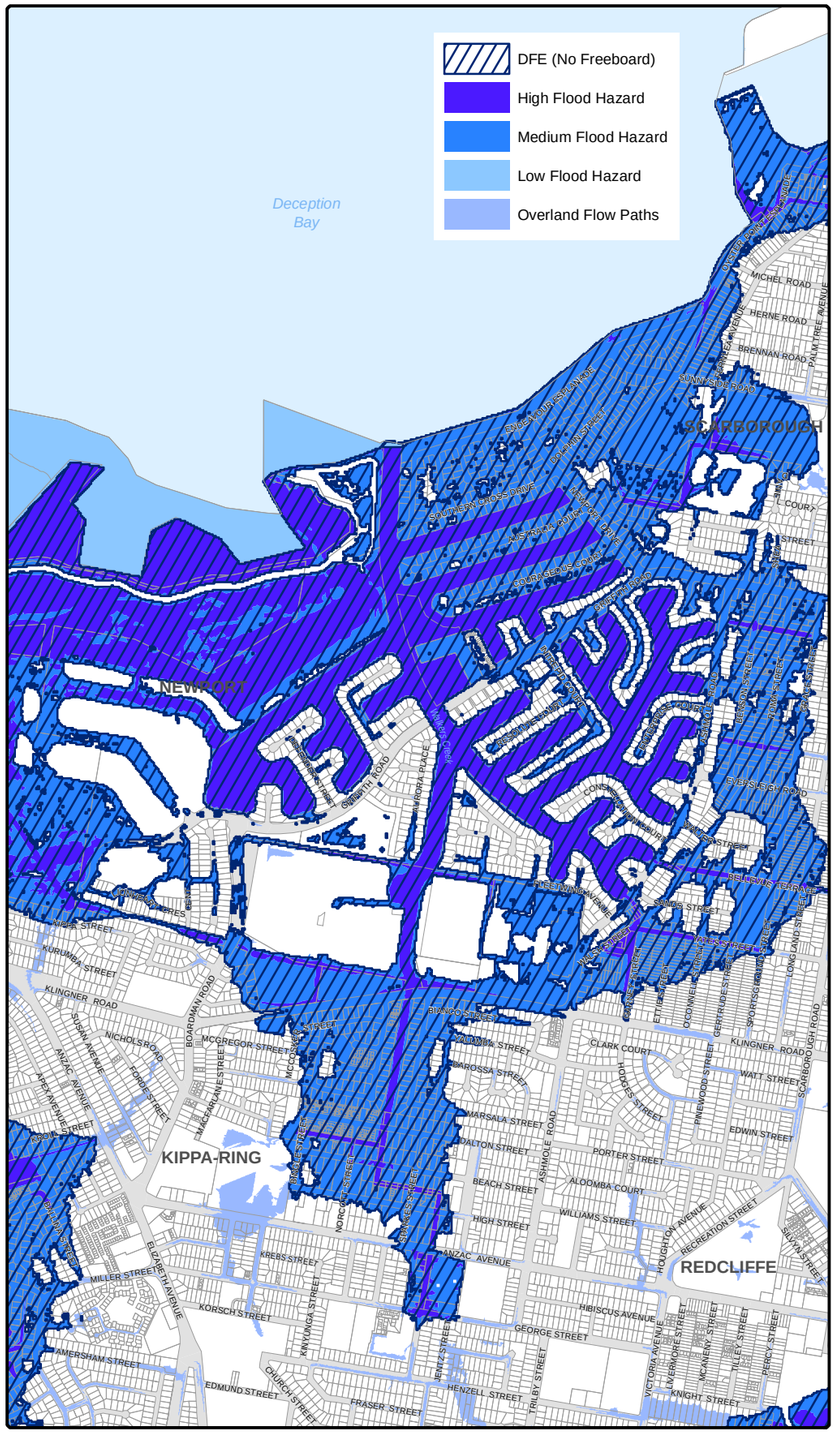
15 June 2015

Z:\AppData\GisData\Templates\A3Lm_Slide Template

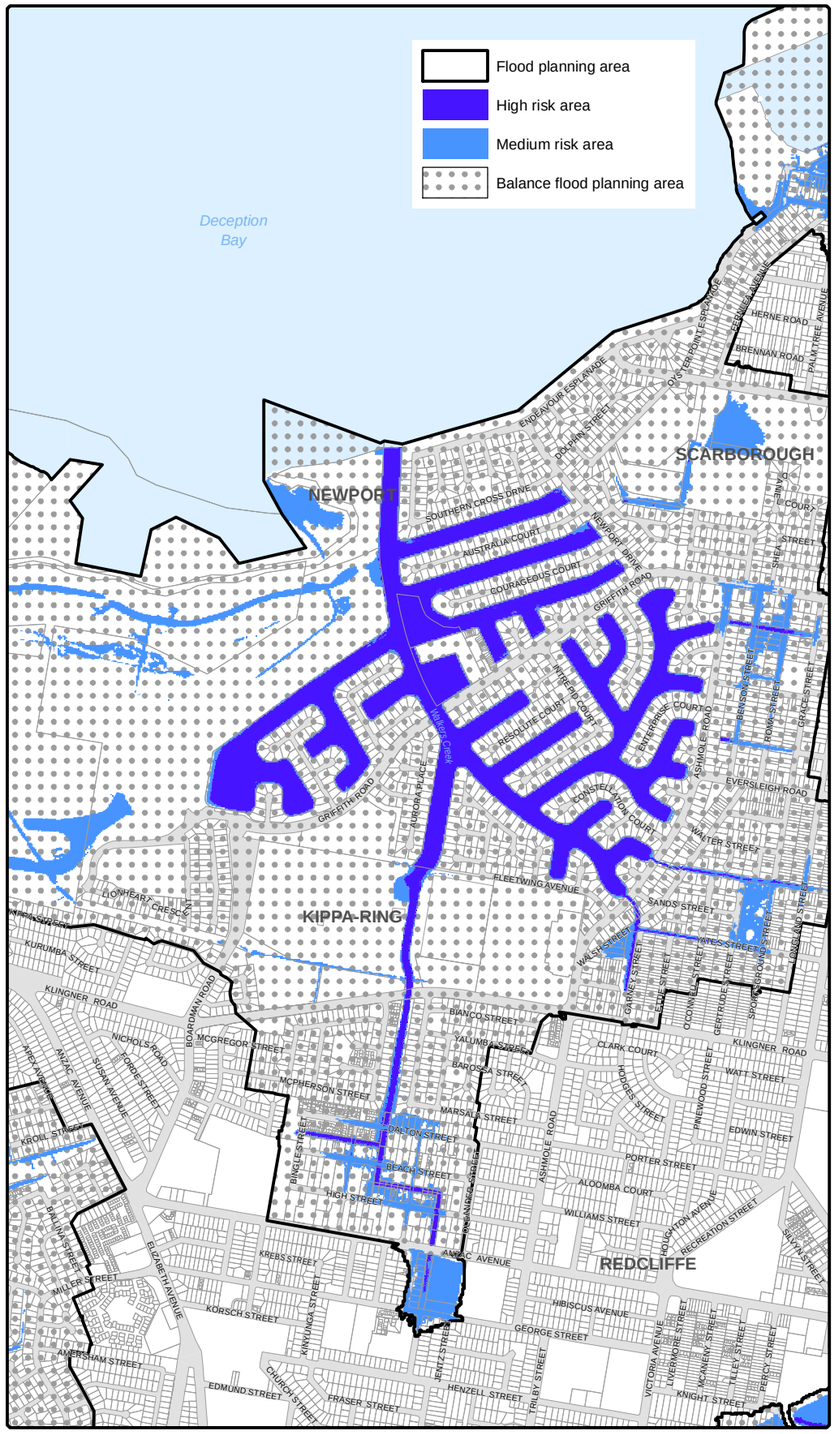
SimonHill

Appendix H - Example Maps - Newport

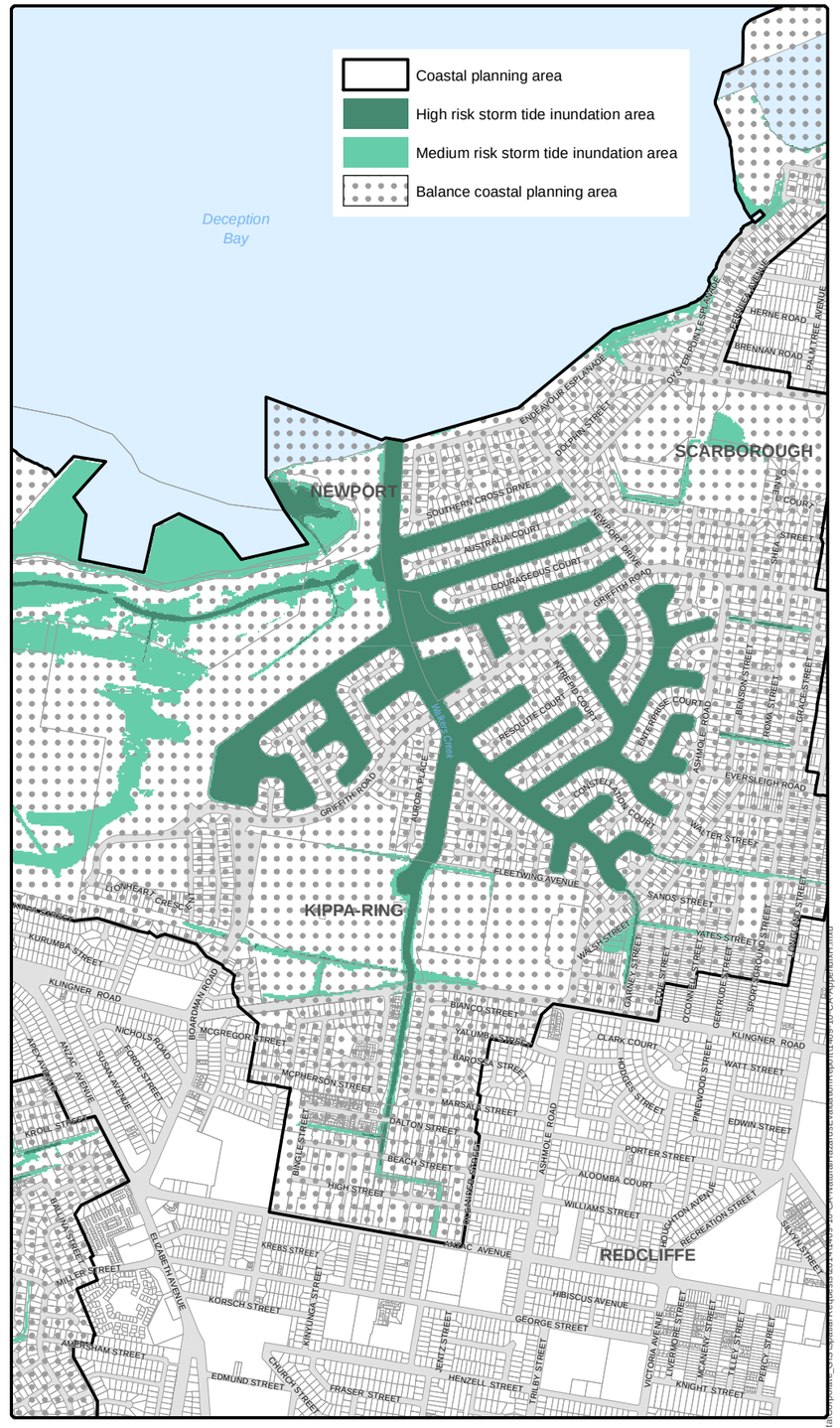
Advertised Flood Hazard (04 July 2014)



New Flood Hazard (Jun 2015)



New Coastal Hazard (Jun 2015)



Geographical Information Services
Moreton Bay Regional Council
PO Box 159,
CABOOLTURE QLD 4510
Ph: (07) 3205 0555
Fax: (07) 3205 0599
Email: gis@moretonbay.qld.gov.au
Web: www.moretonbay.qld.gov.au

N
W E
S

0 100 200 400 600 800
Metres

SCALE (A3) 1:20,000

Ref: 1409-10-CA

15 June 2015

A3Lm_Side Template Z:\AppData\GisData\

SimonHill