Increasing Queensland's resilience to inland flooding in a changing climate:

Final report on the Inland Flooding Study

A joint project of:

Department of Environment and Resource Management

Department of Infrastructure and Planning

Local Government Association of Queensland

Tomorrow's Queensland: strong, green, smart, healthy and fair

Toward Tomorrow's Queensland

Queensland Government

Prepared by:

Office of Climate Change—Department of Environment and Resource Management

Department of Infrastructure and Planning

Local Government Association of Queensland

#29528

Executive summary

Flooding causes significant impacts on Queensland communities and the economy—and with our changing climate, flooding events are likely to become more frequent and more intense. Effective land use planning will ensure our communities are ready for the impacts of climate change.

The Local Government Association of Queensland (LGAQ) approached the Queensland Government to provide a benchmark figure for taking climate change into account when assessing inland flooding risk.

An Inland Flooding Study project was established by the Minister for Climate Change and Sustainability and the Minister for Infrastructure and Planning in partnership with LGAQ to deliver:

1. An improved methodology for assessing inland flooding risk while accounting for climate change.
2. Specific policy options for improved flood risk management in the case study area—Gayndah in the North Burnett Regional Council.
3. General policy options for consideration as part of the review of State Planning Policy 1/03 Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (SPP 1/03).

As a result, this Inland Flooding Study combines the best available science and planning options to provide clear guidance and practical tools to enhance flood risk management by local governments.

This study provides Queensland local governments with a climate change factor for increased rainfall intensity for incorporation into flood studies. It proposes 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 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) Annual Exceedance Probability (AEP)[1] flood events recommended in SPP 1/03. For the purpose of applying this climate change factor local governments should use the following temperature increases and planning horizons: 2°C by 2050, 3°C by 2070 and 4°C by 2100.

This climate change factor will be reviewed and updated when a national position on how to factor climate change into flood studies is finalised as part of the current review of Australian Rainfall and Runoff Engineers Australia Publication (AR&R). The outcomes of this review are not expected to be available before 2014.

In the interim, local governments can use the recommended climate change factor from this project to better identify flood risks. Further technical information on how this climate change factor was derived can be found at ‹www.derm.qld.gov.au›.

Using this climate change factor, the Inland Flooding Study developed recommended policy options to incorporate climate change into the flood risk management framework for Gayndah. These options are included in a draft flood constraint code for assessing development applications, which defines four flood hazard areas linked to the 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood levels. The draft flood constraint code outlines the appropriate land uses for each of these hazard areas. This is a major step forward in shifting the focus from the 1 per cent AEP (Q100) as the only relevant flood level for residential development to the reality that there are varying levels of flood risk that local governments need to consider.

The recommendations also include two implementation options for addressing the increased flood intensity risk from climate change. These two options allow the North Burnett Regional Council to choose how best to represent this risk in its planning scheme.

The first option uses three new flood maps that include the climate change factor:

- Map 1: 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood extents projected for 2050.
- Map 2. 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood extents projected for 2070.
- Map 3: 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood extents projected for 2100.

These maps are used to apply development constraints based on the asset life and location of a development proposal in relation to the revised flood maps.

1 The Annual Exceedence Probability (AEP) refers to the likelihood of occurrence of a flood of a given size (or larger) in any one year. The 1 per cent AEP flood event is also known as the 1-in-100 year Average Recurrence Interval (ARI) or Q100 event, the 0.5 per cent AEP is also known as the 1-in-200 year ARI or Q200 event, and the 0.2 per cent AEP is also known as the 1-in-500 year (ARI) or Q500 event.

The second option uses Gayndah's existing flood maps and increases the level of constraint on development proposals to account for the climate change factor. In effect this extends the area subject to current 1 per cent AEP (Q100) development constraints to:

- an area equivalent to the present day 0.5 per cent AEP (Q200) flood level for areas subject to a development commitment
- an area equivalent to the present day 0.2 per cent AEP (Q500) flood level for new urban development.

This approach is based on the current 0.5 per cent AEP (Q200) approximating the 1 per cent AEP (Q100) level by 2050 and the current 0.2 per cent AEP (Q500) approximating the 1 per cent AEP (Q100) level by 2100.

The two implementation options apply the same climate change factor of a 5 per cent increase in rainfall intensity per degree Celsius of global warming.

The recommended policy options provide the North Burnett Regional Council with interim guidance on how to better manage flood risk for the Gayndah township area in advance of the review of SPP 1/03. While these options are specific to the issues identified by this project for the Gayndah township, the policy approach underpinning the draft flood constraint code will be of interest to other local governments as an example of how the impact of climate change on flood risk can be addressed in planning schemes. A copy of the recommended policy options paper prepared for Gayndah can be found at ‹www.derm.qld.gov.au›.

The Inland Flooding Study raised issues that will be considered by the Queensland Government as part of the review of SPP1/03, including:

- the benefits of requiring a standard hydrological methodology for flood studies
- identifying how frequently flood studies should be reviewed and/or updated
- investigating the circumstances in which local governments should be able to have a Defined Flood Event (DFE)[2] that is higher or lower than the 1 per cent AEP (Q100)
- clarifying which components of the SPP, as they relate to flood risk management, are optional or mandatory
- identifying how to better integrate land use planning and disaster management planning, for example making sure there are sufficient evacuation routes to get people to a safe and secure area in an extreme event (e.g. storm, flood or fire).

The key recommendations from the study are:

- **Recommendation 1**—Local governments should factor a 5 per cent increase in rainfall intensity per degree of global warming into the 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood events recommended in SPP 1/03 for the location and design of new development.
- **Recommendation 2**—The following temperatures and timeframes should be used for the purposes of applying the climate change factor in Recommendation 1:

  - 2°C by 2050

  - 3°C by 2070

  - 4°C by 2100.
- **Recommendation 3**—The Queensland Government will review and update this climate change factor when a national position on how to factor climate change into flood studies is finalised as part of the current review of AR&R.
- **Recommendation 4**—That North Burnett Regional Council consider the two implementation options identified in the paper *Recommended Policy Options for Incorporating Climate Change into the Flood Risk Management Framework in Gayndah* and implement its preferred approach in its planning scheme.
- **Recommendation 5**—The review of SPP 1/03 should consider the benefits of requiring a standard method for undertaking a flood study and determining a DFE.
- **Recommendation 6**—The review of SPP 1/03 should consider whether there is a need to specify how frequently a flood study should be reviewed or updated.
- **Recommendation 7**—The review of SPP 1/03 should develop criteria that outline the circumstances where a DFE higher or lower than the 1 per cent AEP (Q100) is appropriate for residential land use planning.

2 The DFE is the flood event adopted for the management of development in a particular locality. The 1 per cent AEP is the recommended DFE under SPP1/03.

- **Recommendation 8**—The review of SPP 1/03 should clarify what components of the SPP are compulsory and clarify what additional guidance local governments may need to meet those obligations.
- **Recommendation 9**—The review of SPP 1/03 should consider the applicability of the recommended planning response for Gayndah (as per recommendation 4) to other parts of Queensland.
- **Recommendation 10**—The review of SPP 1/03 should consider how to improve the integration of land use planning and disaster management planning.
- **Recommendation 11**—The review of SPP 1/03 should consider issues concerning coincident flooding including: the results of any research into the potential impacts; the extent to which coincident flooding is already covered in flood studies conducted by local governments; and the most appropriate planning instrument to address coincident flooding in the future.
- **Recommendation 12**—Working through the national Building Ministers' Forum (BMF) and the Australian Building Codes Board (ABCB), support the development of a national code for the design and construction of new building work in areas designated as flood prone in local planning schemes.

The Inland Flooding Study has been a joint project of the Queensland Government and the LGAQ. Further information on the project outcomes, including specific recommendations, are set out in the remainder of this report.

Methodology and project governance

Project methodology

The Inland Flooding Study comprised two components:

1. a climate change science component to incorporate climate change into flood studies
2. a planning policy component to recommend policy options for Gayndah and to carry forward to the review of SPP 1/03.

Both components included an analysis of approaches in national and international jurisdictions with a similar propensity for flooding and comparable planning frameworks and governance models.

Various scientific methodologies were examined to identify benchmark figures for planning to take account of the projected impacts of climate change on flood risks. These methods were based on the theory that precipitable water in the atmosphere will increase as global temperature increases. Analysis was undertaken to determine the extent of evidence in the Queensland historical record for this physical relationship. This analysis included both land surface temperatures and sea surface temperatures.

The recent work of Rafter and Abbs (2010)[3] was also considered, which uses extreme value analyses to calculate the percentage increases of intense rainfall from a suite of Global Climate Models. The project also took into account the recently released report from the US National Academy of Sciences (2010) which concludes that: "Extreme precipitation is likely to increase as the atmospheric moisture content increases in a warming climate. Typical magnitudes are 3-10 per cent per degree C warming, with potentially larger values in the tropics, and in the most extreme events globally."

A desktop assessment of relevant planning policy responses in selected national and international jurisdictions identified a number of promising practices to improve Queensland's land use planning response to flood risk management. The most effective practices have informed the planning policy recommendations included in this report.

Gayndah case study

A case study was undertaken in Gayndah in North Burnett Regional Council to trial the increased rainfall intensity climate change factor and consider policy options for improved flood risk management. This was in addition to desktop analyses of relevant science and policy.

3 Rafter T. and Abbs D. (2010). Calculation of Australian extreme rainfall within GCM simulations using Extreme Value Analyses. Unpublished.

In 2008, the former Gayndah Shire Council undertook a flood study to inform its planning and development assessment. The consultant's report recommended that the Council adopt a climate change impact allowance of 20 per cent (i.e. increase river peak flow discharges from the Gayndah catchment by 20 per cent). This increased the area of Gayndah township that would be considered at flood risk for land use planning and development assessment purposes, effectively moving the current 1 per cent AEP (Q100) event up to the current 0.5 per cent AEP (Q200) event.

In January 2009, LGAQ approached the Queensland Government for verification of the advice given to Gayndah Shire Council and to obtain clearer guidance on how to factor climate change into flood studies and land use planning.

As a result, the Queensland Government, in collaboration with LGAQ, undertook this project to deliver a more definitive approach to managing inland flooding risks in a changing climate, based on the best available science and implemented via the Queensland land use planning framework.

Gayndah provides a useful case study area for Queensland on the basis that:

- It is an inland catchment that is not influenced by coastal inundation or sea level rise (therefore the impacts associated with potential changes in rainfall intensity can be clearly measured).
- A recent, calibrated flood study had been completed to current standards including consideration of climate change as a basis for assessment.
- Flood conditions in the area are sensitive to changes in peak discharge (with a secondary flow path opening up at a particular threshold) and therefore the potential impacts of climate change are significant.
- It is within a representative inland catchment being medium-large in size (23 350 km^2).

Project governance

A Project Board was established to oversee both components of the project. The Project Board was chaired by the Office of Climate Change (OCC) and comprised senior representatives from:

- LGAQ
- CSIRO Climate Adaptation Flagship
- the National Climate Change Adaptation Research Facility
- Griffith University
- Department of Infrastructure and Planning
- Department of Community Safety
- Department of Environment and Resource Management.

The science component of the project was led by the Queensland Climate Change Centre of Excellence (QCCCE) within the Department of Environment and Resource Management. The science deliverables for the project were reviewed and endorsed by a Scientific Advisory Group (SAG), comprising scientists and flood specialists from leading scientific institutions and stakeholder organisations. Members of the SAG are listed in Appendix 1.

The recommended climate change factor derived through this project was also discussed and reviewed at an end user workshop on 27 September 2010. Organisations represented at the workshop are listed in Appendix 2.

The policy component of the project was led by the Planning Policy and Legislation Branch in the Department of Infrastructure and Planning (DIP). A Planning Policy Advisory Group (PPAG) reviewed and endorsed the deliverables for the policy component of the project. Members of the PPAG are listed in Appendix 3. Consultations with senior officers from North Burnett Regional Council also occurred on 5 August 2010 and 13 October 2010 to seek their feedback and endorsement of the recommended policy options.

Key findings and recommendations

Context

Flooding is number one in the hierarchy of risks from natural hazards in Queensland, and has significant economic impacts on Queensland communities.

In March 2009 floods occurred across North West Queensland and in Mackay, costing state and local governments approximately $234 million in damage to infrastructure. This event saw one million square kilometres, or 62 per cent of the State underwater. In March 2010, serious flooding occurred across large areas of the State including south-west Queensland.

Although flooding is a natural occurrence, climate change science is indicating that despite a projected decrease in rainfall across most of Queensland, a projected increase in rainfall intensity could result in more flooding events[4].

Effective land use planning can help reduce the impact of flood events by ensuring dwellings, critical infrastructure (such as hospitals) and sensitive land uses (such as storage of fuel) are located where there is a lower risk of flooding or are built to withstand the impacts of flood events (for example, building houses on stumps). This report looks at how the planning framework can assist and how it can be better integrated with disaster management.

By combining the best available science and planning options on climate change and flood risk, the Inland Flooding Study has provided clearer guidance and practical tools for local governments to better understand and manage flood risk in a changing climate when conducting flood risk assessments and developing or reviewing local planning schemes.

Scientific recommendations

Recommendation 1—Local governments should factor a 5 per cent increase in rainfall intensity per degree of global warming into the 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood events recommended in SPP 1/03 for the location and design of new development.

Recommendation 2—The following temperatures and timeframes should be used for the purposes of applying the climate change factor in Recommendation 1:

- 2°C by 2050
- 3°C by 2070
- 4°C by 2100.

Recommendation 3—The Queensland Government will review and update this climate change factor when a national position on how to factor climate change into flood studies is finalised as part of the current review of AR&R.

More detailed information on the rationale for deriving the climate change factor can be found at ‹www.derm.qld.gov.au›.

In summary, the climate change factor is based on the proposition that as the lower atmosphere warms, the atmospheric water vapour also increases, which increases the risk of more intense rainfall events.

The rate of atmospheric warming over time is derived from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report A1FI (high) greenhouse gas emissions scenario. The A1FI scenario assumes continued dependence on fossil fuels. Global temperatures for the past decade have been the warmest on record and are currently tracking at the upper limits of the A1FI scenario.

Using the A1FI emissions scenario, the best estimate of projected changes in annual global mean temperatures is outlined in Table 1.

4 Climate Change in Queensland: What the Science is Telling Us 2010 p.27

Table 1: Global warming best estimate and representative ranges relative to 1990 for relevant planning horizons for the A1F1 scenario

	2050		2070		2100	
	Best estimate	Representative range	Best estimate	Representative range	Best estimate	Representative range
A1F1	1.8°C	1.08–2.88°C	2.9°C	1.74–4.64°C	4.0°C	2.4–6.4°C

Local governments should use the temperatures and timeframes outlined in Recommendation 2 when producing new flood maps. However, local governments may be able to use their existing flood maps to approximate future flood levels that incorporate the recommended climate change factor for example, in the Gayndah case study area the following approximations were used[5].

Table 2: Approximate change to flood level with climate change

Existing flood level	Temperature change scenario	Changes to a future flood level
0.5 per cent AEP (Q200)	2°c warming by 2050	1 per cent AEP (Q100) by 2050
0.2 per cent AEP (Q500)	2°c warming by 2050	0.5 per cent AEP (Q200) by 2050
0.2 per cent AEP (Q500)	4°c warming by 2100	1 per cent AEP (Q100) by 2100

This project acknowledges that the AR&R publication provides the nationally accepted methodologies for undertaking flood studies. However, the publication has not been updated for 23 years and does not consider the impacts of climate change.

While the Australian Government is supporting a review of the AR&R publication, the outcomes of this review are not expected to be available before 2014. This project was therefore undertaken to meet the needs of local governments on how to consider climate change and better identify flood risks.

In that context, the climate change factor identified by this project for incorporation into flood studies will be reviewed and updated when a national position on how to factor climate change into flood studies is finalised as part of the current review of the AR&R publication.

Issues not explicitly addressed by this project will also be considered by the the AR&R publication review. For example, how antecedent conditions (the wetness or dryness of the catchment) may impact on hydrological models with climate change. For the purposes of this project, the current evidence suggests that maintaining the existing antecedent characteristics of the catchment is reasonable and warranted.

Similarly, the review will consider the implications of revised global emissions scenarios provided in the IPCC's Fifth Assessment Report (AR5) on rainfall intensity and flooding. The AR5 is scheduled for release in 2014.

Advice on how to use the climate change factor in flood studies

To account for the impacts of climate change, the nationally accepted methodologies for undertaking flood studies outlined in the AR&R publication should be followed, with the only change being that design rainfall depths are increased by a climate change factor of 5 per cent per degree Celsius of global warming.

Design rainfall depths should be determined through an appropriate method such as the method in the AR&R publication or CRC-FORGE. Given that the climate change factor of 5 per cent is per degree Celsius of global warming, the actual percentage increase used will depend on the timeframe and temperature outlined in Recommendation 2. For example, there will be a 10 per cent increase in rainfall depth for a timeframe of 2050 (i.e. a 2°C increase in global warming by 2050), a 15 per cent increase for 2070 (i.e. a 3°C increase in global warming by 2070), and a 20 per cent increase for 2100 (i.e. a 4°C increase in global warming by 2100).

5 This is general guidance only and local governments need to check with flood hydrologists whether this is a valid approach for their existing flood studies and particular catchments.

The climate change factor of 5 per cent per degree of global warming should be applied to rainfall depths and not directly to hydrographs (i.e. the quantity of water flowing in the river). The scaled rainfall depths should then be applied to the hydrological model in the same way as the current event-based methods to produce design flood hydrographs for climate change scenarios.

There is currently no requirement to adjust the remaining data inputs (temporal patterns, loss models) or modify the hydrological model parameters. The determined climate change hydrographs should, in turn, be applied to the hydraulic model to calculate the flood level, depth and extents for climate change design events.

Note: This climate change factor is limited to flood risk management for planning purposes as described by the SPP 1/03 and does not extend to more frequent events (i.e. >2 per cent AEP or Q50) or more extreme events (i.e. probable maximum flood). The climate change factor applies to floods arising from rainfall events of at least one hour or more.

Policy recommendations

Recommendation 4—That North Burnett Regional Council consider the two implementation options identified in the paper *Recommended Policy Options for Incorporating Climate Change into the Flood Risk Management Framework in Gayndah* and implement its preferred approach in its planning scheme.

The Inland Flooding Study has identified two policy options for the North Burnett Regional Council to incorporate the effect of climate change on flooding into its planning scheme.

Both options comprise three components:

1. A policy that incorporates different approaches depending on a development commitment being in place or not

For proposals already subject to a development commitment, conditions will ensure that development is subject to stringent design and evacuation standards. To achieve this, development either has to be consistent with appropriate land uses for specific flood hazard areas or development must be designed and constructed to appropriate flood level and height of habitable rooms. In addition, evacuation routes must be maintained to specific flood levels.

For land that is not already subject to a development commitment, the policy directs development to areas of lowest flood hazard based on the proposed land use by requiring that new development is built above specific flood levels and that evacuation routes must also be maintained to specific flood levels.

2. A draft flood constraint code to address development in flood affected areas

A flood constraint code is a requirement within local planning schemes for flood affected areas. The draft flood constraint code developed through this project for Gayndah defines four flood hazard areas based on the three relevant flood levels described in the SPP1/03—the 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEPs.

A land use table included in the draft flood constraint code outlines the appropriate land uses for each of these hazard areas. This is a major step in shifting the focus from the 1 per cent AEP (Q100) as the most important flood level for residential development to the reality that there are many flood hazard levels and associated risks that local governments need to consider.

3. A choice of flood overlay maps based on different planning horizons

Using the new climate change factor outlined in recommendations 1 and 2, flood overlay maps for different planning horizons were developed for the Gayndah township. These maps will allow North Burnett Regional Council to identify the geographic areas affected by flooding risks over time and will inform application of the draft flood constraint code.

The policy approach proposed for Gayndah is intended to minimise the risk to life and property in flood affected areas, including the accentuated risk from climate change, by:

- reducing the adverse impacts of flooding by encouraging, for example, flood resilient design and layout
- facilitating development in lower probability flooding areas
- maintaining local floodplain processes (water storage and flows; river discharge and capacity; banks of river, streams and water bodies protected from erosion)

- maintaining a network of evacuation routes
- maintaining critical emergency infrastructure and services during flood events
- maintaining functionality of community infrastructure during and immediately following flood events.

These policy options have been developed specifically for the Gayndah township and in response to a request by the North Burnett Regional Council and LGAQ for advice and guidance. While the outcomes of the study have been developed for Gayndah, the findings will be of interest to other local governments in Queensland. Further information can be found in the publication *Recommended Policy Options for Incorporating Climate Change into the Flood Risk Management Framework in Gayndah* available at ‹www.derm.qld.gov.au›.

The policy options provided for Gayndah are transitionary arrangements in advance of the current review of SPP 1/03 (due for completion in 2013). The review of SPP 1/03 will provide all Queensland local governments with definitive policy requirements on how to address flood, bushfire and landslide hazards in their planning schemes. Until this review is complete, any council seeking to amend their planning schemes must continue to reflect the current policy requirements in SPP 1/03.

General recommendations for consideration as part of the review of SPP 1/03

In the context of this review, planners, consultants, engineers and council representatives were consulted on the practical issues associated with implementation of the current SPP 1/03. The Project Board has had regard to all of the issues that were identified during those discussions in formulating the following recommendations for consideration as part of the broader review of SPP 1/03.

Recommendation 5—The review of SPP 1/03 should consider the benefits of requiring a standard method for undertaking a flood study and determining a DFE.

There is currently no requirement on local governments to use a standard calibrated engineering method for undertaking flood studies. Under the current SPP, local governments may elect instead to use, for example, historical flood data (including the lack of data) to determine their DFE. This discretion in how local governments assess their flood risk results in varying degrees of accuracy and predictive value of current and future flood hazards.

Development of a standard method for flood studies which includes advice on the Queensland Government's endorsed climate change factors and takes account of different catchment characteristics (e.g. large rural catchments and highly developed urban catchments) would improve the consistency and accuracy of flood studies in Queensland. On this issue, the Project Board and advisory group members identified that New South Wales appears to have overcome issues of accuracy in the assessment of flood hazards by requiring uniform state-wide application of a standard method for flood studies.

Recommendation 6—The review of SPP 1/03 should consider whether there is a need to specify how frequently a flood study should be reviewed or updated.

While SPP 1/03 requires that a flood study be undertaken for natural hazard management areas, there is currently no guidance on when local governments should review or update those studies. In practice, this means that local governments may be using flood studies that do not reflect recent development in the area and the impact of that development on potential flood risks.

Therefore it is recommended that the review of SPP 1/03 identify appropriate triggers to guide when local governments need to review and/or update their flood studies, taking into consideration the likely cost impacts on local governments of increasing the frequency of undertaking flood studies. Triggers could include undertaking a planning scheme review (review hydraulic components) and updated AR&R advice (update hydrological components).

Recommendation 7—The review of SPP 1/03 should develop criteria that outline the circumstances where a DFE higher or lower than the 1 per cent AEP (Q100) is appropriate for residential land use planning.

SPP 1/03 currently requires local governments to determine a DFE to set limits for land use and development in any floodplain area. SPP 1/03 specifies the 1 per cent AEP (Q100) as the preferred DFE for residential land use planning. SPP 1/03 guidelines indicate that the residual risk (the risk of a flood exceeding the DFE) should be addressed in local government counter disaster plans and emergency procedures.

However, there are currently no criteria to determine when it may be appropriate for a council to use another DFE (i.e. above or below the 1 per cent AEP or Q100). In practice this has led to local governments adopting varying flood levels to constrain development without reference to any consistent criteria. The review of SPP 1/03 should develop clear and transparent criteria for use by local governments and referral agencies on the circumstances where a DFE above or below the 1 per cent AEP (Q100) is appropriate.

Recommendation 8—The review of SPP 1/03 should clarify what components of the SPP are compulsory and clarify what additional guidance local governments may need to meet those obligations.

The review provides a useful opportunity to clarify the core components of what local governments must do to assess and manage their flood risk, as well as provide more detailed guidance on how local governments should meet those obligations (as per recommendations 1 and 2). This would help to address current inconsistencies in how local governments interpret and implement the SPP. More generally, the review provides an opportunity to provide clearer guidance to local governments on core requirements and standards, as well as those matters on which they continue to have discretion. This could include guidance on how the revised SPP should be reflected in statutory regional plans.

Recommendation 9—The review of SPP 1/03 should consider the applicability of the recommended planning response for Gayndah (as per Recommendation 4) to other parts of Queensland.

The recommended planning responses for Gayndah township should be considered for applicability in other local government areas and to establish if the policy options provide an appropriate planning response to direct new development to areas with lower levels of flood risk now and in the future under climate change.

This should include consideration of the utility of incorporating draft flood overlay codes (modelled on the draft flood constraint code developed for Gayndah) in the Queensland Planning Provisions (QPPs).

An assessment of the useability of the draft flood constraint code developed for Gayndah should form part of this broader consideration of state-wide applicability.

Recommendation 10—The review of SPP 1/03 should consider how to improve the integration of land use planning and disaster management planning.

The SPP 1/03 guidelines currently outline how residual risk can be addressed in disaster management plans and emergency procedures developed by local governments.

The review provides an opportunity to consider what changes need to be made to improve the integration of land use planning and disaster management planning, including whether any additional guidance is required and what, if any, elements of that guidance should become mandatory provisions under a revised SPP (for example, ensuring land use planning takes account of population growth and its impact on the efficient evacuation of people to a safe and secure area in an extreme event).

Recommendation 11—The review of SPP 1/03 should consider issues concerning coincident flooding including: the results of any research into the potential impacts; the extent to which coincident flooding is already covered in flood studies conducted by local governments; and the most appropriate planning instrument to address coincident flooding in the future.

The AR&R publication provides national guidance for undertaking flood studies. The publication is currently being reviewed to include consideration of climate change and incorporate new data and technological advances in rainfall/runoff assessment. This review is due for completion in 2014.

One component of the AR&R review includes examining the interaction of coastal processes and severe weather events and should result in guidelines for incorporating the joint effects of flood flows from storm rainfall and elevated ocean levels into flooding predictions (coincident flooding). Elevated ocean levels caused by the storm (storm surge) as well as those caused by climate change (sea level rise) will be considered.

The Department of Environment and Resource Management has been allocated National Disaster Resilience Program funding to examine the impacts of coincident flooding in Queensland.

The results of this research should be considered as part of the review of SPP 1/03 to determine how this issue should be addressed in Queensland's land use and disaster planning frameworks.

National guidance on coincident flooding is expected to be provided from the AR&R review in 2014.

Recommendation 12—Working through the national Building Ministers' Forum (BMF) and the Australian Building Codes Board (ABCB) to support the development of a national code for the design and construction of new building work in areas designated as flood prone in local planning schemes

Queensland is represented at the BMF by the Minister for Infrastructure and Planning. In 2009, the Minister sought recognition at the forum of the significant impact of flooding on buildings in Australia, the current lack of national building codes to address this issue, and for the ABCB to develop a national code for building in flood prone areas for regulatory adoption by individual States and Territories.

Subsequently, the ABCB has drafted a proposal to develop national design and construction requirements under the Building Code of Australia for new building work in designated areas vulnerable to flooding. Minimum requirements under the Building Code of Australia would include performance requirements and deemed-to-satisfy provisions to minimise damage to buildings and building materials from flooding.

The ABCB is expected to develop this new code by the end of 2012. This code would be referenced in Queensland under the *Building Act 1975* and, once developed, will specify the design and construction requirements that apply in Queensland for new building work in designated flood prone areas.

Conclusion

The outcomes from this project provide guidance to local governments on how to better manage their flood risks and land use planning responses in a changing climate. This has been done by providing a climate change factor for incorporation into flood studies, developing specific land use policy options to improve the flood risk management framework in Gayndah, and identifying a series of recommendations for consideration in the SPP 1/03 review.

The project provides all Queensland local governments with a climate change factor for incorporation into the 1 per cent (Q100), 0.5 per cent (Q200) and 0.2 per cent (Q500) AEP flood events recommended in SPP 1/03 for the location of new development. This approach will be reviewed and updated when a national position on how to factor climate change into flood studies is finalised as part of the current review of the AR&R publication. In the interim, Queensland local governments can use the approach from this project to better identify flood risks.

A progressive policy approach for the Gayndah township has also been developed that incorporates multiple flood hazard zones and reduces reliance on one flood level in local government planning. The broader applicability of this approach will be considered as part of the review of SPP 1/03.

The project also makes recommendations to address challenges in the planning framework and its consistent implementation through the review of SPP 1/03. These recommendations are designed to address challenges and gaps in the current planning framework and improve the connectivity between disaster management and land use planning.

By integrating the best available science and innovative planning options through multiple flood hazard zones and reducing reliance on one flood level in local government planning, this joint project between the Queensland Government and the LGAQ has delivered clearer guidance and practical tools for local governments so they are better positioned to manage flood risk for Queensland communities.

Appendix 1: Membership of the Inland Flooding Study Scientific Advisory Group

Name	Organisation
Prof Colin Apelt	University of Queensland (retired)
Prof Nigel Arnell	Director, Walker Institute for Climate System Research
Peter Baddiley	Queensland Hydrology Manager, Bureau of Meteorology
Helen Fairweather	Chief Scientist, Coastal Impacts Unit, Queensland Climate Change Centre of Excellence
Dr Ryan McAllister	Research Scientist, CSIRO
Ken Morris	Principal Engineer, Water and Environment, Brisbane City Council
Prof Jean Palutikof	Director, NCCARF (National Climate Change Adaptation Research Facility)
Jeff Perkins	Hydrologist, Bureau of Meteorology
Richard Priman	Director, Regional Water Supplies, Department of Environment and Resource Management
David Robinson	Director, Coastal Impacts Unit, Queensland Climate Change Centre of Excellence
John Ruffini	Director, Water Science, Department of Environment and Resource Management
Dr Bill Weeks	Director (Hydraulics), Department of Transport and Main Roads

Appendix 2: Organisations represented at the Inland Flooding Study Workshop

The following organisations were represented at the Inland Flooding Study Workshop held in Brisbane on 27 September 2010:

- Department of Environment and Resource Management
- Department of Infrastructure and Planning
- Office of Climate Change
- Queensland Climate Change Centre of Excellence
- Bureau of Meteorology
- Local Government Association of Queensland
- SEQ Water
- Brisbane City Council
- Ipswich City Council
- Redland City Council
- Moreton Bay Regional Council
- Cardno Associates
- BMT WBM
- Sinclair Knight Merz
- Kellogg Brown and Root.

Appendix 3: Membership of the Inland Flooding Study Policy and Planning Advisory Group

Name	Organisation
Michael Allen	Project Manager, Industry Projects Facilitation, Department of Infrastructure and Planning
Megan Bayntun	Director, Planning Policy and Legislation, Growth Management Queensland
Helen Fairweather	Chief Scientist, Coastal Impacts Unit, Queensland Climate Change Centre of Excellence
Christophe Manchon	Senior Project Officer, Office of Climate Change
Tracy Haynes	Senior Advisor, Local Government Association of Queensland
Deborah Mangu	Principal Planner, Planning Services, Department of Infrastructure and Planning
Amy Marsden	Director, Planning Services, Department of Infrastructure and Planning
Shane O'Brien	Principal Advisor, Building Codes Queensland
Tom Orr	Principal Advisor, Planning Policy and Major Development, Department of Transport and Main Roads
Mark Piorkowski	Manager, Environment and Planning, Local Government Association of Queensland
Robert Preston	Manager, Climate Change, Planning Policy and Legislation, Growth Management Queensland
Christina Sinnemann	Senior Project Officer, Climate Change, Planning Policy and Legislation, Growth Management Queensland
Carol Wall	Principal Policy Officer, Office of Climate Change
Graham Wiltshire	Director, Strategic Policy, Department of Community Safety