Queensland Reconstruction Authority

Planning for stronger, more resilient floodplains

Part 2 – Measures to support floodplain management in future planning schemes

Queensland Government

Planning for stronger, more resilient floodplains *is a toolkit that promotes improvements in the maturity of the flood mapping available for Queensland's floodplains and the land use planning mechanisms used to address development in these areas through a fit-for-purpose approach. The Guideline encourages all Councils, regardless of resources or capacity, to undertake the floodplain management measures that are appropriate for their local government area.*

Queensland has a unique opportunity to learn from the weather events of 2010/11 by ensuring that resilience to flooding events is built into the new generation of planning schemes, particularly those prepared under the ***Sustainable Planning Act 2009****. Given very few councils are at an advanced stage in preparing these planning schemes, now is the time to address flood resilience across the State in a consistent and coordinated manner. This approach is supported by the recommendations of the Queensland Floods Commission of Inquiry (QFCoI).*

Planning for stronger, more resilient floodplains *provides a 'roadmap' to improve floodplain management practice across Queensland, particularly in relation to the role of land use planning in managing and delivering appropriate development outcomes in floodplains.*

While the local context for each floodplain around Queensland is unique, the ultimate goal for floodplain management should be the same for all – ensuring our floodplains and the communities within them are resilient to future flooding events so that we learn to live with flooding.

This is a document for planners and policy-makers. It aims to help planners understand the investigations needed to identify flood hazard and the issues to consider in developing appropriate land use responses.

Part 2 Consultation

Part 2 – Measures to support floodplain management in future planning schemes was released for consultation on 23 January 2012. The draft Part 2 was open for non-statutory consultation for 35 business days, closing on 9 March 2012.

During the consultation period, the Authority visited and briefed 41 Councils, 9 State agencies and presented to 6 industry groups. These sessions provided an overview of Part 2, progress updates on the State-wide floodplain mapping project, and offered a discussion forum for Councils to further consider how floodplain management could be appropriately integrated into their future planning schemes.

The Authority received 19 submissions during the consultation period. Of the 19 submissions received, 3 were from industry groups, 10 from Councils and 6 from State agencies. Following the consultation period, briefings of individual councils, agencies and industry groups in relation to the whole ***Planning for stronger, more resilient floodplains*** body of work has continued.

A Consultation Report was prepared to provide an overview and analysis of the submissions and feedback received during the consultation period. The Authority duly considered the feedback received during the consultation period in the finalisation of this Guideline. A copy of the Consultation Report is available at www.qldreconstruction.org.au

This toolkit focuses on riverine flooding only. While the Guideline does not specifically relate to overland flow, stormwater drainage or flooding caused by storm tide, they remain important considerations when preparing planning schemes and assessing development.

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Continuing the journey towards stronger, more resilient floodplains

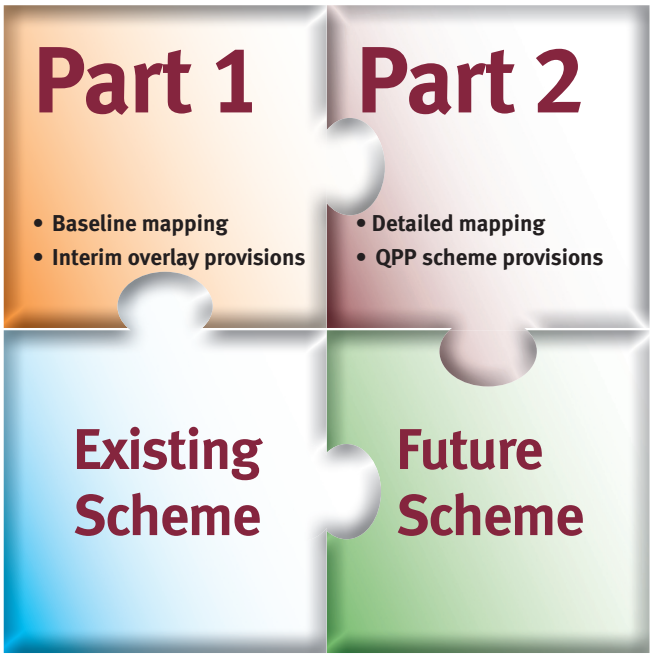
The weather events of 2010/2011 will forever be a turning point for Queensland. With more than $7.5 billion in damage to State assets and 91% of the State disaster activated as a result of flooding, improving the resilience of our floodplains is key to a more resilient future. And then again, in 2012, Mother Nature bought new record flooding to many parts of South West Queensland. Whilst rebuilding is continuing at a rapid pace around the State there is still much to be done.

Key to this rebuilding effort is ensuring that the State is more resilient to future weather events. While we won't ever eliminate flooding fully, we can ensure communities are more resilient to it. Building resilience enhances our ability to minimise the effects of future floods on our communities, economy and environment. It also means we efficiently and effectively cope with their impacts when they do occur. Resilience is a dynamic quality and is usually developed and strengthened over time - it builds upon rather than replaces existing strengths and arrangements. Bringing the floodplain management system into better alignment with the planning scheme preparation process is paramount in achieving development outcomes that exhibit this resilience.

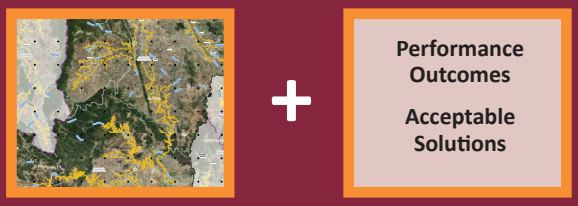
Very simply, better floodplain management results in more resilient communities. Land use planning, as a key component of the floodplain management process, can greatly assist in improving community resilience.

As a first step in achieving this, Part 1 of the toolkit provided the initial measures to address flooding in existing planning schemes through a sub-basin wide approach to floodplain management. Part 1 provided a Guideline, floodplain mapping and development assessment provisions in the form of an Interim Floodplain Assessment Overlay and a Model Code for local verification and immediate adoption into existing planning schemes.

Part 2 builds upon this work by providing further guidance on integrating floodplain management principles and processes into future planning schemes. Across the State, Councils are currently in the process of preparing new planning schemes – either Queensland Planning Provision (QPP)-compliant Planning Schemes in accordance with the requirements of the ***Sustainable Planning Act 2009*** (SPA), or under the superseded ***Integrated Planning Act 1997***. Both planning scheme formats will benefit from the Part 2 Guideline.



Part 1 provided interim measures to support floodplain management in development assessment processes, and included floodplain mapping and a model code for inclusion in existing Planning Schemes through a minor scheme amendment process.



Floodplain Maps + Model Code Provisions

Flood Hazard Overlay – Floodplain Assessment

Part 2 provides guidance on:

1. Undertaking flood investigations, including:
   - selecting the right investigation for each sub-basin or part of sub-basin
   - how to undertake the relevant flood investigation(s)
2. Land use strategies for development in existing infill and broad hectare areas, including:
   - undertaking a planning evaluation to balance flood hazard with other land use considerations to identify planning-specific flood risk
   - land use response strategies for existing and future development
   - how a planning scheme can address the strategies
3. Example QPP-compliant planning scheme provisions developed from the land use strategies, including:
   - key considerations and example provisions for the strategic framework
   - model zone codes that deliver the intent of the strategic framework and an Overlay code with additional provisions from the Model Code presented in Part 1

About this Guideline

This Guideline is divided into four key sections:

1. Understanding

- National and State context
- Where are we now?
- A sub-basin wide approach to floodplain management
- Hazard versus risk
- The flood risk equation
- Consequence - the key element of flood risk
- What should planners know about flood?

2. Analysis

- Fit-for-purpose floodplain management system
- Flood investigation guidance

3. Implementation

- Undertaking a planning evaluation
- Land use response strategies
- Using the planning scheme to build flood resilience

4. Delivery

- Delivering Part 1 and Part 2
- Undertaking the sub-basin wide approach
- QFCoI response and key future actions
- Indicative flood investigation case study
- Preparing the planning evaluation
- Tying it all together

This Guideline also includes schedules with specific details on undertaking flood investigations and planning evaluations. A planning evaluation case study, checklists for planning scheme drafters and reviewers, and example planning scheme provisions are also provided.

Both Part 1 and Part 2 offer practical, fit-for-purpose measures to address pressing floodplain issues currently facing Councils across Queensland. This guidance will allow Councils to address these issues in their planning schemes, through a process that is appropriate to their circumstances. Addressing flooding issues so that practical, fit-for-purpose solutions can be adopted and implemented is an appropriate step towards better floodplain management and more resilient communities.

Floods in Mitchell, early 2012 *Source: QldRA*

> A disaster resilient community is one that works together to understand and manage the risks that it confronts. Disaster resilience is the collective responsibility of all sectors of society, including all levels of government, business, the non-government sector and individuals.
>
> **National Strategy for Disaster Resilience, piii**

Floodplain Management - Part 2

Stronger, more resilient floodplains

Context

2010/2011 events

QldRA
Roles and Functions

Understanding	Analysis	Implementation	Delivery
1	2	3	4
• Where are we now? • Sub-basin wide approach • Flood risk equation • What should planners know?	• Fit-for-purpose floodplain management system • Flood investigation guidance	• Planning evaluation • Land Use response strategies • Future planning scheme	• Delivering Parts 1 & 2 • QFCoI response • Process for incorporating toolkit into future planning scheme

The approach to floodplain management

A conventional integrated floodplain management process usually involves the following core elements:

- Emergency planning and management
- Structural works
- Land use planning
- Building controls
- Landscape and environment programmes
- Community awareness and communication.

This comprehensive approach usually takes around two to three years and involves significant community engagement and resources (refer to **Figure 1**).

Planning for stronger, more resilient floodplains recognises that this is the adopted 'best practice' approach to floodplain management. However, past practice has tended to focus more on the other elements such as emergency management and structural controls, rather than land use planning.

Part 1 and Part 2 have been developed with consideration to this approach focussing principally on the land use planning element of the process. This is intended to draw a greater correlation and connection between the floodplain management process and the land use planning framework.

Planning for stronger, more resilient floodplains provides a toolkit where a fit-for-purpose approach to floodplain management can be utilised to support land use planning responses and decision making, through a risk management framework.

The fit-for-purpose approach advocates selecting the appropriate level of flood investigation, undertaking a planning evaluation and preparing implementation mechanisms appropriate for local circumstances.

Figure 1: The floodplain management process provides a comprehensive suite of measures that contribute to building resilience in the floodplain.

Planning for stronger, more resilient floodplains promotes:

- **A sub-basin wide approach to floodplain management, coordinated at the regional level through Regional Planning Committees;**
- **A fit-for-purpose approach to floodplain management unique to the local circumstances, financial and capacity constraints of each responsible jurisdiction across the State; and**
- **Improved floodplain management outcomes through a risk management approach to flood hazard mapping and land use planning responses.**

Part 2 Elements

1 ☑ Flood Investigation

2 ☑ Planning Evaluation

3 ☑ Land Use Strategies

PLANNING SCHEME

- ☑ Strategic framework
  - ☑ Zoning
    - ☑ Overlay

NON-SCHEME MEASURES

- Building provisions
- Land-swap programs
- Resumptions
- Voluntary purchase schemes

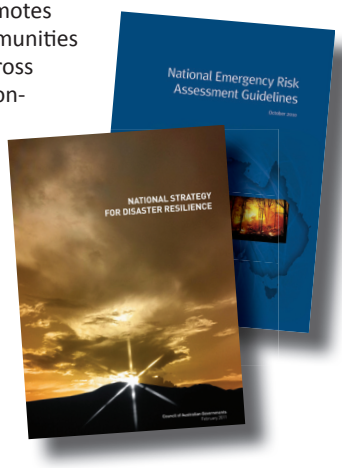
Figure 2: Summary of key elements of Part 2

1. Understanding

National context

National Strategy for Disaster Resilience

Planning for stronger, more resilient floodplains is an initial response to the Council of Australian Governments' National Strategy for Disaster Resilience (the National Strategy). The National Strategy advocates developing and implementing effective, risk-based land management and planning arrangements and other mitigation activities. The National Strategy promotes the building of resilience within communities through a collective responsibility across government, business, individuals, non-government entities and vounteers.



National Emergency Risk Assessment Guidelines

In 2007, the Australian Emergency Management Committee endorsed a National Risk Assessment Framework to support the development of an evidence base for effective risk management decisions and to foster consistent baseline information on risk.

The National Emergency Risk Assessment Guidelines (NERAG) have been developed as one of the first outputs of the framework's implementation plan. NERAG aims to improve the consistency and rigour of emergency risk assessments. NERAG acknowledges the role of urban planning as a prevention and preparedness control.

National Flood Risk Information Portal

The Commonwealth government announced in November 2011 that it will develop a nation-wide flood risk information portal. The portal, to be hosted by Geoscience Australia, will provide a single access point to existing flood mapping data for users throughout Australia. It is intended to assist in emergency management, land use planning and environmental management as well as informing the setting of insurance premiums.

To support the development of the national portal, the Authority is currently collating existing flood studies held by councils, industry and State agencies across Queensland, with the intention of launching a Queensland-specific Flood Portal by the end of 2012. Councils can submit the relevant details of studies undertaken and any electronic data (including GIS layers and/or copies of reports) to: https://qldreconstruction.org.au/floodstudies

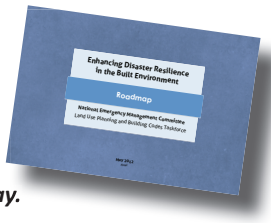
Review of SCARM 73 Report

Floodplain Management in Australia has been the principal national floodplain management guidance document since its adoption in 2000. The document is now under review, and in accordance with Recommendation 2.20 of the QFCoI, the Authority is providing assistance to the Department of State Development, Infrastructure & Planning (DSDIP) in collaborating with the drafters of the new National Guideline to ensure that it reflects recent lessons learnt in the implementation of floodplain management policy in Queensland.

Land Use Planning and Building Codes Taskforce

The Authority recently led a significant body of work on behalf of the National Land Use Planning and Building Codes Taskforce, a working group of the Standing Council on Police and Emergency Management (SCPEM) reporting to the Council of Australian Governments (COAG). The project supports the National Strategy for Disaster Resilience including a nationwide review of land use planning and building codes as they relate to natural disasters. Four reports have now been delivered including a Vision Statement, Current State Review, Gap Analysis and a Roadmap.

The document defines a built environment future state and outlines a national vision for disaster resilience through land use planning and building codes. The Built Environment Vision is: ***By 2025, I am contributing to a more resilient Australia by being informed and prepared for the natural hazards that may affect where I live, work and play.***



The Roadmap outlines the actions, including the requirement for State based Capability and Investment Plans. The reports were endorsed by the National Emergency Management Committee on 25 May 2012 and noted by SCPEM on 29 June 2012.

The Authority has prepared a National Capability and Investment Plan template for use by all jurisdictions. The Capability and Investment Plans will underpin the development of a detailed Implementation Strategy in each State and Territory. Queensland is the first jurisdiction to commence work on its capability and investment plan.

The State context

Queensland Floods Commission of Inquiry

On 16 March 2012, the QFCoI handed down its final report into the Queensland floods of 2010/2011. The final report included 177 recommendations across a number of areas including land use planning, building controls, emergency management, mining and insurance.

On 7 June 2012, the Queensland Government tabled its detailed response to the QFCoI recommendations. These recommendations are being addressed in full by the Government over time. This Guideline provides an initial response to a number of these recommendations, including some of those in chapters 2, 4, 5, 7, 10 and 11. The response to these recommendations is elaborated upon in section 4 of this Guideline.

SPP 1/03 Review

State Planning Policy 1/03 – Mitigating the adverse impacts of flood, bushfire and landslide (SPP1/03) is currently under review by DSDIP. The review will examine the manner in which flood is addressed through planning instruments and the development assessment process. The review will align with the recommendations of the QFCoI and ensure that lessons learnt from Queensland's natural disasters are taken forward to ensure improved land use outcomes that respond to natural hazards are implemented on the ground.

Where are we now?

Through the mapping project undertaken in Part 1 of this Guideline, a total of 119 of the 129 sub-basins across Queensland have now been mapped to at least Level 1 on the floodplain mapping maturity model (see **Figure 4** below). Combined with existing flood mapping in the other sub-basins, this will represent full coverage of all relevant areas of the State.

For the first time, we now have a State-wide picture of the extent of floodable areas (see **Figure 3** at right). The mapping project has identified that approximately 26.6% of Queensland's land mass falls within a floodplain. This has significant and wide ranging implications for land use policy in our State. Hence, this information is relevant to all stakeholders involved in making land use decisions throughout Queensland.

Local verification of the floodplain mapping using any available local or historic information is of critical importance to validate the mapping, which represents Level 2 on the maturity model below. Following consultation with those councils that were initially mapped following the release of Part 1, the majority of these Councils will be moving to Level 2 within the model. It is also important to note that some Councils, through their own efforts, are already at the higher level on the maturity model.

This floodplain mapping exercise, enhanced by local governments and adopted into existing planning schemes via the local verification process outlined in Part 1, will result in a significant increase in the total number of planning schemes that include flood mapping.

Part 1 outlines a streamlined adoption process for councils wanting to incorporate mapping and planning scheme provisions within their existing planning schemes. This is of particular relevance to those councils who are a number of years away from finalising their new planning scheme.

Part 2 continues to promote the improvement of floodplain mapping across Queensland by providing additional guidance on how floodplain mapping may move to Levels 3 – 5 in the mapping maturity model where appropriate.

The Interim Floodplain Assessment Overlay is now available for free download from the Queensland Government Information Service – via http://dds.information.qld.gov.au/dds/

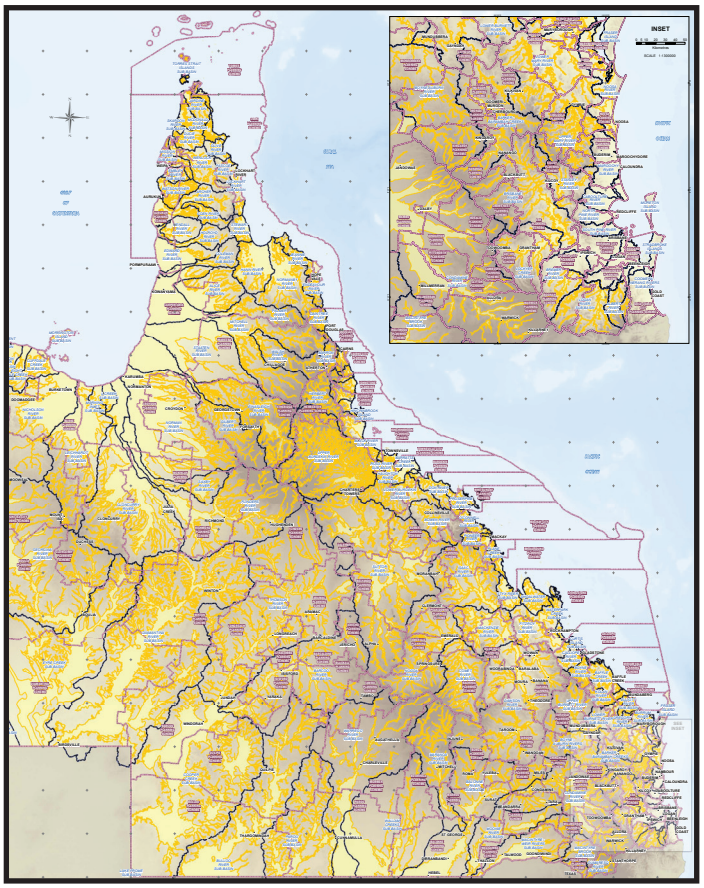


Figure 3: The State-wide picture of our floodplains, depicted in yellow. Around 26% of the State lies within a floodplain.

"Working with [the former] DERM, the QldRA has over a matter of months, created maps covering most of Queensland. The Commission acknowledges the extensive work that has gone into the interim floodplain maps."

Queensland Floods Commission of Inquiry Final Report, March 2012, p67

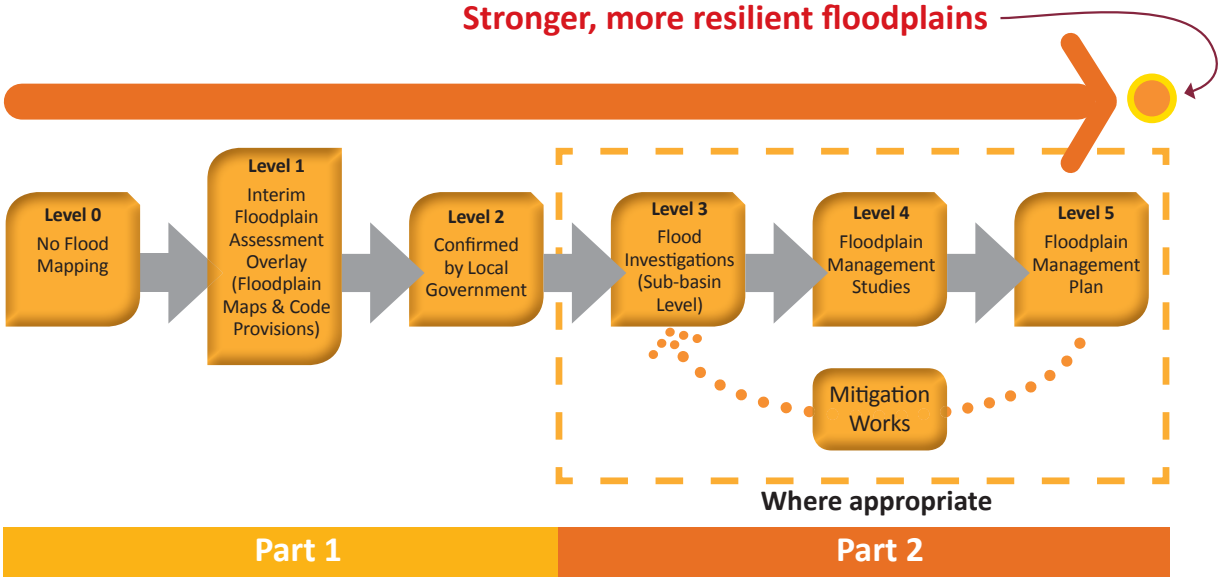


*Figure 4: The floodplain mapping maturity model, noting the application of the different parts of the **Planning for stronger, more resilient floodplains** Guideline series*

Queensland's floodplains

Queensland's floodplains are very diverse. From the steep coastal floodplains to the east, to the wide and flat floodplains of the Channel Country in the west, Queensland's floodplains differ widely in their topographic, hydrological and hydraulic characteristics. The communities who live within these floodplains are equally diverse. With this in mind, the environmental characteristics, population, development pressures, existing urban form, economic activity and community perception of risk will be different in every floodplain.

A 'one-size-fits-all' approach to floodplain management is therefore not appropriate – tailored solutions are required. The assessment of risk in each floodplain must be dependent on the likelihood of certain types of floods and the consequence of that flooding relative to those unique local circumstances.

Typically, each part of the floodplain is subject to varying levels of risk depending on the flood event, principally because the behaviour of floodwaters will differ in each part of the floodplain, and the extent of risk to life and property in each of these parts will also vary. The following images illustrate the varying characteristics of floodplains across Queensland in the context of principles derived from the Next Generation Planning Handbook.

These images depict typical examples of place types that may fall within a floodplain. The examples do not cover the full extent of place types that may exist within a floodplain, but are illustrative of the varying floodplains existing with Queensland.

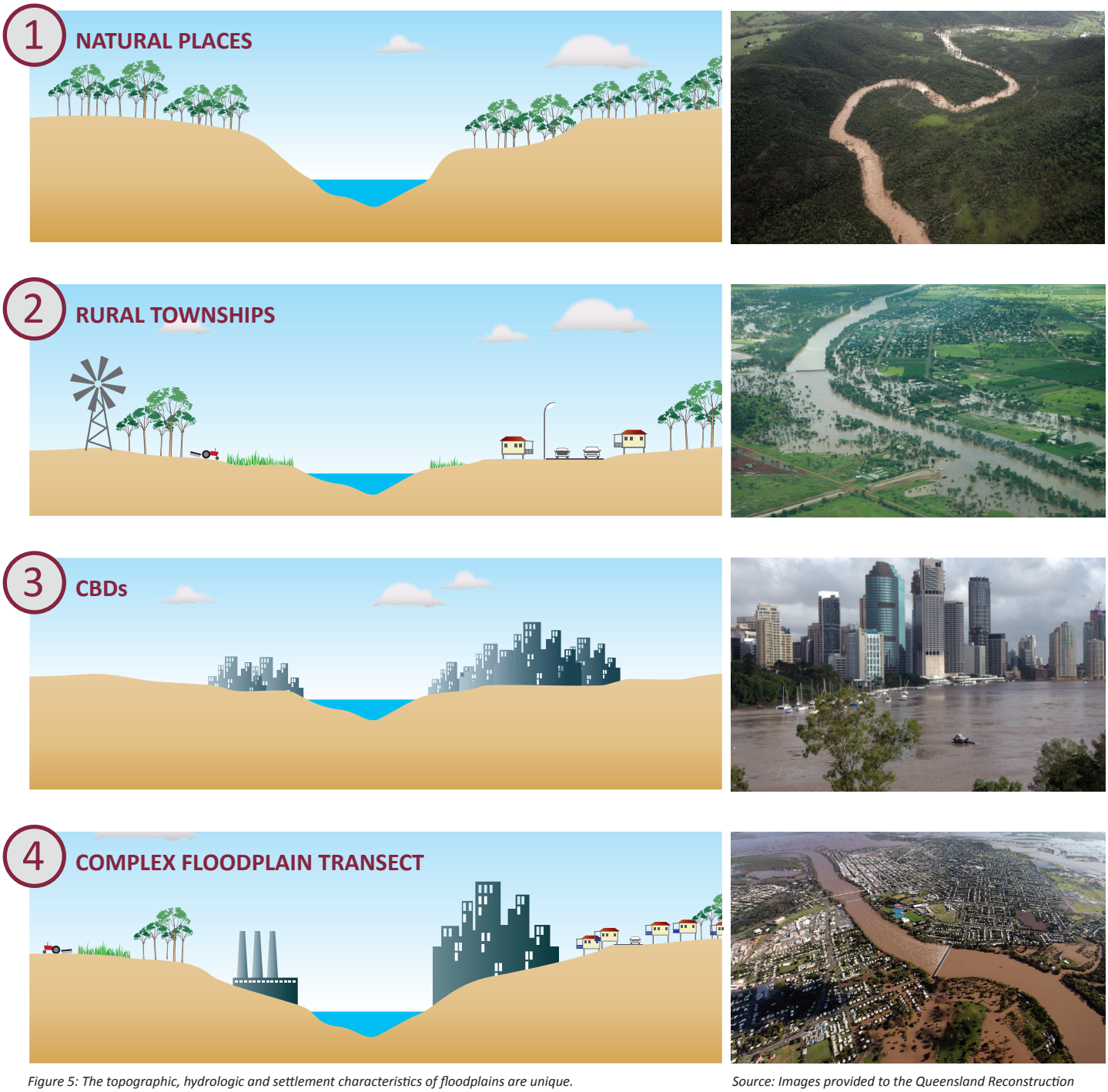


Figure 5: The topographic, hydrologic and settlement characteristics of floodplains are unique.

Source: Images provided to the Queensland Reconstruction Authority

A sub-basin wide approach to floodplain management

Historically, the responsibility for floodplain management has been borne by local governments, however not one local government boundary in the State correlates to a sub-basin boundary (refer to **Figure 6** below). This lack of correlation between local government boundaries and sub-basin catchments has resulted in challenges in coordinating flood investigations, land use planning and floodplain management programmes. Undertaking floodplain management at a regional level allows a coordinated approach to be undertaken across the whole sub-basin. This sub-basin wide approach means the responsibility for floodplain management is shared across the sub-basin by those jurisdictions whose areas lie within it.

In practice, this sub-basin wide approach means:

- When flood investigations are undertaken, a common methodology can be used to avoid problems where different methodologies result in different study results within the same sub-basin, and therefore different identified flood levels and characteristics;
- Responses to floodplain issues can be agreed and delivered across the whole floodplain, not just within certain local government areas; and
- More coordinated and consistent land use planning controls can be implemented where development pressures and population densities across the floodplain are similar.

Figure 6: Sub-basins do not correlate to local government boundaries – not one sub-basin falls within a single local government area in Queensland.

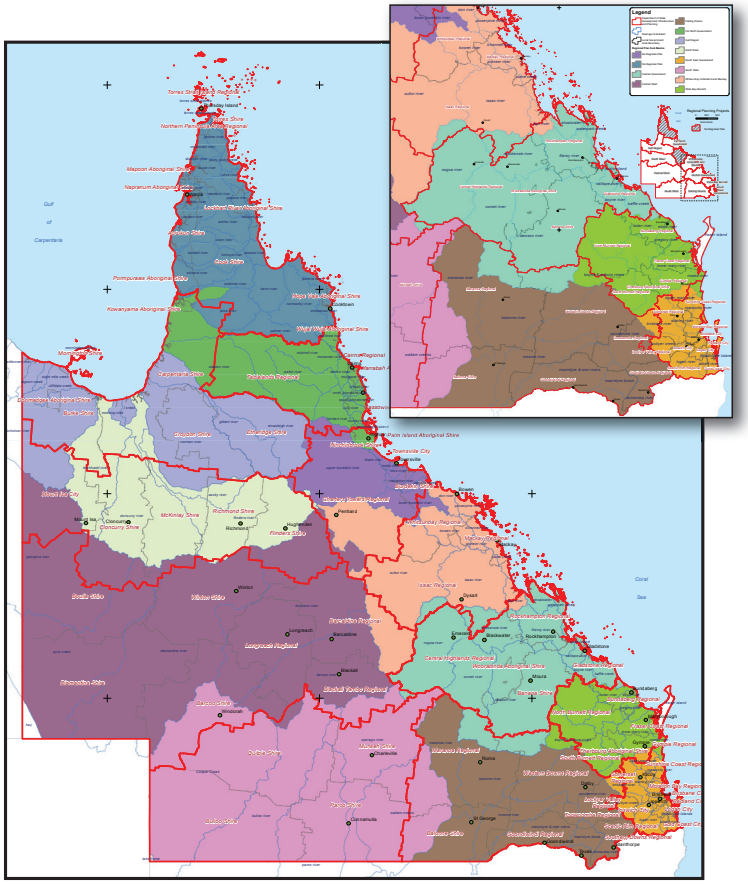


Figure 7: Regional Planning Committees (RPC) allow local governments to collaborate (in association with the State) to deal with floodplain management at the sub-basin level. 70% of sub-basins fall wholly within one RPC.

The State-endorsed position on responsibility for flood mapping is that such responsibility should vest at the local level, however there is a significant role for Regional Planning Committees (RPCs) to oversee and coordinate floodplain management at the sub-basin level, particularly through the regional planning process. By their nature, RPCs involve a partnership between the State and Councils in delivering regional outcomes that are usually articulated through the relevent Regional Plan for the RPC area - **Schedule 1** provides the list of Queensland's sub-basins and their corresponding RPCs. The extent of correlation between RPC boundaries and sub-basin boundaries is great; approximately 70% of all sub-basins fall within one RPC (see **Figure 7** above). In addition, a further 20% (approximately) of sub-basins lie within two RPC areas. Collaboration between the two relevant RPCs for the management of that sub-basin will ensure that consistent outcomes for these sub-basins can also be achieved.

There is a strong nexus between the RPC level of collaboration and floodplain management, given the existing role of regional planning instruments in driving regional settlement and development outcomes. Over three-quarters of the State is covered by statutory regional plans, with additional regional planning processes underway in some other areas. In particular, the regional planning process may assist the delivery of consistent and coordinated policy responses and land use/development controls across the floodplain.

The role of regional natural resource management (NRM) plans is also relevant to the sub-basin wide approach to floodplain management. NRM bodies offer practical means of improving landscape and environmental resilience through various plans, guidelines and programs that are of significant value in floodplain management. Also, activities outside the floodplain can have an effect on downstream areas when runoff or flooding occurs that need consideration on a catchment-wide basis. These matters, usually captured through the NRM plans, are useful in informing the sub-basin wide approach to floodplain management.

Hazard vs risk

In understanding how floodplain management can be addressed through land use planning, it is important to note the distinction between the terms 'hazard' and 'risk'. These terms are often used interchangeably in both common and technical language, when in fact they describe separate but related matters. The difference from a planning perspective is critical, as 'hazard' relates principally to the nature of the event itself, while 'risk' relates to the possible impacts on people, property, infrastructure and the environment when that event occurs.

In terms of flood hazard, the definition of what constitutes the various levels of 'hazard' is provided in national and State-specific floodplain management literature such as *Floodplain Management in Australia*. What defines a level of flood 'risk' involves an evaluation of the consequence of a flood of a certain likelihood on a community.

Land use planners in particular must be very cognisant of the risk of a hazard, particularly when balancing competing development outcomes through strategic planning and development assessment. This is discussed further with particular reference to land use planning in **Section 3 - Implementation**.

In simple terms, a hazard will exist whether or not it poses a risk. A risk cannot exist without the presence of the hazard, and the other key elements of people, property, infrastructure and the environment. The way in which these key elements are affected by or respond to the hazard gives an indication of the extent of risk posed by the hazard.

In practical terms, a high hazard may indeed be high risk. It is also possible for a significant hazard to exist, but with little risk. **Figure 8** below demonstrates this difference. Both floodplains below are subject to the same flood event, and therefore the same extent of flood hazard. However, the first floodplain is a highly urban one, whereas the second floodplain is one where rural activities dominate. The risk to life, property and infrastructure is obviously greater in the urban example, given many more people and properties would be affected by the hazard (and those persons may also be more vulnerable and less resilient to flood than their rural counterparts). The risk to life and property in the rural example is lower, for the same reasons – not as many people and properties are likely to be affected.

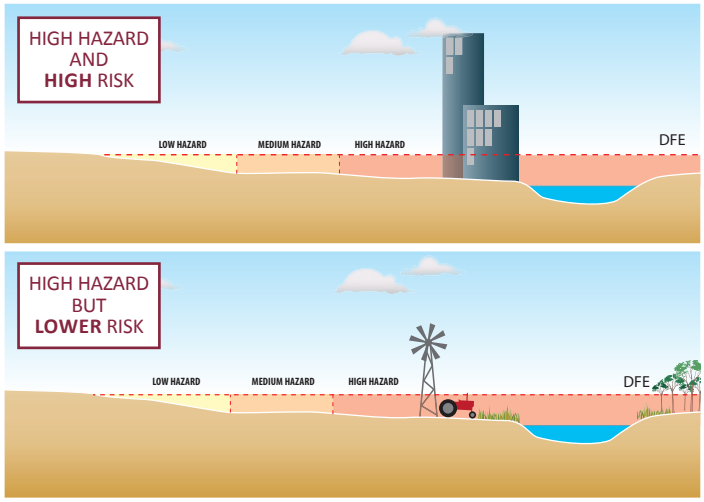


Figure 8: The difference between flood hazard and risk. The flood hazard is depicted here is the same in each example, however the risk will change depending on the land use exposed to that hazard.

Hazard maps are important for planning development and for policy development.

Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century, Jha, Bloch, Lamond p28

The flood risk equation

The Standing Committee for Agriculture and Resource Management (SCARM) describes floodplain risk management as a formal means of identifying and managing the existing, future and residual risks of flooding[1]. It is a cornerstone of floodplain management. Specifically, existing floodplain management practice[2] describes risk as a relationship between Likelihood and Consequence.

Figure 9: The flood risk equation

Likelihood is the probability of occurrence of a specific flood event, or range of events occurring, whereas consequence is an evaluation of what is affected by the event(s) and how.

An acceptable likelihood for planning and building purposes is usually defined as a Defined Flood Event (DFE), such as the 1% Annual Exceedance Probability (AEP). However, for planners, an understanding of the consequence of that event, and the range of flood events that also may occur, is paramount.

The element of consequence requires an understanding of flood behaviour (hazard) and the exposure, vulnerability and tolerability of people, property and infrastructure to a flood of that likelihood. The factors which may be relevant to determining the hazard associated with flooding, and those factors which may influence the consequences for life, buildings and infrastructure potentially affected by flooding, are specified in **Table 1** below.

Flood Hazard		Urban & Social Impacts
Depth of inundation Flood velocities Duration of Inundation Rates of Rise of floodwaters Water Volume Warning times Evacuation capabilities		Risks to life Damage to buildings/ infrastructure and contents Restoration capability/ resilience of built form Community vulnerability and resilience to economic and social impacts Community response to risk

Table 1 - The factors contributing to flood hazard and the urban and social impacts of Consequence [3]

Regardless of a community's acceptance of flood risk, people should not become complacent about the potential flood risk to themselves or their property.

1 *Floodplain Management in Australia, pg 14*
2 *Statement of Paul Grech, (October 2011), Report to Queensland Floods Commission of Inquiry Addressing Town Planning Issues, pg 7*
3 *Derived from Statement of Paul Grech (October 2011) Report to Queensland Floods Commission of Inquiry Addressing Town Planning Issues, pg 8, and SCARM Report 7,3 and NSW Floodplain Development Manual*

Consequence – the key component of flood risk

Quantifying consequence involves an evaluation of the interplay between three other key elements – Exposure, Vulnerability and Tolerability (refer to **Figure 10**). These three elements are the key considerations in making balanced development decisions in floodplains, whereby the flood hazard is understood and then evaluated in the context of competing planning interests and community preferences.

Planners need to understand that floodplains are complex. Floods are dynamic and no two floods are the same or have the same impact.

Figure 10: The key elements that make up the consequence component of the flood risk equation.

From a land use planning perspective, consequence is therefore understood through a planning evaluation – refer to **Section 3 - Implementation**. The differing consequences of flood are illustrated through the examples of Condamine and Dalby in **Figures 11 - 13** at right. In this example, the different floodplain characteristics of the Condamine River (Condamine) and the Myall Creek (Dalby) at these locations are evident. The Myall is a smaller tributary of the Condamine, though it flows through the larger town of Dalby (population approximately 12,000). While the town of Condamine is much smaller than Dalby (population approximately 400), the Condamine River at that point is much larger than the Myall.

A historical review of the Condamine River has shown that over time it rises significantly higher (and more often) than the Myall in times of flood. While this in itself indicates differing levels of hazard, the presence of differing human settlements, population levels and places of economic importance in these floodplains means that the consequences of these floods require different consideration.

The relationship of the flood height and the general height of each settlement is indicated through **Figure 13**. It can be seen that the consequence of flood in Condamine is naturally higher than in Dalby; generally speaking, the height of floodwater in the older parts of Dalby may only reach around 1m during times of flood. This height of floodwater may not be so great as to preclude development given that dwellings can be elevated (using the 'Queenslander' style of construction) and commercial properties can be constructed to be resilient to that hazard. However, in Condamine the levels of floodwater may be so great as to preclude a built form response to the hazard. Another relevant consideration is the number of properties that may be at risk in these two towns.

Assigning a specific likelihood of these events (such as identifying a 1% AEP), from a planning perspective, is of lesser importance than the consequence of these floods. The reality is that significant floods, whether or not they occur frequently, may have significant impacts for the use of flood-prone land and planners need to be aware of this. The different consequences of floods on these two floodplains therefore requires careful consideration in the land use planning process.

A `one size fits all´ approach to floodplain management is therefore not possible.

While [the 1% AEP] may be a useful general approach, it is important that policy makers should review this risk level and adopt a suitable flood probability based on an acceptable risk for different locations, land-use and infrastructure in the floodplain.

Comments on Queensland Floods Commission of Inquiry Final Report, Engineers Australia, p8

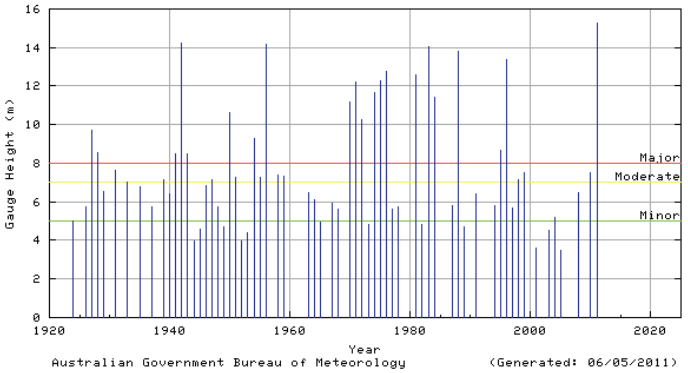


Figure 11: Highest annual flood peaks – Condamine River at Condamine *Source: BoM*

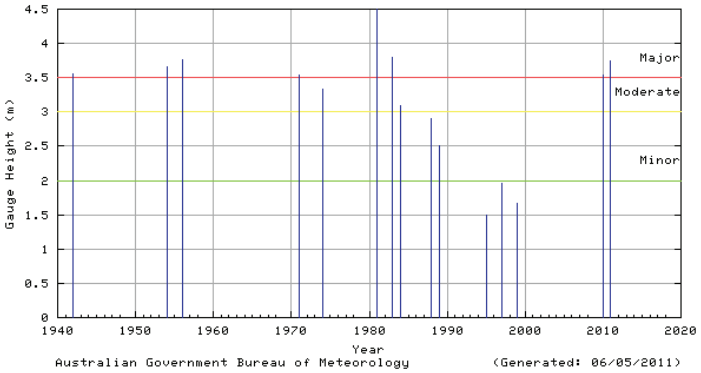


Figure 12: Highest annual flood peaks – Myall Creek at Dalby *Source: BoM*

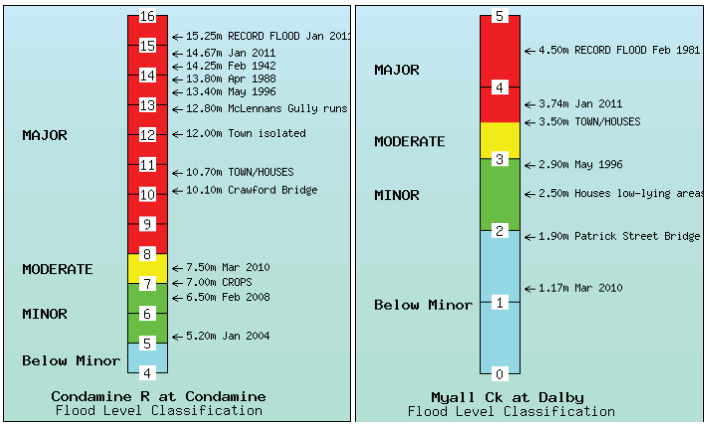


Figure 13: Flood levels at the gauges in Condamine and Dalby *Source: BoM*

What should planners know about flood?

Floods are complex hazards

In undertaking land use planning in floodplains, the approach taken within each floodplain needs to respond to the unique characteristics and conditions of that floodplain. The land uses appropriate for one floodplain may not be appropriate for another. It is critical to understand both the flood hazard and the broader considerations of economic, environmental and social impact when making land use decisions within the floodplain.

Land use planners also must be aware of, and sensitive to, the realities of development (particularly the constraints of existing, well-established communities) that exist within areas of flood risk. Often significant parts of a town or city, even the central business districts and higher density residential areas, are within the 1% AEP. In Queensland, we face the reality of our towns having historically developed over time in these locations, and we must tailor our land use responses to this existing flood risk. It is not practical or economic to sterilise or relocate all of these areas, nor would this be desirable from a community perspective given that many of these locations are chosen by members of the public as desirable places to live from an amenity perspective. The ultimate response to flood hazard through the land use planning system must balance these economic and social considerations with the reality of the hazard and the community's acceptance of the risk it presents.

1% AEP is not the only aspect of flood to consider

Currently the 1% AEP event is designated as having an 'acceptable risk' for planning purposes nearly everywhere in Australia regardless of the potential consequences of the flood. However, good planning needs to consider more than just the 1% AEP flood.

In particular, good land use planning should consider the possibility of a range of floods across the full floodplain extent, and also give greater attention to the consequences of flood. To date, the likelihood or probability part of the risk equation (usually identified as a DFE in planning policy documents) has been generally well understood by planners throughout Australia, principally because of the focus on the AEP measure. The concept of the AEP measure is, by its definition, a probability-based approach to identifying a flood event.

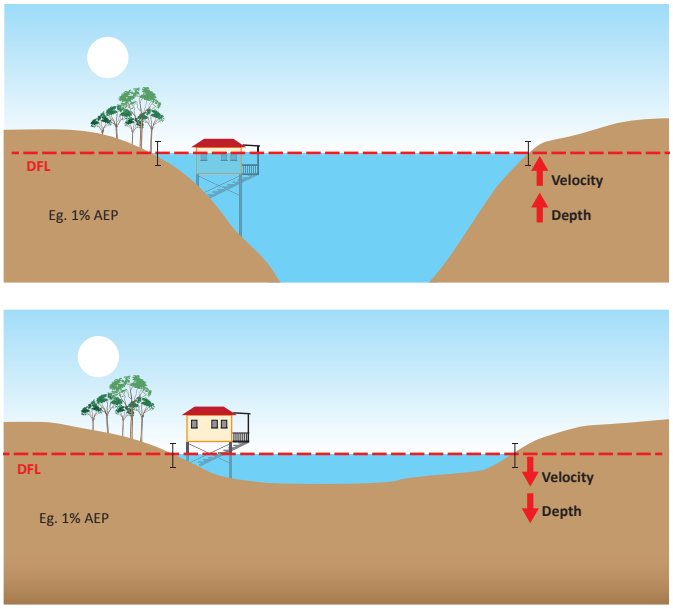


Figure 14: A 1% AEP flood for one floodplain may be significant due to the velocity and depth of that flood, while on another floodplain, the impact for that same flood event may be significantly less. The land use and built form responses to each situation should naturally be different.

Consequence is a key element of floodplain risk management that requires further consideration by land use planners in ensuring that all facets of the complex relationship between floods and human settlements are addressed. This is not as well understood by planners, given the complex array of factors that are used to determine it. The Implementation section of this Guideline promotes the consideration of consequence in land use planning through the planning evaluation process.

Community attitude to risk

A community's acceptance of flood risk will frame the local land use responses used to address risk within a local government area. For example, a North Queensland community's acceptance of flood risk (given the nearly annual incidence in some places of flooding, storm tide or other inundation) may be greater than that of another community that has little experience of significant flooding events.

In addition, a community's acceptance of risk is likely to be different in new urban areas when compared with existing areas. There is the basic expectation in many communities that new development areas should avoid areas of significant hazards. Risk acceptance in existing areas that have developed over time adjacent to waterways and that have weathered previous flooding events is likely to be higher. In these places the focus on building design, and resilience and emergency management is paramount.

The importance of strategic planning

To date in Queensland, assessment of flood risk in the land use planning process has generally been addressed through the development assessment process.

Ideally though, land use provisions including strategic frameworks and zoning plans tailored to the unique conditions of the floodplain would be included in all planning schemes relevant to that sub-basin. In particular, there is a key role for the strategic framework component of new Queensland Planning Provision (QPP) compliant planning schemes to clearly articulate the community's vision and response to flood risk, and to set land use policy and planning scheme provisions to meet that vision.

Clear planning scheme provisions are likely to reduce the reliance upon applicants to undertake site-specific flooding investigations, and the obligation of councils to make development assessment decisions that may not be uniformly consistent.

Towns and cities have grown and expanded into floodplain areas without consideration of the flood risks involved. Land use zoning and its effective enforcement is a key management tool in trying to prevent such development. Where pressure on land is too great for this, then there is a need to design and construct buildings so that they are able to cope with flood risks.

Cities and Flooding: A Guide to Integrated Urban Flood risk Management for the 21st Century, Jha, Bloch, Lamond p198

The key for planners is ensuring that the right planning tools are available to confidently promote or discourage land uses in existing urban areas relative to the present flood hazard. It is also to set a strong strategic direction for development in future urban broadhectare areas that is appropriate to minimise risk of flood and improve resilience in those new areas. The 'Place Model' principles from the Next Generation Planning Handbook (discussed on page 8) can be used to tailor land use planning to the unique characteristics of a floodplain.

Integrating strategic planning and infrastructure delivery

A key component of a Queensland Planning Provisions (QPP) compliant planning scheme is its priority infrastructure plan (PIP). The PIP sets out the local government's intentions for the provision of trunk infrastructure within the local government area. Guiding and managing the development of infrastructure that is resilient to natural hazards should be a key function of a PIP.

Consideration of natural hazards when planning for infrastructure is important. Designing and constructing infrastructure to withstand the hazard carries its own increased cost over and above that for infrastructure provided to areas of low or no hazard. In some cases repairing or replacing the infrastructure as a result of a hazard event will be unavoidable (such as the overriding need to provide infrastructure in that location) or unforeseeable (such as a severe storm), however it does increase the costs to government over and above normal routine maintenance and replacement programs, and this should be considered during the decision making process. This cost implication may prove at minimum a nuisance through an increase in maintenance costs, or it may become untenable over time if hazard events affecting the infrastructure become more frequent or severe. Both are relevant considerations when identifying areas for future settlement growth, and in planning to augment existing infrastructure in hazard areas.

The PIP must coordinate infrastructure provision with the way in which settlement growth is expected to occur over time in order to enhance the resilience of both the infrastructure and the community it supports. Planning schemes can account for the resilience of infrastructure in their PIPs by:

Planners need to know:

- **That floods are complex hazards with complex relationships with our towns and cities, which require fit-for-purpose solutions**
- **That floodplains don't stop at local government boundaries**
- **That the 1% AEP floodline does not mark the boundary between safety and hazard, and that taking a whole-of-sub-basin approach to planning is more appropriate**
- **That flood risk is comprised of consequence in addition to likelihood or probability, and that consequence is arguably more important from a land use planning perspective**
- **The community's attitude to risk in formulating land use strategies that respond to flood hazard**
- **The importance of strategic planning tools in setting development parameters in floodplains, and not rely only on the development assessment process**

1. ensuring infrastructure planning and strategic land use planning are well-coordinated, where both settlement decisions and the infrastructure planned for it consider the impact of natural hazards;
2. ensuring that where the strategic framework and zoning plan envisage future urban growth, the priority infrastructure area (PIA) and plans reflect those intentions for future growth;
3. identifying programs of mitigation work in the PIP that reduce the impact of natural hazards (for example, flood mitigation works); and
4. identifying priority areas for infrastructure decommissioning in instances where planned retreat from a particular location has been determined (such as those areas at intolerable risk of natural hazard).

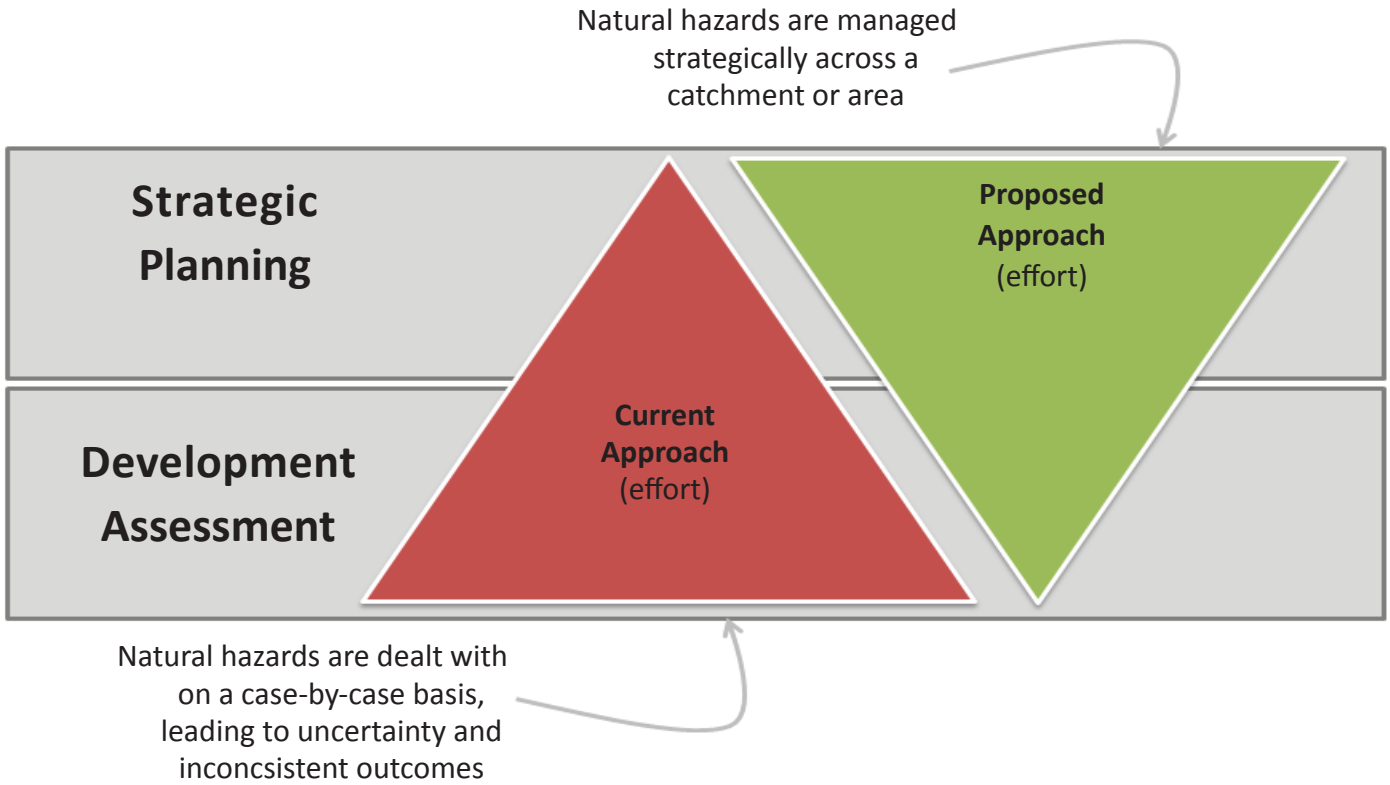


Figure 15: Changing the approach from development assessment to strategic planning

2. Analysis

The fit-for-purpose floodplain management system

Choosing the right approach for the right circumstances

This Guideline advocates a fit-for-purpose approach to floodplain management. This involves presenting both the conventional, comprehensive approach and an alternative approach for those Councils who may not have the capacity or resources to undertake a comprehensive floodplain management process.

The best practice principle for floodplain management is that a comprehensive planning process to develop a floodplain management plan is the most effective and equitable way to realise the multiple objectives of floodplain management[1]. In summary, the floodplain management process typically encompasses three sequential stages[2]:

1. **Flood Study** – a technical study to determine the nature and extent of flooding
2. **Floodplain Risk Management Study (FRMS)**– an options assessment which evaluates management measures and options for the floodplain in respect to both existing and future development
3. **Floodplain Management Plan (FMP)** – formal adoption of a plan of management for the floodplain

The floodplain management process described above is a comprehensive and robust process, usually taking around two to three years and involving significant community engagement and resources (refer to **Figure 3** on Page 3). The process results in a range of management measures, including emergency planning and management, structural works, community awareness, land use planning and building controls.

This comprehensive approach will be appropriate for use by Councils who are in the position to undertake such an investigation, such as those who have significant population and/or development pressures, significant flood hazard and/or the resources and capacity to prepare them. The comprehensive floodplain management process is the preferred approach for those councils who are in this situation.

If the comprehensive approach is adopted, it is imperative that the timeframe and resources required to complete a comprehensive process are factored into the planning scheme preparation process to ensure that a disconnect does not occur. This may mean starting a comprehensive floodplain management process well in advance of planning scheme preparation. However, it is not always possible for a comprehensive floodplain management process to be undertaken for a sub-basin, for the following reasons:

- The floodplain management process usually takes 2-3 years during which time a planning scheme may need to be prepared for a local government area. This may be the case for Queensland local governments now in the process of preparing their new planning schemes;
- Councils may not have the time, capacity or resources to undertake the full process, particularly where there are other competing local priorities; and
- A comprehensive approach may not be necessary or justifiable, particularly for councils with limited population and/or growth.

While these are challenges to the completion of a comprehensive floodplain management process, this does not mean investigations should not be undertaken in some form. It is important that investigations are still carried out, particularly for land use planning purposes given the need for such investigations to inform planning scheme preparation.

The *State Planning Policy 1/03* (SPP 1/03) Guideline[7] acknowledges the need for a fit-for-purpose solution for flood investigations, noting 'the scope of studies [for the determination of Natural Hazard Management Areas] will vary between local governments, and sometimes between different locations within the same local government area'.

It may not be cost-effective and practicable to conduct these studies for areas that are not subject to significant development pressures, especially in small and/or low-growth local governments. The SPP 1/03 Guideline goes on to note that the variation in scope should depend on:

- The size and distribution of the population;
- The degree of risk to people, property, economic activity and the environment posed by development in areas affected by natural hazards;
- The availability or difficulty of obtaining and analysing information; and
- The capacities and resources of local government.

The current drive to prepare new QPP-compliant planning schemes pursuant to the SPA, when very few councils have undertaken a recent floodplain management plan process, highlights the need to consider alternative processes for those councils who may not need to undertake the comprehensive approach. These alternative approaches are also relevant for those councils whose new scheme (that may be at an advanced stage of development) will not correlate with flood investigation outcomes.

5 *SCARM pg xv*
6 *Mark Babister, WMA Water, Natural Disaster Insurance Review August 2011*
7 ***State Planning Policy 1/03 Guideline section 7.2***

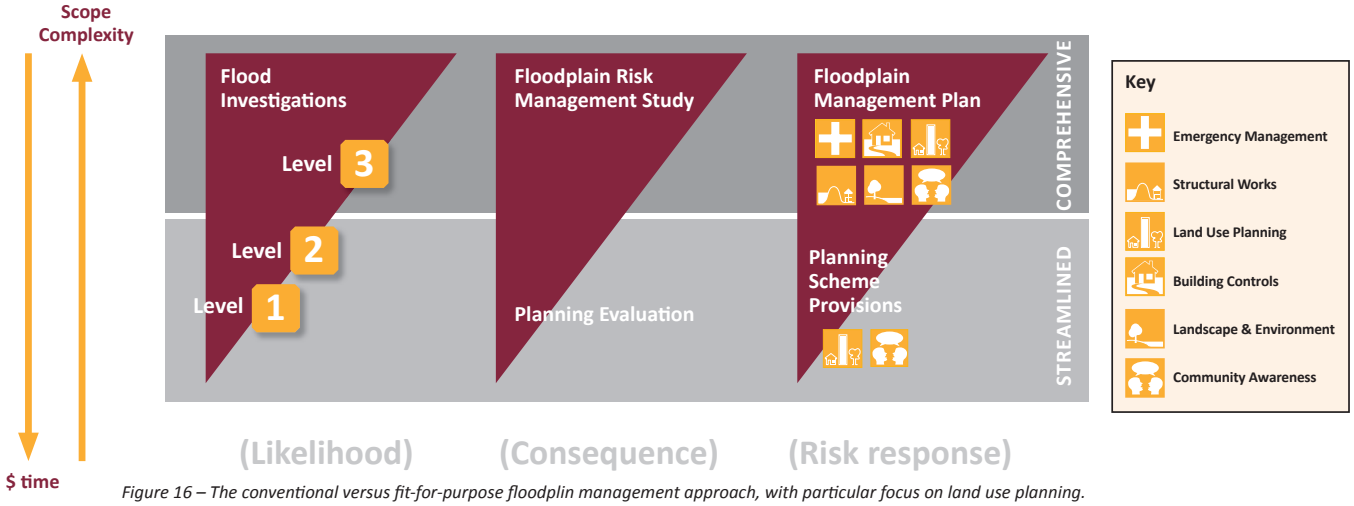


Figure 16 – The conventional versus fit-for-purpose floodplin management approach, with particular focus on land use planning.

The alternative approach

The key principles, intent and general approach of floodplain management should still be reflected in new planning schemes, given land use planning is a key element of the integrated floodplain management approach. An alternative approach, which tailors the existing floodplain management process for a specific land use purpose, involves:

- selecting a flood investigation(s) that is fit-for-purpose
- undertaking a planning evaluation to identify land uses compatible with the characteristics of the floodplain and other management measures (e.g. structural controls)
- developing land use transition strategies for at-risk existing areas; and
- preparing appropriate land use planning provisions within new planning schemes that support the transition strategies.

Flood investigations

Councils and the public may have viewed flood investigations in the past as complex and expensive, particularly in the context of drought, low rate base or other competing priorities. However, there are multiple methodologies for undertaking flood investigations that need not be costly or time/resource consuming. These different levels of flood investigation are discussed later in this section.

The planning evaluation

The FRMS is the conventional approach in which outputs of a flood study are investigated having regard to the urban and social impacts described in **Table 1**. The methodology for undertaking this type of study is well documented through national guidance and other floodplain management literature.

An alternative approach involves undertaking a planning evaluation of the issues affecting development in the floodplain.

These issues may include:

- selection of one or more defined flood events to plan for;
- the flood hazard of that event(s) identified through the flood investigation;
- the possible extent of property/infrastructure damage and risk to life from that hazard;
- the community's expectations of flood protection; and
- the impact of any existing or proposed structural controls or riparian management programmes.

The planning evaluation therefore investigates the consequence(s) of flooding, from a land use planning perspective. **Section 3 - Implementation** gives further guidance on the content and process for undertaking a planning evaluation.

Focusing on land use planning

The Floodplain Management Plan usually comprises a coordinated mix of measures that address the existing, future and residual flood problems, including land use planning. Through the planning evaluation approach described above, appropriate land use controls can be identified and tailored specifically to address the development issues affecting the floodplain without undertaking a comprehensive Floodplain Management Plan. The Implementation section of this Guideline gives further guidance on possible land use strategies and planning scheme responses to address these strategies.

8 SCARM Report 73 – Floodplain Management in Australia pg 16

Does every floodplain need to undergo a comprehensive risk management process?

"Not all parts of Queensland need a comprehensive flood study."

Queensland Floods Commission of Inquiry Final Report, March 2012, p54

While the comprehensive floodplain risk management process is the preferred approach, it may not be necessary for every sub-basin in Queensland – particularly in areas where risk to life or property is low or where there are limited development pressures.

The alternative approach may be appropriate for sub-basins where resources are limited and development pressures/ population are low, particularly those councils who are in the process of preparing their future planning scheme.

The fit-for-purpose floodplain management system focuses on:

1. Floodplain investigations that are appropriate for the population, development pressures and resources available
2. A graduated approach to the evaluation of the flooding investigations, which may involve floodplain risk management studies or more qualitative planning evaluations to develop land use strategies
3. Tailor-made land use provisions developed from the selected land use strategies

Flood investigation guidance

A graduated approach

The floodplain mapping prepared in Part 1 presented a first step in the maturity level of floodplain mapping for those parts of the State without flood mapping. Where detailed flood information is not already available, this mapping can be further refined through a range of flood investigations that identify the extent, occurrence, depth and velocity of floodwaters as required in a graduated way, relative to development pressures and population (see **Figure 17** at right). This section offers a range of flood investigation options (Levels 1 through 3) that accord with this graduation in mapping detail and complexity.

This section also presents a suggested governance framework that can progress the graduated approach to undertaking flood investigations, and outlines the purposes and characteristics of each type of investigation. It also provides guidance on how to select the approach (or combining a range of approaches) appropriate for a floodplain relative to a range of practical considerations. Finally, it provides more detailed guidance on the mapping options.

Flood investigation governance

A sub-basin wide approach is considered the most appropriate way to ensure that there is consistency in the delivery of flood investigations across the floodplain. As noted in the Understanding section of this Guideline, the Regional Planning Committee (RPC) may be best placed to oversee and guide the investigations and associated consultation with the community, industry and government agencies. This is particularly the case given the RPC framework is an existing statutory mechanism under SPA and there are strong linkages between RPCs and the regional planning process.

One possible process to developing a sub-basin wide approach to flood investigations is:

1. Regional Planning Committee to identify one member responsible for delivery of the flood investigation program – this member may also be advised by a Flood Advisory Panel to provide expert guidance to the RPC.
2. The member (assisted by the Flood Advisory Panel) to oversee:
    a. the initial review of exposure to flooding in the sub basin(s) and the identification of investigation areas;
    b. determine the type of flood investigation to be undertaken in the investigation areas throughout the sub basin;
    c. delivery and coordination of the respective investigations and studies in the sub basin; and
    d. the community engagement and consultation processes required to inform the community of flood risk and to ensure there is informed input to the flood investigations.
3. Relevant councils in the Sub-basin applying planning responses to identified hazard areas through their future planning schemes.

It is envisaged that the RPC would be responsible for prioritisation, coordination and management of the flood investigations. Monitoring and verification responsibilities could lie with the State. The Advisory Group could be a multi-disciplinary panel of experts (sourced from within councils, or assisted by industry) to ensure the floodplain management process is robust and fit-for-purpose.

The above process is indicative and may be reviewed as part of the Government's planning reform agenda.

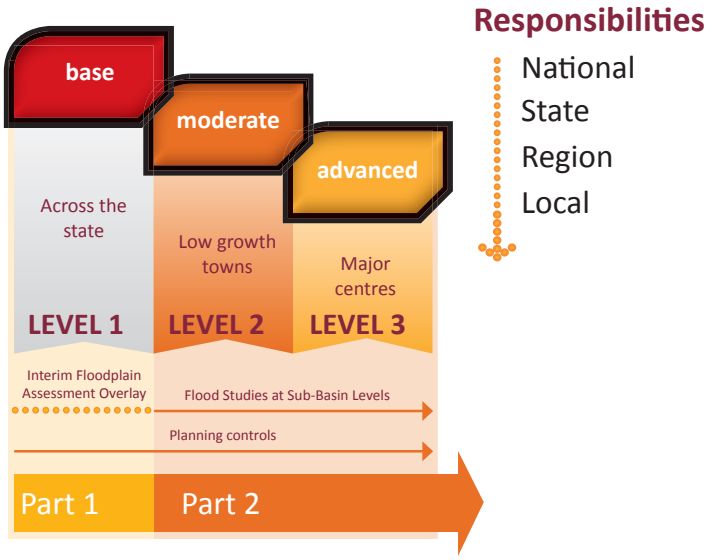


Figure 17: The different levels of flood investigation in the fit-for-purpose approach.

Flood gauges on the Balonne River at St George, early 2012. *Source: QldRA*

As part of the Queensland Government's response to the QFCoI and specifically recommendation 2.5, the Authority (with support from the Department of Science, Information Technology, Innovation and the Arts), has committed to undertaking Level 2 flood investigations for up to 100 flood prone towns across Queensland by January 2013. When RPCs are reviewing the towns within their jurisdiction for flood exposure, please contact the Authority to check whether flood investigations for these towns have already been completed. Please refer to Section 4 – Delivery of this Guideline for further information.

Options for flood investigations

Three options for flood investigations have been identified that offer flooding information at increasingly greater levels of detail. Naturally, the methodology for each of these levels is also different, and increases in complexity. The objective for each investigation is to define the flood behaviour with an increasing level of detail and clarity. The flood investigation options are:

- **Flood Investigation Level 1 (FI1)** – the methodology already identified in Part 1. It provides details on the broad extent of floodplains and is suitable for regional landscapes that have low intensity rural production and where flood impacts and population are low, or as an interim solution.
- F**lood Investigation Level 2 (FI2)** – increases the level of detail so that general flood hazard areas and stream velocities can be identified. The approach relies on local knowledge, historic information, and a basic analysis of stream flow. As such this approach can be applied to towns when the anticipated impact of floods is generally low.
- **Flood Investigation Level 3 (FI3)** – provides the greatest level of certainty, and is commonly termed a 'flood study'. This comprehensive study approach uses more detailed hydrologic and hydraulic modelling and analysis at a more local geographic level. This approach suits situations where the impact or consequence of flooding is likely to be significant, such as a medium to high level of flooding impact which would necessitate a detailed study.

These levels of flood investigation can be used to meet the flood mapping hierarchy set out by the QFCoI in its recommendations 2.13 and 2.14:

1. Map with zones of risk derived from flood likelihood & behaviour

2. Map showing flood likelihoods (at least three)

3. Historic Flood Map with flood frequency analysis

4. Historic Flood Map without flood frequency analysis

5. QldRA Interim Floodplain Asseement (IFAO) Overlay Mapping (to identify areas requiring further studies, or as DA trigger)

Refer to **Section 4 – Delivery** of this Guideline for further information.

Level	Key Inputs	Methodology	Key Output	Cost & Delivery
Flood Investigation Level 1	Interim Floodplain Assessment Overlay provided through the Part 1 Guideline, verified with the addition of local information	Take available mapping and refine using historic data (e.g. of specific event) or anecdotal knowledge to confirm extent of floodable area Refer to Part 1 Guideline for further information	Map showing areas potentially subject to flooding	Low cost Suitably competent person (e.g. Shire Engineer or Planner, or Surveyor/GIS Operator)
Flood Investigation Level 2 a) Validated Model b) Validated GIS c) Un-validated GIS Refer to Table 4 and Figure 20 for more detailed information	LiDAR-derived Digital Elevation Model (minimum 0.25m contour intervals) Aerial imagery of subject area and aerial imagery of historic events (if available) Stream flow, heights, flood slope and velocity information (if available) Flood frequency analysis using computer model or Government assistance	Use available inputs and historic knowledge to identify historic flood levels with probabilities determined from flood frequency analysis. Use local knowledge to estimate flood velocities (for validated/ unvalidated GIS only) FI2a and 2b mapping validated against information on historic event (such as aerial imagery or recorded GPS points of flood extent) Refine initial flood hazard area through local verification	Map(s) showing flood hazard areas based on a range of flood lines and estimated velocities Estimate of the AEP for each flood line selected	Low to medium cost Suitably competent person (e.g. GIS Operator or consultant)
Flood Investigation Level 3	Builds on material collected for a Flood Investigation Level 2 Topographic information of better than 0.3 metres vertically with a grid size of typically 1-10 metres, (May be larger depending on area of interest and level of development) More detail may be required for specific areas of interest	Calibrated hydrological models are used to estimate design flood flows. A calibrated hydraulic model determines flood characteristics. Climate change is usually incorporated	Maps showing the extent of various design flood flows (at a range of AEPs), and hazard areas based on depths and velocities Computer model produced	Medium to high cost Generally highly trained council engineering staff or consultant required to undertake Level 3 investigation

Table 2: A summary of the inputs, methodology and key outputs for each flood investigation.

Selecting the appropriate flood investigation

Table 3 gives initial guidance on the minimum type of investigation that may be appropriate for the sub-basin. Most sub-basins will naturally include some or all of the areas identified in the table below.

Councils, and where relevant, their RPCs, may decide on what best describes the exposure to flooding in specific parts of their area and the level of flood investigation required in recognition of the costs and benefits of undertaking more detailed investigations. The criteria for exposure includes geographic scale, population, property and infrastructure exposed to flooding and the demand for new development, economic drivers and inherent community resilience.

The step by step guidance outlined across pages 18 and 19 below further demonstrates how a particular investigation (or number of investigations, if multiple investigation areas are within the floodplain area) may be selected.

Having determined a level of flood investigation given the likely exposure to flooding for each investigation area using **Table 3**, this level (or levels) of flood investigation should be tested against the data needs, advantages and disadvantages, scale and cost considerations. This testing will confirm whether the investigation selected is the most appropriate for the circumstances.

Indicative Terms of Reference (ToR) for a flood investigation Level 3 are available in the supporting technical document to this Guideline. Councils and/or RPCs may wish to use these ToR as a ready-made template in preparing a detailed scope of work for an investigation, or for preparing a tender document for consultant input (if required).

Flood investigations – key considerations

As a general guide, Level 1 mapping may be appropriate (with local verification) for regional landscape and rural areas, and low-density and/or very low growth areas where additional flood investigations such as Level 2 or 3 may not be required. Using Level 1 mapping in these areas will ensure that a baseline, holistic picture of the floodplain throughout the sub-basin can be obtained.

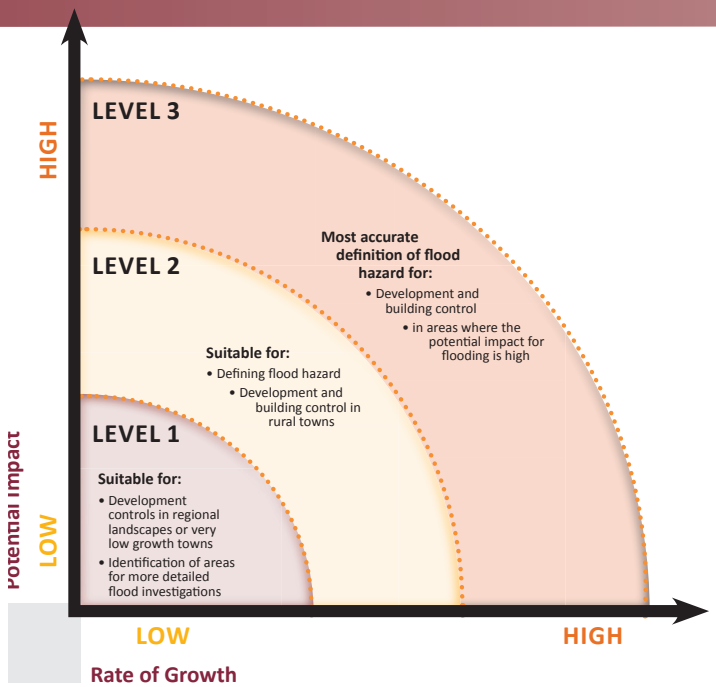


Figure 18 – The three levels of flood investigation

More commonly, Level 2 or Level 3 flood investigations may already be available for the key town(s) within a local government area, but Councils may have no further flood information for any other area, such as areas between towns. In this instance, Councils are encouraged to integrate the Level 2/3 work within the key town(s) with the existing Level 1 mapping between those towns to ensure that all parts of the floodplain within their jurisdiction are mapped.

Alternatively, the Level 1 mapping may be used as a general benchmark to inform further detailed investigation (such as a Level 2 investigation, or if needed in some areas, a Level 3 investigation) of the floodplain.

Investigation Area / Categories of Exposure	Base Mapping	Expected Rate of Growth			Community / Industry resilience	
		None/Very Low	Low	Medium - High	Resilient	Vulnerable
Regional landscape / low intensity rural production	Level 1	Level 1			Level 1	Level 2
Intensive rural production including large scale irrigation development	Level 1	Level 1			Level 2	Level 2
			Level 2	Level 2	Level 2	Level 3
Low density rural townships and settlements (e.g. discrete settlements less than 5000 persons)	Level 1	Level 1			Level 1	Level 2
			Level 2		Level 2	Level 3
				Level 3	Level 3	Level 3
Urban Areas (e.g. discrete settlements greater than 5000 persons)	Level 1	Level 2	Level 3			
Industry or Infrastructure of Regional or State significance (e.g. mines, state development areas)	Level 1	Level 3				

Table 3 – Selecting the appropriate flood investigation. The table is to be read from left to right. When a certain level of investigation is reached, another criterion cannot suggest a lower investigation is appropriate. The indicative guidance above is the minimum level of investigation that may be undertaken for the area.

Step 1 – Revise the Interim Floodplain Assessment Overlay as provided through Part 1

- Use local knowledge to update the Level 1 sub-basin map published by the Queensland Reconstruction Authority

Step 2 – Identify Investigation Areas

- Use the revised Level 1 sub-basin map to identify potential investigation areas based on the exposure of life, property and infrastructure located on the floodplain

Step 3 – Initial Determination of Level of Flood Investigation

- For each investigation area consider the rate of growth, ie low, medium or high growth
- Table 3 shows the initial recommended level for flood investigation
- If Flood Investigation Level 3 is shown, for a particular investigation area, then go to step 5

1 → 2 → 3

In terms of the preparation of new planning schemes, it is important to clearly note the outputs of each flood investigation:

- Level 1 mapping is not hazard map, and so information regarding consequence cannot be drawn from it. However it can be used to trigger development controls (such as an Overlay) as described in the Part 1 Guideline. Level 1 mapping will be also useful in identifying areas for further investigation.
- Level 2 will produce a basic flood hazard map and multiple (if required) AEP floodlines, from which a basic understanding of consequence can be drawn. Level 2 can allow the selection of zoning controls for a particular area subject to flood, based on a basic understanding of risk as it relates to planning purposes. It can also allow basic building controls to be set. Level 2 mapping is consistent with the requirements of the QFCoI.
- Level 3 will provide a detailed flood hazard map and multiple AEPs (if required). Level 3 can be used to comprehensively understand the consequence of flood impact and appopriate zoning controls can be selected with a high level of certainty.

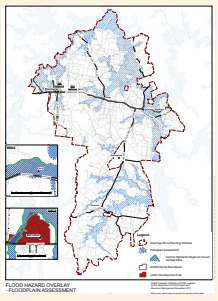
Within their new QPP-compliant planning schemes, unless the whole local government area has been mapped using the advanced techniques of a Level 3 investigation, councils may use a combination of all of the above techniques to prepare flood overlay mapping. Councils are encouraged to use locally-verified Level 1 mapping in the rural and landscape areas between towns, Level 2 investigations in smaller towns (where appropriate), and Level 3 investigations in their larger towns. Where this has been undertaken, councils may take advantage of the suggested zoning controls outlined in **Schedule 5** that have been tailored for use where Level 2 and Level 3 investigations have been undertaken.

Available in late 2012, the Queensland Flood Portal and Database will help address recommendations of the QFCoI that relate to the availability and enhancement of flood information.

Schedule 4 contains a flood hazard definition based on latest guidance from Engineers Australia.

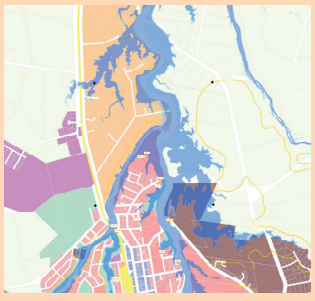
Level 1
BASE
As per Part 1 Guideline

Locally Verified QldRA mapping
+
Flood Level investigations
=
Areas of Inundation + Local flood



Level 2
MODERATE
Mid-level Investigation

Standard Data Inputs
+
Flood Frequency Analysis
=
Basic Hazard Mapping, incl. Extent and Depth (+ velocity) + Ranges of AEPs



Level 3
ADVANCED
Comprehensive Flood Study

Detailed Data Inputs
+
Computer Modelling
=
Detailed Hazard Information, incl. full Hazard Mapping + Ranges of AEPs

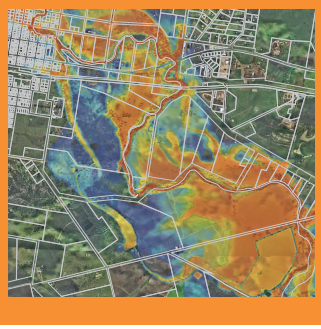


Figure 19: Basic inputs and outputs for each level of flood investigation.

Step 4 – Review Determination of Flood Investigation Level 1 or 2

- Consider the resilience of the community, industry or infrastructure in the investigation area
- If resilience is considered to be strong, then maintain the initial level of investigation. If not, then increase the level of investigation to the next level

Step 5 – Confirm the Level of Investigation

- Consider are the scale of the investigation area, the data needs, the relative complexity of any modelling, the need to able to assess the impact of future development and the relative costs
- Finalise the choice of investigation to provide a cost effective and fit-for-purpose approach to providing the basis for the subsequent planning evaluation and planning responses

4 5

Undertaking a Flood Investigation Level 2

The Level 2 investigation is a suitable tool for lower growth areas in understanding and identifying flood hazard in those areas where an advanced flood investigation is not warranted. There are three categories of Level 2 flood investigation that involve different methodologies and varying resolutions of mapping output. **Table 4** below gives a detailed overview of each approach, including the data inputs required, indicative costs, mapping outputs, accuracy, confidence and suitability.

The methodologies used for undertaking the different Level 2 flood investigations are provided in **Figure 20** on the right.

In undertaking a Level 2 investigation, the intention should be to create as many AEP maps as the data inputs can support, so that the community can understand a broad range of the hazards to which it is subject.

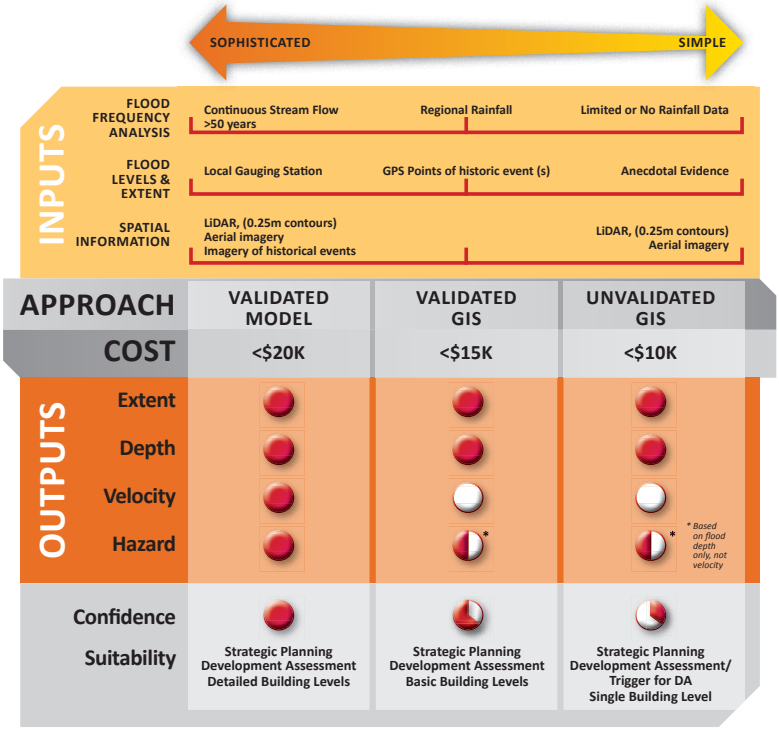


Figure 20: Inputs, approaches and outputs possible from the three types of Level 2 flood investigation.

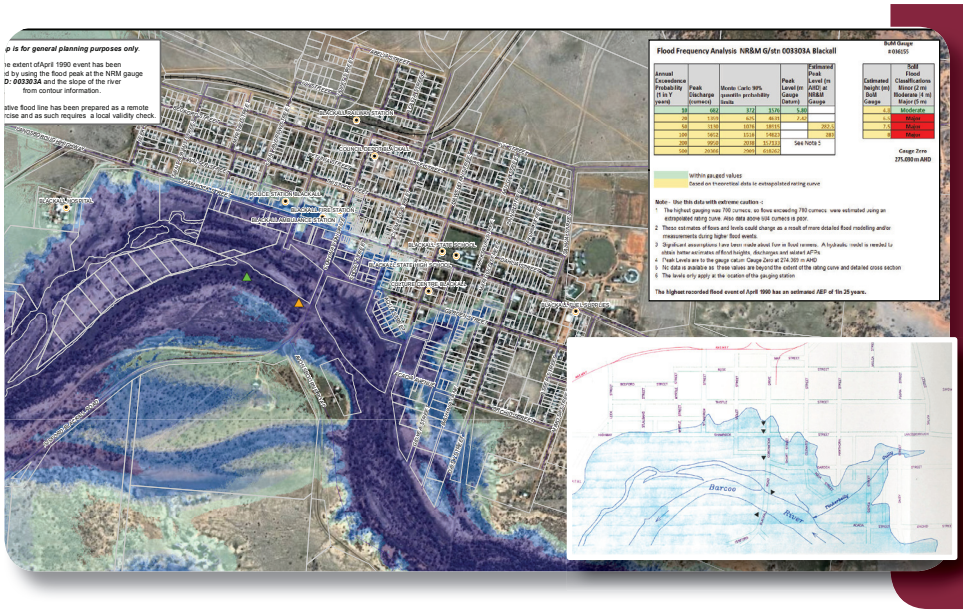
Key steps	Validated Model	Validated GIS	Unvalidated GIS
Produce an FFA	Produce a flood frequency analysis (FFA), including 90% quantile probability limits (use AR&R as a guide).	Produce a flood frequency analysis (FFA), including 90% quantile probability limits(use AR&R as a guide).	Produce a flood frequency analysis (FFA), including 90% quantile probability limits(use AR&R as a guide).
Compile the spatial information	Compile Digital Elevation Model (with 0.25m contours derived from LiDAR capture) and GIS layers (high resolution aerial photography, QldRA level 1 base mapping, planning scheme details, Points of Interest data base, details on historic floods – ideally aerial photography capturing the peak of the highest recorded event, or GPS points / plan of record event).	Compile Digital Elevation Model (with 0.25m contours derived from LiDAR capture) and GIS layers (high resolution aerial photography, QldRA level 1 base mapping, planning scheme details, Points of Interest data base, details on historic floods – ideally aerial photography capturing the peak of the highest recorded event, or GPS points / plan of record event).	Compile Digital Elevation Model (with 0.25m contours derived from LiDAR capture) and GIS layers (high resolution aerial photography, QldRA level 1 base maping, planning scheme details, Points of Interest data base, details on historic floods – anecdotal information).
Hydrology	Develop a hydrograph for a known flood event and for which the spatial extent is available – to simulate the maximum flow for the event.	Identify the level of the "baseline" flood for which sufficient data is available (sources include Bureau of Meteorology, Qld Department of Natural Resources & Mines, SunWater etc). Calculate flood level and floodslope from available information (observed by Hydrographers, estimated from local terrain).	Identify flood level for which sufficient data is available (sources include Bureau of Meteorology, Qld Department of Natural Resources & Mines, SunWater etc). Calculate flood level and floodslope from available information (observed by Hydrographers, estimated from local terrain).
"Modelling" and "validation"	Develop a 1D or 2D hydraulic model (eg HEC-RAS, TUFLOW, MIKEFLOOD etc). Use industry standard Mannings"n" roughness coefficients for broad landuse types a high resolution DEM as the basis for the model – it may be appropriate to use 10m grid cells to manage simulation run times. Validate model against the known spatial extent and any recorded heights of the modelled "baseline" event(s).	Use GIS software to map the extent and depth of the "baseline" flood event. This may include using the software to determine the terrain slope as an indicator of floodslope. The floodslope is applied to a known flood height location (eg an observed height at a gauging station) and intersected with the DEM (typically at a 1 m grid cell) to identify the extent of the event. The extent is validated against the known extent of the events per specific spatial information (maps, GPS points). The modelled extent can be adjusted as necessary to achieve the best alignment with the known extent.	Use GIS software to map the extent and depth of the "baseline" flood event. This may include using the software to determine the terrain slope as an indicator of floodslope. The floodslope is applied to a known flood height location (eg an observed height at a gauging station) and intersected with the DEM (typically at a 1 m grid cell) to identify the extent of the event. The extent is reviewed against anecdotal information and adjusted according to the validity of the anecdotal information.
Products - hazard maps	Use the "validated" model to produce hazard maps (depth and velocity) for the "baseline" event and for a range of estimated AEPs.	Use the "validated" GIS mapping to produce hazard maps (depth only) for the "baseline" event and for a range of estimated AEPs. The identified flood surface for the 'baseline" is applied to the gauge levels as required. Note that subsequent identification of backwater and noflow areas can be used to produce a hazard map (depth and velocity).	Use the "unvalidated" GIS mapping to produce hazard maps (depth only) for the "baseline" event and for a range of estimated AEPs. The identified flood surface for the 'baseline" is applied to the gauge levels as required. Note that subsequent identification of backwater and noflow areas can be used to produce a hazard map(depth and velocity).

Table 4: Key steps in the methologies used to undertake each of the three types of Level 2 flood investigation.

Validated Model

Outputs:

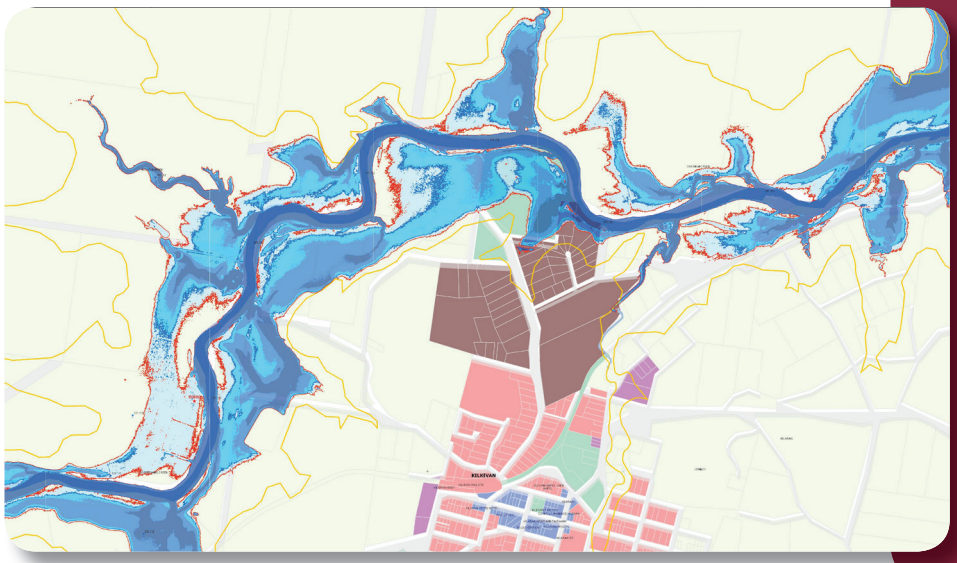
- Range of AEP maps
- Extent, depth & velocity
- Time sequence of inundation
- Validated against historic event(s)



Validated GIS

Outputs:

- Extent and depth
- Range of AEP maps (where stream flow data permits)
- Validated against historic event(s)



Unvalidated GIS

Outputs:

- Extent and depth
- Range of AEP maps (where stream flow data permits)

Figure 21: Indicative outputs of the different three different methodologies available using the Level 2 flood investigation approach.

3. Implementation

Undertaking a planning evaluation

Bridging the gap

A planning evaluation can be used to bridge the gap between flood investigations and any risk treatment options, where a Council determines not to undertake a comprehensive Level 3 floodplain risk management study. It will assist in determining land use compatibility in the floodplain and the risk treatment options (including land use response strategies) required to achieve that compatibility.

The planning evaluation has two key stages:

1. Undertaking an evaluation of a range of planning considerations to assess the consequence of flood hazard on the built environment and assign a level of planning-specific flood risk; and
2. Developing options to treat the flood risk presented by the hazard, including possible land use response strategies, where a need to alter the existing approach to land use within the floodplain has been identified by the risk evaluation.

A basic work flow for the planning evaluation is outlined below. The flood hazard to be used in the planning evaluation is that identified by the flooding investigation (refer to **Section 2 - Analysis**). **Schedules 5 and 6** provide more detailed information than that provided in this section, and **Schedule 7** provides an indicative worked example (a case study) of how the planning evaluation process may be undertaken.

The National Emergency Risk Assessment Guidelines (NERAG) include detailed guidance for emergency managers on identifying, evaluating and treating hazard risks, and this remains the principal guidance document for these purposes. The guidance below has been derived from NERAG and applied to the context of land use planning.

Figure 22 – The process workflow for undertaking a planning evaluation using the hazards identified through the flood investigation previously selected and prepared.

Selecting flood likelihoods to evaluate

Planning evaluations should be undertaken for a range of likelihoods (such as at least the 2%, 1%, and 0.5% AEPs, but potentially more in circumstances that warrant it) in order to develop a good understanding of the flood risk to which an area may be subject. The decision to adopt a likelihood(s) of a particular probability for land use planning purposes should be undertaken in close consultation with the community. Taking this approach means that communities can choose the final likelihood(s) to regulate development based on a good understanding of the consequences and resultant risk for a range of events.

The key elements of consequence

In terms of land use planning, the consequence of a flood can be understood by assessing three important elements – the exposure of a community to the hazard, the vulnerability of that community to the hazard, and the community's tolerability of that hazard. Consequence can be described as the sum of exposure and vulnerability, minus tolerability, as identified in **Figure 23** below:

Figure 23: The key elements of consequence.

The key criteria for assessing each element of consequence are noted in **Table 5** below:

Exposure	Vulnerability	Tolerability
Hazard Severity	Personal Safety	Community Awareness & Education
Population Size	Vulnerable Persons	Community Attitudes/Experience of Flood
Settlement Pattern, Land Use and Networks	Property Impact/Built Form	Insurance Levels
	Isolation	Social Networks & Capacity
	Transport Linkages	Socioeconomic Status
	Critical Infrastructure (e.g. hospitals, emergency services)	Emergency Plans & Services
	Other infrastructure/community services	Emergency Volunteers
		Private & Public Business Continuity

Table 5: Planning evaluation checklist for urban areas.

Planning evaluation criteria

The planning evaluation checklist and calculation process in **Schedule 5** has been developed from the key criteria from **Table 5** above to guide the planning evaluation of the impact of flood hazard on land use and development. The checklist is provided in a question/ready reckoner format for ease of use and reference, and is intended to trigger the investigation of the key criteria in **Table 5** through the step-by-step calculation process. The data/information/analysis required in order to adequately address each question within the checklist is also noted in this checklist.

Identifying risk through the planning evaluation

The most effective scale at which to undertake a planning evaluation is the property level or street level. Where a wider scale understanding is required, analysis at the lower scale can be aggregated up to provide a suburb or city-wide understanding of flood risk – this is discussed further in the following section titled 'Prioritising flood risk treatment across jurisdictions'.

Once a flood likelihood is selected for evaluation, the weighting methodology provided in **Figure 24** demonstrates how to quantify the elements that make up the consequence of a flood hazard at a particular likelihood – exposure, vulnerability, and tolerability. Using this weighting, each element is assigned a score of between 0 and 5 points based on the calculation process that supports the evaluation. The analysis results in a final score out of ten (10), with ten (10) representing the highest level of consequence, and zero (0) representing no consequence.

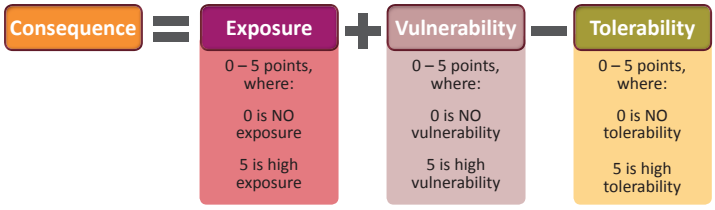


Figure 24: Quantifying consequence using a weighting approach to the key elements of exposure, vulnerability and tolerability.

Once a consequence score has been identified, the flood risk matrix (**Table 6**) demonstrates how to assign a level of risk to that score, relative to the flood likelihood against which the evaluation was undertaken. It can be seen from the matrix that the risk level identified is a product of the 'Risk = Likelihood x Consequence' formula discussed in **Section 1 – Understanding**. Therefore, the consequence assigned to a flood hazard can be compared relative to the likelihood at which it occurs. Naturally, a flood hazard that is expected to occur once every ten years less tolerable than a flood hazard of the same consequence that may occur once every thousand years. This is also demonstrated in **Figure 25.**

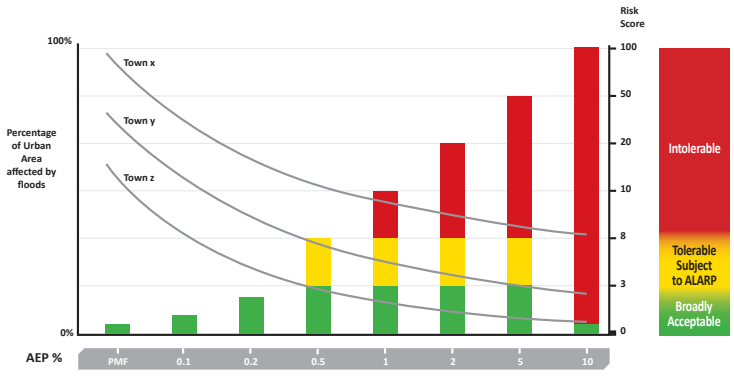


Figure 25: The risk scores possible at each level of Annual Exceedance Probability (AEP) using the Likelihood x Consequence matrix presented in Table 6 at right. Note how risks become more acceptable the lesser the likelihood of their occurrence

The planning evaluation considers the approach to evaluating risk promoted by the NERAG guidelines, principally through the application of the 'ALARP' principle. According to NERAG, the ALARP (As Low As Reasonably Practicable) Principle is applied to define boundaries between risks that are generally intolerable, tolerable or broadly acceptable. The ALARP principle will help to prioritise a risk hierarchy and determine which risks require action and which do not. Those that are broadly acceptable naturally require little, if any, action while risks that are at an intolerable level require attention to bring them to a tolerable level. According to NERAG, it is entirely appropriate and accepted practice that risks may be tolerated, provided that the risks are known and managed.

The ALARP Principle from the NERAG document gives further guidance on the approach to evaluating risk, illustrated in **Figure 26.**

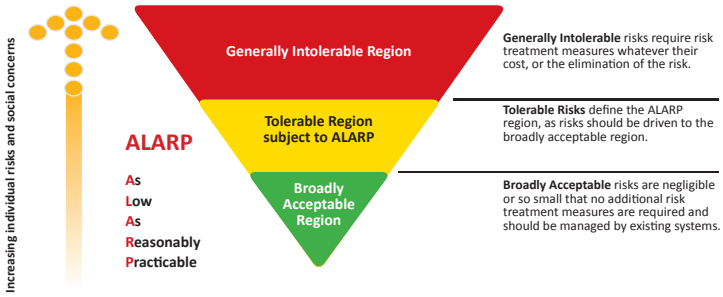


Figure 26: The ALARP Principle, derived from the National Emergency Risk Assessment Guidelines.

Through the responses to the planning evaluation checklist, the planning evaluation will divide the subject area into the three categories of risk promoted by NERAG. Risk treatment options can then be developed for each of these three categories of risk.

It is important to remember that it is the role of the planning evaluation to translate the hazard presented by the flood investigation into usable information related to risk. Therefore, as noted on page 10, while an area may be identified by the flood investigation as 'high' hazard, because of the exposure, vulnerability and tolerability factors considered through the planning evaluation, this area may be of little concern and so may be of broadly acceptable or tolerable risk for the purposes of land use planning.

An indicative case study of the planning evaluation process that includes calculations of the consequence scores and the overall risk levels for an area of flood hazard is provided in **Schedule 7.**

	Consequence Score										
Likelihood	0	1	2	3	4	5	6	7	8	9	10
10%	0	10	20	30	40	50	60	70	80	90	100
5%	0	5	10	15	20	25	30	35	40	45	50
2.5%	0	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25
2%	0	2	4	6	8	10	12	14	16	18	20
1%	0	1	2	3	4	5	6	7	8	9	10
0.5%	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
0.2%	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
0.1%	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

Broadly Acceptable
Tolerable subject to ALARP
Generally Intolerable

Table 6: The likelihood x consequence risk matrix.

Prioritising flood risk treatments

The planning evaluation process provides a mechanism by which the flood risk of one suburb or town may be compared against the flood risk in another suburb or town. This is important for Councils, RPCs and other levels of government in allocating resources to treat instances of flood risk in their jurisdiction.

For each subject area, the planning evaluation can identify the amount of land area, number of lots, or population subject to the varying levels of flood risk for the likelihoods selected – refer to **Figure 27.** The relative extent of flood risk provides a means by which suburbs or towns can be prioritised for treatment. Any treatment programme should be developed with regard to available resources and the timings for undertaking the treatment options.

Knowing where the greatest extent of flood risk exists within a jurisdiction ensures the allocation of resources and the timing in undertaking the treatment is appropriate for the levels of risk identified. In taking a sub-basin wide approach to floodplain management, the regional planning process undertaken by RPCs and expressed through the relevant Regional Plan may be the most appropriate mechanism to prioritise flood risk treatment relative to planning outcomes sought and the funding/resources available to treat the risk. Treatment programmes can then be articulated or referenced in the Regional Plan, with land use planning responses in the Regional Plan and the planning schemes within that regional area reflecting those treatment programmes.

Treating flood risks

The NERAG Guidelines offer a comprehensive risk treatment process that can be applied to the context of land use planning – refer to **Figure 28.** The various components of the process relative to land use planning are also identified, and are discussed in detail below.

Fig 28: Integrating the land use planning process with the NERAG risk treatment process

Further analysis may be required for each option developed as a part of the treatment plan. For example, if a levee is proposed in addition to land use planning considerations, this option will require specific flood investigations and cost-benefit analysis. A step by step guide to undertaking the risk treatment process is provided in **Schedule 5**.

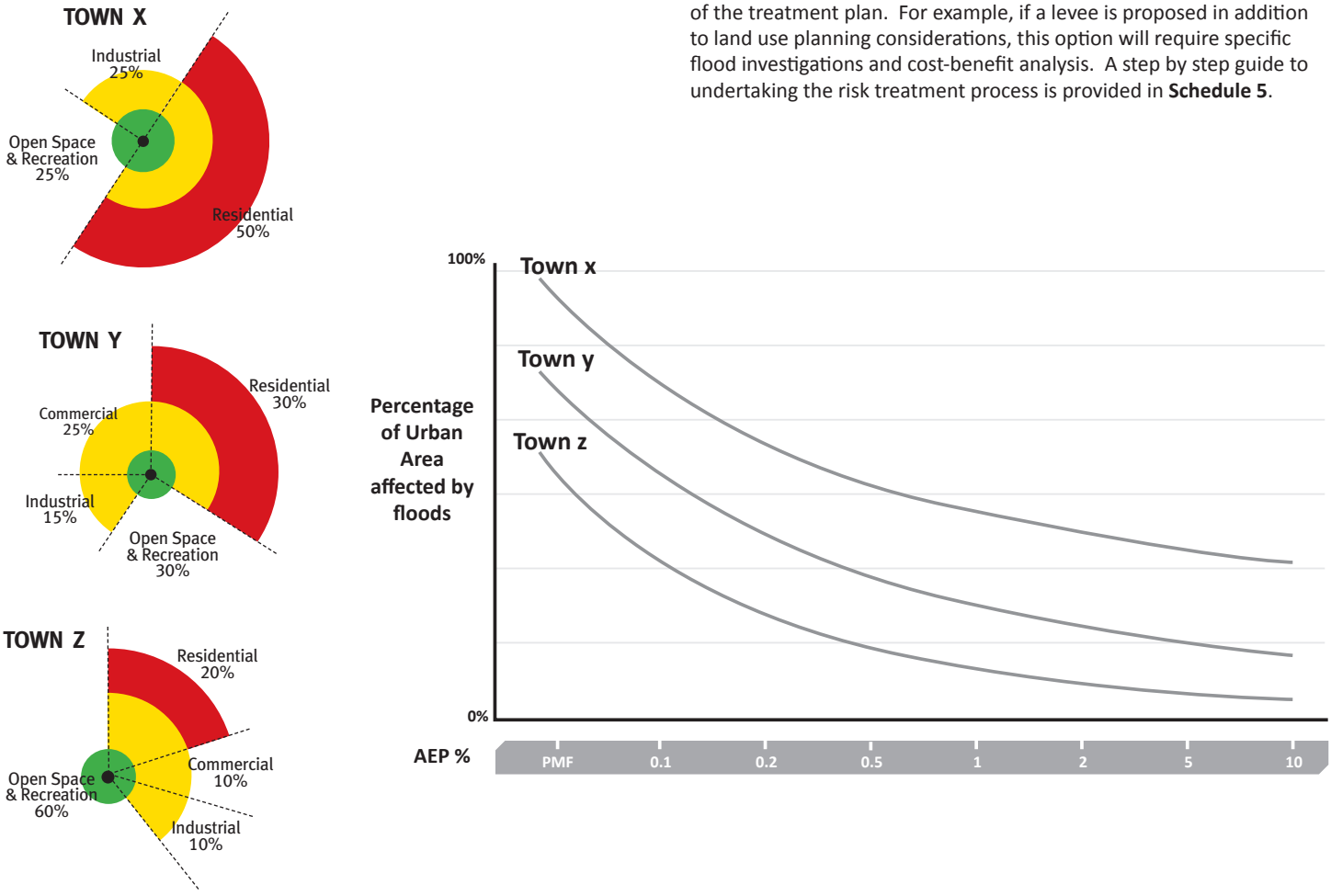


Figure 27: Understanding the different flood risks that towns or suburbs are exposed to allows prioritisation of treatment options where they are needed most

Setting the resilience target

Once the level of flood risk for areas or properties has been identified through the planning evaluation, a resilience target can be set as a 'goal' to strive for when preparing options to treat the flood risk. The target (such as percentage of urban area affected by flood) can be used as a metric to quantify the effect of those measures used to address the flood risk, when considered against the current situation. In line with the principles of NERAG, the broad intention is to set a resilience target that is lower than the current level of resilience, so that the amount of area affected by flood is reduced to as low as reasonably practicable (refer to **Figure 29**).

Setting a resilience target ensures that what is sought to be achieved by flood risk treatment measures is clear and definable; it provides an easily understandable objective to assess the appropriateness or usefulness of a certain measure (or suite of measures) in achieving that target.

It is possible that different resilience targets may be required depending on local circumstances; the target proposed might differ depending on the local flood characteristics and the local settlement context. Other possible resilience targets could be:

- Eliminating or reducing the number of lots subject to intolerable flood risk, where the priority is treating the highest level of risk only;
- Eliminating or reducing the flood risk to transport linkages between critical infrastructure (such as evacuation centres/airports) and the balance of urban areas where such a risk exists; and/or
- Reducing the number of lots subject to tolerable flood risk, to ensure these lots are then subject to broadly acceptable risk.

Therefore, a more specific resilience target relevant for some councils may be to focus on reducing the number of lots for residential and/or commercial purposes that are at intolerable flood risk. In this situation, the existing number of lots at intolerable risk can be quantified through the planning evaluation process, and the resilience target could be to eliminate or reduce as far as practicable the flood risk to these lots.

An example of such a target may be: There are 100 urban residential lots at intolerable risk of flood in Smithtown, which require treatment to reduce the risk. Over the next 20 years, the risk to all lots will be reduced to an acceptable level by a combination of back-zoning and property buy-back programs to remove persons and property from the flood hazard and some mitigation works by the Council.

The planning scheme therefore plays a strong role in achieving this resilience target, given the back-zoning required. The resilience target can be identified through the planning scheme prepared for the Council area, such as through the vision or the strategic intent of the strategic framework. The balance of the planning scheme provisions can then be calibrated against the community's level of acceptance of flood risk, and this resilience target. For example, these lots could be zoned Limited Development (constrained land), the zone code would include land use assessment criteria to avoid inappropriate development, and development generally within the zone would be impact assessable. Where a resilience target is set that also involves non-planning scheme matters (such as structural mitigation works) this can be made clear in the target outlined by the strategic framework and duly reflected in the zoning choices used in the zoning plan.

There is also a role for regional planning in setting resilience targets. Given the likely prioritisation of flood risk treatment that will occur either across a local government area or an RPC area, the regional plan also may be an appropriate place to set resilience targets, though at a broader scale than that in a planning scheme. For example, the resilience target in a regional plan may set requirements for the highest risk towns in the RPC area to reduce their flood risk to a tolerable level. Alternatively, where there is a regional interest for the largest town in the RPC to be the most resilient for the purposes of maintaining economic and social linkages during flood events, this can be quantified in the resilience target for the RPC area. The relevant Council would take the steps needed to ensure this resilience through the measures available to it, including its planning scheme and other land use measures.

It is acknowledged that the process of achieving resilience targets may either occur relatively quickly where strong interventions such as relocation programmes are undertaken, or it may take some time where the treatment options chosen involve voluntary buy-back schemes. The decision to take strong action or action over time to address the risk is a matter for councils or RPCs. In any case, fully meeting a resilience target is likely to require generational change that should be supported by successive regional plans and planning schemes over time.

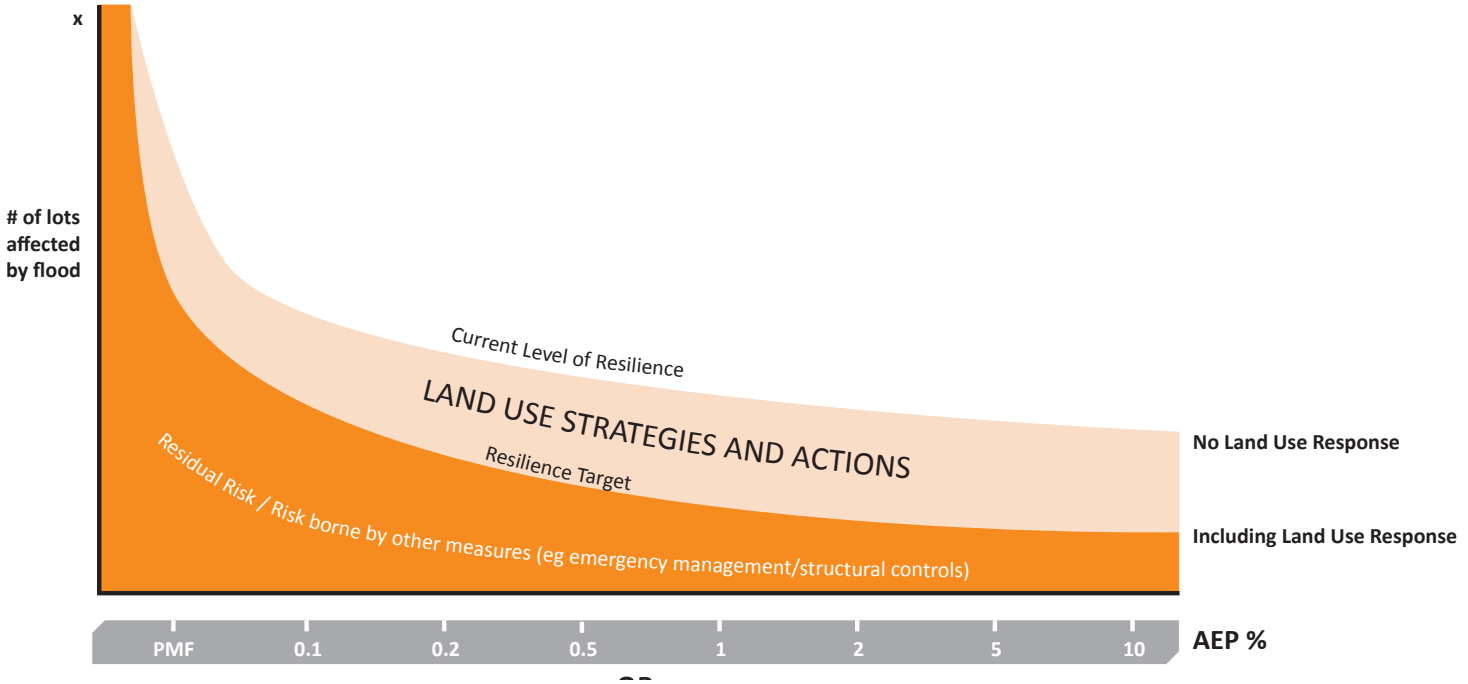


Figure 29: Setting a resilience target (for flood risk at a certain level of likelihood, or for a range of likelihoods) provides an easily identifiable goal for improving resilience to flood risk, particularly through land use responses such as planning schemes.

Treating risks through land use planning

The planning evaluation should identify options for treating the flood risk identified through the planning evaluation. **Figure 30** below elaborates upon the ALARP Principle contained in NERAG and applies possible high-level land use responses to treat the risks as described. These land use risk treatment options are elaborated upon in the following section titled 'Land Use Response Strategies'.

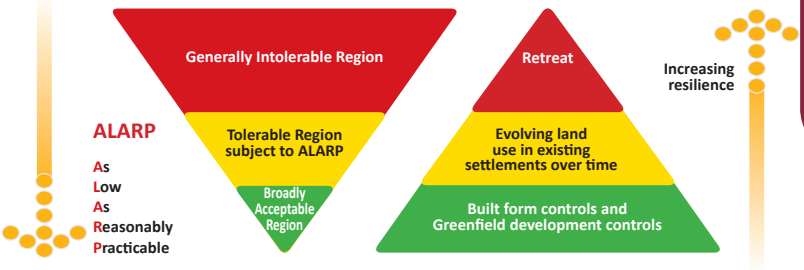


Figure 30: The land use responses that increase resilience relative to the three categories of risk prescribed by NERAG.

However, the planning evaluation may also identify that it is appropriate to treat some flood risk outside the planning system (such as through structural mitigation works or controls, or through emergency management procedures). Other possible measures to treat flood risk include those identified previously in **Figure 1**, including:

- structural or natural mitigation
- building controls
- emergency management procedures
- insurance
- community awareness/education programs.

These measures should be identified early on for investigation and assessment by the relevant experts. For example, if risk to a certain urban area was deemed intolerable, following consultation with the public, Council may deem that the appropriate response to that risk is to protect the existing community using structural works such as a levee.

Compare the options and decide suite of measures

While a land use response to retreat from an area at intolerable flood risk using back-zoning and buy-back/land swap arrangements may eliminate the risk, the community may decide to remain in the area regardless. This would necessitate consideration of risk treatment options that would rely on more than a planning scheme response and a land swap programme. It may involve non-planning considerations such as structural works.

Therefore, the views and attitudes of the community are important in testing possible options to treat flood risk. All options proposed should be presented to and considered by the community so that a preferred option or suite of measures can be identified and agreed.

Cost also may be a relevant consideration in the options used to treat the identified risk. For example, the building of a levee to protect a certain settlement or area may be more expensive than the cost of property buy-backs or land swap programmes for those areas. However, the need to treat the identified risk in a manner that reduces the risk to as low as reasonable practicable should be the paramount consideration in determining the appropriate course of action.

Critically, the outcomes of any non-land use planning investigations to treat flood risk should feed back into the land use planning process. For example, where a levee is to be constructed to protect a town, the details of the level of protection (i.e. a 2% event or a 1% event, etc) should be made available to land use planners within Council so that they may tailor land use provisions accordingly. If the levee is to be built only to protect the town up to a 2% event, land use planning provisions may still be required to treat the residual risk left by the levee in a manner that was acceptable to the community. This would ensure that in the instance that the levee is overtopped or breached, these areas are still resilient to the ensuing inundation.

Land use planning contributes to both mitigation of, and adaptation to, urban floods.

Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century – A Summary for Policy Makers, Jha, Bloch, Lamond p29

Ongoing management of residual risk through development assessment and other local responsibilities

It is important for planners to consider development assessment as a risk management exercise. While a planning scheme may address flood risk through appropriate zoning and strategic policy, development assessment decisions made pursuant to that planning scheme must also reflect that intent. Given development assessment requires professional judgment to be exercised within that decision-making process, the NERAG risk treatment principles are also relevant at this point in the planning process.

Other persons or entities involved in natural hazard risk management should also be informed of planning decisions made over time. A clear point of communication should be created between the Local Disaster Management Group personnel and the planning personnel of Council to ensure that emergency management personnel are aware of planning decisions made that may affect their emergency planning and procedures.

Emergency management procedures and ongoing maintenance of structural works also play a part in managing residual risk. In practice, the extent to which these operations are undertaken will materially affect the level of actual risk to which a settlement may be subject and so should be monitored carefully for their appropriateness relative to the evolving settlement(s) they assist in protecting.

In managing flood risk today, and in planning for the future, a balance must be struck between common sense approaches that minimize impacts through better urban management and the maintenance of existing flood mitigation infrastructure, and far-sighted approaches which anticipate and defend against future flood hazard by building new flood mitigation infrastructure or by radically reshaping the urban environment. The balance will be different for each city or town at risk...an understanding of both current and future flood risk is needed.

Cities and Flooding: A Guide to Integrated Urban Flood risk Management for the 21st Century, Jha, Bloch, Lamond p29

Land use response strategies

The risk treatment component of the planning evaluation should identify a land use response, or a number of responses, that may be used in those areas of risk that are commensurate with the level of risk identified for that area. The broad categories of land use responses include:

- adapt existing urban areas or sites;
- retreat from specific existing urban areas or sites;
- expand into new areas suitable for urban development;
- maintain agricultural and rural landscape values; and
- treat risks to linkages (e.g. transport routes) and isolated places.

The combination of land use response measures used to treat flood risk will vary depending on the level of risk identified, the scale of that level of risk (i.e. the amount of area subject to that risk), the prioritisation given to treating that risk, community expectations and the resources available to Council to treat the risk.

The suggested land use response measures are outlined in **Table 7** below. An indicative case study of the planning evaluation process that includes selection of land use responses is provided in **Schedule 7**.

Land Use Response	Land Use Strategy
Maintain the status quo	
Make no changes to existing land uses as risk is minimal	None required
Adapt existing urban areas	
Support built form change over time	– Improve built form outcomes through urban design and building code controls – Promote traditional Queensland building designs & construction methods – Set habitable floor levels – Build with resilient materials – Maintain/rehabilitate natural waterways and flowpaths – Avoid filling to minimise cumulative impacts on floodplain
Limit certain land uses that are not appropriate for the hazard	– Adjust current zonings to reflect appropriate land uses – Create flood-constrained precincts within zones, which may limit certain land use types or density increases
Retreat from specific existing urban areas	
Remove existing vulnerable land uses from areas of highest risk	– Actively transition existing at-risk land uses – Back-zone areas of highest concern – Investigate planned retreat programmes such as voluntary purchase, land swaps, compulsory acquisition to complement scheme response
Expand into new areas suitable for urban development	
Allocate future urban areas in areas of lowest or no risk	– Avoid zoning areas of medium or highest concern for future urban purposes – Site-based investigations during application stage may identify additional areas of concern. Avoid inappropriate land uses in these areas
Maintain agricultural and rural landscape values	
Support flood-appropriate land uses in non-urban areas	– Tailor rural land uses appropriate to the areas of concern, particularly intensive animal husbandry or intensive agriculture
Treat risks to linkages and isolated places	
Ensure transport and infrastructure routes are resilient to the hazard, and address isolation risks created through interruptions to such linkages	– Avoid creating additional risks by not placing key transport/infrastructure linkages in floodable areas, or by ensuring their resilience to those events – Investigate existing areas to identify possible points or areas where linkages may be impacted by flood events & consider resilience or relocation strategies to address this risk – Investigate existing settlements to identify areas that would not flood but would be isolated from balance of urban area when flood occurs, and treat linkage accordingly

Table 7: The range of potential land use responses to flood risk, and the transition strategies that are required to support those responses

Dalby in flood *Source: Western Downs Regional Council*

Oakey in flood *Source: Toowoomba Regional Council*

Using the planning scheme to build flood resilience

A planning scheme needs to have a clear line of sight in how it deals with natural hazard risks. This line of sight provides a clear linkage throughout the document to ensure that all levels of the planning scheme appropriately and consistently reflect the desired approach to dealing with flood risk in the planning scheme area.

The line of sight is based on two key elements – understanding the hazard/risk, and the community's intentions for responding to that risk. The balance of the scheme can then be calibrated to respond to these elements.

The following three components of new QPP-compliant planning schemes are considered to be the most effective tools to mitigate natural hazard risks (including floods) through a statutory planning mechanism for a local government in Queensland.

1. **Strategic framework** - sets the vision and land use direction for the planning scheme and forms the basis for ensuring that appropriate development occurs within the planning scheme area, including how a community responds to flood risk
2. **Zones (including precincts)** - ensure that development within the scheme area responds to the desired outcomes contained in the strategic framework by setting clear land use intent and calibrating levels of assessment for development that reflect the strategic intent
3. **Overlays** – provide further assessment criteria for specific constraints or opportunities (such as flood hazard) within the scheme area, such as built form controls.

Flooding across the Oakey - Pittsworth Road, 2011 *Source: Western Downs Regional Council*

Schedule 8 provides detailed guidance and examples on how Councils can utilise these components within their new QPP-compliant planning schemes to mitigate and regulate flood risk. Councils may also use other scheme mechanisms (such as planning scheme policies or planning partnerships) to also address flood risk as desired.

A key role for the strategic framework is to define the desired settlement pattern for the Council area. The settlement pattern proposed by Council will be developed taking into consideration expected population growth, economic development strategies, existing urban areas and desired built form outcomes. It should also be informed by responses to, among other things, flood hazard.

It is also the role of the strategic framework to articulate the extent to which the community accepts or tolerates natural hazard risk, what resilience target is appropriate to strive for through the life of the planning scheme and how the community wishes to address the risk of natural hazard, having regard to other factors such as population growth and economic development. This policy position then needs to filter down into the detailed planning scheme provisions, such as zones and overlays.

There is a key role for a community vision in defining the conceptual way forward for development within the planning scheme area, as the more detailed policy positions in the strategic framework will be informed by this vision. The vision as it relates to natural hazard risk will be built upon the community's acceptance of risk and the resilience target identified. The vision can then assist planners to calibrate the land use plan (e.g. zoning) and detailed assessment mechanisms such as codes within the scheme to address exactly what the community intends for the area.

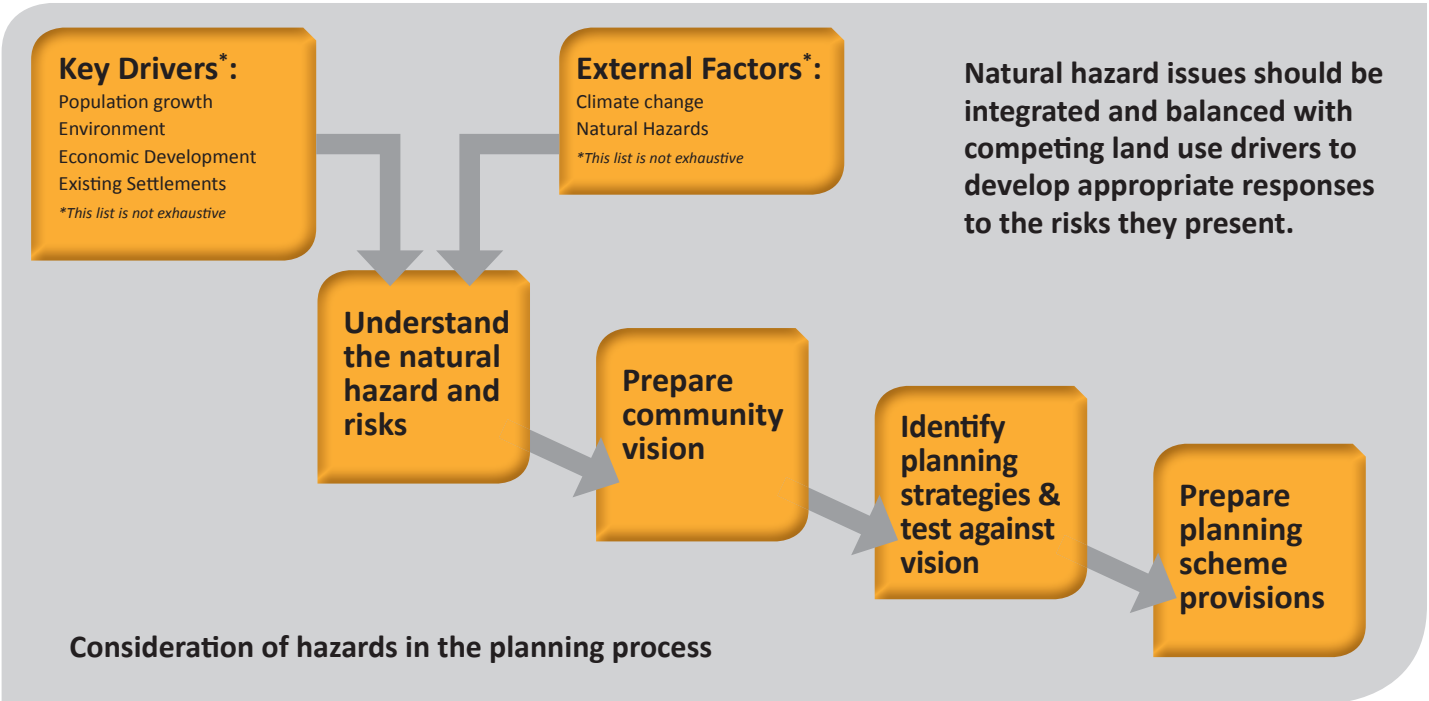


Figure 31: The line of sight in planning scheme preparation

Hazard maps vs risk maps

A key output of the planning evaluation will be maps showing the level of identified flood risk at a property or street-by-street level. This mapping will be used to inform strategic planning and to calibrate zonings for properties affected by flood where this has been identified as an appropriate risk treatment option.

However, it is important that the flood hazard map be included in any planning scheme, not the flood risk map developed from the planning evaluation. As the scheme cannot accurately predict every type of development that may be proposed within a Council area, the risks presented by future development may change. For example, a Council may identify a rural, undeveloped area at 'acceptable' risk because it is not an urban settlement and is not envisaged as such under life of the scheme. This risk level is appropriate for this current circumstance, though there may be instances where development not envisaged by the planning scheme occurs. For example, resource/mining activity that commences after the scheme is adopted triggers the need for additional urban development (a residential subdivision, for example) in that area. As it was not identified as a future urban area in the scheme, the stated 'acceptable' level of risk for the area is not appropriate to assess the development. Therefore, a risk map is not appropriate for inclusion in a planning scheme but should be used to inform the strategic land use planning process and the allocation of zonings based on the identified levels of risk.

A hazard map is the correct mechanism to assess the appropriateness of the land use though the development assessment process. This is because the hazard map will depict the actual nature of the flood – i.e. how 'hazardous' it is. Councils are encouraged to include all hazard maps (including various levels of AEP – e.g. 1%, 0.5%, 0.2%) available for their council area in their planning scheme. One specific Shire-wide map may be used as the overlay map to trigger assessment criteria, while the balance of AEP maps may be included in a planning scheme policy or similar to provide additional context for councils and applicants during the development assessment process. The case study provided in **Schedule 7** demonstrates the difference between a hazard map and a risk map.

Land use strategies and planning scheme responses

Schedule 6 provides further detailed guidance on the land use strategies and the possible planning scheme measures that will achieve these strategies. Further detailed guidance and example provisions for the strategic framework, zones and overlay code is provided in **Schedule 8.** Checklists to assist scheme drafters and scheme reviewers are also included in **Schedules 9** and **10** respectively.

The use of maps for communicating hazard and associated risks is therefore a valuable aid to decision making.

Cities and Flooding: A Guide to Integrated Urban Flood risk Management for the 21st Century, Jha, Bloch, Lamond p28

Risk Map

Use to inform strategic planning & zoning. Particularly important in the development of planning scheme strategies

Hazard Map

Use for development assessment and include in planning scheme

Bringing back the 'Queenslander' in Condamine

case study

In the recent 2010/2011 floods, the residents of Condamine in the western Darling Downs had to be evacuated twice – once on 30 December 2010 in anticipation of a record flood peak of 15.25 metres on 1 January 2011, and again on 11 January 2011.

Following these floods, in the course of rebuilding, some residents have decided to proactively address future floods by adopting the traditional 'Queenslander' style of home. In moving away from 'slab on ground' construction and raising the floor height above ground level through the use of structural posts and poles, a more resilient built form outcome has resulted.

The 'Queenslander' is a part of our cultural and architectural history. It is a resilient form of housing that has been proven over generations to be compatible with the nature of our floodplains.

The residents' rebuilding efforts in Condamine demonstrate how the community and the development industry have embraced a proven traditional approach to dwelling design, but used contemporary resilient materials and building techniques to create a modern equivalent of the traditional "Queenslander".

Source: QldRA

The Stawell River at Cambridge Crossing near Richmond, mid 2012

Source: QldRA

4. Delivery

Bringing Part 1 and Part 2 together

Planning for stronger, more resilient floodplains has been developed to help councils introduce consistent and specific planning controls to manage flood risks. Part 1 delivered state-wide floodplain mapping targetted specifically to those areas of the State where no mapping existed. Through local verification these maps together with the model code provisions enabled councils to introduce interim measures to support floodplain management in existing planning schemes through a streamlined process. Councils are encouraged to continue to use the Part 1 Guideline for implementing measures into their existing planning schemes.

The desired result for Part 2 is that future planning schemes appropriately consider and respond to flood consequence within the context of the characteristics of each local government area through a sub-basin wide approach.

Councils may use both Parts 1 and 2 in tandem to address flooding through both their existing and future schemes (see **Figure 32**).

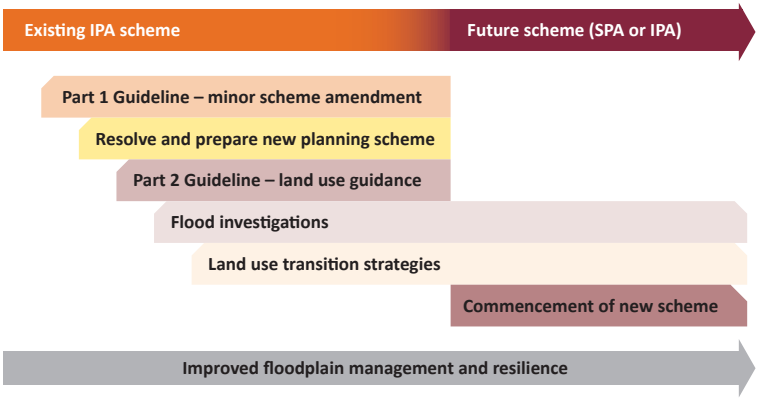


Figure 32: Part 1 and Part 2 Guidelines working together

Delivering Part 2

Figure 33 identifies the three key elements of Part 2 that a Council (and where appropriate, an RPC) should consider in the preparation of the future planning scheme.

A key consideration for Council is how it may undertake these elements in advance of/or as part of the planning scheme preparation process, to ensure that the new planning scheme can appropriately address flooding issues.

To assist in determining this workflow, **Figure 33** provides an overview of the entire process that councils (in association with their respective RPCs, if applicable) can utilise to improve floodplain management outcomes through land use planning.

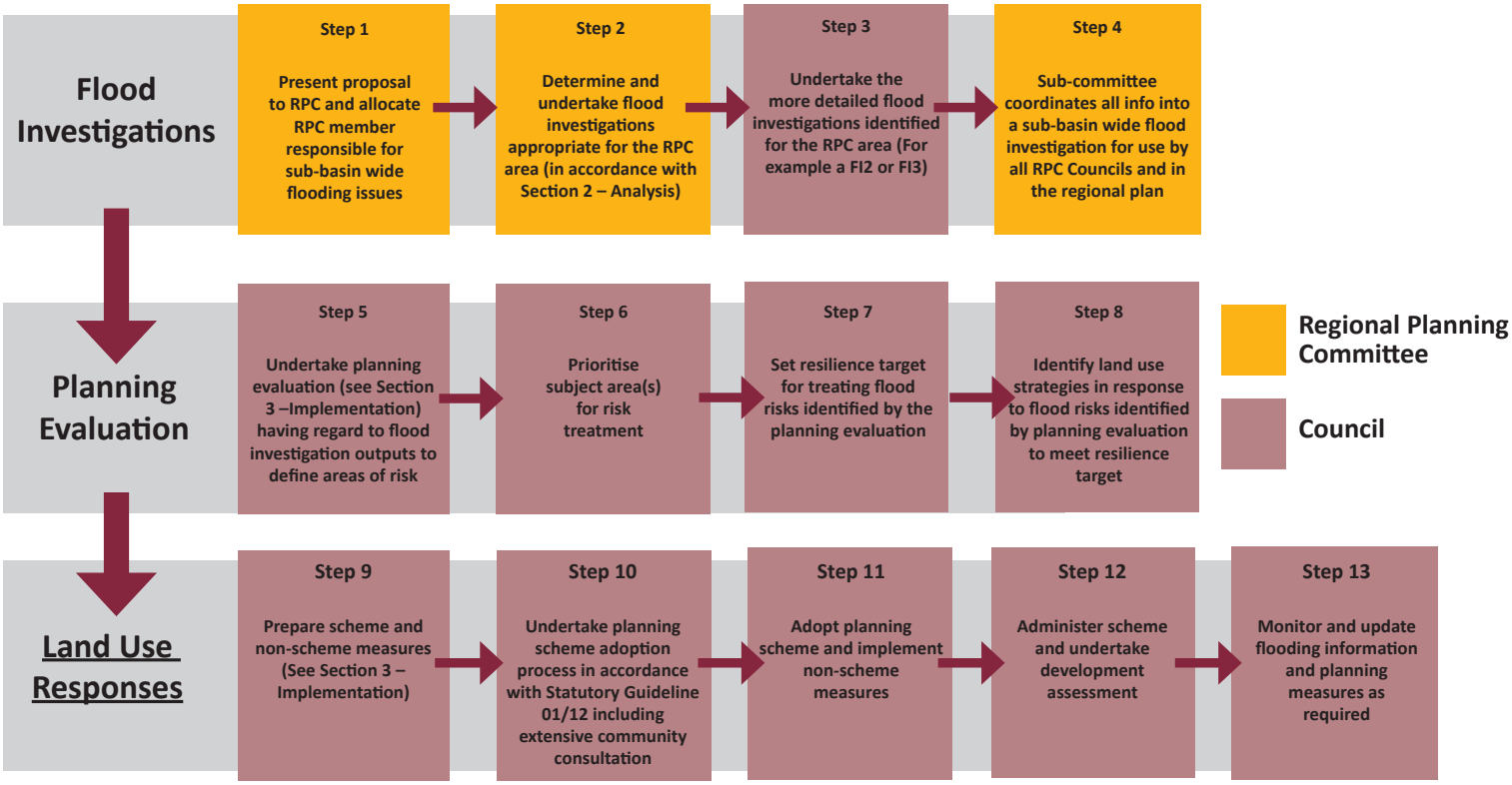


Figure 33: Process flowchart, providing step-by-step guidance on how to implement the Part 2 guidance

QFCoI response & key future actions

QFCoI and Planning for stronger, more resilient floodplains

TheQFCoI was responsible for undertaking an independent examination of the 2010/11 floods and their consequences. The QFCoI investigated a wide range of matters during this examination, and of particular relevance for the work of the Authority are those recommendations that relate to land use planning and floodplain management.

The QFCoI Final Report was released on 16 March 2012, after the non-statutory consultation period for this Guideline had closed. However, while the final report was not strictly a submission received in relation to this Guideline, it was important that the relevant recommendations of the QFCoI Final Report be addressed in the final version of this document. Importantly, the Chapters relevant to the ***Planning for stronger, more resilient floodplains*** body of work include:

- Chapter 2 – Floodplain management
- Chapter 4 – State planning instruments
- Chapter 5 – Local planning instruments
- Chapter 7 – Development and flood considerations
- Chapter 9 – Building controls
- Chapter 10 – Essential services
- Chapter 11 – Buy-backs and land-swaps.

Therefore, the ***Planning for stronger, more resilient floodplains*** body of work responds to a number of key floodplain management and land use planning recommendations set down by the QFCoI Final Report of the QFCoI, as per the following table (**Table 8**):

Key Matter raised in QFCoI Final Report	Recommend–ations	Relevant principles/section(s) of the *Planning for stronger, more resilient floodplains* Part 2 Guideline
The recommended approach to floodplain management, which involves undertaking flood investigations at a catchment (sub-basin) wide level and ensuring such investigations are fit-for-purpose, relative to population and growth pressures, historical flood risk and Council resourcing capabilities	2.4 2.11 – 2.18	Fit-for-purpose approach to floodplain management Sub-basin wide floodplain mapping completed State-wide
The roles and responsibilities of all levels of government – including how the State and Councils should undertake and administer flood mapping and floodplain management	2.5 – 2.6	Support for Regional Planning Committee (RPC) governance structure to administer floodplain management across local government boundaries at sub-basin wide level Identifying priority towns for improved flood mapping
The extent of existing flood mapping across the State, which was identified as being inadequate	2.4 – 2.6	Sub-basin wide floodplain mapping completed State-wide Guidance provided on fit-for-purpose flood investigations Government commitment to undertake up to 100 Level 2 investigations for priority towns across Queensland
The availability of best practice guidance available to government – all levels of government would benefit from access to Guidelines	2.20 – 2.22	Collaboration with drafters of the update to national floodplain management policy Completion of Queensland-specific land use policy guidance in relation to floodplain management
The purpose and operation of statutory planning mechanisms related to managing development in flood areas	4.5 – 4.7	Implementation and amendment of ***Temporary State Planning Policy: Planning for stronger, more resilient floodplains***
The availability of model flood planning controls for use by Councils – example provisions that use a similar format and structure to the Queensland Planning Provisions (QPP)	5.1 – 5.7 7.2, 7.4, 7.11, 7.16, 7.24	Example QPP-compliant planning scheme provisions, including demonstrating use of strategic framework, limited development (constrained land) zone, model assessment criteria and example planning scheme policy
The ability of government to continually update and make available flood mapping to the public – including using the minor scheme amendment process to include improved flood mapping into planning schemes quickly and efficiently, and the availability of flood mapping through interactive website portals	2.7, 2.11, 2.16 – 2.18 5.8 – 5.9	Implementation of Queensland-wide 'flood check' floodplain mapping portal (http://www.qldreconstruction.org.au/flood-check-map) Development of the 'Queensland Flood Studies Database' as a repository of all existing and future flood information Queensland-wide (https://qldreconstruction.org.au/floodstudies/)
Other findings and recommendations related to building controls, essential services and buy-backs/land swaps	10.10, 10.11, 10.16, 11.1	Example assessment criteria (model planning controls) Advice on undertaking buy-back/land swap arrangements, and the decision-making process to arrive at that risk treatment option

Table 8: QFCoI recommendations and how they have been addressed through the Planning for stronger, more resilient floodplains body of work.

Flood management in an area can be made highly effective by means of vulnerability zoning, in which areas classified from higher to lower levels of vulnerability. This further helps in the proposition of flood defence mechanisms, effective flood control measures, evacuation planning and flood warning.

Cities and Flooding: A Guide to Integrated Urban Flood risk Management for the 21st Century, Jha, Bloch, Lamond p176

Future key actions

The QFCoI recommendations have set a clear framework for advancing floodplain management practice in Queensland. Six key elements have been identified, which in themselves include a range of actions, that are needed to advance this framework:

- funding – commitment & availability
- legislation – to support floodplain management objectives
- organisational roles & responsibilities
- operation – capacity building within jurisdictions
- data - improvements in collation & availability
- strategy – evolution in floodplain management policy & strategy

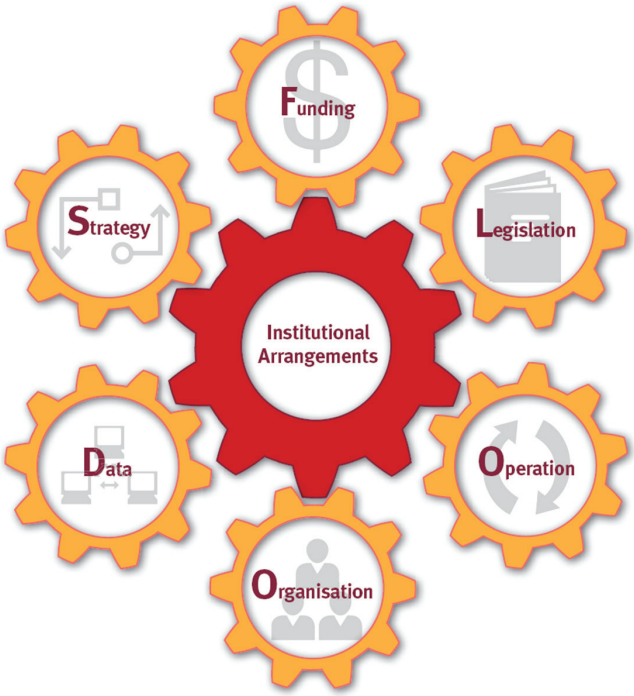


Figure 34: The FLOODS institutional arrangements necessary to build on the Planning for stronger, more resilient floodplains body of work.

The actions to implement and deliver on these six key elements (**Figure 34**) are discussed below.

Flood mitigation funding

As a key element of its response to the QFCoI and in addition, the government will provide funding support for local government projects relevant to the recommendations through the following programs:

- Local Government Grants and Subsidies Program— $40 million will be allocated from this program over three years to provide financial support for local governments with limited capacity to self-fund projects to implement Commission recommendations.
- Floodplain Security Scheme—$40 million will be allocated over four years under the Royalties for the Regions initiative, with an ongoing commitment of $10 million per year, to provide funding for local government for flood mitigation infrastructure. A funding contribution is being sought from the Commonwealth Government on a 2:2:1 basis, which would provide total funding of $100 million over four years from the Queensland Government, Commonwealth Government and the relevant Council.
- Natural Disaster Resilience Program—approximately $10 million of shared Queensland and Commonwealth Government funding will be available in 2012/13 for disaster resilience projects including, for example, flood studies and mitigation works.

Legislation

A planning reform process is currently underway to examine the existing Queensland planning system to identify areas where efficiency and regulatory improvements can be made. In addition, the recommendations of the QFCoI foreshadowed the need for legislative changes to address some key roadblocks to improving floodplain management practice in Queensland.

As part of the planning reform process and in response to the QFCoI, DSDIP is leading the revisions to relevant legislation (including the *Sustainable Planning Act 2009*).

Of key relevance to this legislative reform is the power of councils to make planning decisions as a consequence of the risk of natural hazards. *The Sustainable Planning Act 2009* currently has provisions (section 706) limiting compensation for land use or zoning changes on land for development that "would have led to significant risks to persons or property from natural processes (including flooding...)" – but it is a limited exclusion as it does not apply if "the risk could not have been significantly reduced by conditions attached to a development approval". This will be particularly important where a Council wishes to 'back-zone' properties (such as through the use of the Limited Development Zone) that are subject to intolerable flood risk (as determined via the planning evaluation process). This matter will be addressed as part of the planning reform process.

Organisational and operational

In its response to the QFCoI, the Queensland Government committed to implementing all recommendations of the inquiry. The response, released on 7 June 2012, notes the recommendations contained in the final report are wide-ranging and will require focused and collaborative implementation activity across a number of state agencies and councils. To achieve this, the Queensland Government will put in place an implementation framework that clearly identifies key areas of work and allocates clear lines of responsibility to ensure that the work gets done.

Implementation groups will be established to deliver the Commission's recommendations along five key streams of delivery:

- planning
- building
- environment and mines
- emergency management
- dams.

These implementation groups will be responsible for ensuring coordinated and focused action is taken over the next 12 months in delivering the Commission's recommendations. Each group will be chaired by a Director-General and will consist of representatives of other key departments and agencies. In addition, to ensure representation of Council interests in the implementation of state responses to those recommendations affecting councils, the Local Government Association of Queensland (LGAQ) or relevant individual Councils will be invited to participate in implementation groups. The progress of these implementation groups will be monitored by a CEO committee chaired by the Director General of the Department of the Premier and Cabinet and comprising Directors-General and Chief Executives of key departments and agencies. The governance structure for oversight and implementation of the Commission's recommendations and the key areas of work to be undertaken by the implementation groups are outlined in the Government's response – refer to http://www.premiers.qld.gov.au/publications/categories/reports/assets/gov-response-floods-commission-inquiry.pdf

Data – Queensland flood portal

A key focus of the QFCoI recommendations related to the availability and accessibility of flood information for all parts of Queensland. The QFCoI noted this information should be publicly available and be readily understandable by people wanting to access that information. In response to this, and to support the implementation of the National Flood Risk Information Portal in Queensland, the Authority is creating a Queensland Flood Portal that will house all floodplain mapping (Level 1), moderate level investigations (Level 2), comprehensive investigations available from Councils and others (Level 3), and floodlines of historic events (such as the 1974 Brisbane flood and all captured 2010 - 2012 flood events). The Flood Portal will also house spatial information such as Digital Elevation Models useful for undertaking flood investigations, and will also provide links to further information and guidance at State and local levels.

Strategy - national policy and SPP1/03 reviews

A national floodplain management policy framework that promotes a risk management approach to best practice relative to local circumstances is a key component to evolving floodplain management practice over time. The existing national policy, Floodplain Management in Australia, is currently under review. This review is timely given recent events around the country, as there is the opportunity for lessons learnt from all jurisdictions to inform the improvement of best practice around the country. The Authority, in association with DSDIP, is working with the drafters to ensure that Queensland conditions are addressed in the revision, in accordance with the QFCoI recommendations.

The SPP 1/03 review, currently being undertaken by DSDIP, will also embody an evolution of floodplain management practice in Queensland that responds to the lessons learnt from recent years and focuses on the implementation of flood mapping into planning schemes to build resilience outcomes.

Bridge across the Cloncurry River Anabranch, mid 2012 *Source: QldRA*

In association with DSDIP, the Authority is working to ensure Queensland conditions are appropriately reflected in the review of national floodplain management guidelines, in accordance with recommendations 2.20 and 2.21 of the QFCoI.

Sign indicating flooding across a tributary of the Cloncurry River. *Source: QldRA*

Undertaking the sub-basin wide flood approach

The Analysis section of the Guideline introduces the concept of fit-for purpose flood investigations across the sub-basin. The RPC working with each relevant Council is encouraged to nominate the appropriate investigation for local circumstances using the step-by-step process on pages 18 and 19.

Under the fit-for-purpose framework, the sub-basin wide approach may include one or a combination of flood investigation techniques across the sub-basin, including Level 3 investigations where needed, a range of Level 2 investigations where applicable, and Level 1 base mapping in the balance of the floodplain. The combination of techniques will depend on the local circumstances of the floodplain in the RPC area. The following case study of the Balonne River sub-basin provides an example of a possible combination of techniques relevant for that sub-basin.

case study

Balonne River sub-basin

The Balonne River sub-basin in south-west Queensland includes the local governments of Balonne Shire Council, Western Downs Regional Council and Maranoa Regional Council. The sub-basin is included within the Darling Downs regional planning area.

Roma is a regional town of 8,000 people which is known to flood periodically from the nearby Bungil Creek. It is located within the gas-producing Surat Basin area, and is the terminus of the Roma to Brisbane gas pipeline hub. A 1000MW gas-powered power station is also proposed near Roma.

Resource and infrastructure development is increasing through the expansion of the coal seam gas industry in the Surat Basin. Additional development to support this industry is likely over time in the Balonne River sub-basin, particularly as resident population numbers are expected to grow significantly over the next 20 years, and non-resident worker numbers are expected to grow sharply between 2012 and 2017.

St George is a smaller town of 2,500 people located on the Balonne River. According to the Bureau of Meteorology, St George floods frequently (on average, once every two years). It is a centre for the surrounding agricultural industries of cotton, wheat and grazing. St George has been selected to demonstrate the process for undertaking a Level 2 investigation.

The sub-basin also includes a number of smaller regional settlements located along the Balonne River and its tributaries. While development in these towns may be generally low, many of these towns have been known to flood in the past, sometimes frequently. The balance of the Council area comprises rural production and regional landscape areas.

On the basis of the above, using the Part 2 Guideline, the RPC may consider the following indicative approaches to investigating flooding within the sub-basin (see Figure 35**).**

A Level 3 investigation is currently underway for Roma.

- When proposals for mining or gas operations are submitted in the sub-basin, the councils may require Level 3 investigation from the applicant(s) to properly assess the impact of the operation on the floodplain. Councils may use the Terms of Reference provided in this Guideline to outline the scope of work required for the proposal.
- Level 2 investigations may be undertaken for the other smaller towns in the sub-basin area (such as St George, Surat, Yuleba and Miles), as population and development pressures in these areas are low and Level 2 represents an appropriate, cost effective response.
- A Level 1 investigation has been undertaken for the balance of the sub-basin.

Councils, through their RPCs, may wish to undertake more detailed investigations of the rates of population growth expected in their settlements, or the extent of proposed development (such as resource, industrial or infrastructure development) in the RPC area in deciding on the appropriate investigations to undertake across the area. In addition, councils will need to consider their resource and capacity capabilities when deciding on the mix of investigations to undertake.

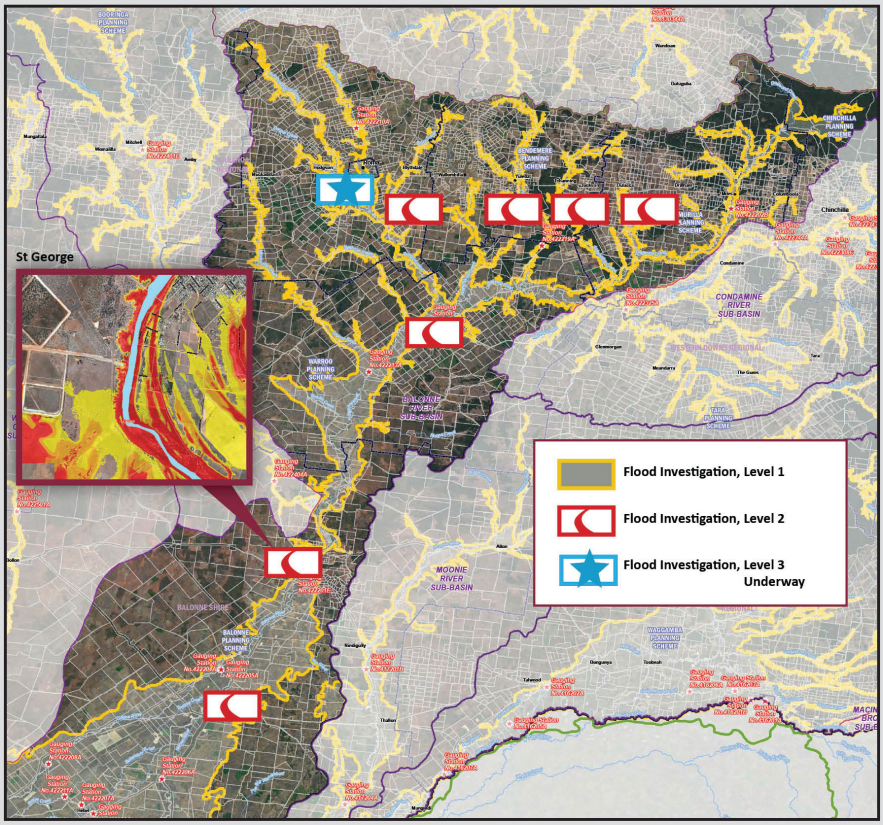


Figure 35:- Balonne River sub-basin with suggested levels of flood investigations for further investigations. Inset shows the hazard map produced for St George based on a Level 2 investigation.

Flood investigation processes

Flood investigation Level 2 rollout plan and data collation

The Authority has identified approximately 140 towns across 45 Councils where the available data, including detailed contour mapping and stream flow information, is suitably detailed to undertake at least a Flood Investigation Level 2 for each of those towns. These towns are classified by the Bureau of Meteorology as being at medium or high flood risk. The Authority has undertaken approximately 20 of these investigations to date.

As part of the Queensland Government's response to the QFCoI and specifically recommendation 2.5, the Authority (with support from the Department of Science, Information Technology, Innovation and the Arts), has committed to undertaking Level 2 flood investigations for up to 100 flood prone towns across Queensland by January 2013. Where an RPC (or Council) is considering undertaking flood investigations for towns in their area, please contact the Authority to ascertain whether a flood investigation may already have been undertaken, or is scheduled to be undertaken, for those towns.

To support this rollout of Level 2 flood investigations, the Queensland Government is continuing its current program of LiDAR (Light Detection and Ranging) data capture across the State. LiDAR systems collect positional (x,y) and elevation (z) data to create digital elevation models. From this model, contour lines can be derived and when overlaid on geometrically corrected aerial photography provide accurate contour maps as a basis for the preparation of flood investigations.

This program will greatly improve the quality of contour information available for hundreds of Queensland's cities and towns and so increase the number of Queensland's towns and cities for which flooding investigations can be undertaken.

Preparing each level of flood investigation

An RPC (or Council) may wish to undertake flood investigations in addition to, or more broadly than those being undertaken by the Authority. Therefore, the outcome of the sub-basin wide approach is that the RPC may nominate a level of investigation for each town or area of the floodplain for which further detailed assessment will be completed.

As discussed in Section 2, the type of flood investigation(s) selected for an RPC area, Council area or town will vary depending on local circumstances.

A step-by-step guide to undertaking both the Level 2 validated and un-validated GIS mapping techniques is provided in Schedule 2. Please note a flood frequency analysis needs to be undertaken in addition to the GIS mapping process in order to produce a flood map that can depict events with a corresponding AEP. If a flood frequency analysis is not undertaken, either mapping technique will only produce a map depicting the extent and depth of the historic event chosen to be mapped (e.g. the 'January 1991 event').

In addition, indicative terms of reference are provided for undertaking a Level 3 flood investigation in **Schedule 3**. These terms of reference may be useful for those RPCs/councils who have identified the need to undertake a Level 3 investigation, but have limited experience in scoping the work required.

Preparing the planning evaluation

Guidance on preparing the planning evaluation, setting flood risk levels and identifying resilience targets is provided in **Section 3 – Implementation**. An indicative planning evaluation process is provided in **Schedule 5**.

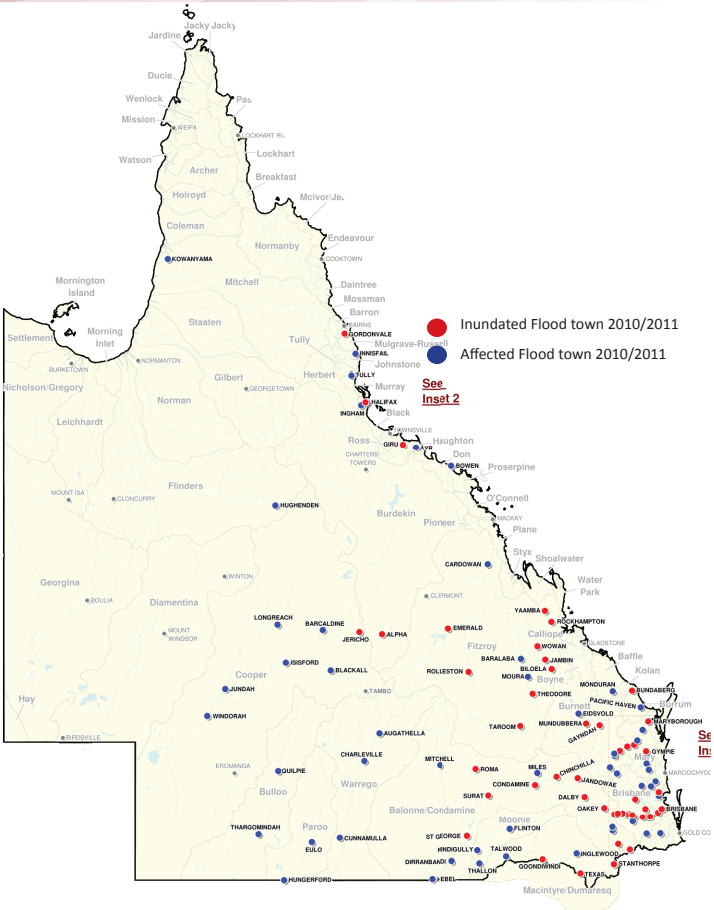


Figure 36: Flood affected cities and towns in Queensland December 2010 and January 2011
Source: BoM

The path toward improved flood maps

The National Academy of Sciences in the United States notes that there are several key considerations for the development of flood maps:

- **Capture of high-quality topographic data (such as through LiDAR capture) is key to flood mapping accuracy**
- **Producing flood depth information, not just extent means the mapping is more useful to a wider range of stakeholders**
- **Linking different data depositories and creating consistency in mapping specifications improves accessibility and usability**
- **Communication of flood risk, not just flood hazard, can ensure the consequence of a flood is understood by the community**

Level 1 Investigations

Use *Planning for stronger, more resilient floodplains* **Part 1 Guideline**

Level 2 Investigations

Use Step by Step process in Schedule 2 for GIS mapping

Level 3 Investigations

Consider the Terms of Reference provided in Schedule 3

Tying it all together

Preparing the planning scheme provisions

Schedule 8 provides detailed examples and guidance on how to write SPA compliant planning tools that have regard to flood. In addition to the guidance provided in **Schedule 8**, when drafting new schemes, planners should consider the following key drafting tips that support the overall approach advocated in this Guideline:

- Continuously use the line of sight concept to maintain focus on what is to be achieved and how throughout the drafting process;
- Use the strategic framework to articulate the outcomes desired for the area; and
- Ensure the code (zone or overlay) provisions link back to and achieve key parts of the strategic framework, specifically the specific outcomes of the Elements, the strategic outcomes of the Themes, and the Strategic Intent.
- Guidance for planning scheme drafters and for planning scheme reviewers is provided in **Schedules 9** and **10** respectively.

Non-planning scheme land use measures

Some land use planning responses to flood risk do not reside within planning schemes, but they do complement the land use intentions presented in the planning scheme. These responses tend to be more interventionist as they may seek to directly address the existing type or scale of development in key areas of risk. Such responses include:

- voluntary or compulsory purchase schemes of properties within areas that are at intolerable risk, with the intention of returning such areas to their natural state, of a more appropiate land use compatable with the flood hazard;
- programmes of planned retreat that involve phasing out of certain land uses over time based on a graduated approach; and
- land swap programmes that encourage residents in higher risk areas to relocate to other, safer locations.

A range of other non-land use planning measures are also available to councils in addressing the risk of flood. While this Guideline considers but does not specifically deal with these measures, it is important to note the possible role structural measures, emergency management and planning, building controls, landscape management programmes and community awareness will play in any response to any hazard assessment undertaken by Council.

Councils should investigate whether such non-scheme approaches are viable having regard to their local circumstances. It is critical to test these proposals against community expectations for the future development of the area affected by the proposal. In some instances, structural control options may be more appropriate to address flood risk in these areas than land use change. However, Council must weigh up the cost, both financial and to the community, of each approach and act accordingly.

Economic viability of land use transition strategies

Councils will need to consider the effects of any land use change proposed through a planning scheme (such as back-zoning) as a result of responding to the identified flood risk. There may be possible impacts on land values, insurance concern or compensation requests for loss of development rights in some circumstances.

In making this decision, Council will determine whether the risk to life and property outweighs the cost of taking such an action. The Planning Evaluation will assist Council to make this decision.

Building Provisions

Building work has not been considered through this Guideline as it is being addressed by the Department of Housing and Public Works (DHPW) through Building Codes Queensland (BCQ). As noted in the Part 1 Guideline, the State Government intends to undertake an early adoption of the Australian Building Codes Board Construction of Buildings in Flood Hazard Areas code into the Queensland Development Code.

It is important to note that the flood investigation options presented in this Guideline will facilitate the operation of these new flood hazard building provisions where councils choose to implement the provisions by following the process suggested in the Part 1 Guideline for determining a flood hazard area under the *Building Regulation 2006*.

In accordance with recommendation 4.6, this Guideline demonstrates how to use the Limited Development (constrained land) zone in future planning schemes, and provides examples of model flood planning controls compliant with QPP (recommendations 5.1 – 5.7.)

Improving Queensland's flood resilience through land use planning

Through its two-part Guideline series, ***Planning for stronger, more resilient floodplains*** has provided detailed planning guidance and a practical suite of measures to help improve the resilience of Queensland's cities and towns to the impacts of flood. While Queensland may be a state of meteorological extremes, with floods, cyclones, droughts and bushfire affecting the State in equal measure, it is intended that ***Planning for stronger, more resilient floodplains*** has furthered the journey to improving floodplain management practice in the State.

In particular, it is intended that:

1. the quality and availability of flood mapping throughout the State will be continuously improved (overtime);
2. governance of floodplains will be improved through a sub-basin wide approach that enables coordinated, fit-for-purpose flood investigations across the whole floodplain; and
3. land use practice within floodplains will benefit from the application of the planning evaluation process and the suite of measures promoted in the Guideline series.

Using this suite of tools, councils for the first time will be able to develop consistent and fit-for-purpose responses to flooding to contribute to a stronger, more resilient Queensland.

Heavily-engineered structural measures can be highly effective when used appropriately, but they share one characteristic: that they tend to transfer flood risk from one location only to increase it in another. In some circumstances this is acceptable and appropriate, while in others it may not be.

Cities and Flooding: A Guide to Integrated Urban Flood risk Management for the 21st Century, Jha, Bloch, Lamond p196

case study

Flooding in St George

Over the last three years, the town of St George (population approximately 2,500) in Queensland's South West has experienced four major floods. The town sits on the Balonne River, one of southern Queensland's largest rivers.

In March 2010 large portions of the western side of town were inundated in a flood that at the time was the highest recorded - 13.39m at the local Bureau of Meteorology (BoM) gauge. Another two floods of 13.20m and 12.49m occurred in early January and late January 2011 respectively.

While other parts of the State were spared a repeat of the 2010/2011 flood events during 2012, South West Queensland again was flooded earlier this year. In February, St George was inundated with a 13.95m flood at the BoM gauge that is now the highest on record.

Events leading up to the flood peak were dramatic and uncertain, with constantly rising predictions of floodwaters occurring every few hours in the days prior to the peak. In line with their usual emergency management practice, Council constructed a temporary earthen levee around much of the town, which was built to withstand a 14.7m flood. However, the predictions for the rising floodwaters from Balonne were as high as 15m – in this scenario, much of the town would have been inundated as the levee overtopped. Given the possibility of such a large flood, the decision was made to evacuate the town ahead of the flood peak to ensure the residents were safe.

Fortunately, this scenario did not come to pass as floodwaters broke out of the floodway north of the town, ensuring the flood peak in St George was reduced to 13.95m. However, while much of the town was spared as the temporary levee held, the western part of town was again severely inundated. This area included approximately 40 existing dwellings and a large amount of existing urban residential zoned land.

In the wake of the floods, Balonne Shire Council has taken significant steps to improve the resilience of its community. The Authority has assisted Council to work through its options to address the flood risk in this western area of town in particular. The following is a summary of how the fit-for-purpose approach to floodplain management has been applied to the specific situation of St George. This case study demonstrates how this approach can be applied in a manner that is flexible, responsive and appropriate for the circumstances to ensure that communities can be presented with options to improve their resilience.

Source: QldRA

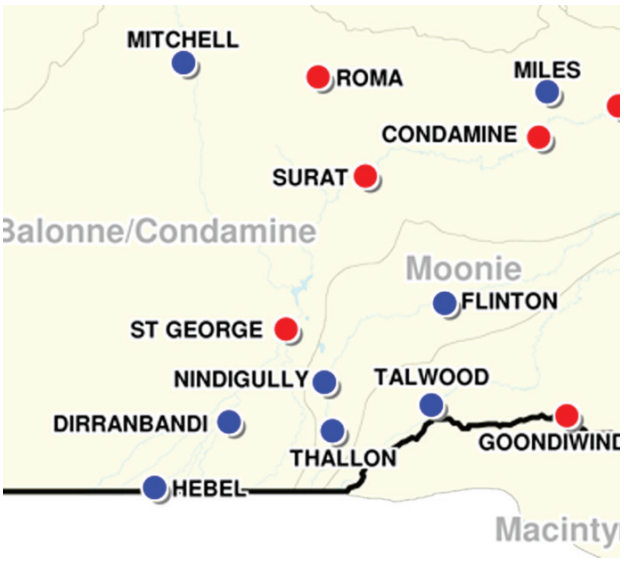


Figure 33: St George show as an affected town from the 2010/2011 event
Source: Bureau of Meteorology.

St George during flood in March 2010. *Source: Balonne Shire Council*

St George during flood in February 2012. *Source: QldRA*

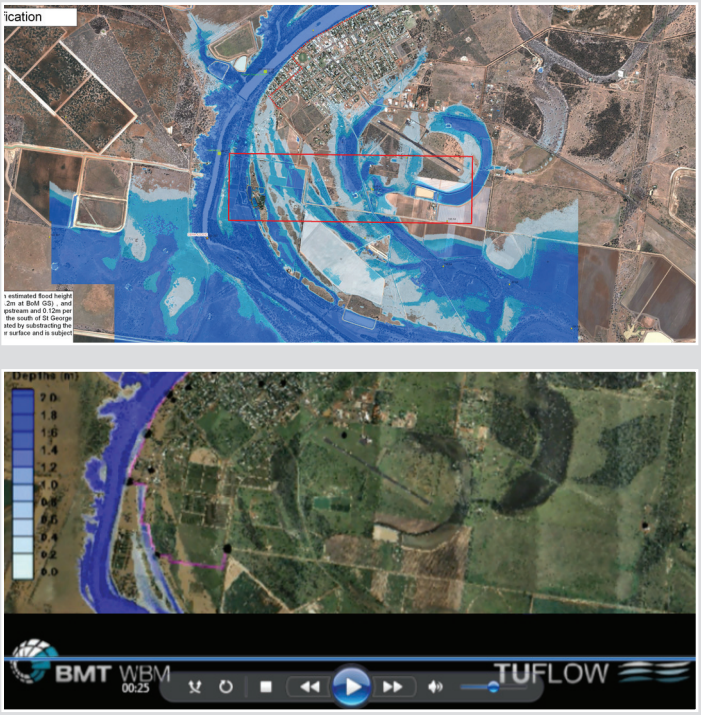
case study

Flood investigations

The Authority piloted its Level 2 GIS-based mapping methodology with Balonne Shire Council in January 2012, prior to this year's highest recorded flood. This Level 2 validated GIS approach was used to develop an initial understanding of the flood hazard affecting the town following the previous highest recorded event of 2010 (approximately a 1% AEP event), which informed initial land use planning evaluations.

As the Balonne River north of St George started to rise in early February this year, the Authority used a Level 2 unvalidated GIS approach to develop flood scenarios that gave a spatial indication of the predictions issued by BoM, which increased from 13.5metres up to 15metres over the period of a weekend. Within several hours of receiving a flood height prediction from BoM, the Authority was able to develop the corresponding flood map showing flood extent and depth and supply it to the State Disaster Management Group. This mapping helped inform emergency management decision making, including the evacuation of the town.

Following the February 2012 flood, the Authority piloted a Level 2 validated model approach with Council to help inform Council decision-making related to land use planning and structural works for the area affected. This validated model approach has confirmed Council's on-the-ground understanding of the flood hazard to which St George is subject, and also provided an indication of the behavior of the Probable Maximum Flood (PMF). Council now has a clearer understanding of the flood hazard affecting St George, from which further analysis of mitigation options can be drawn.



Example outputs of the Level 2 unvaldated GIS investigation ond a Level 2 validated model undertaken for St George. Note the outputs do not depict the same event.

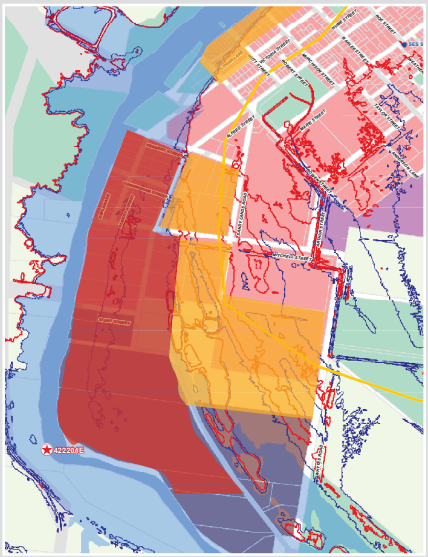
Planning evaluation

Prior to the 2012 event, an initial planning evaluation was completed for the western area of St George affected by the 2010 event. This planning evaluation reviewed the flood hazard in this area, and developed an initial understanding of areas of risk based on the relationship between this hazard and the existing land use. This planning evaluation provided an initial analysis for Council to identify its areas of risk, and to begin to consider options for mitigation, including the possible land use changes that may be required in that area.

Following the 2012 event and the delivery of the Level 2 validated model, the Authority undertook a range of more detailed assessments of the affected area to assist Council decision making, including:

- a damages assessment of the 2012 event;
- a land use assessment to identify vulnerable land uses;
- a built form assessment of property within the area, to understand the number and type structures affected; and
- an urban land supply analysis to quantify an indicative number of future lots the area could accommodate under existing planning controls.

Council, in conjunction with the community and with assistance from the Authority, is using the outputs of the Level 2 validated model and the planning assessments undertaken to develop a more detailed planning evaluation that will consider the range of flood mitigation options in the hazard area, including a levee, back-zoning, buy-back scheme and relocation. Critically, the involvement of the community will determine the level of tolerance to flood, which will assist Council to determine the appropriate response.



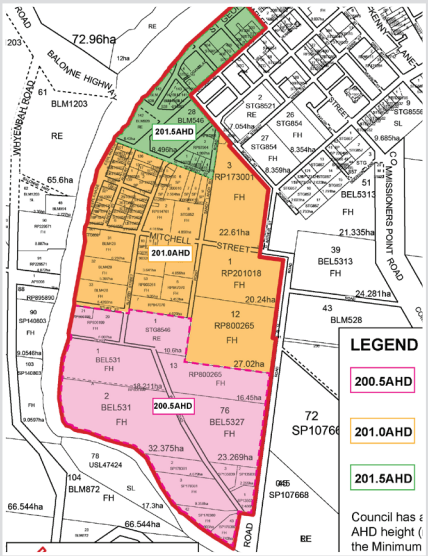
Key areas for consideration in the planning evaluation.

Planning response

Council is currently reviewing its options, however currently under discussion with the community is limiting development in the hazard area through the adoption of a Temporary Local Planning Instrument (TLPI), and the financial, social and environmental implications of a levee. If it is decided that a levee is the most appropriate course of action through the planning evaluation, this will necessitate a more detailed Level 3 flood investigation of the area. This because greater certainty of flood behavior is required in order to design these structural works.

The application of a TLPI can set an intended land use scenario for development in the affected area, ahead of the adoption of its future planning scheme which will provide more detailed land use policy and regulation. Using the Level 2 flood investigation approach and the results of the planning evaluation, through the TLPI Council can limit future development in the area or otherwise adopt habitable floor levels for dwellings and other planning regulations, so that development in the area can be more resilient to future events.

Importantly, by undertaking the fit-for-purpose approach in responding to its highest recorded event, Council have been using a range of tools in a short timeframe to understand, frame and resolve a solution that will be appropriate for their local circumstances.



Subject area for specific statutory planning responses.

Schedule 1 – Sub-basins by Regional Planning Committee Area

Sub-basins in one RPC

Sub-basin	RPC
Balonne River Moonie River Macintyre & Weir Rivers Macintyre Brook Dumaresq River Maranoa River	Darling Downs
Settlement River Eight Mile Creek Lagoon Creek Cliffdale Creek Morning Inlet Mornington L Creek	Gulf Region
Endeavour River Hann River Jeannie River Kendall River Holroyd River Edward River Stewart River Lockhart River Archer River Coen River Watson River Embely River Mission River Wenlock River Misc Other Islands Pascoe River Torres Strait Island Olive River Ducie River Jacky Jacky River Skardon River McDonald River Jardine River Normanby River	No Regional Plan (Cape York)
Walsh River Tully River South Johnstone River North Johnstone River Russell River Daintree River Hinchinbrook Island Mulgrave River Barron River and Freshwater Creek Mossman River Murray River	Far North Queensland
Black River Bohle River Ross River Haughton River Barratta Creek	No Regional Plan (NQ)
Proserpine River Bowen River Pioneer River Plane River Whitsunday Island Isaac River O'Connell River	Whitsunday Hinterland and Mackay
Fitzroy River Waterpark Creek Shoalwater Curtis Island Comet River Calliope River	Central Queensland
Lower Burnett River Elliott River Upper Burnett River Gregory River Isis River Burrum River Lower Mary River Barker & Barambah River Fraser Island	Wide Bay-Burnett
Bremer River Logan River Albert River Coomera & Nerang River Stanley River Caboolture River Stradbroke Island Moreton Island North Pine River South Pine River Maroochy River	South East Queensland
Paroo River Lake Frome	South West
Hay River	Central West

Sub-basins with two RPCs

Sub-basin	Applicable RPC
Cooper Creek	South West Central West
Bulloo River	South West Central West
Wallam Creeks	South West Darling Downs
Eyre Creek	Central West North West
Georgina River	Central West North West
Barcoo River	South West Central West
Boyne & Auburn Rivers	Darling Downs Wide Bay-Burnett
Lockyer Creek	SEQ Darling Downs
Upper Mary River	Wide Bay-Burnett SEQ
Noosa River	Wide Bay-Burnett South East Queensland
Mackenzie River	Central Queensland Whitsunday Hinterland and Mackay
Nicholson River	Gulf Region North West
Cloncurry River	Gulf Region North West
Norman River	Gulf Region North West
Saxby River	Gulf Region North West
Lower Burdekin River	No Regional Plan (NQ) Whitsunday Hinterland and Mackay

Sub-basin	Applicable RPC
Don River	No Regional Plan (NQ) Whitsunday Hinterland and Mackay
Herbert River	Far North Queensland No Regional Plan (NQ)
Palmer River	Far North Queensland No Regional Plan (Cape York)
Diamantina River	Central West North West
Baffle Creek	Central Queensland Wide Bay Burnett
Boyne River	Central Queensland Wide Bay Burnett
Styx River	Central Queensland Whitsunday Hinterland and Mackay
Coleman River	Gulf Region No Regional Plan (Cape York)
Staaten River	Gulf Region Far North Queensland
Kolan River	Wide Bay Burnett Central Queensland
Alice River	No Regional Plan (Cape York) Gulf Region

Sub-basins with three RPCs

Sub-basin	Applicable RPC
Suttor River	Central West No Regional Plan (NQ) Whitsunday Hinterland and Mackay
Warrego River	South West Central West Darling Downs
Nogoa River	Central West Central Queensland Whitsunday Hinterland and Mackay
Dawson River	Darling Downs Central Queensland Wide Bay Burnett
Brisbane River	South East Queensland Wide Bay Burnett Darling Downs
Leichhardt River	Gulf Region Central West South West
Mitchell River	Gulf Region Far North Queensland No Regional Plan (Cape York)
Condamine River	Darling Downs South East Queensland Wide Bay Burnett
Einasleigh River	Gulf Region Far North Queensland No Regional Plan (NQ)
Gilbert River	Far North Queensland Gulf Region North West

Sub-basins with 4 RPCs

Sub-basin	Applicable RPC
Flinders River	Gulf Region North West No Regional Plan (NQ) Central West
Thomson River	North West Central West Whitsunday Hinterland and Mackay No Regional Plan (NQ)
Upper Burdekin River	Far North Queensland North West Gulf Region No Regional Plan (NQ)
Sub-basins mapped with no IFAO - Lake Frome, Hay River	

Sub-basins not mapped

Caboolture River, Stradbroke Island, Moreton Island, Curtis Island, Fraser Island, Whitsunday Islands, Hinchinbrook Islands, South Pine River, North Pine River, Maroochy River and miscellaneous other islands

Schedule 2 – Flood investigation Level 2 step-by-step methodology

Please refer to http://www.qldra.org.au/publications-guides/land-use-planning/planning-for-stronger-more-resilient-flood-plains for the latest step-by-step methodology.

Schedule 3 – Terms of reference – Flood investigation Level 3

Flood investigation level 3
<Insert name of study area>

Project governance

The <*insert name of sub basin*> Flood Investigation sub committee has been established by the <*insert Regional Planning Committee*>. The project subcommittee oversees the project and provides advice to the <*insert the name of the Regional Planning Committee*>.

Objectives

The objective of the flood investigation level 3 is to comprehensively define the flood behaviour and hazards of the <*insert the name of the river*> and its associated sub-basin as shown on attached map <*insert map name/number*>, so that appropriate planning responses can be included in the <*insert planning scheme name*>.

The primary component of the investigation is estimation of flood discharges and Annual Exceedance Probabilities, for floods of various severities, and the estimation of water levels and velocities for those floods.

Rationale for flood investigation Level 3

This level of flood investigation has been selected because: <*insert the below options as appropriate*>

1. the study area covers developed/urban areas;
2. there is a medium to high rate of growth;
3. there is a history of repeated significant impacts of flooding in this area; and/or
4. the community resilience to floods is limited.

Data collection

The data collection phase is to compile available reports and historic information on floods in the study area, including the source of the material. This includes the QldRA mapping showing the Interim Floodplain Assessment Overlay, aerial photography, satellite imagery and other applicable local knowledge.

This will require consultation with a range of organisations including the Bureau of Meteorology, the Department of Environment and Resource Management and Department of Transport and Main Roads as well as local residents who have experienced flood events.

The digital data set provided by the Department of Environment and Resource Management for the Interim Floodplain Assessment Overlay mapping may be used as the base data.

The rationale for determining the level of topographic information collected is to be outlined. Topographic information (typically 0.1 to 0.3m vertical and 1 to 10m grid size) needs to be captured from aerial imagery and or field survey. The grid size should be determined to give a good representation of the areas of interest. Broader scale and resolution of data may be appropriate.

The specification for this topographic detail needs to be confirmed with a Registered Professional Engineer of Queensland due to the complexity of the investigations and the computer modelling to be developed.

A public consultation process is to be conducted to assist in finding all available information. information.

Hydrologic analysis and flood frequency analysis

Determine the design discharge hydrograph and peak design discharges for a range of design floods across the <insert study area name> floodplain by undertaking hydrologic analyses. The design discharge hydrograph and peak design discharges are to be for the following design floods, 2%, 1% 0.5% and 0.2% AEPs and the PMF.

The size and nature of the study area, the availability of recorded flood and rainfall data will determine which method or combination of methods is most effective.

A calibrated hydrological model may be used to estimate design flood flows based on design rainfalls, checked by flood frequency analysis if possible.

The outcome is an estimate of design discharge hydrograph and peak design discharges.
The specification for range of design floods and the approach to be undertaken for the hydrologic analyses needs to be confirmed with an experienced flood modeller who is preferably a Registered Professional Engineer of Queensland due to the complexity of the investigations and the computer modelling to be developed.

Clearly state the rationale as determined by the Registered Professional Engineer of Queensland for the approach undertaken for the hydrologic analyses of design floods. This may include consideration of the data available, the complexity of the investigations and the computer modelling developed.

Hydraulic analysis

Determine the flood behaviour in terms of water levels, velocities and the extent of flooding for the range of design floods being considered.

This may be undertaken using a 1-dimensional (1D), 2-dimensional (2D) or 3-dimensional (3D) model hydraulic model to represent the design discharge hydrographs and peak design discharges for the design floods.

The model is to be calibrated to historical flood events.

The rationale as determined by the Registered Professional Engineer of Queensland for the approach undertaken for the hydraulic analyses should be outlined. This may include consideration of the data available, the complexity of the investigations and the computer modelling developed

Climate change

Climate change is to be incorporated using the "*Increasing Queensland's resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study*", and specifically how the following climate change factors for increased rainfall intensity. The climate change factors are - a 5 per cent increase in rainfall intensity per degree of global warming. This 5 per cent increase in rainfall intensity per degree of global warming can be incorporated into the 2%, 1%, 0.5% and 0.2% Annual Exceedance Probability (AEP) flood events. For the purpose of applying this climate change factor, use the following temperature increases and planning horizons: 2°C by 2050, 3°C by 2070 and 4°C by 2100.

Accounting for uncertainty

The uncertainty related to the output from this flood investigation is to be outlined.

The degree of uncertainty in the definition of flood behaviours is dependent on the quality and the quantity of topographic, rainfall, streamflow and flood data. The uncertainty relates to the quality of this data.

The grid size and vertical accuracy of topographic information is to be outlined. This will include recognition of the type of any development to be assessed.

Outline if a sensitivity analysis was used to test the significance of errors in relevant data inputs and assumptions.

Deliverables

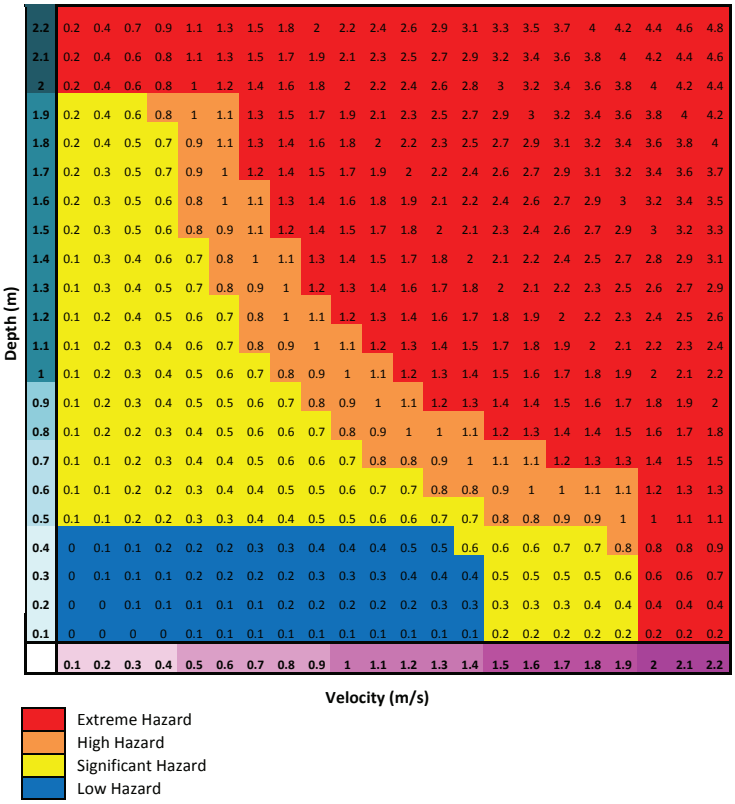
The flood study is to produce maps showing the extent of various design flood flows (at a range of AEPs – 2%, 1% 0.5% and 0.2% and the PMF), and low/medium/high hazard areas based on depths and velocities across the study area. Determination of low/medium/high hazard areas should be made with reference to the best practice categorisation of these hazard areas relative to at least flood height and velocity.

A computer model is to be made available to enable assessment of new development (where size of development is greater than the distance between cross-sections).

Schedule 4 - Flood hazard criteria

Indicative flood hazard criteria

The following indicative flood hazard criteria have been prepared for use in preparing flood investigations (level 2), and planning evaluations based on latest available engineering guidance. In the absence of other more appropriate flood hazard definitions, the criteria below may be used.



Rules

	Low	Significant	High	Extreme
Depth	<0.5	<2	<2	2+
Velocity	<1.5	<2	<2	2+
DxV Ratio	<0.6	0.6 to <0.8	0.8 to <1.2	1.2 +

Rationale

1. **Low** – self evacuation possible for adults and children, vehicle stability within tolerance for large 4WD
2. **Significant** – working limit for trained safety workers, Vehicle evac unsuitable, Building Code limitation
3. **High** – limit of uncompromised stability for adults (dangerous to most)
4. **Extreme** – in excess of known stability limits

References

1. ARR Revision Project 10: Appropriate Safety Criteria for People
   a. Children – Significant Hazard DV ≤ 0.6 & D ≤ 0.5
   b. Adult – Moderate Hazard DV ≥ 0.6
   c. Working limit for trained safety workers or experienced and well equipped persons DV < 0.8
2. ARR Revision Project 10 State 2 Report: Appropriate Safety Criteria for Vehicles (Draft)
   a. Large 4WD DV ≤ 0.6 & D ≤ 0.5
3. Dale et al. (2004) Structural flood vulnerability and the Australianisation of Black's Curves
   a. Fibro/Tile construction D < 0.5 & V < 2
   b. Draft QDC for flood hazard areas for Deemed to Satisfy provisions – V < 1.5
4. BMT WBM (2012) Newcastle City-wide Floodplain Risk management Study and Plan P.81-82
   a. Hydraulically suitable for wading by able-bodied adults V < 2 & D < 0.8
   b. Hydraulically suitable for light construction (e.g. timber frame and brick veneer) V < 2 and D < 2
5. Jonkman et al. (2008) Methods for the estimation of loss of life due to floods: A literature review and proposal for a new method Natural Hazards P. 364
   a. Level of hazard to people can be categorized as low, moderate, significant or extreme.

Schedule 5 – Planning evaluation checklist and process

	Checklist – Existing Urban Areas	Considerations	Notes	Data Required	Score
1	What is the nature of the hazard in the floodplain and where does it occur?	In terms of the flood hazard affecting a Council area, it is likely that there are varying degrees of hazard depending on location relative to the main floodway. It is important to note that different land use responses may be possible in each location due to the variation in flood hazard.	Understanding of hazard derived from flood investigation output	Output of Level 2 or Level 3 investigation	Exposure
2	Where are existing settlements, infrastructure or other places of key social or economic importance located within each hazard area?	It is important to identify existing key areas and uses that may be susceptible to the flood hazard identified through the flooding investigation. The relationship of the hazard to these areas/uses will frame a decision as to the current appropriateness of that area/use in that location, and will also prompt a question of the appropriateness of future use or intensification of that existing area.	A review of the Council area to identify points of interest, critical infrastructure, services, economic drivers, and industries can be undertaken to identify the key areas for consideration located within each hazard area	Map with key places/areas of social or economic importance spatially represented relative to the hazard, with commentary on important areas/issues	
3	Are there existing development commitments in the hazard areas?	Existing development commitments may need to be considered in land use decisions to alter zoning or avoid development in the area subject to the hazard.	A review of existing development commitments will assist in identifying additional or future risk areas for consideration	Notes on review undertaken with key commitments specified, may also be spatially represented on a map	
4	Do these exposed places include vulnerable persons, property and/or infrastructure or is the hazard (such as flood depth or velocity) when it occurs so great that living in the area is of significant concern?	Land uses may involve vulnerable persons (such as child care or aged care), or vulnerable property (such as libraries, funeral parlours or places of cultural significance. These land uses are at greater flood risk than others, regardless of the nature of the hazard. Other land uses may be more tolerant to certain instances of flood hazard		A qualitative assessment (e.g. based on historic records and community information) or formal quantitative vulnerability assessment may be undertaken to identify vulnerable persons/ property, depending on local circumstances	Vulnerability
5	Is the area served by appropriate emergency management procedures?	Evacuation routes, warning systems and emergency management procedures are critical in both existing and future urban settlements. Intensification of development in particular depends on the availability of clearly identified and passable evacuation routes.	A review of existing or proposed emergency management procedures (e.g. evacuation routes and early warning systems) will assist in determining how resilient the community may be to flood hazard	Map or reporting based on existing Local Disaster Management Group procedures	
6	Is the built form resilient to the hazard?	Some existing communities respond very well to flood hazard, and this can be attributed primarily to two things – the resilience of the community and the type of built form prevalent in the area. For example, the 'Queenslander' style of home performs far better in a flood than a slab on ground home, in terms of actual damage, cost to repair and the time required for the repairs.	A built form assessment may be used to determine built form styles in the subject area	Built form assessment (via formal site-based survey, or via desktop analysis of aerial imagery/street view information)	
7	What is the community's attitude to the hazard – are they resilient or vulnerable?	Resilience generally is an unmeasurable quality, given it relates to the 'strength' of a community to withstand and bounce back from the impacts of a natural hazard. However, it may generally be quantified to some degree by an assessment of community awareness of the hazard and its associated risk, the level of property insurance prevalent in the community, in addition to levels of employment and (to some degree) the socio-economic status of residents.	Community attitudes and resilience can be ascertained through normal community consultation methods during planning scheme preparation, and also via more formal methods such as insurance reviews and socio-economic analysis	Flood hazard-specific public consultation strategy for engagement during planning scheme preparation process (e.g. online commentary, workshops, social media etc) Analysis of insurance levels, extent of home ownership versus renting, socio-economic analysis	
8	Is there an overriding economic or social need to continue living and working in this area?	If the consequence to life or property is acceptable in an area but may not be ideal, where such areas are of significant economic or social importance, a balanced approach to the land use response for this area should be taken that considers these economic and/or social needs.		A qualitative assessment (e.g. based on Council's strategic or community plan) or formal economic analysis may be undertaken, depending on local circumstances	Tolerability
9	Are there existing or proposed structural controls for the area that will reduce the hazard?	Existing or proposed structural controls (such as levees, floodgates or dams) will have a significant impact on the land use controls proposed for an area. Such controls may allow a wider range of development types and intensities in the area.	A review of existing or proposed structural controls should be undertaken to ascertain their role in altering the hazard	Report on existing or proposed structural mitigation controls and their function, benefits and dis-benefits	
10	What are the community's expectations regarding immunity and protection?	Community expectation of roles and responsibilities will determine which land use transition strategies Council may consider. This may be a dynamic matter that is influenced (either positively or negatively) by community exposure to recent events	Community expectations of flood immunity can be ascertained through normal community consultation methods during planning scheme preparation	Flood hazard-specific public consultation strategy for engagement during planning scheme preparation process (e.g. online commentary, workshops, social media etc)	
				Consequence Score (E + V – T)	

Use this checklist as a 'ready reckoner' of key issues to address in the planning evaluation process. Refer to the following step by step process to determine risk levels.

Planning evaluation – determining risk levels

The following is a step-by-step guide to answering the questions in the planning evaluation checklist to identify and treat flood risk. See **Section 3 – Implementation** for more information. Evaluations should be undertaken on a lot by lot basis, but where lots are large (eg. rural properties), these may be divided into smaller areas for the purposes of evaluation.

Step 1 – Select a flood likelihood to undertake the planning evaluation and create flood map

AEP	Chance of occurrence in any 1 year period	Chance of occurrence in any 70 year period	Chance of occurring twice in any 70 year period
10%	1 in 10	99.9%	99.3%
5%	1 in 20	97%	86%
2%	1 in 50	76%	41%
1%	1 in 100	51%	16%
0.5%	1 in 200	30%	5%
0.2%	1 in 500	13%	

Note: This step is the output of a flood investigation Level 2 or Level 3, as discussed in Section 2 – Analysis. The ability to choose a flood likelihood to evaluate will be dependent on whether that likelihood was mapped as part of the flooding investigation.

Step 2 - Identify Exposure to hazard per lot

Hazard Severity* (at selected likelihood)	Land Use Type (existing and/or future)	Score
N/A	Landscape	0
N/A	Open space and recreation/Rural	1
Low Hazard	Industrial	2
Significant Hazard	Commercial	3
High Hazard	Infrastructure & Utilities/Rural Residential	4
Extreme Hazard	Residential/Community & Cultural	5

Read table from left to right and from top to bottom. The highest score assigned must be the score chosen to identify Exposure.

E.g. A low hazard affecting a landscape area will score 3, while that same hazard affecting a residential lot will score 5.

Equally, an extreme hazard will always score 5 regardless of the land use it affects.

** Derived from AR&R Project 10 (Australian Rainfall & Runoff, Revision Projects, Project 10 Appropriate Safety Criteria for People, and other references) – refer to Schedule 4 for the breakdown of flood depths and velocities*

Step 3 – Identify Vulnerability to hazard severity per lot

Vulnerable Land Use	Built Form & Associated Safety	Flood Warning Times* for affected persons	Isolation of affected persons in urban areas via nearby roads	Score
Existing/proposed built form not affected by hazard (regardless of use), or No existing/proposed vulnerable land use or affected persons (e.g. Landscape, Open Space and Recreation)	Existing built form not affected by hazard	More than 3 days	No isolation	0
Commercial, Industrial, Rural, Rural Residential and Residential without vulnerable persons	At grade – industrial	49 hours – 72 hours	0.2%/0.1%/PMF	1
Hazardous Materials/ Warehousing	Elevated (elevated above selected flood), or Where currently vacant or underutilised, ability of zoned use(s) to be compatible with flood hazard	25 hours – 48 hours	0.5%	2
Community & Cultural with Vulnerable Property, or Minor infrastructure	At grade – commercial	13 hours – 24 hours	1%	3
Community & Cultural with Vulnerable Persons, or Residential with Vulnerable Persons	At grade - community	7 hours – 12 hours	2%	4
Evacuation Centres/Airports/ Other Critical Infrastructure or	Not elevated above selected flood – residential,			
Where currently vacant or underutilised, inability of zoned use(s) to be compatible with flood hazard	Less than 6 hours	10%	5	

Read table from left to right and from top to bottom. The highest score assigned must be the score chosen to identify Vulnerability.

E.g. A residential property would score 1 where no other vulnerability considerations were present (i.e. the building on the lot may be out of the hazard). However, where this property is elevated above the selected flood, the score increases to 2. Where it is not elevated, the score increases to 5.

Equally, any land use with less than 6 hours flood warning will always score 5 regardless of the use.

** Warning times based on BoM Classification of less than 6 hours warning as a 'flash flood', with per-day metrics used for warning times greater than 6 hours.*

Step 4 – Identify Tolerability to hazard severity per lot

Community Awareness/ Understanding	Community Perception of Hazard	Community Preparedness	Emergency Management* Procedures/Evacuation	Level of Protection to Lot from Existing or Proposed Structural Works (e.g. Levee)	Ability of use to remain operational during/after selected flood event (critical infrastructure only)	Score
OVERRIDING NEED TESTS^						
Unaware	Intolerant and not resilient	No individual preparedness, business continuity & social networks	For residential/critical infrastructure - no emergency services access to lot, or For non-residential - no evacuation procedures in place on lot	None	Not able to remain operational	0
Partially Aware	Fearful and generally not resilient	Limited individual preparedness, business continuity & social networks	For residential/critical infrastructure - limited emergency services access to lot, or For non-residential – limited evacuation procedures in place on lot	Less than 2%	N/A	1
Moderately Aware	Cautious and moderately resilient	Acceptable individual preparedness, business continuity & social networks	For residential/critical infrastructure – acceptable emergency services access to lot, or For non-residential – acceptable evacuation procedures in place on lot	2% - 1%	Reduced but acceptable operations	2
Generally Aware	Generally tolerant and resilient	Strong individual preparedness, business continuity & social networks	For residential/critical infrastructure – strong emergency services access to lot, or For non-residential – strong evacuation procedures in place on lot	1%	N/A	3
Very Aware	Tolerant and Resilient	Very strong individual preparedness, business continuity & social networks	For residential/critical infrastructure – very strong emergency services access to lot, or For non-residential – very strong evacuation procedures in place on lot	Above 1%	Able to remain fully operational	4
No persons or property affected, or emergency services/evacuation procedures and structural controls unnecessary						5

Read table from left to right and from bottom to top. The lowest score assigned must be the score chosen to identify Tolerability.

E.g. A community that is aware and tolerant of the flood hazard will score more than a community that is unaware or intolerant. Tolerability therefore can include common elements such as community awareness that are not lot-specific.

Equally, critical infrastructure that is rendered inoperable by the selected flood event, regardless of community awareness or perception must score 0. This is a lot-specific criterion.

^ Overriding economic or social need to remain in a flood hazard area must balance these imperatives with community awareness/understanding of the hazard to which they are subject, the community's perception of the hazard, their preparedness to such a hazard, and the extent of responsibility placed upon emergency management.

** Advice should be sought from local disaster management coordinator in evaluating emergency management procedures/evacuation plans*

Step 5 – Calculate consequence score per lot

Calculate Consequence Score using the consequence formula:
Consequence = Exposure + Vulnerability – Tolerability
E.g. Consequence = 4 + 4 - 2

Step 6 – Apply consequence score to likelihood x consequence matrix to determine risk level per lot

	Consequence Score										
Likelihood	0	1	2	3	4	5	6	7	8	9	10
10%	0	10	20	30	40	50	60	70	80	90	100
5%	0	5	10	15	20	25	30	35	40	45	50
2.5%	0	2.5	5	7.5	10	12.5	15	17.5	20	22.5	25
2%	0	2	4	6	8	10	12	14	16	18	20
1%	0	1	2	3	4	5	6	7	8	9	10
0.5%	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
0.2%	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
0.1%	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1

Broadly Acceptable
Tolerable subject to ALARP
Generally Intolerable

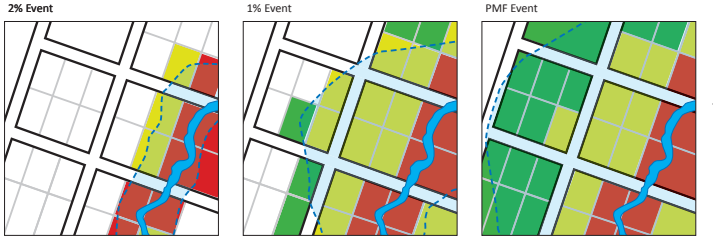
Step 7 – Map risks and calculate area (ha) at risk

Refer to Case Study in **Schedule 7** for a demonstration.

Important note: When undertaking multiple planning evaluations (i.e. of multiple event likelihoods), the approach taken to quantifying the risk should be a cumulative one. That is, once a planning evaluation has been completed for a certain event (e.g. a 2% event), subsequent planning evaluations of more infrequent events (e.g. a 1% event) should not also include those lots that were affected during the 2% event – the evaluation of the 1% event should only be undertaken on those lots that were unaffected by the 2%.

This means that where a lot is identified at intolerable risk during a lesser event, (e.g. a 2% event) this risk level should not be altered, but simply brought forward in the planning evaluation undertaken for the 1% event. This is due to the fact that if a lot is identified at intolerable risk during a 2% event, it will not be subject to lesser risk during a 1% event given the 1% would by its nature include a 2% event that is then exceeded.

Therefore, for completeness, when displaying risk levels on a map for a certain event (e.g. the 1% event), this map should display the outputs of previous evaluations (such as the 2% event) on those lots affected by those lesser events, and the risk levels identified by those additional lots only affected by the 1% event. A mapped example is provided below.



Successive evaluations should only be made for lots not affected in a more frequent event. As each planning evaluation is undertaken, the evaluation should maintain the level of risk identified on a lot by the evaluation of the more frequent event.

Step 8 - Repeat evaluation for less frequent AEP levels

In order to provide a wider understanding of the flood risk affecting an area, evaluations of at least the key AEP levels (such as the 2%, 1%, and 0.5% AEP) should be undertaken to ensure that planning responses can be developed for a wider level of risk than simply the 1% AEP event.

Definitions - Land use type classification

Land Use Type	QPP Activity Group	Additional Land Use Description
Landscape	None	National Park/State Forest, Unallocated State Land, area for environmental management, waterbody & waterway, nature conservation
Open space and recreation	Recreation Activities	Golf course, paintball
Rural	Rural Activities	N/A
Industrial	Industry Activities Waterfront Activities	N/A
Commercial	Business Activities Centre Activities Entertainment	N/A
Infrastructure & Utilities (including Critical Infrastructure and Minor Infrastructure)	None	Critical Infrastructure - Airport, power station, sewage treatment plant, water supply plant, electrical sub-station, telecommunications sub-station Infrastructure - mining/ resource activities, railway station/network, port Minor Infrastructure – roads, sewerage, stormwater networks, etc.
Rural Residential	None	Acreage dwellings
Residential	Accommodation Activities	N/A
Community & Cultural	Community Activities	Hospital, police station, fire station, ambulance station, museum, library

QPP Activity Groups specified are found in draft QPP V3.0.

Other definitions

Affected persons – those persons who are either impacted by floodwaters directly on their properties, or impacted by isolation due to rising floodwaters elsewhere.

Underutilised – where a lot is zoned under the existing planning scheme for a certain use, however the existing use on site is not that highest and best use possible. For example, a 2 hectare lot zoned urban residential that includes only one dwelling house on that lot. This lot could be expected to accommodate additional single dwellings through subdivision because of its urban residential zoning and is therefore underutilised.

Planning evaluation – risk treatment process

Step 1 – Set resilience target

a. Set scale for target (suburb/town/LGA/Regional Planning Area) – based on prioritisation performed in Step 8 in Planning Evaluation – Determining Risk Levels

b. Identify key risk priority through results of risk assessment and community consultation, such as:

   i. Treating intolerable risks, or treating intolerable risks to residential properties

   ii. Treating risks to linkages (e.g. links to critical infrastructure)

c. Refine target(s) over the course of the risk treatment process, if required.

Step 2 – Identify options to treat flood risk

a. Select the land use response(s) appropriate for the risk level for assessment relative to local circumstances

   i. Identify the measures needed to achieve that land use response – refer to page 27 and Schedule 6

b. Measures to achieve the land use response will include:

   i. Planning scheme responses (zoning, overlays, development requirements, etc) – refer to Schedules 6 and 8

   ii. Non-planning scheme measures such as property buy-back, relocation, resumption etc

   iii. Structural works such as levees

   iv. Building controls (setting habitable floor levels etc)

   v. Emergency management plans and procedures

   vi. Community awareness programmes

c. Identify the role each measure plays in treating risk, including function, benefit(s) and limitation(s)

   i. Where back-zoning through a planning scheme is proposed as a potential risk treatment mechanism, use the back-zoning assessment criteria in this schedule to guide this process

Step 3 – Compare options & prepare suite of measures

a. Compare measures needed to achieve desired land use response relative to the following criteria:

   ii. Flood mitigation/avoidance function

   iii. Cost/financial implications (including whole-of-life cycle costings)

   iv. Resourcing requirements

   v. Community views

   vi. Social & environmental implications

   vii. Timing

b. Prepare complementary suite of measures appropriate to local circumstances, ensuring role/function of each measure is articulated relative to achieving the resilience target set

Step 4 – Develop implementation plan

a. Agree suite of options and test with community – refine if necessary based on community feedback

b. Prepare implementation plan once options are agreed that sets works programme and timing schedule to achieve resilience target

c. Deliver options as per implementation plan

Step 5 – Manage ongoing risk

a. Perform development assessment in accordance with planning scheme requirements

b. Undertake emergency management procedures as required

c. Undertake maintenance of structural works in accordance with design/operational requirements

Schedule 6 - Land use response and back zoning assessment criteria

Land use responses

Land Use Responses and Possible Scheme Measures				
Planning Evaluation Risk Category	**Land Use Response* & Description * From table 7**	**Possible Land Use Transition Strategies**	**Possible Planning Scheme Options**	**Land Uses (QPP terms) * Consider relative to urban/rural location**
Intolerable Risk	**Retreat from specific existing urban areas** **Expand into new areas suitable for urban development** *The strongest land use response required to avoid risks to life or property. This would involve limiting land uses (e.g. 'back-zoning' in existing areas) and active measures to move people or property out of harms way*	• Actively limit future development in this area that may increase risk to life or property through strong zoning controls • Promote transition of at-risk existing uses & promote low-impact, non-urban uses • Discourage further intensification of existing uses • Implement built form improvements through application of Overlay Code for remaining land uses • Consider how to maintain community connectivity in areas to be transitioned • Also investigate complementary measures (e.g. voluntary purchase) to actively reduce existing at-risk people and property in this area • Also investigate structural controls to further reduce risk to life and property	Strategic Framework: • Intents/Outcomes limits development in these areas that would create unacceptable risk as per SPP1/03 policy Zoning: • Limited Development • Environmental Management • Conservation • Sport & Recreation • Open Space • Waterfront and Marine Industry • Rural • Flood-constrained Precincts as required (e.g. Residential Living – Flood Constrained Precinct) Overlay: • Built form controls	Appropriate (subject to assessment): Aquaculture Cropping Landing Market (temporary only) Outdoor Lighting Outdoor Sport and Recreation Park Permanent Plantations Port Services Waterfront and Marine Industry
Tolerable Risk (subject to ALARP)	**Adapt existing areas** **expand into new areas suitable for urban development** **Maintain agricultural and rural landscape values** *A considered approach to land use and urban design is required where a greater range of land uses may be appropriate than in areas of highest risk, but others generally remain inappropriate*	• Discourage sensitive land uses but permit majority of land uses • Use Precincts as transition zones for land use change over time • Density increases may be appropriate in line with good planning principles (e.g. TOD or infill development) - where strong emergency management, evacuation routes & early warning systems are available • Implement built form improvements through application of Overlay Code • Investigate improvements to transport/infrastructure linkages to improve resilience through PIP	Strategic Framework: Intents/Outcomes discourages incompatible land uses in these areas as per SPP1/03 policy Zoning: • Flood-constrained Precincts within all zones as required (e.g. Residential Living – Flood Constrained Precinct) Overlay: • Built form controls	Inappropriate: Child Care Centre Community Care Centre Community Residence Correctional Facility Educational Establishment Emergency Services High Impact Industry Hospital Intensive Animal Husbandry Intensive Horticulture Major Electricity Infrastructure Major Sport, Recreation and Entertainment Facility Medium Impact Industry Non-resident Workforce Accommodation Noxious and Hazardous Industry Relocatable Home Park Residential Care Facility Retirement Facility Substation Telecommunications Facility Tourist Park Appropriate: All other uses (subject to assessment)
Broadly Acceptable Risk	**Adapt existing areas** **Expand into new areas suitable for urban development** *Minimal land use changes required to respond to flood risk - urban design controls may be implemented to improve resilience*	• Broad consideration to be given to concern of flood – no specific strategy suggested • Land uses and density increases appropriate in line with good planning principles (e.g. TOD or infill development) - where strong emergency management, evacuation routes & early warning systems are available • Implement built form improvements through application of Overlay Code • Investigate improvements to transport/infrastructure linkages to improve resilience through PIP	Strategic Framework: • Intents/Outcomes support appropriate development in these areas Zoning: • No changes based on flooding concern Overlay: • Built form controls	Appropriate: All uses subject to appropriate built form controls being achieved

Land Use Responses and Possible Scheme Measures

Assessment criteria for back zoning and other measures to address intolerable flood risk

Please refer to Section 3 – Implementation for detailed advice on how to address intolerable flood risk by back zoning the affected lots through a local planning instrument such as a planning scheme. These assessment criteria generally follow the risk treatment process outlined in S**ection 3 – Implementation**, but provide specific guidance for strategic planners to consider when preparing new planning schemes.

For the purposes of this Guideline, back zoning is defined as the planning process used to reduce the currently permissible development capability of land to a type or level that is compatible with the constraints affecting the land.

Other sections of the Guideline provide advice on how a planning scheme may treat areas of tolerable and broadly acceptable risk.

Performance Outcome	Acceptable Outcome
PO1 An analysis of the flood risk present on the site relative to a range of flood events is undertaken.	**AO1.1** Planning evaluations of at least three flood events (including the 2%, 1% and 0.5% AEP levels of likelihood) are undertaken to quantify the flood risk of the affected lots at each level of flood likelihood. *Note: Councils should use the planning evaluation process in Section 3 – Implementation, or industry standard floodplain risk management process to quantify the flood risk(s).*
PO2 Development scenarios for the highest and best use(s) allowable under the existing planning scheme are tested and evaluated for their practical ability to be compatible with the flood hazard(s). *Note: The existing land use may be the highest and best use of the land – such as an existing dwelling house on land zoned as low density residential.*	**AO2.1** Development scenarios envisaged by the existing planning scheme are tested to evaluate the practical outcome(s) of the development scenario, against at least the following: • Subdivision requirements, such as filling of lots to achieve flood immunity and creation of flood free access to the lot; • Built form requirements, such as raising of habitable floor levels to achieve flood immunity; • Operational work requirements, such as not adversely impacting upon flood flows to neighbouring properties; and • Operational requirements, such as the preparation of emergency management plans to evacuate residents. *Note: Development scenarios that result in exposing persons or property to intolerable levels of risk, or that result in unacceptable built form outcomes to make the development compatible (such as an unacceptable volume or level of fill, or unmitigated flows of floodwater onto adjacent sites) are considered incompatible with the flood hazard.*
PO3 Where the development scenarios allowable under the planning scheme are not appropriate or practical, planning and non-planning measures are developed to address the flood risk on the lot.	**AO3.1** Planning measures may include: • Planning scheme measures such as back-zoning and supporting scheme provisions (including overlays & development codes); • Voluntary purchase or resumption; • Planned retreat; • Land-swap; and/or • Other land use programme(s) as required. **AO3.3** Non-planning measures may include: • Building controls; • Structural works (e.g. levees); • Emergency management procedures; and • Community awareness/education. **AO3.2** Planning and non-planning measures are developed in combination to ensure that a comprehensive and complementary approach to building resilience is undertaken. *Note: Back-zoning may be employed as a specific planning scheme measure for lots at intolerable risk of flood, however this approach should be complemented by voluntary purchase, resumption or land swap programmes to minimize economic/social hardship for those persons at intolerable risk of flood. Non-planning measures such as structural works and emergency management should also be considered as complementary measures to address the intolerable flood risk, if appropriate.*

PO4 Planning scheme measures proposed (such as back-zoning) ensure risk to life and property presented by the events is adequately addressed, while minimising sterilization of land and economic impact of the planning scheme measures.	**AO4.1** A structure plan process is undertaken on each lot (or group of lots) classified at intolerable risk to identify part of the site (if any) that is: • Not subject to a flood hazard at the level of likelihood(s) used by Council to manage development; or • Able to accommodate development that is compatible with that specified level of flood hazard. **AO4.2** Planning scheme measures consider and address the cost/economic implications of the option for Council and the landowner, including any compensation that may be payable pursuant to the relevant legislation (refer to AO3.2 above). **AO4.3** For back-zoning options, zoning choices are drawn from the Queensland Planning Provisions (QPP) and promote the highest and best use(s) for the site that is compatible with the flood hazard presented on the site. *Note: Split zoning may be used where parts of lot(s) are not subject to the level of flood likelihood used by Council to manage development* **AO4.4** Due consideration is given to decommissioning of existing infrastructure or future infrastructure plans in the subject areas, including changes required to: • Ongoing maintenance programmes; • Existing capital works programmes; and • Future infrastructure planning
PO5 The planning measures are presented to the community for consideration and comment prior to adoption by Council.	**AO5.1** The community is consulted via: • Formal notification of affected property owners, seeking their comment on the planning measures proposed; • Community workshops to present and discuss the flood risk, the development scenarios tested and the planning measures developed; • Any formal consultation requirements pursuant to the *Sustainable Planning Act 2009* (as amended) related to compensation; and • Consultation methods used in planning scheme preparation pursuant to the *Sustainable Planning Act 2009.*
PO6 The planning measure(s) adopted by Council are included in Council's planning scheme.	**AO6.1** Where a new QPP-compliant planning scheme is due for preparation, the planning measure(s) adopted are incorporated into this new scheme. **AO6.2** Where an existing planning scheme is in place and is not likely to be renewed within a reasonable timeframe (i.e. within 1 year), the planning measure(s) are incorporated into the planning scheme via an amendment process pursuant to the relevant guidelines (such as *Statutory Guideline 1/12: Making and Amending Local Planning Instruments).* *Note: A planning scheme amendment is the preferred mechanism to address flood risk rather than a temporary local planning instrument (TLPI).*

Schedule 7 - Planning evaluation case study

The following is a worked example of how to undertake the planning evaluation process described in **Section 3 – Implementation**, using the detail provided in **Schedules 5** and **6**.

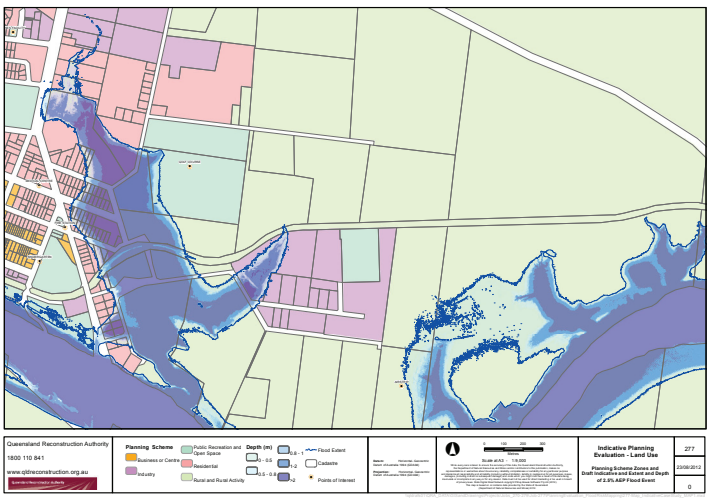
This case study is of a 'real-world' Queensland town recently affected by the recent flood events of 2010/2011. The town is at considerable flood risk, however in the past there has been limited opportunity to undertake flood investigations and evaluation of options to address this flood risk. The planning evaluation case study below demonstrates options for how this town might improve its resilience to flood events in the future through a risk-based, fit-for-purpose approach.

The case study evaluates the risk of a recent flood event, which was identified as a 2.5% AEP flood event via a Level 2 flood investigation that was undertaken to inform the evaluation process. The flood extent of this event, its hazard (expressed through depth), and the existing land use planning zones are displayed in **Map 1** below.

The flood event selected is a relatively frequent occurrence. Such an event has an approximately 80% chance of occurring at least once in 70 years, and approximately 50% chance of occurring twice in this period. The historic flood record for this town indicates that a flood of this magnitude or greater has actually occurred three times in the last 70 years.

Overview

Case Study Details	
Location	Regional Queensland
Population	1100
Flood investigation undertaken	Level 2 – Validated GIS
Flood event selected for evaluation	2.5% AEP flood event – historic event
Main areas of flood hazard exposure	• Residential areas • Road links to industrial estate and airstrip • Rural areas



Map 1 – The subject area. Existing land use zonings for the town overlaid with the indicative 2.5% AEP flood event that recently affected the town. Refer to larger map at end of Schedule 7 for more detail.

Planning evaluation – determining risk levels

Using the step by step process provided in **Schedule 5**, the following suite of maps were developed to identify those properties subject to flood exposure and vulnerability, as well as the level of flood tolerability, in order to assign specific levels of flood risk to each property. A spreadsheet (**Figure 1**) was prepared so that the exposure, vulnerability and tolerability scores for each lot could be identified and risk per lot calculated. Each lot in the area of interest was assigned a simple number (1, 2, 3, etc) which was used as a unique identifier for the calculations and the mapping created from this spreadsheet. In practice, Lot/RP numbers can be used as this unique identifier.

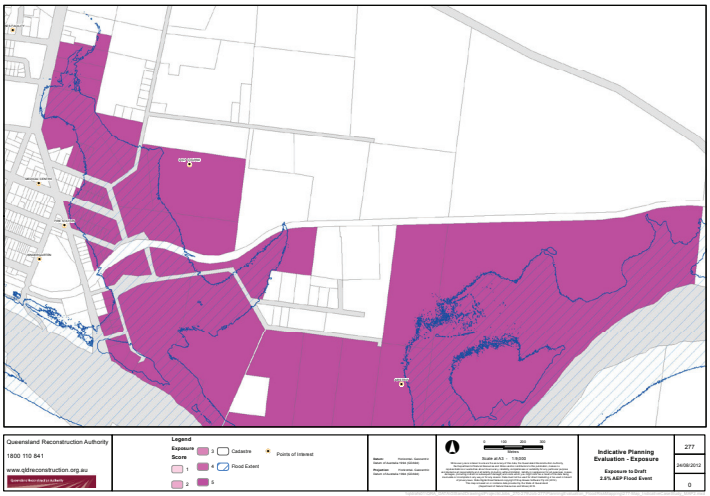
Lot	Exposure	Vulnerability	Tolerability	FloodRiskScore	FRS label	FloodRiskName	Generic_SGE
8	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
7	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
6	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
37	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
11	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
29	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
28	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
59	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
60	5	0	4	2.5	< 3.99	Broadly Acceptable	Residential
53	5	0	5	0	< 3.99	Broadly Acceptable	Public Recreation and Open Space
54	5	0	5	0	< 3.99	Broadly Acceptable	Rural and Rural Activity
57	5	0	5	0	< 3.99	Broadly Acceptable	Rural and Rural Activity
1	5	0	4	2.5	< 3.99	Broadly Acceptable	Industry
81	0	0	0	0	< 3.99	Broadly Acceptable	Public Recreation and Open Space
82	0	0	0	0	< 3.99	Broadly Acceptable	Industry
52	5	0	5	0	< 3.99	Broadly Acceptable	Public Recreation and Open Space
56	5	0	5	0	< 3.99	Broadly Acceptable	Rural and Rural Activity
9	5	2	4	7.5	4 - 7.99	Tolerable	Residential
4	5	2	4	7.5	4 - 7.99	Tolerable	Residential
3	5	2	4	7.5	4 - 7.99	Tolerable	Residential
2	5	2	4	7.5	4 - 7.99	Tolerable	Residential
30	5	2	4	7.5	4 - 7.99	Tolerable	Residential
38	5	2	4	7.5	4 - 7.99	Tolerable	Residential
12	5	2	4	7.5	4 - 7.99	Tolerable	Residential
19	5	2	4	7.5	4 - 7.99	Tolerable	Residential
49	5	2	4	7.5	4 - 7.99	Tolerable	Residential
48	5	2	4	7.5	4 - 7.99	Tolerable	Residential
72	5	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
91	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
92	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
93	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
76	5	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
75	5	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
74	5	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
73	5	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
78	5	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
83	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
84	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
85	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
86	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
90	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
89	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
88	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
87	0	4.5	2	6.25	4 - 7.99	Tolerable	Industry
94	0	1	4	5	4 - 7.99	Tolerable	Rural and Rural Activity
39	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
40	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
5	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
10	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
64	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
62	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
61	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
63	5	5	1	22.5	8 - 100	Generally Intolerable	Residential
71	5	4	1	20	8 - 100	Generally Intolerable	Residential
70	5	4	1	20	8 - 100	Generally Intolerable	Residential
69	5	5	1	22.5	8 - 100	Generally Intolerable	Residential

Figure 1 – a spreadsheet can be used to easily keep track of the scores allocated per lot, and to perform the basic calculations required to determine the level of risk per lot.

Determining exposure

Using the exposure scoring matrix in **Schedule 5**, **Map 2** below was developed. Each lot in the subject area was scored for its level of exposure to the flood hazard of the 2.5% AEP flood event.

Note that the levels of exposure are the same (a maximum exposure of 5 points) in both the rural area adjacent the main river channel and the residential area further north. This is even though the flood hazard (refer to Map 1) in the rural area is more significant than that in the residential area. This is due to the scoring matrix giving strong weight to both instances of higher hazard and uses of increasing sensitivity to that hazard.



Map 2 – Exposure scorings identified per lot. Note that the exposure score is applied to the whole lot, even though the hazard may affect only a portion of the lot. Refer to larger map at end of Schedule 7 for more detail.

Determining Vulnerability

Using the vulnerability scoring matrix in **Schedule 5**, **Map 3** below was developed. Each lot in the subject area was scored for its level of vulnerability to the flood hazard of the 2.5% AEP flood event. Of particular interest for the subject area is the vulnerability to:

1. the existing residential properties, caused by vulnerable built form such as slab-on-ground or low-set construction; and
2. critical infrastructure such as the airstrip caused not by flood inundation itself but by isolation created by the inundation.

Flood warning time was not considered an element that would contribute to the vulnerability of land use in the subject area, as the community has a long forewarning of floodwaters due to its position in the sub-basin and the flood warning system already in place. In addition, there were no land uses that included vulnerable persons (e.g. aged care or child care) or vulnerable property (such as museums/ libraries or electrical sub-stations) in this area.

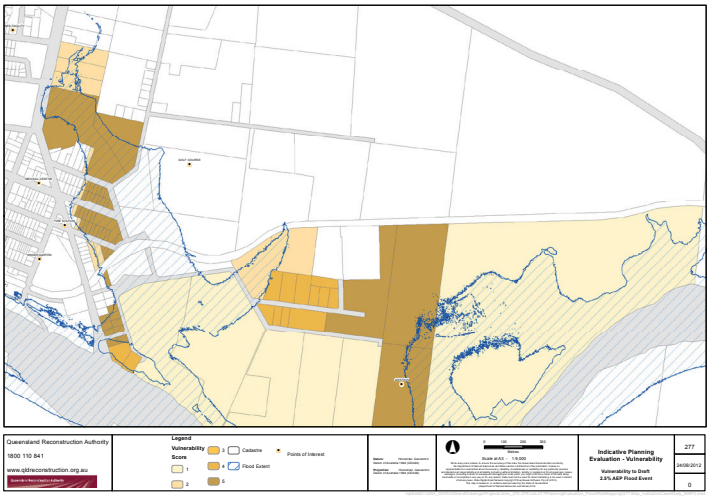
A built form assessment of all urban residential zoned land was undertaken to determine those buildings that would be inundated above their ground floor level during the 2.5% event. This was undertaken using publicly-available streetview information, and the results of the assessment are noted in **Table 1** below. Note that the majority of existing residential properties scored a maximum vulnerability score of 5, while a small number scored only 2 points. This is due to the majority of homes either being low-set/slab-on-ground construction, or where elevated, the flood depth was so high that these homes would still be inundated.

Built Form Type	Number of Lots	Vulnerability Score Assigned (per lot)
Elevated above flood height	8	2
Not elevated above flood height	22	5
Vacant lots	22	5
Other – Minor inundation not affecting built form	12	0
Total lots:	64 lots	

Table 1 – A built form assessment of existing urban residential-zoned land was undertaken to identify the number of existing properties that would be inundated above ground floor level during the 2.5% flood event.

Those residential lots that were identified as vacant also still scored a maximum 5 points for vulnerability. Given the significant depth of the floodwaters (at least 3 – 4 metres) in the area of the vacant properties, it would have been difficult for a home to be approved on that lot given it would be improbable that a house could be reasonable designed to be compatible with the depth of floodwater on those sites. In practice, this may be an indication as to why these urban residential lots are still vacant.

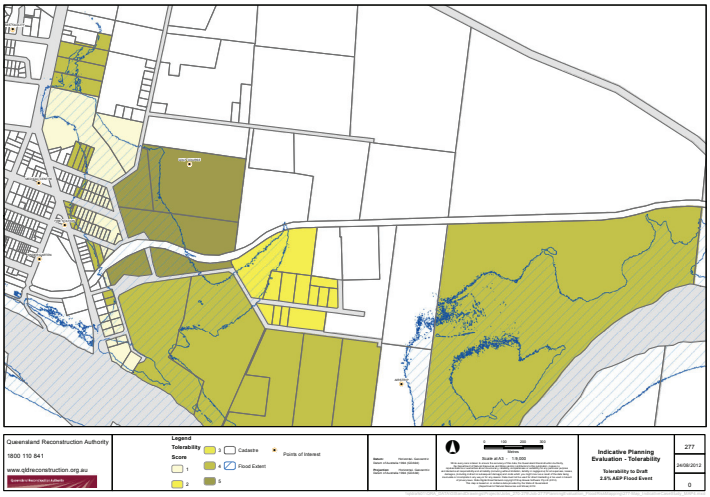
Also note that the vulnerability mapping includes some land (particularly the industrial area and parts of the airstrip land to the east) that was not actually inundated during the event. This is due to the criterion in the vulnerability scoring matrix related to isolation. During this event, the single road leading to this industrial area and the airstrip adjacent to it is cut, isolating this part of town from the balance of the urban area. The airstrip, given it is a highly vulnerable land use that should be operational during such events (particularly at a relatively high frequency of 2.5%), scored a maximum 5 points for vulnerability.



Map 3 – Vulnerability scorings identified per lot. Note that there are some lots (in the centre of the case study area) that were not exposed to the flood hazard, but are vulnerable to it nonetheless. This is due to the isolation to those lots caused by the event – the only road to these properties is cut during this event. Refer to larger map at end of Schedule 7 for more detail.

Determining Tolerability

Using the tolerability scoring matrix in **Schedule 5**, **Map 4** below was developed. Each lot in the subject area was scored for its level of tolerability to the flood hazard of the 2.5% AEP flood event.



Map 4 – Tolerability scorings per lot. Note the tolerability scores are higher for open space than residential areas. Refer to larger map at end of Schedule 7 for more detail.

The Community Awareness/Understanding criterion is a community-wide, rather than lot-specific consideration. For this criterion, it is not the intention to interview each resident on each lot, but to form a community-wide view of these matters that is then applied at the property level. The size or spatial area of a 'community' will be subjective – it should focus on a size that is representative of the persons likely to be affected by the flood hazard.

Therefore, given the historic experience of flood in this town, it was assumed that, the community' awareness and understanding of flood would be generally high. Notwithstanding, the 'Community Perception of Hazard' is an important consideration that is relative to the type of land use on the lot. The extent of flood hazard on some residential lots would be so great that it would be improbable that a community member would reasonably be able to tolerate the effects of that flood, such as the potential for impacts on personal safety and property. Therefore, residential lots where the flood hazard severity and the vulnerability to it were high were assigned a low tolerability score. In addition, the airstrip scored 0 points as it was not able to remain operational during the event (due to the isolation to the airstrip).

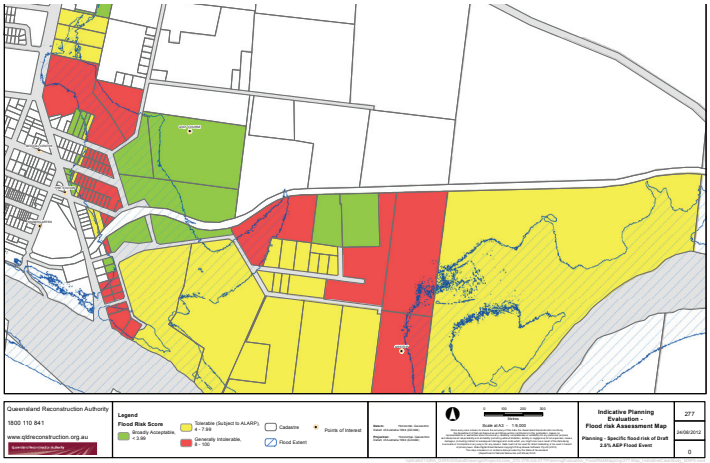
However, some residential lots where the flood hazard was not so severe that it had only minimal impact on the lot or its built form, and those lots with a non-sensitive land use such as open space and some industry were assigned high tolerability scores.

In practice, the tolerability criteria in the matrix can be used to 'weigh up' a community's tolerance of the flood hazard and therefore understand how or whether an overriding need to remain in or advance into the floodable area can be demonstrated. For example, as above a low score for 'Community Perception of Hazard' can be used where the severity of the flood is simply so great that the community affected cannot tolerate it or be resilient to it. 'Community Preparedness' can be used to rate the ability of a community to prepare for floods of certain types – i.e. if flash floods are being evaluated, the ability of individuals and businesses to be fully prepared for such an event is likely to be limited. The 'Emergency Management Procedures/Evacuation' criterion could be assigned a higher score where floods are slow, shallow and there is long warning time of the event. The key in undertaking a tolerability assessment is to assess all criteria, but the lowest score assigned must be the score chosen to identify Tolerability.

Notably, this town does not include any structural works that may protect the floodable part of town during such an event. This criterion in the tolerability matrix therefore was not used in this instance.

Flood risk mapping & initial analysis

Using the Likelihood x Consequence flood risk matrix in **Schedule 5**, the risk levels relative to the selected flood event and its consequences were translated into areas of generally intolerable, tolerable and broadly acceptable risk and mapped on **Map 5**. A breakdown of these risk levels relative to land use and area are noted in the table below.



Map 5 – Identified risk levels per lot. Note the main areas of generally intolerable risk are the residential properties in the west of the subject area, and the airstrip in the centre of the subject area. Refer to larger map at end of Schedule 7 for more detail.

Land Use Type	Risk Level	Number of Existing Lots	Total Lot Area within Risk Level	Inundated Area within Risk Level (approx.)	% of Total Lot Area Inundated	% of Land Use at Specific Risk level
Residential	Broadly Acceptable	9	2.03ha	0.40ha	20%	6.3%
	Tolerable	10	7.57ha	4.31ha	57%	23.5%
	Generally Intolerable	45	22.53ha	18.42ha	82%	70.2%
Community	Broadly Acceptable	0	N/A	N/A	N/A	N/A
	Tolerable	0	N/A	N/A	N/A	N/A
	Generally Intolerable	0	N/A	N/A	N/A	N/A
Commercial	Broadly Acceptable	0	N/A	N/A	N/A	N/A
	Tolerable	0	N/A	N/A	N/A	N/A
	Generally Intolerable	0	N/A	N/A	N/A	N/A
Industrial	Broadly Acceptable	2	4.35ha	0.13ha	3%	14%
	Tolerable	11	8.75ha	0.01ha	0.1%	28%
	Generally Intolerable	2	18.18ha	5.18ha	28%	58%
Open Space/Recreation	Broadly Acceptable	3	24.85ha	5.46ha	22%	100%
	Tolerable	0	N/A	N/A	N/A	N/A
	Generally Intolerable	0	N/A	N/A	N/A	N/A
Rural	Broadly Acceptable	3	14.76ha	8.73ha	59%	5.3%
	Tolerable	7	219.18ha	131.72ha	60%	79.2%
	Generally Intolerable	2	43.03ha	9.39ha	22%	15.5%
Totals						
	Total Lots Affected	Affected Area Per Risk Level	% of Affected Area			
Broadly Acceptable	17	14.72ha	8%			
Tolerable	28	136.04ha	74%			
Generally Intolerable	49	32.99ha	18%			

Table 2 – A breakdown of the number of lots, total lot area and area affected by the flood event relative to the assigned risk level per lot. Note that approximately 70% of residential land within the subject area has been identified at intolerable risk, while 100% of open space and recreation land (the local golf course) has been assigned a broadly acceptable risk. The levels of intolerable risk within the industrial and rural land use areas is due to the location of the airstrip on a combination of industrial and rural zoned land, rather than an actual use of the land for those purposes.

Naturally, the residential areas that are severely inundated during this 2.5% event are identified at intolerable risk, while the golf course further to the east is identified at generally acceptable risk. This is because the residential area presents a higher and therefore less tolerable risk than the nearby golf course. While the golf course may be severely inundated in parts, the risk to life, property and infrastructure is minimal in comparison to the residential area. Therefore, any flood risk treatment should focus principally on addressing the intolerable risk to the residential properties, with lesser focus on the risk to the golf course – even if the hazard to each is similar.

While not currently built upon, there are significant tracts of urban residential zoned land that are exposed to the flood hazard. A high level urban land supply analysis was undertaken to provide an initial understanding of the amount of land subject to flood hazard that could be developed based on the underlying zonings assigned to each lot, and the reconfiguration potential of those lots prescribed by the relevant planning scheme.

Land Use Type	Area affected by selected event (ha)	Number of existing lots	Number of potential future lots (as per planning scheme)
Residential	23.1267	64	~328 lots within inundated area (500m2 lots at 70% developable land)
Community	0	0	0
Commercial	0	0	0
Industrial	5.3224	4	~31 lots within inundated area (1000m2 at 60% developable land)
Open Space/ Recreation	5.4596	2	N/A
Rural	149.8426	12	N/A
Total	183.7513	82	
Other lots vulnerable but not inundated	25.3363	12	

Table 3 – This high-level urban land supply analysis demonstrates that the zonings within the planning scheme assigned to these lots could result in around an additional 328 urban residential lots in the flood hazard area. The planning scheme only provides minimal regulation for flood hazard.

The results of this analysis demonstrate that the current zoning of land, particularly residential land, presents a significant future risk, given that these areas are envisaged for future urban development. Areas that are currently vacant but zoned for urban residential development should be treated by reassessing the manner in which the planning scheme envisages that future development.

The existing location of the airstrip presents a significant risk also. While the operational components of the airstrip (such as the runway and the terminal) do not appear to be inundated during this event, the isolation caused by the only access road to the airstrip being cut during this relatively frequent event creates significant concern. This risk has been considered generally intolerable due to:

- the inability to access the airstrip during the flood event for evacuation purposes; and
- the inability for emergency services to use the airstrip as a base of operations to conduct emergency responses to outlying areas that may require such services during the event.

Flood risk prioritisation

No flood risk prioritisation relative to other suburbs or towns has been identified in this case study, given it relates only to one specific example of flood risk rather than multiple areas across a jurisdiction.

If a prioritisation was to occur, the information in Table 2 would provide a good basis to prioritise one area over another – for example, a comparison of % areas of intolerable risk, or % areas of residential land at intolerable risk may provide good metrics for prioritisation.

Risk treatment analysis

Please note this risk treatment analysis has been undertake for only one flood event. In practice, multiple events should be evaluated for risk and the treatment analysis undertaken with regard to all events. ***Refer to Section 3 – Implementation*** *for further information.*

Resilience Target

Based on the significant extent of intolerable flood risk identified through the process above, two resilience targets were set for this case study, as below:

1. Eliminate intolerable flood risk to all existing and future urban residential areas of the town; and
2. Treat the isolation risk created from the inundated road linkage between the airstrip and the balance of town.

Identification of options

Three land use responses (refer to **Section 3 – Implementation**) are relevant for consideration within the subject area. To achieve resilience target 1 above, the following land use responses could achieve that target:

1. Retreat from specific urban areas; and
2. Adapt existing urban areas.

The choice to evaluate either one or both of these land use responses should be made relative to the local circumstances – for example, due to the severity of flood and recent experience of it, there may be little tolerance to remain in the existing area, which then naturally mean a focus of investigation should be on how to retreat from that area. Conversely, if the severity of flood is not great, then investigating the options related to both land use responses would be of value to the community.

To achieve resilience target 2 above, the following land use response could achieve that target:

1. Treat risks to linkages and isolated places

The following options could achieve all three of these land use responses, to varying degrees and in varying combinations:

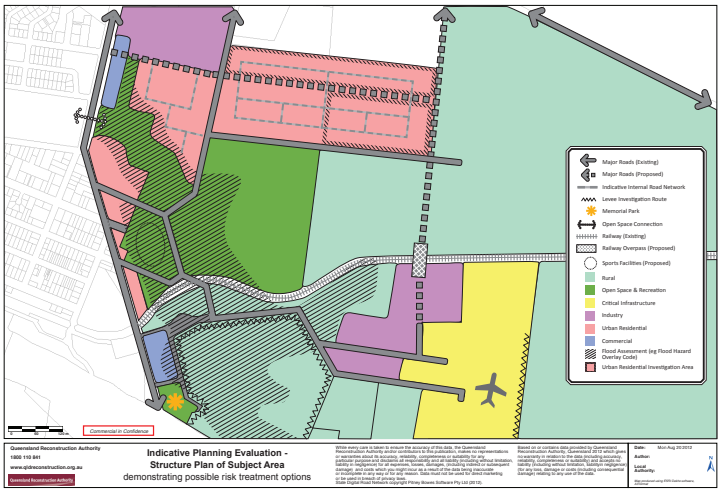
1. Planning scheme responses (zoning, overlays, development requirements, etc)
2. Non-scheme planning measures such as property buy-back, land-swap, relocation, resumption etc
3. Structural works such as levees
4. Building controls such as setting habitable floor levels
5. Emergency management plans and procedures
6. Community awareness programmes

A high level structure planning process was undertaken to help frame the options needed to achieve the resilience targets set for the subject area, and this process has been mapped on **Map 6**. Given the requirement in the resilience target to eliminate intolerable risk to residential properties, this structure plan process has been undertaken with reference to the back-zoning assessment criteria in **Schedule 6**. This process particularly investigates how the lots identified at generally intolerable risk (whether currently built upon or vacant) could be back-zoned and relocated to minimize the future possibility of that land being developed for urban (particularly residential) purposes. This approach generally accords with the land use responses of ***retreating from existing urban areas***.
The structure plan also illustrates options to treat the risk to the airstrip, which generally accords with the land use response to treat risks to linkages and isolated places.

The indicative structure plan also identifies levee investigation routes that are also relevant for consideration as an option to treat the identified flood risk.

Compare options & prepare suite of measures

The key indicative options are presented on **Map 6**, and focus principally on back-zoning and relocation of properties at intolerable risk and indicative levee investigation routes. The structure plan also identifies possible future land use patterns that complement the response to the flood risk. Therefore, options to treat the flood risk to the residential areas based on the land use response desired are likely to fall into two suites of options:



Map 6 – Indicative structure plan noting the various land use specific flood risk treatment option described below. Refer to larger map at end of Schedule 7 for more detail.

	Main Option	Supplementary Options
Option Suite 1 *Retreat from specific urban areas*	Back-zone existing properties and allocate additional flood free residential land, using a detailed structure planning process	A land-swap or purchase scheme to implement the transition to flood free land Infrastructure works to develop the new land Emergency management procedures Zoning changes to limit future development in back-zoned area
Option Suite 2 *Adapt existing urban areas*	Construction of a levee to treat the flood risk up to an acceptable level (such as the 1% AEP event + freeboard amount)	Zoning changes (such as limiting vulnerable land uses) to address residual risk left by levee Building controls to manage residual risk Emergency management procedures Community awareness of levee function and limitations

Options to address the flood risk to the airstrip are likely to fall into three suites of options, based on the available means of achieving the land use response to treat risks to linkages and isolated places:

	Main Option	Supplementary Options
Option Suite 1 *Treat risk to linkages and isolated places*	Relocate the airstrip to a flood free location, where access to it cannot be cut by natural hazards (such as flood and bushfire)	Transition industrial land adjacent to old airstrip location over time to new airstrip location using zoning
Option Suite 2 *Treat risk to linkages and isolated places*	Construction of a levee to treat the flood risk up to an acceptable level (such as the 1% AEP event + freeboard amount)	Zoning changes (such as limiting vulnerable land uses) to address residual risk left by levee Building controls to manage residual risk Emergency management procedures, including airstrip operational procedures Community awareness of levee function and limitations
Option Suite 3 *Treat risk to linkages and isolated places*	Where inundation does not affect the actual operations of the airstrip during the event (and less frequent events such as the 1% AEP event), create a flood-free road access to the airstrip from the north.	Implement road access in conjunction with development of flood-free residential land created to address flood risk to existing residential properties to minimise cost & exploit common linkages Undertake minor flood mitigation works to minimise nuisance inundation of runway and other key operational points

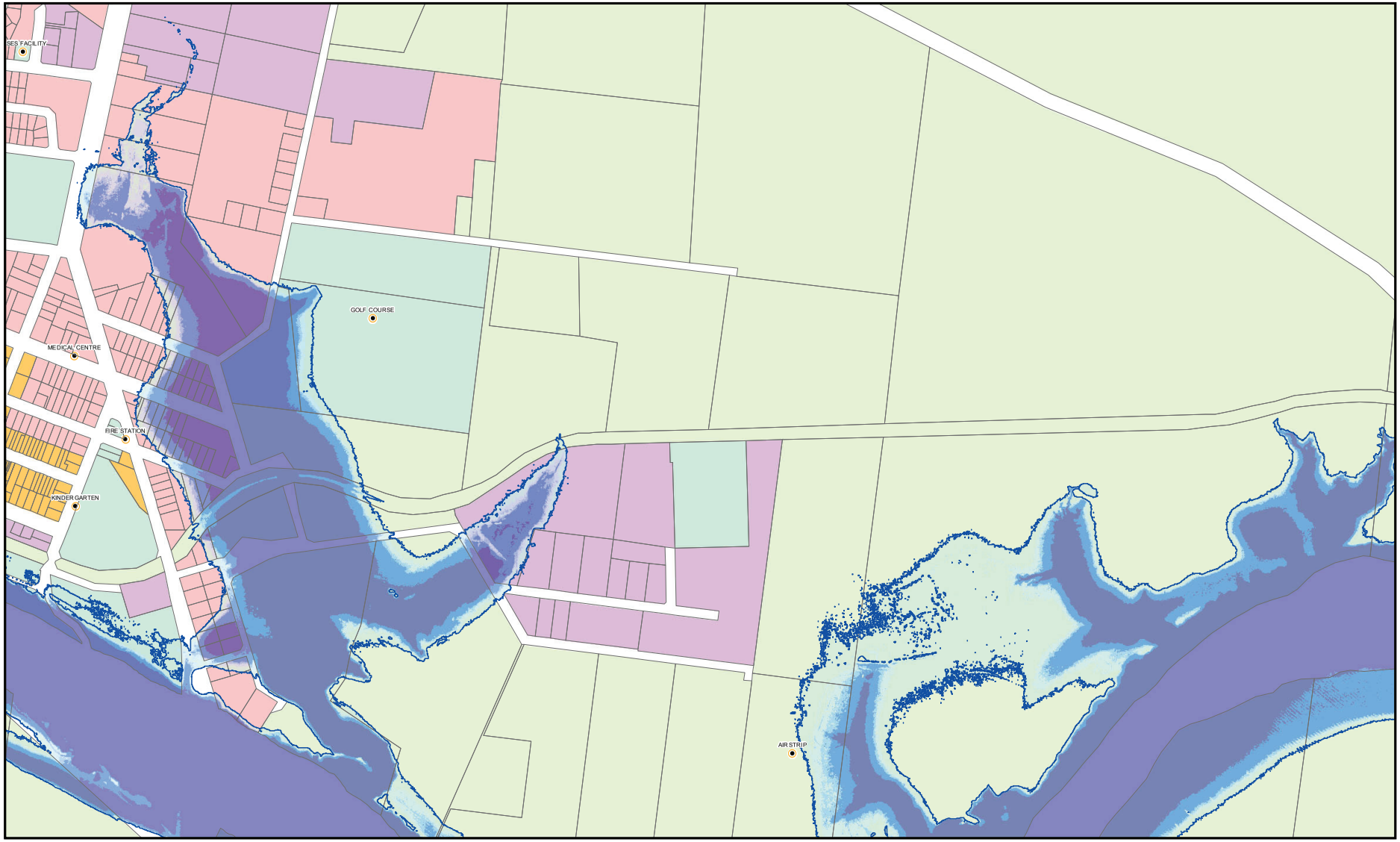
These options suites should be assessed relative to each other in order to decide on an appropriate suite of measures that meet the resilience target, having regard to the benefits and limitation of each with regard to:

1. Flood mitigation/avoidance function
2. Cost/financial implications (including whole-of-life cycle costings)
3. Resourcing requirements
4. Community views
5. Social & environmental implications
6. Timing

Given the indicative nature of this case study and the large number of variables involved in assessing the options relative to the six points above, this analysis does not provide a definitive approach to assessing the options and deciding on the approach required to address the flood risk. However, the structure plan process provides a key way by which options can be identified and compared, when also supplemented by an assessment relative to the financial, operational, social and environmental implications noted above. Other key considerations such as improvements to the flood warning system, telecommunications, fuel supplies and infrastructure considerations (e.g water supply and sewerage) can be considered in the context of the land use options presented to treat the flood risk.

As noted above, the final suite of measures used to address the identified flood risk will likely be a suite of different measures that address different aspects of the flood risk, so that the resilience of the community to flood hazard can be improved over time.

Map 1 – The subject area. Existing land use zonings for the town overlaid with the indicative 2.5% AEP flood event that recently affected the town.



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Planning Scheme

- Business or Centre
- Industry
- Public Recreation and Open Space
- Residential
- Rural and Rural Activity

Depth (m)

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 1
- 1-2
- >2

- Flood Extent
- Cadastre
- Points of Interest

Datum: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

Projection: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

0 100 200 300
Metres

Scale at A3 - 1:9,000

Indicative Planning Evaluation - Land Use

Planning Scheme Zones and Draft Indicative and Extent and Depth of 2.5% AEP Flood Event

277

23/08/2012

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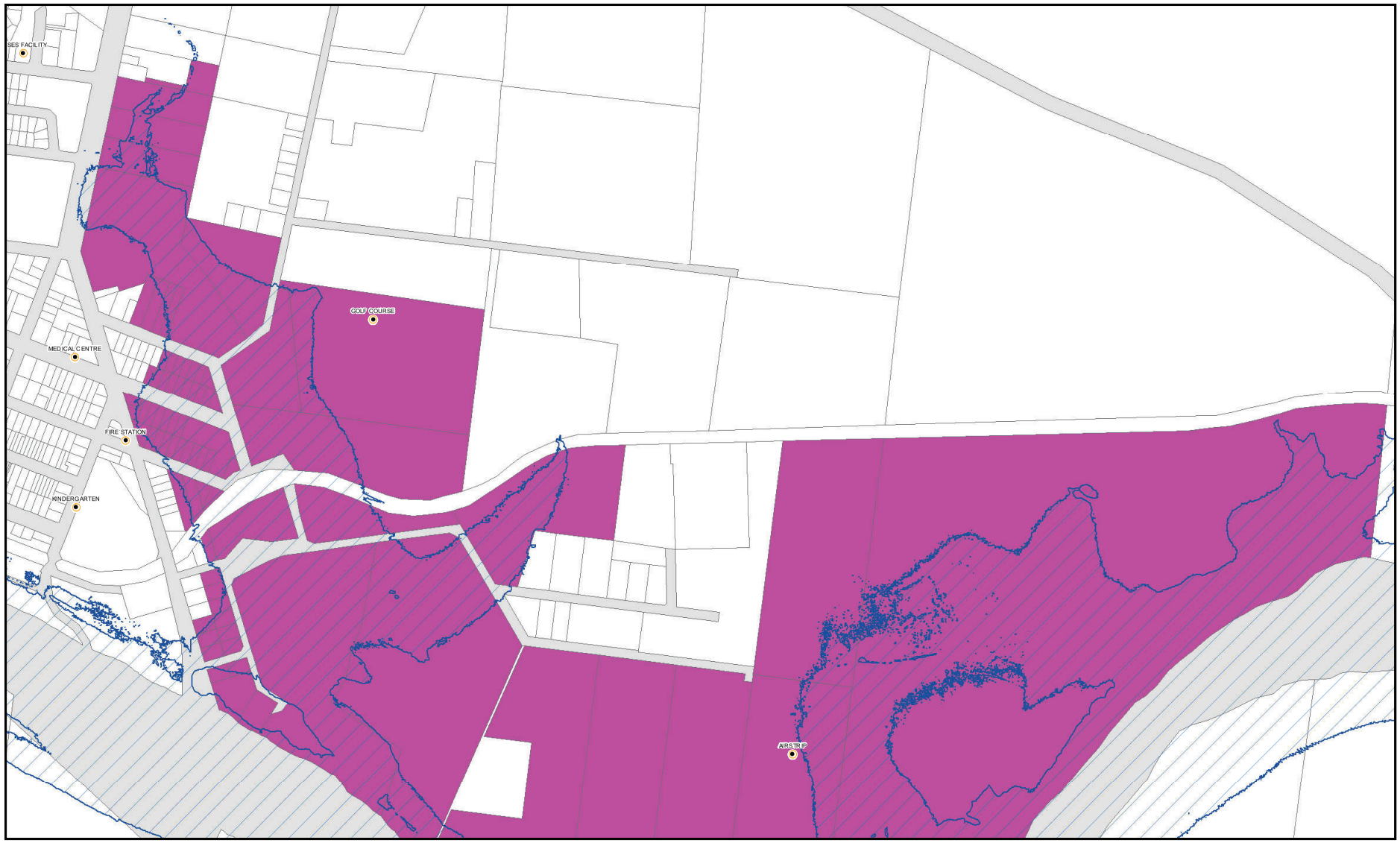
Map 2 – Exposure scorings identified per lot. Note that the exposure score is applied to the whole lot, even though the hazard may affect only a portion of the lot.



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Legend

Exposure Score

1
2
3
4
5

Cadastre

Flood Extent

Points of Interest

Datum: Horizontal - Geocentric Datum of Australia 1994 (GDA94)

Projection: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

0 100 200 300

Metres

Scale at A3 - 1:9,000

Indicative Planning Evaluation - Exposure

Exposure to Draft 2.5% AEP Flood Event

277

24/08/2012

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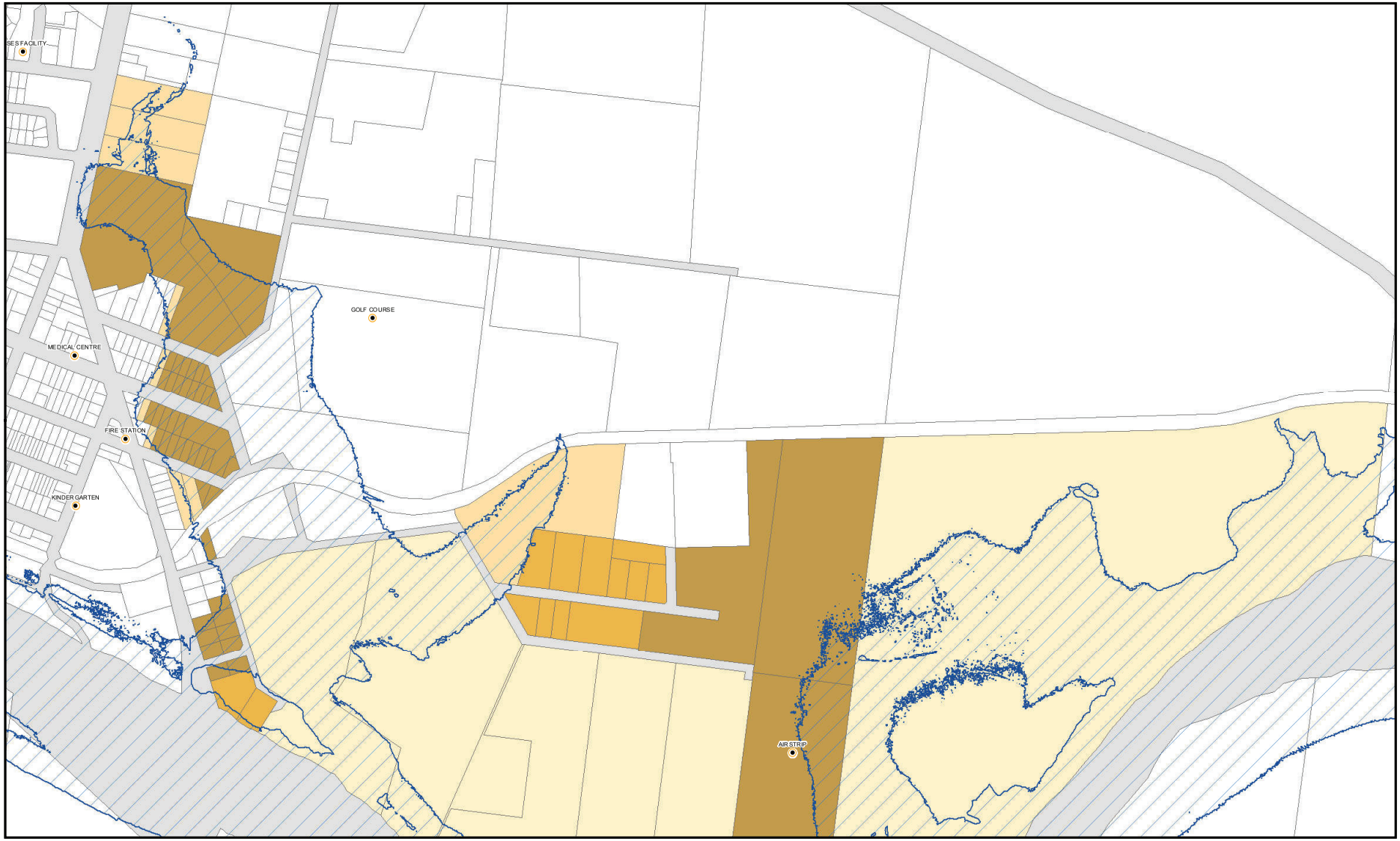
Map 3 – Vulnerability scorings identified per lot. Note that there are some lots (in the centre of the case study area) that were not exposed to the flood hazard, but are vulnerable to it nonetheless. This is due to the isolation to those lots caused by the event – the only road to these properties is cut during this event.



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Legend

Vulnerability Score

1 2 3 4 5

Cadastre

Flood Extent

Points of Interest

Datum: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

Projection: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

0 100 200 300

Metres

Scale at A3 - 1:9,000

Indicative Planning Evaluation - Vulnerability

Vulnerability to Draft 2.5% AEP Flood Event

277

24/08/2012

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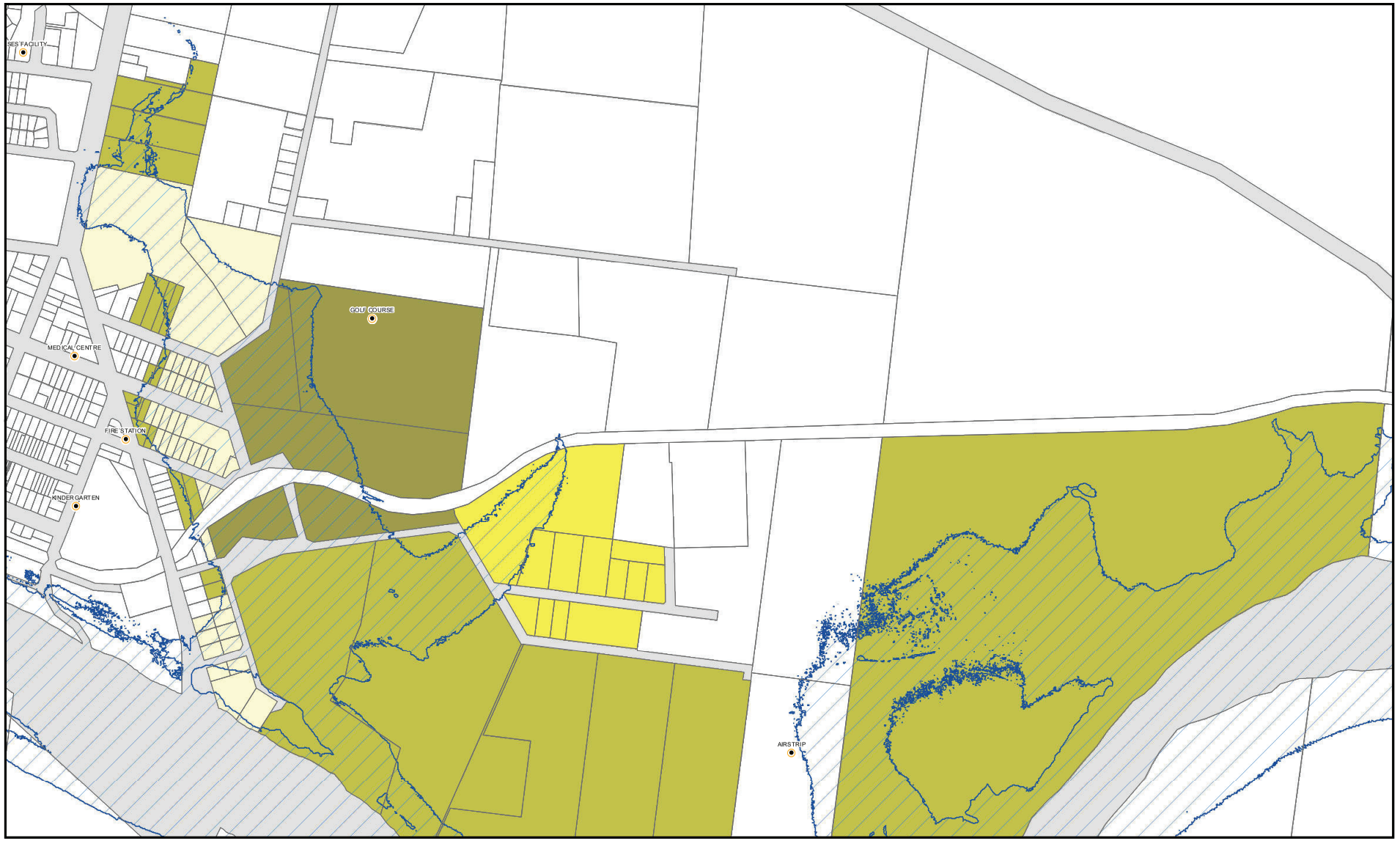
Map 4 – Tolerability scorings per lot. Note the tolerability scores are higher for open space than residential areas.



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Legend

Tolerability Score

1

2

3

4

5

Cadastre

Flood Extent

Points of Interest

Datum: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

Projection: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

0 100 200 300

Metres

Scale at A3 - 1:9,000

Indicative Planning Evaluation - Tolerability

Tolerability to Draft 2.5% AEP Flood Event

277

24/08/2012

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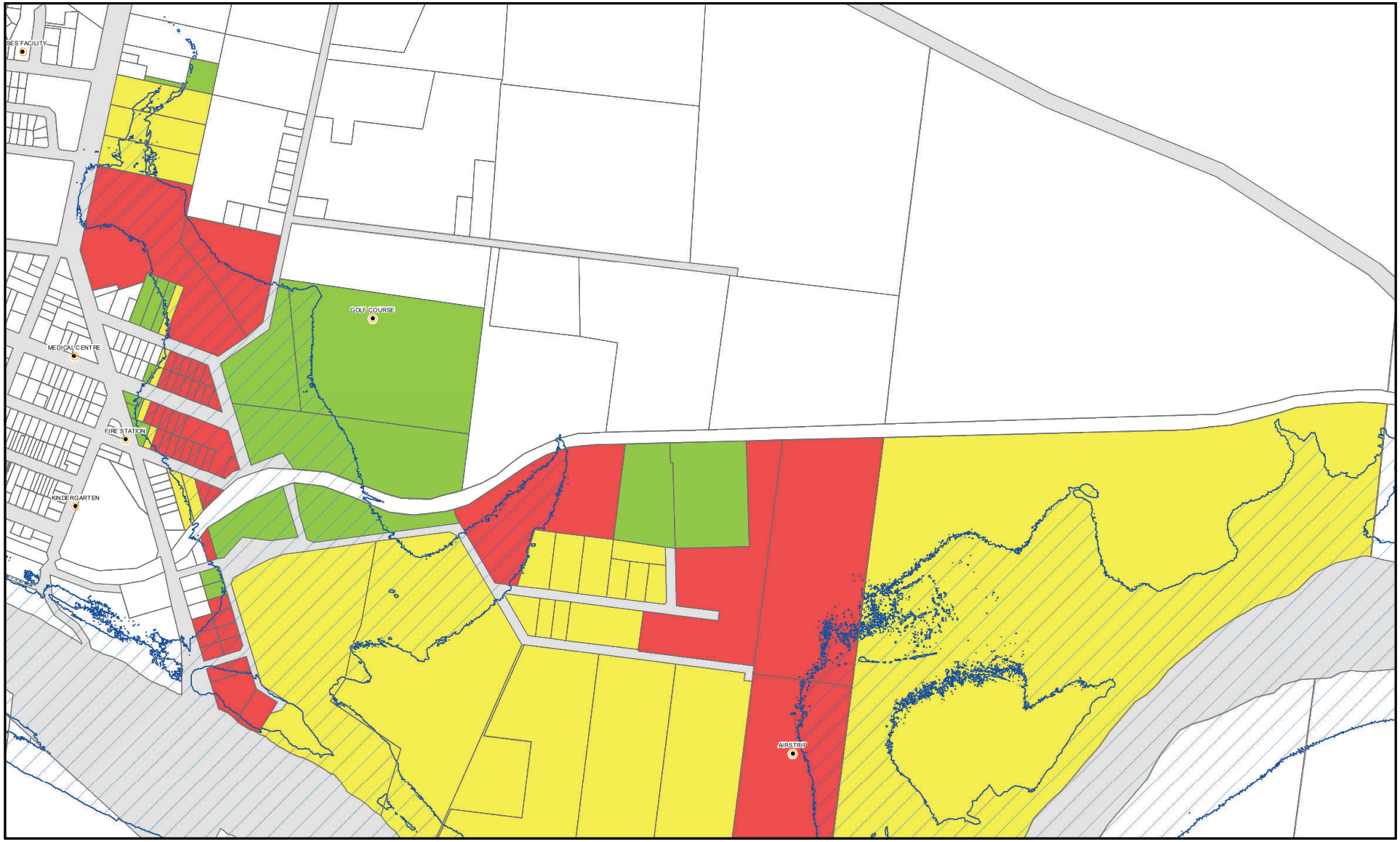
Map 5 – Identified risk levels per lot. Note the main areas of generally intolerable risk are the residential properties in the west of the subject area, and the airstrip in the centre of the subject area.



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Legend

Flood Risk Score

- Broadly Acceptable, < 3.99
- Tolerable (Subject to ALARP), 4 - 7.99
- Generally Intolerable, 8 - 100
- Cadastre
- Flood Extent
- Points of Interest

Datum: Horizontal - Geocentric Datum of Australia 1994 (GDA94)

Projection: Horizontal- Geocentric Datum of Australia 1994 (GDA94)

0 100 200 300

Metres

Scale at A3 - 1:9,000

Indicative Planning Evaluation - Flood risk Assessment Map

Planning - Specific flood risk of Draft 2.5% AEP Flood Event

277

24/08/2012

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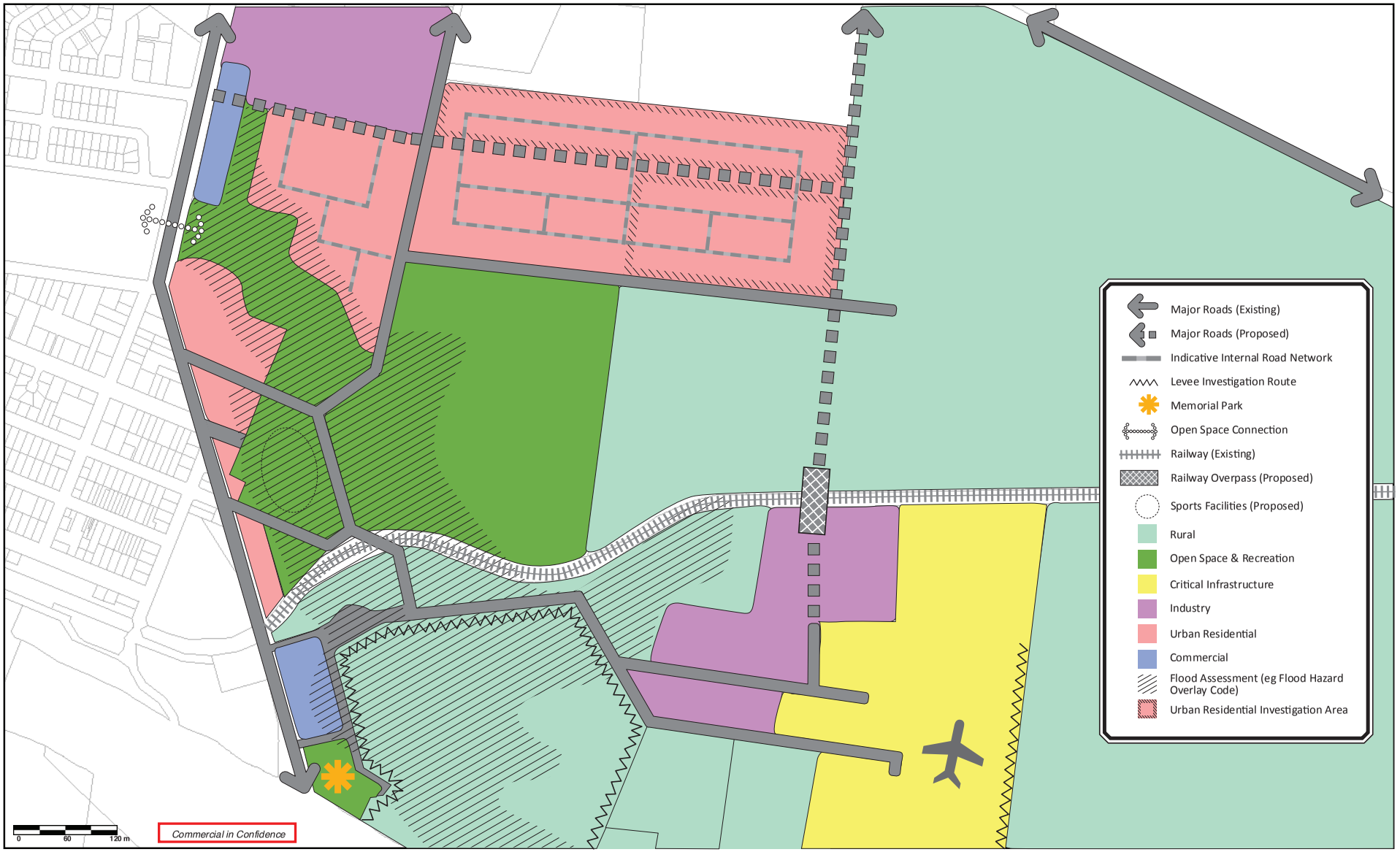
Map 6 – Indicative structure plan noting the various land use specific flood risk treatment options.



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Indicative Planning Evaluation - Structure Plan of Subject Area
demonstrating possible risk treatment options

Date: Mon Aug 20 2012
Author:
Local Authority:

Map produced using ESRI Dekho software, A3 format

Schedule 8 – Example planning scheme provisions

Introduction

This Schedule provides example Queensland Planning Provision (QPP) compliant planning scheme provisions that deal with flooding for Councils to consider in the course of preparing their new planning scheme that reflect the land use responses set out in the implementation section of the Guideline. The example provisions below have been drafted in accordance with draft QPP version 3.0 and the *Sustainable Planning Act 2009*.

The examples below provide guidance on dealing with flooding through the:

1. Strategic Vision
2. Strategic Framework, via the Strategic Intent, Themes, Strategic Outcomes, Elements, Specific Outcomes and Land Use Strategies
3. Priority Infrastructure Plan
4. Zone Codes, via two key zone mechanisms, including the Limited Development (Constrained Land) Zone and the use of Precincts within other zones (such as the Residential Choice Zone)
5. Flood Hazard Overlay Code, via an enhanced version of the Model Code originally provided in the Part 1 Guideline.
6. Community Use Code
7. Planning Scheme Policy – Site Based Planning Evaluation

It is noted that the **coloured** text sections have been drafted by the Authority and represent an example application only. The examples represent some key components of the framework through which the treatment of flood can be demonstrated. Other parts of the QPP framework (such as the administrative provisions, and other provisions that do not relate to flood) must also still be included within the planning scheme.

Strategic Vision

The strategic vision is a non-mandatory component of the QPP which is extrinsic material to the planning scheme. The strategic vision is a narrative describing the aspirations of the community and should therefore incorporate a local governments long term goals for considering and managing flood hazard across a region. The strategic vision should also include a statement about the community's level of acceptance of flood risk. An example of how the considerations of the Guideline can be practically applied when drafting the strategic vision is found below.

Strategic Vision

It has been 20 years since I have been to <Insert location>…. I am happy to see that the community is aware and reminded of past floods by the bright flood markers on power poles and buildings as I walk through the streets... It looks like people have also accepted the frequent flooding because 20 years ago this place was full of slab on ground but now all I can see is Queenslanders… I've noticed a new development up on the hill which won't get wet any time soon… The residential places I remember flooding are now parklands that run along the river.

Strategic Framework

The strategic framework sets the policy direction and future development intent for the planning scheme area. In areas where flooding is identified as a matter of concern for a local government area, it is crucial that the below questions are considered when drafting a strategic framework and other planning scheme provisions. It is noted that the below information supports the land use transition strategies outlined in the Guideline.

Does the strategic framework:

1. represent a picture of the future development of the planning scheme area that reflects the land use transition strategies adopted by council in response to flood risk? ☑
2. incorporate the community's general broad attitude to, and acceptance of, flood risk? ☑
3. depict how the community has responded to the risk over time, including demonstrating any built form changes? ☑
4. provide strategic advice about the placement of critical infrastructure for example hospitals, evacuation centre, major electrical infrastructure and roads to ensure greater resilience of infrastructure networks in the future, particularly during natural disasters? ☑
5. if there are existing areas where Council has determined it necessary to retreat because of intolerable risk, reflect this through broad statements about limiting future development of these areas? ☑
6. outline the need for new broad hectare development to respond to flood hazard by avoiding areas at risk? ☑
7. if there are areas where Council has determined that the flood risk is tolerable or acceptable, reflect this as a future outcome through considered appropriateness of vulnerable land uses and built form responses, such as elevation and resilient materials? ☑
8. if built form responses are required in order to treat flood risk, does the strategic framework provide comment on maintaining compatibility with the existing character and identity of the planning scheme area? ☑
9. provide direction on intended density increases or decreases in certain areas in response to adopted land use transition strategies? ☑
10. have regard to maintaining the natural environment as far as practicable in new development to minimise or avoid the worsening of flood impact? ☑
11. reflect relevant regional planning policy and programs, particularly in relation to natural hazards? ☑

An example of how the considerations of the Guideline can be practically applied by a Council when drafting the strategic framework for their new planning scheme is provided below.

Part 3 Strategic framework

Editor's note – Section 3.1 – Preliminary has been removed for the purposes of these examples.

3.2 Strategic intent

Parts of <insert area> are subject to the natural hazards of flood, bushfire and landslide. The community's improved resilience to these hazards has developed from a good understanding of the hazards and the risks they present. While the flood risk for areas <insert> and <insert> has been identified as tolerable, built form outcomes and limiting vulnerable uses will further improve the resilience to the hazard. The lower-lying residential areas of <insert> at intolerable risk of flood (a total of <xx> lots) have transitioned to open space and public recreation

uses during the life of the planning scheme. All new broad hectare development occurs in areas of no or low flood hazard, thereby minimising risk to these future communities. Environmental management, open space and recreation, and water oriented development characterise all those future urban/undeveloped urban areas that are subject to medium and high flood hazard. Land uses and activities in the rural parts of the region respect and respond to the flood hazard.

3.3 Settlement pattern

3.3.1 Strategic outcome

The shape of the city/region evolves to respond to the natural hazards affecting it, including bushfire, landside and flooding <insert others as required> by ensuring that the location and intensity of development does not place people, property and infrastructure at intolerable risk of the hazard. The zoning plan in this planning scheme has been prepared with consideration to the risks posed by natural hazards.

3.3.2 Element - Broad hectare development

3.3.2.1 Specific outcome

Development on broad hectare land that includes areas of medium or high flood hazard avoids development of these hazard areas for urban purposes.

Broad hectare developments ensure the new urban form (including layout, built form and transport/communications linkages) is accessible and permeable in order to not isolate settlements from adjacent flood free urban areas in the event of a flood and supports the functioning of emergency services and evacuation response/procedures.

3.3.2.2 Land use strategy

Land that is identified as ‘new urban area’ or ‘future urban area’ on Strategic Plan Map X and X does not include areas of medium and high flood hazard.

3.3.3 Element - Infill development

3.3.3.1 Specific outcome

Infill development is promoted in locations with tolerable or acceptable natural hazard risk, and avoided where the type of infill development is incompatible with the hazard. Compatible development in these locations also employs necessary built form outcomes to further minimise risk and ensure greater resilience to flooding impacts.

3.3.3.2 Land use strategy

Land within the existing urban area that has development constraints due to intolerable risk of flood hazard is zoned as Limited Development (constrained land).

Land at tolerable risk of flood hazard is identified through flood constrained precincts within the relevant zones.

3.4 Safe communities

3.4.1 Strategic outcome

Development is compatible with, and responsive to, the known risk to life, property and infrastructure of natural hazard (including bushfire, landslide and flooding) affecting the site.

3.4.2 Element - Natural hazards

3.4.2.1 Specific outcome

Land use that is compatible with the natural hazards affecting it also employs resilient built form measures to further minimise the risk.

Residential dwellings improve their response to potential flood impacts by elevating habitable floor levels above a flood level <if no flood level then above a certain height> and adopting the resilient built form of the Queenslander style house.

3.4.2.2 Land use strategy

Further studies to identify the nature and extent of natural hazards affecting the local government area will be undertaken, particularly in Location X and Location Y. Further planning evaluation o to identify the level of risk and the possible land use responses to those hazards will be undertaken.

3.5 Infrastructure and services

3.5.1 Strategic outcome

Infrastructure provision [and decommissioning (if proposed)] programs have regard to the risk of natural hazards that the local government area is subject to by matching trunk infrastructure requirements to changes in settlement pattern and land use transitions occurring in response to the risk of hazard.

3.5.2 Element - Infrastructure planning and provision

3.5.2.1 Specific outcome

Infrastructure planning identifies any flood mitigation works proposed to mitigate risk of flood hazard as well as the decommissioning of infrastructure for those areas transitioning from urban uses to low impact uses (such as open space and outdoor recreational uses) in response to intolerable flood risk.

The planning and provision of infrastructure caters for the efficient and continued operation of critical community infrastructure and services, such as hospitals, evacuation centres and emergency services, during natural hazard events.

3.5.2.2 Land use strategy

Decommissioning of trunk infrastructure provision will occur in <Location X> and <Location Y> due to land use transition occurring in the area in response to intolerable flood risk.

Priority Infrastructure Plan

The priority infrastructure plan (PIP) identifies and describes the intentions for the provision of trunk infrastructure within the local government area. The PIP particularly identifies the:

1. Planning assumptions (type, scale location and timing of development) and growth estimates used in undertaking the planning of trunk infrastructure networks;
2. Geographic area within the LGA where local government will give priority to provide infrastructure to service development (the priority infrastructure area (PIA));
3. Desired standards of service to which the trunk infrastructure will be supplied; and
4. Plans for trunk infrastructure and schedules of work, including the network routes, systems and components of that infrastructure.

The QPP and Statutory Guideline 01/11 – Priority Infrastructure Plans set the above framework for PIPs, and the example provisions following reflect that template.

Part 4 Priority infrastructure plan

Editor's note – Section 4.1 – Preliminary, Section 4.2 Planning Assumptions and the sub-sections within all sections identified below have been removed for the purposes of these examples.

4.3 Priority infrastructure area

Infrastructure provision in natural hazard areas should be viewed in a two-fold manner:

1. Land use decisions and the provision of trunk infrastructure need to be tightly coordinated, bearing in mind the decision to allocate land for particular use(s) will naturally result in obligations to provide appropriate infrastructure, including the costs associated with repairing and maintaining that infrastructure in the face of natural hazards; and
2. Where a planning evaluation of the impact of a natural hazard (such as flood) identifies that the risk to an existing area is intolerable, along with a retreat of inappropriate land use out of the area, the planned decommissioning of infrastructure in this location may be required.

The PIP and PIA respectively should therefore account for both scenarios; it should identify all existing infrastructure that require augmentation (such that may be required through infill/densification), and those areas that will accommodate urban growth during the life of the planning scheme.

Equally, where a land use retreat strategy has been enacted in a certain location (such as through back-zoning, land-swap arrangements or other programs), and this strategy is intended to be enacted during the life of the planning scheme, the PIP can identify that the areas that will be subject to infrastructure decommissioning and exclude them from the PIA.

4.4 Desired standards of service

As the desired standards of service contained within a PIP are an indication of the preferred standard of performance for infrastructure rather than a prescriptive requirement, there is an opportunity to ensure that these desired standards are calibrated to the land use intentions for specific areas.

For example, as parks are a reasonable use to expect in floodable areas (and indeed may be the most appropriate use for such land given the characteristics of flooding in that location) it is desirable to ensure any standards of service reflect that intention. Therefore, while setting a basic level of flood immunity for parks (such as 1% AEP) generally is appropriate, there may be instances where parks are used to buffer floodable areas from other urban uses, and the standards can be drafted to reflect that reality.

4.5 Plans for trunk infrastructure

Plans for trunk infrastructure within the PIP provide details on existing and future trunk infrastructure and their catchments planned within the PIA.

These plans should include details of areas and infrastructure proposed to be decommissioned. Decommissioning of infrastructure will be a natural consequence of the decision to retreat from existing areas of settlement, and so providing clear plans on where, when and how decommissioning of existing infrastructure in areas of intolerable risk will occur provides clarity to the community and other stakeholders.

It is intended that section 4.5 of a PIP also include information regarding the plans for trunk infrastructure and schedule of works. For the provision of infrastructure, assumed time of completion relative to development, estimated costs and service catchments can all be provided in this section.

For infrastructure to be decommissioned, similar information should be provided. For example, timeframes for decommissioning that accord with the retreat program should be provided, while costs to remove and the service areas affected by the decommissioning are also important.

In terms of infrastructure works required to mitigate against natural hazards (such as flood levees, detention basins, or other waterway works), while they might not always be termed ‘trunk infrastructure’, these mitigation works are infrastructure regardless and do greatly affect decision making regarding land use pattern evolution and development intent for the local government area.

Including details of such planned works within a planning scheme is beneficial. It provides clarity to the community and other stakeholders regarding the commitment to address natural hazards in areas where a decision has been made to maintain a settlement in a particular location, notwithstanding the risk to which the area may be subject. It also clarifies the role mitigation works are intended to play in the achievement of the settlement pattern envisaged by the strategic framework of the planning scheme in the face of natural hazard events.

Zones

Based on the intentions outlined in the strategic framework, zones provide a more targeted delivery mechanism for the desired future outcomes for a local government area through clear and thought-out land use zoning plans. Zonings are the appropriate place to clearly articulate the land use intent desired for areas subject to that zone.

Zonings have associated levels of assessment which can be calibrated against the vision to ensure that desired development is not required to undergo unnecessary assessment and approval processes. Moreover, this means that any development not desired in the area can be subject to impact assessment. Zonings and their associated levels of assessment can therefore be considered as a highly effective statutory mechanism for ensuring development occurs in line with the vision of the community. Essentially, zones deal with land use appropriateness and include assessment criteria to support the desired land use envisaged through the zoning.

In light of this, the importance of effective and well thought out zoning in a planning scheme and how this can be applied to treat flood risk is paramount.

Under the QPP framework Councils have the opportunity to select zonings from a suite of options. Zones are able to include precincts which provide further guidance about the desired development in that area. In other words, precincts may be used to identify areas that require a considered land use/design response over the general assessment criteria of the zone itself.

To assist Councils in utilising the QPP framework to effectively regulate development in relation to flooding, two examples of zones (including precincts) that respond to flood risk in different ways are provided below. Councils may wish to consider the use of precincts for other zones (such as mixed use or commercial precincts) used in the planning scheme with regard to flood risk in those areas.

Part 5 Tables of assessment

Editor's note – Sections 5.1 – Preliminary to Section 5.4 Prescribed Levels of Assessment have been removed for the purposes of these examples.

5.5 Levels of assessment–Material Change of Use

The following tables identify the levels of assessment for development in a zone associated with a material change of use.

Table 5.5.1–Limited development (constrained land) zone

Use*	Level of assessment*	Assessment criteria*
Aquaculture	Code assessment	Limited development (constrained land) Zone code Other codes if applicable*
Cropping	Exempt	
Landing	Code assessment	Limited development (constrained land) Zone code Other codes if applicable*

Market (if temporary)	Exempt	Limited development (constrained land) Zone code Other codes if applicable*
Outdoor sport and recreation	Code assessment	Limited development (constrained land) Zone code Other codes if applicable*
Park	Exempt	Limited development (constrained land) Zone code Other codes if applicable*
Permanent plantation	Exempt	Limited development (constrained land) Zone code Other codes if applicable*
Marine industry	Code assessment	Limited development (constrained land) Zone code Other codes if applicable*
Impact assessment		
Any other use not listed in this table. Any other undefined use.		The planning scheme.

*For further consideration by Council dependent on local context.

Table 5.5.2– Residential choice zone

Use*	Level of assessment*	Assessment criteria*
Dwelling house	Self assessment	Residential choice Zone code Other codes if applicable*
Dwelling unit	Code assessment	Residential choice Zone code Other codes if applicable*
Dual occupancy	Self assessment	Residential choice Zone code Other codes if applicable*
Food and drink outlet	Self assessment	Residential choice Zone code Other codes if applicable*
Home based business	Self assessment	Residential choice Zone code Other codes if applicable*
Market	Exempt	
Multiple dwelling	Code assessment	Residential choice Zone code Other codes if applicable*
Park	Exempt	
Place of worship	Code assessment	Residential choice Zone code Other codes if applicable*
Sales office	Exempt	
Impact assessment		
Any other use within the Residential choice (flood constrained precinct) Zone		The planning scheme.

Any other use not listed in this table. Any other undefined use.	

*For further consideration by Council dependent on local context.

Editor's note – the default level of assessment is impact unless otherwise prescribed within the Act or the Regulation.

Editor's note – Section 5.6 – Levels of assessment - Local plans has been removed for the purposes of these examples.

5.7 Levels of assessment–Reconfiguring a lot

The following table identifies the levels of assessment for reconfiguring a lot.

Table 5.7.1–Reconfiguring a lot

Zone	Level of assessment	Assessment criteria
Limited development (constrained land) zone	Impact assessment	The planning scheme
Residential choice zone	Impact assessment If in flood constrained precinct and involving subdivision of land Code assessable otherwise	The planning scheme

Editor's note*** – the default level of assessment is impact unless otherwise prescribed within the Act or the Regulation.

5.8 Levels of assessment–Building work

There is no building work regulated under the planning scheme.

5.9 Levels of assessment–Operational work

The following table identified the levels of assessment for operational work.

Table 5.9.1 – Operational work

Zone	Level of assessment	Assessment criteria
Limited development (constrained land) zone	Code assessment	
	If associated with a material change of use or reconfiguring a lot.	Operational work code Reconfiguring a lot code Limited Development (Constrained Land) Zone Code Other codes if applicable*
	If involving filling or excavation.	Operational work code Limited Development (Constrained Land) Zone Code Other codes if applicable*
Residential choice zone, where located within the flood constrained precinct	If associated with a material change of use or reconfiguring a lot.	Operational work code Reconfiguring a lot code Residential Choice Zone Code Other codes if applicable*

	If involving filling or excavation.	Operational work code Residential Choice Zone Code Other codes if applicable*
Exempt		
Any other operational work not listed in this table.		

Editor's note – ***the default level of assessment is exempt unless otherwise prescribed within the Act or the Regulation.

5.10 Levels of assessment – Overlays

The following table identifies where an overlay changes the level of assessment from that stated in a zone or local plan and the relevant assessment criteria.

Table 5.10.1 – Assessment criteria for overlays

Development	Level of assessment	Assessment criteria
Flood Hazard Overlay		
All development, except Operational work for filling and excavation	As prescribed by zone code(s)	Flood Hazard Overlay Code
Operational work for filling and excavation	Code assessment	Flood Hazard Overlay Code

Part 6 Zones

Editor's note – Section 6.1 – Preliminary has been removed for the purposes of these examples.

6.2 Zone codes

6.2.1 Limited development (constrained land) zone code

6.2.1.1 Application

This code applies to assessing material change of use, reconfiguring a lot and operational work for development in the limited development (constrained land) zone.

Editor's note – These are example flood assessment criteria intended for inclusion in the zone codes. Other land use matters to be addressed in zone codes have not been included here.

6.2.1.2 Purpose for Limited development (constrained land) zone

(1) The purpose of the limited development (constrained land) zone code is to identify land known to be significantly affected by one or more development constraints (such as past or future mining activities, flooding, land contamination, defence requirements, historical subdivisions and buffer areas). Such constraints pose severe restrictions on the ability of the land to be developed for urban purposes.

(2) The local government purpose of the zone code is to:

a. Limit future development that may increase risk to life or property to intolerable levels.

b. Promote the transition of existing uses at intolerable risk of hazard (including flood) away from the hazard, and promote development that is generally non-urban and of low scale and intensity within the zone.

(3) The purpose of the code will be achieved through the following overall outcomes:

a. The limited development potential of land restricts the type, scale and intensity of land uses that are appropriate.

b. Residential uses are not located in this zone and acceptable land uses are aquaculture, cropping, landing, market (if temporary), outdoor sport and recreation, park, permanent plantations and marine industry.
c. The transition of existing land uses that are incompatible with the high (flood) hazard is facilitated.
d. Where generally non-urban development is proposed it is of a low intensity and scale and must be compatible with the flooding constraints of the land.
e. Existing uses may remain however no increases in scale or density of these uses are intended.
f. No additional lots are created and amalgamation of lots is encouraged to facilitate non-urban use.

6.2.1.3 Assessment criteria

Criteria for self-assessable, compliance assessable and assessable development

Performance outcomes	Acceptable outcomes
For self assessable and assessable development	
PO1 Development for urban purposes (including increases to scale and intensity of existing urban uses) is avoided and non-urban development is compatible with the hazard. [1]	AO1.1 There is no increase in the number of people living on site. AO1.2 Additional lots are not created. *Note – residential uses are not appropriate for this zone.*
PO2 Development that does not increase the risk to life or property is compatible with the natural landscape values and character of the locality.	AO2.1 Riparian/waterway corridors and other areas of environmental significance (e.g. stands of vegetation) on site are protected.

6.2.2 Residential choice zone

6.2.2.1 Application

This code applies to assessing material change of use, reconfiguring a lot and operational work for development in the residential choice zone.

6.2.2.2 Purpose for Residential choice zone

(1) The purpose of the residential choice zone code is to provide for a range and mix of dwelling types including dwelling houses and multiple dwellings supported by community uses and small-scale services and facilities that cater for local residents.
(2) The local government purpose of the code is to:
    a. Ensure development within the zone is compatible with the natural hazards affecting properties within this zone.
(3) The purpose of the code will be achieved through the following overall outcomes:
    b. Development provides a range of residential dwelling choices including multiple dwellings and other residential development and short-term accommodation for visitors in locations clustered around or near centres and transport nodes.
    c. Development encourages and facilitates urban consolidation and the efficient use of physical and social infrastructure.

[1] A site based planning evaluation may be required in order to demonstrate compliance with this performance outcome in accordance with Planning Scheme Policy X

d. Non-residential uses that provide for the everyday needs of the residential community are facilitated.
e. Development is supported by employment nodes, community facilities and services, transport and commercial hubs where appropriate.
f. Development provides for an efficient land use pattern that is well connected to other parts of the local government area.
g. Development is designed to provide safe and walkable neighbourhoods.
h. Development facilitates other non-residential uses that integrate work and family and complement local residential amenity.
i. Development is designed to incorporate sustainable practices including maximising energy efficiency, water conservation and public/active transport use.
j. Development is supported by transport infrastructure which is designed to provide and promote safe and efficient public transport use, walking and cycling.
k. Development provides a high level of amenity and is reflective of the surrounding character of the area.
l. Development maintains a high level of residential amenity having regard to traffic, noise, dust, odour, lighting and other locally specific impacts.
m. The scale and density of development facilitates an efficient land use pattern that supports walkable neighbourhoods that are well connected to employment nodes, centres, open space and recreational areas, community services and educational opportunities.
n. Non-residential uses may be supported where such uses directly support the day to day needs of the immediate residential community, do not detract from the residential amenity of the area and do not undermine the viability of nearby centres.
o. Development responds to land constraints, including but not limited to topography, bushfire and flooding constraints.
p. Development mitigates any adverse impacts on adjoining areas of environmental significance, including creeks, gullies, waterways, wetlands, coastal areas, habitats, vegetation and bushland through location, design, operation and management.
q. Flood constrained precinct:
    i. land uses that include persons that are vulnerable to flood hazard are not located in the flood constrained precinct, including child care centre, community care centre, community residence, educational establishment, emergency services, relocatable home park, residential care facility, retirement facility and tourist park.
    ii. Additional lots are not created in the flood constrained precinct.
    iii. Built form responds to the flood hazard and is compatible with the existing character of the locality.

6.2.2.3 Assessment criteria

Criteria for self-assessable, compliance assessable and assessable development

Performance outcomes	Acceptable outcomes
For self assessable and assessable development	
Flood constrained precinct	
PO1 Uses that include persons who would be vulnerable to flood hazard are not located in the precinct. [2]	AO1.1 The number of vulnerable persons living and working in the precinct is not increased.

[2] A site based planning evaluation may be required in order to demonstrate compliance with this performance outcome in accordance with Planning Scheme Policy X

PO2 Land uses that do not include vulnerable persons are otherwise compatible with the level of flood hazard identified for the site.[2]	AO2.1 No acceptable outcome *Note – The flood hazard overlay code provides acceptable outcomes for acceptable built form in flood hazard areas.*
PO3 Development is resilient to flood events by ensuring design and built form account for the potential risks of flooding and is compatible with the predominant residential character of the area.	AO3.1 No acceptable outcome *Note - The desired built form character is prescribed by PO XX* in the general section of the residential choice zone code.* *Note – The flood hazard overlay code provides acceptable outcomes for acceptable built form in flood hazard areas.*

* Cross reference to general section of residential choice zone code dealing with character.

Flood hazard overlay

Within the QPP framework, Councils have the ability to utilise overlays to further regulate the type of development that occurs within a particular area, i.e. the flood affected land within a planning scheme area.

Overlays are an effective tool as they allow for, in relation to flood hazard, an additional set of assessment criteria to apply to assessable development to ensure greater control of built form outcomes. Overlays act as a trigger, meaning that an application for self-assessable or assessable development on land within an overlay area will trigger an additional set of assessment criteria.

Overlays should focus on site based, built form outcomes as opposed to matters of land use appropriateness (which are dealt with through zones).

While an overlay may change the level of assessment, it is recommended that Council ensure that the levels of assessment allocated in the tables for zones and local plans represent the desired outcomes which then eliminates the need to duplicate the levels of assessment in the overlay code.

The below provides an example of a Flood Hazard Overlay as permitted under the QPP framework to complement efficient land use planning by ensuring Councils can further consider development outcomes (particularly built form outcomes) within flood affected areas. The use of the Flood Hazard Overlay in new schemes provides an effective tool that supports the land use transition strategies identified in the Guideline.

Part 8 Overlays

Editor's note – Section 8.1 – Preliminary has been removed for the purposes of these examples.

8.2 Overlay codes

8.2.1 Flood Hazard Overlay Code

8.2.1.1 Application

This Code is an applicable code for self-assessable and assessable development prescribed by a level of assessment table in the planning scheme and involving land wholly or partially within the Flood Hazard Overlay as shown on **<insert overlay map title and no.>**

The Code must be considered together with other relevant planning scheme codes that are applicable to the subject development.

8.2.1.2 Purpose

(1) The purpose of the code is to manage development outcomes in the floodplain so that risk to life, property, community and the environment during future flood events is minimised, and to ensure that development does not increase the potential for flood damage on site or to other property.

(2) The purpose of the code will be achieved through the following overall outcomes:

a. Development maintains the safety of people on the development site from flood events and minimises the potential damage from flooding to property.

b. Development does not result in adverse impacts on people's safety, the environment or the capacity to use land within the floodplain.

8.2.1.3 Assessment Criteria

Criteria for assessable and self assessable development

Performance outcomes	Acceptable outcomes
PO1. Development siting and layout responds to flooding potential and maintains personal safety at all times.[3]	**For Material Change of Use** **AO1.1.** New buildings are: • not located within the overlay area, or; • located on the highest part of the site to minimise entrance of floodwaters; or • designed with elevated habitable floor levels[4]; and • provided with clear and direct pedestrian and vehicle evacuation routes off the site.[5] *Note: If part of the site is outside the Flood Hazard Overlay area, this is the preferred location for all buildings.* **For Reconfiguring a Lot** **AO1.2.** Additional lots: • are not located in the flood hazard overlay area; or • are demonstrated to be above the flood level[7] identified for the site; or • where no flood level is adopted, located on the highest part of the site to minimise entrance of floodwaters *Note: If part of the site is outside the Flood Hazard Overlay area, this is the preferred location for all lots (excluding park or other relevant open space and recreation lots).* *Note: Buildings subsequently developed on the lots created will need to comply with the relevant building assessment provisions under the Building Act 1975.* **AO1.3.** Road and/or pathway layout ensures residents are not physically isolated from the adjacent flood free urban areas[6] and provides a safe and clear evacuation route path:

[3] Council may choose to require the applicant to submit a site-based flood study that investigates the impact of the development on the floodplain and demonstrates compliance with the relevant Performance outcomes

[4] The level to which the habitable floor levels must be built may be set by Council resolution in accordance with section 13 of the *Building Regulation 2006*. Where a level is not set, habitable floors must be elevated above natural ground to a height determined by Council.

[5] Council may set appropriate water depth, distances and velocities deemed to allow for safe and clear access.

	• if a flood level is adopted[7], by locating entry points into the reconfiguration above the flood level and avoiding culs-de-sac or other non-permeable layouts; or • if a flood level is not adopted, by direct and simple routes to main carriageways.[5] **AO1.4.** Signage is provided on site (regardless of whether land is in public or private ownership): • indicating the position and path of all safe evacuation routes off the site; andif the site contains or is within 100m of a floodable waterway, hazard warning signage and depth indicators are also provided at key hazard points, such as at floodway crossings or entrances to low-lying reserves.
PO2. Development is resilient to flood events by ensuring design and built form account for the potential risks of flooding.	**For Material Change of Use (Residential Uses)** **AO2.1.** Residential dwellings are not designed as single-storey slab on ground. *Note: The highset 'Queenslander' style house is a resilient low-density housing solution in floodplain areas. Higher density residential development should ensure only non-habitable rooms (e.g. garages, laundries) are located on the ground floor.* **AO2.2.** Residential buildings: • use screening to ensure that the understorey is not visible from the street; and • orient to the street by ensuring that the stairs to the dwelling and at least one habitable room overlook the street; and • have ground floors that allow for the flow through of flood water. *Note: For higher density residential uses, commercial activities on the ground floor are acceptable where the ground floor has been specifically designed in accordance with the relevant building assessment provisions to include resilient materials and to be structurally appropriate.* *Note: The highset 'Queenslander'-style house is a resilient low-density housing solution in floodplain areas. Higher density residential development should ensure only non-habitable rooms (e.g. garages, laundries) are located on the ground floor.* **For Material Change of Use (Non-Residential Uses)** **AO2.3.** Non residential buildings and structures: • orient to the street by activating the street frontage through ground floor commercial uses or urban design treatments such as recess wall treatments, screening and or landscaping; and • allow for flow through of flood waters on the ground floor. *Note: Businesses should ensure that they have the necessary continuity plans in place to account for the potential need to relocate property prior to a flood event (e.g. allow enough time to transfer stock to the upstairs level of a building or off site).* *Note: The relevant building assessment provisions under the Building Act 1975 apply to all building work within the Flood Hazard Overlay area and must take account of the flood potential within the area.* *Note: Resilient building materials, including those required for wet and/or dry flood proofing, for use within the Flood Hazard Overlay area should be determined in consultation with Council, in accordance with the relevant building assessment provisions.*

[6] It is important to ensure that new reconfigurations are not isolated from other urban areas in the event of a flood.
[7] As resolved by Council.

	AO2.4
PO3. Development directly, indirectly and cumulatively avoids any increase in water flow velocity or flood level, and does not increase the potential for flood damage either on site or on other properties.[1]	**For Material Change of Use, Reconfiguring a Lot and Operational Works** **AO3.1.** Works in urban areas[8] associated with the proposed development do not involve: • any physical alteration to a watercourse or floodway including vegetation clearing; or • a net increase in filling (including berms/mounds). *Note: Berms/mounds are considered to be an undesirable built form outcome and are not supported.* **AO3.2.** Works (including buildings and earthworks) in rural areas either: • do not involve a net increase in filling greater than 50m^3; or • do not result in any reductions of on-site flood storage capacity and contain within the subject site any changes to depth/duration/velocity of flood waters; or • do not change flood characteristics outside the subject site in ways that result in: ○ loss of flood storage; ○ loss of/changes to flow paths; ○ acceleration or retardation of flows; **or** any reduction in flood warning times elsewhere on the floodplain. **AO3.3.** In rural areas, buildings and infrastructure are set back 50m[9] from natural riparian corridors to maintain their natural function of reducing velocity of flood waters. *Note: Fences and irrigation infrastructure (e.g. irrigation tape) in rural areas should be managed to minimise adverse impacts that they may have on downstream properties in the event of a flood.*
PO4. Development avoids the release of hazardous materials into floodwaters.	**For Material Change of Use** **AO4.1.** Materials manufactured or stored on site are not hazardous in nature; **OR** **AO4.2** If a flood level is adopted[10], hazardous materials and their manufacturing equipment are located above this level; **OR** **AO4.3.** If a flood level is not adopted, hazardous materials and their manufacturing equipment are located on the highest part of the site to enhance flood immunity. *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.*

[8] As defined in the *Sustainable Planning Regulation 2009*
[9] Council can determine appropriate setbacks for their local circumstances.
[10] As resolved by Council.

Community use code

QPP allows local governments to utilise development codes in the planning scheme, however these are not a mandatory part of the framework. Development codes include use codes which can be used to regulate certain land uses, for example a house code or a community use code. Use codes are effective for regulating particular uses, or groups of similar uses, that may occur across a number of different zones and have certain desired development outcomes.

Use codes are triggered either through identifying the code in the level of assessment tables or through description in the application section of the code, for example applying to self-assessable, compliance and assessable development for the listed uses, regardless of zoning.

The below provides an example of a Community Use Code as permitted under the QPP framework to ensure Councils can further consider development outcomes (particularly built form outcomes) for both community services and community infrastructure that may be within flood affected areas.

The Community Use Code below may also be used as a Zone Code where Council may deem that appropriate, i.e. the Community Facilities Zone under QPP.

Part 9 Development codes

9.3 Use codes

9.3.1 Community Use Code

9.3.1.1 Application

This code applies to self-assessable and assessable development for the community services and community infrastructure activity group (as defined in advisory note below) in all zones.

Editor's note – The example assessment criteria contained here may be used in a zone code, for example Community Facilities Zone or Special Purpose Zone codes.

9.3.1.2 Purpose

(1) The purpose of the Community Use Code is to ensure that adequate community uses, including facilities and infrastructure, are established in the local government area to provide needed services and benefit to the community.

(2) The purpose of the code will be achieved through the following overall outcomes:

a. Community services are compatible with hazard, except those uses that involve vulnerable persons or property which are located outside of the flood hazard area.

I. Uses that involve vulnerable persons include child care centre, community care centre, community residence, community use, correctional facility, health care services residential care facility, retirement facility

II. Uses that involve vulnerable property include, cemetery, club, crematorium, place of worship, and funeral parlour

b. Community infrastructure[11] is not located in hazard areas, except where an overriding need for the use is demonstrated. [12]

c. <Insert other overall outcomes as desired by Council>

[11] As derived from the *Sustainable Planning Regulation 2009* and assessable under the scheme.

[12] A site based planning evaluation may be required in order to demonstrate compliance with this performance outcome in accordance with Planning Scheme Policy X

9.3.1.3 Assessment criteria

Criteria for self-assessable, compliance assessable and assessable development

Table 9.3.1.3 (a)

Performance outcomes	Acceptable outcomes
For self assessable and assessable development	
Community services	
PO1 Community services that include vulnerable persons or property are not located in flood hazard areas.	AO1.1 The number of vulnerable persons living and working in the flood hazard area is not increased. A01.2 Land uses with property vulnerable to flood hazard are not located in the flood hazard area.
PO2 Community services that do not include vulnerable persons or property are otherwise compatible with the level of flood hazard identified for the site.[13]	AO2.1 No acceptable outcome. *Note – the flood hazard overlay code provides acceptable built form outcomes in flood hazard areas.*
Community infrastructure	
PO3 Community Infrastructure[14] is able to function effectively during and immediately after flood events.	AO3.1 Community infrastructure development is not located in an area that has been identified by flood hazard mapping as being below the Recommended Flood Level (RFL) specified for that community infrastructure in Table 9.3.1.3 (b) below[15]; or The community infrastructure is located below the RFL but can function effectively during and immediately after the RFL flood event.

Table 9.3.1.3 (b) Recommended flood levels for community infrastructure

Recommended Flood Levels for Community Infrastructure	
Type of Community Infrastructure	**Recommended Flood Levels**
Emergency services	0.2% AEP
Emergency shelters	0.5% AEP
Police facilities	0.5% AEP
Hospitals and associated facilities	0.2% AEP
Stores of valuable records or items of historic or cultural significance (e.g.	0.5% AEP

[13] A site based planning evaluation may be required in order to demonstrate compliance with this performance outcome in accordance with Planning Scheme Policy X

[14] As derived from the *Sustainable Planning Regulation 2009* and assessable under the scheme.

[15] A flood study may be required to identify the RFL for the subject site.

galleries and libraries).	
• State-controlled roads • Works of an electricity entity not otherwise listed in this table • Railway lines, stations and associated facilities • Aeronautical facilities • Communication network facilities	No specific recommended flood level but development proponents should ensure that the infrastructure is optimally located and designed to achieve suitable levels of service, having regard to the processes and policies of the administering government agency.
Power stations	0.2% AEP
Major switch yards	0.2% AEP
Substations	0.5% AEP
Sewage treatment plants	DFE
Water treatment plants	0.5% AEP

Advisory note:

The activity groups identified in the above Community Use Code, being community services and community infrastructure, include the following groups of land uses:

- Community services:
  - retirement facility, cemetery, club, child care centre, community care centre, community residence, community use, correctional facility, crematorium, place of worship, indoor and outdoor sport and recreation, major sport, recreation and entertainment facility, park, funeral parlour, health care services,
- Community infrastructure[16]:
  - education establishment, hospital, telecommunications facility, emergency services, air services, major electrical infrastructure, renewable energy facility, substation, transport depot, utility installation.

[16] As derived from the *Sustainable Planning Regulation 2009* and assessable under the scheme.

Schedule 6 Planning scheme policies

SC6.2 Site based planning evaluation – flood hazard

Evaluation Criterion	Considerations and potential applicant requirements
What is the nature of the hazard affecting the site (i.e. highest recorded flood height, velocity and other flood characteristics)?	A site based flood study may be required as part of the development application to identify the specific flood characteristics of the subject site. The outputs of the flood study will inform the assessment and decision of the application, including any conditions of approval about ensuring resilient built form and design techniques are employed.
What impacts could the proposed development have on the nature of the hazard both on the subject site and its surrounding areas?	Council will need to have a clear understanding of the layout and intensity of the proposed development on the site in order to assess the potential impacts that the development could have on the level of flood hazard (on site and in surrounding areas).
How does the development respond to the hazard? Does the development present an intolerable risk to people and property? Can the development be conditioned to result in a tolerable or acceptable level of risk?	Where the risk to life or property posed by the proposed development is intolerable, this may result in Council refusing the application or setting wide ranging and comprehensive conditions as part of an approval to ensure that the development presents a tolerable or acceptable risk (i.e. built form conditions).
Are there existing or proposed structural controls on site that will reduce the risk of the hazard to a tolerable or acceptable level? Does the structural work required result in increases to flood hazard elsewhere, or poor environmental outcomes, visual amenity or urban design outcomes?	Existing or proposed structural controls (such as levees, floodgates or dams) may mitigate the hazard affecting the site, however they may involve significant environmental or visual impact that will need to be assessed. They may also exacerbate flood hazard impacts downstream of the site, which will also need to be assessed relative to the relevant planning scheme provisions. Structural controls may be acceptable where an overriding need for the land use can be demonstrated through the planning evaluation, and adverse impacts caused by these controls can be addressed.
Is the area served by appropriate emergency management procedures? Would the development be isolated in the event of a flood?	Evacuation routes, warning systems and emergency management procedures are critical in both existing and future urban settlements. Intensification of development in particular depends on the availability of clearly identified and passable evacuation routes and therefore an application for development on land subject to flood hazard will be required to demonstrate appropriate access to emergency management procedures. Applicants should analyse existing evacuation routes and procedures in and around the subject site to identify whether the development will be isolated. Issues of isolation/evacuation must be addressed as part of the development assessment process.
Is the built form resilient to the hazard?	The type of built form largely influences a development's resilience to flood hazard. Council may request particular built form and design outcomes for development occurring in flood hazard areas to ensure improved resilience and a more appropriate response to the risk is achieved. For example, the 'Queenslander' style of home performs far better in a flood than a slab on ground home, in terms of actual damage, cost to repair and the time required for the repairs.
Can the extent of floodways (up to an acceptable flood event, such as 1% AEP) be maintained in their natural state for flood conveyance?	In broadhectare areas, it is important that development layout and design maintains existing floodways and waterways in their natural state to assist flood conveyance which may minimise risk from flood. If proposing a broadhectare development, Council may request further information to be provided which demonstrates that the natural state of the flood conveyance will be maintained and subsequent plans showing how the layout achieves this. For infill development, Councils may also require applicants to demonstrate how flood conveyance via existing waterways on-site will be achieved in

	these areas up to a certain flood event (determined by Council).
Is there an overriding economic or social need to continue living and working in this area?	If the consequence to life or property on a site is tolerable or acceptable but may not be ideal, where such areas are of significant economic or social importance, a balanced approach to considering appropriate development for the site should be taken that considers these economic and/or social needs. Council may require an applicant to prepare an analysis demonstrating that overriding need.

Schedule 9 – Guidance checklist for planning scheme drafters

The following is a step by step methodology for consideration of flood hazard when preparing and drafting new planning schemes.

1. Use the IFAO to prepare an LGA-wide overlay map in conjunction with any other available flood information for the LGA

a) Locally verify the IFAO using historical information, anecdotal evidence or existing flood studies, using one or a combination of the following hierarchy:

i. a map showing 'areas of hazard' derived from information about the likelihood and behaviour of flooding;
ii. a map showing the extent of floods of a range of likelihoods;
iii. a flood map based on historic flood levels that have been subjected to a flood frequency analysis to estimate the annual exceedance probability of the selected historical flood;
iv. a historic flood map without flood frequency analysis;
v. the IFAO that has been locally verified and either accepted or amended by the relavent local government

2. Treat flood risk identified in the planning evaluation through the strategic framework and zonings

a) Ensure the strategic framework provides clear and unambiguous statement(s) regarding:

i. The community's level of acceptance of flood risk – Vision or Strategic Intent;
ii. The resilience target desired for the community – Vision or Strategic Intent;
iii. The desired evolution of the settlement pattern required over time to treat the flood risk, including land use intent for specific areas and directing future growth away from hazard areas – Strategic Intent and Settlement Pattern theme or similar;
iv. More detailed policy statements related to response of development to flood hazard, including compatibility of development with hazard, resilient built form outcomes, resilience of infrastructure etc – Natural Hazards, Safe Communities or Infrastructure Services themes or similar.

b) Ensure the zonings used reflect the community's level of acceptance of flood risk and the resilience target set

i. Ensure the zoning plan accords with the levels of flood risk for sites/suburbs identified through the planning evaluation;
ii. Use section 3 – Implementation for guidance on appropriate and inappropriate uses:
    i. In areas of intolerable risk – use restrictive zoning such as Limited Development (constrained land), Open Space & Recreation, & Rural;
    ii. In areas of tolerable risk – use 'flood-constrained precincts' to limit certain uses in the flood hazard area but allow others;
    iii. In areas of acceptable risk – little (if any) land use change required, built form requirements can be sufficient (through the overlay code).
iii. Direct future growth away from floodable areas, or where this is not possible, identify very clearly on strategic planning maps and in the framework that some parts of the future urban growth areas are constrained by flood and will not be appropriate for development, unless those uses are compatible with the flood hazard.
iv. Remember that some land uses are flood-compatible and may be appropriate in areas identified as flood hazard (subject to appropriate built form assessment):
    i. Particularly water-oriented development such as aquaculture, landings, marine industries etc that require waterways by the nature of their use;
    ii. Parks, many sport and recreation activities (such as golf courses & paintball), many agricultural activities such as cropping are also generally compatible with flood hazard;
    iii. Develop strategies to deal with flood hazard in existing urban areas.

c) Consider articulating relocation strategies for intolerable risk areas that sit outside of the planning scheme – through the land use strategy section in the settlement pattern theme.

3. Tailor zone outcomes and levels of assessment accordingly

a) Clearly articulate the desired intent for land use within the overall outcomes of the zone – including the desired response to flood risk. E.g If the Limited Development (Constrained Land) Zone is used in areas of intolerable flood risk, then the overall outcomes should be worded accordingly to strongly limit land uses that are incompatible with that level of risk.

b) Impact assessment should be used for those land uses that are incompatible with that level of risk to discourage that form of development in that location.

c) Code assessment can be used for those uses that require an assessment of flooding impact on the land use to ascertain if that development is appropriate for that location, where code drafting is sufficiently clear on land use intent for that zone

d) Self-assessment or exempt can be used for land uses in low risk areas (or where that land use type would be acceptable relative to the level of hazard) where provisions are simple enough for self-assessment.

i. For example, a park need not be subject to significant assessment, exempt is likely to be appropriate unless there are specific assessment criteria a Council desires such a use to address

4. Tailor the overlay code for built form outcomes

a) The overlay code should deal only with built form outcomes. It should not present policy in relation to the appropriateness of land use in that location.

b) Outcomes sought by the overlay should promote built form resilience – such as the use of the 'Queenslander' style of home, or 'flow-through' building design for commercial properties. In addition, the use of fill on the floodplain should be addressed, and subdivision design should be considered closely to ensure isolation is avoided and appropriate evacuation routes are provided for residents.

c) Acceptable outcomes that need a site-based flood study to identify (for example) a 1 in 100 year flood level for habitable floor levels is not a self-assessable criterion that is easily achievable. The Model Code provides example provisions that may be suitable for self-assessment.

d) Acceptable outcomes that need a site-based flood study to identify (for example) a 1 in 100 year flood level for habitable floor levels is not a self-assessable criterion that is easily achievable. The Model Code provides example provisions that may be suitable for self-assessment.

5. Ensure public notification period includes specific consultation on flood hazard mapping

a) In areas where only Level 1 or Level 2 flood investigations have been completed, specific consultation (of the community broadly, and of local interest groups such as a historical society or floodplain management group) to obtain anecdotal evidence of historic floods can provide additional information necessary to enhance the flood information in these other areas.

Schedule 10 – Guidance checklist for planning scheme reviewers

The following is a step by step checklist for reviewing new draft planning schemes for consideration of flood hazard.

Mapping

1.	**Does the draft scheme have a flood hazard overlay map?**	☐ ☐
a)	If not, councils should use the IFAO (locally verified and amended if required) and any other available information noted in point 3 below	☐ ☐
2.	**Does the map show all floodable areas shire-wide or only for certain towns/areas?**	☐ ☐
a)	If information is available for towns only, this should be supplemented with the IFAO in between towns	☐ ☐
3.	**What information was used to create that map?**	☐ ☐
a)	Hierarchy of possible mapping techniques used to prepare the map is as follows (consistent with QFCoI recommendations 2.13 & 2.14): i. a map showing 'areas of hazard' derived from information about the likelihood and behaviour of flooding; ii. a map showing the extent of floods of a range of likelihoods; iii. a flood map based on historic flood levels that have been subjected to a flood frequency analysis to estimate the annual exceedance probability of the selected historical flood iv. a historic flood map without flood frequency analysis; v. the IFAO that has been locally verified and either accepted or amended by the relevant local government.	☐ ☐

Provisions

4. **Has the community's views on the level of acceptable flood risk been captured?** ☑ ☒

5. **Has a resilience target been set for the local government?** ☑ ☒

a) The resilience target is a useful way to demonstrate how a local government intends to address floodplain resilience through its various responsibilities, including through the planning scheme. ☑ ☒

6. **Does the scheme rely on the development assessment process to assess the compatibility of land use with flood hazard, or are flood hazard considerations 'front-loaded' into the planning scheme?** ☑ ☒

a) Front-loading as much information and land use policy as possible is the preferred approach.

7. **Are the draft planning scheme provisions generally in accordance with the example planning provisions in the *Planning for stronger, more resilient floodplains Part 2 – Measures to support floodplain management in future planning schemes?*** ☑ ☒

a) The draft provisions should be consistent with the intent of the example planning scheme provisions and the broader intent of the Guideline. ☑ ☒

8. **Does the strategic framework consider flooding/natural hazards appropriately?** ☑ ☒

a) Is it clear the settlement pattern (e.g through the Settlement Pattern theme) will evolve over time to respond to the hazards? ☑ ☒

b) Is there a 'Natural Hazards' or 'Safe Communities' theme that gives further detail on how flood is considered in the scheme? Are infrastructure services also addressed through the strategic framework? ☑ ☒

9. **Does the priority infrastructure plan consider the natural hazard risks prevalent in the scheme area?** ☑ ☒

a) Do the priority infrastructure area and plans for trunk infrastructure correspond to the settlement pattern intent articulated by the strategic framework? ☑ ☒

b) Where back-zonings are proposed, are details of infrastructure decommissioning provided in the PIP? ☑ ☒

10. **Do the zonings used reflect the flood risk identified for the LGA (or parts of the LGA)?** ☑ ☒

a) Are areas at different levels of risk zoned appropriately? ☑ ☒

11. **Is there 'horizontal' and 'vertical' integration of flood matters throughout the scheme?** ☐ ☐

12. **Where is the flood hazard map located in the scheme?** ☐ ☐

a) An overlay map is the preferred location for flood hazard. Floodable areas can also be identified on the relevant strategic framework map(s) where this demonstrates how the settlement pattern responds to the flood risk. ☐ ☐

13. **How is the mapping used?** ☐ ☐

a) Does it trigger an overlay code? An overlay code is appropriate to house built form assessment criteria primarily, rather than land use criteria. ☐ ☐

14. **Does the overlay code deal with built form matters, or does it also include land use provisions?** ☐ ☐

a) It is preferred that the overlay code only deals with built form matters, and that land use intent be addressed through the zone codes. ☐ ☐

Schedule 11 – Glossary and further information

Glossary

It is helpful for Planners and other development professionals to understand a number of common terms used in floodplain management. It is particularly important to understand the meaning and application of the terms identified below, which have been derived from current best practice guidance[1].

Annual Exceedance Probability (AEP) – the likelihood of a flood of a certain size or larger being exceeded in any one year.

Annual Recurrence Interval (ARI) – the average interval in years which would be expected to occur between exceedances of flood events of a given magnitude.

Community Resilience – the characteristics of a resilient community are: functioning well while under stress; successful adaptation, self-reliance; and social capacity.

Floodplain – For the purposes of this Guideline, all parts of a sub-basin potentially subject to riverine flooding.

Natural Hazard – a naturally occurring situation or condition with the potential for loss or harm to the community, property or environment.

Probable Maximum Flood (PMF) – An estimate of the largest possible flood that could occur at a particular location, under the most severe meteorological and hydrological conditions as they are currently understood.

Risk – Risk is a combination of likelihood (or chance) of an event occurring, and the consequences of that occurrence. Consequences are in turn determined by the level of exposure to the ocurrence and the vulnerability of people, property and infrastructure to the occurrence.

Sub-basin – the area of land draining to a particular site. It always relates to a specific location and includes the catchments of tributary streams as well as the main stream. The term 'sub-basin' is used in this document to denote 'catchment'.

Vulnerability – the degree of susceptibility of individual persons, the community and the environment to natural hazard.

Further Information and Guidance

Detailed information on the floodplain management system and its processes is available through:

- SCARM Report 73 – *Floodplain Management in Australia: Best Practice Principles and Guidelines*, available from the CSIRO website: www.publish.csiro.au/Books/download.cfm?ID=2260
- New South Wales *Floodplain Development Manual: the management of flood liable land*, available at www.environment.nsw.gov.au/floodplains/manual.htm
- *Australian Rainfall and Runoff* (AR&R), Engineers Australia – available at: www.arr.org.au

More general information on flooding is available via the Understanding Floods: Questions and Answers publication, produced by the Queensland Chief Scientist and available at www.chiefscientist.qld.gov.au/publications/understanding-floods.aspx

1 Including State Planning Policy 1/03,the National Strategy for Disaster Resilience and the Standing Committee for Agriculture and Resource Management (SCARM) Report 73 – Floodplain Management in Australia

Source: Western Downs Regional Council

Queensland
Government