

## Building walls around flood problems: the place of levees in Australian flood management

This document provides supplementary tables that expand on information published in:

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Tables synthesize findings of a review of levee provisions in Victoria, New South Wales and Queensland. Documents surveyed include: legislation, regulations, guidelines, policies, strategies, programs and assessment / approval. Notes about the individual documents reviewed, including those referenced in the below tables, are located on the [Bushfire and Natural Hazards CRC website](#).

**Supplementary Table 2a: Legislative and administrative arrangements for levees in Victoria**

ISSUE	DESCRIPTION OF INSTRUMENT/TOOL, STATUS, COMMENTS
Levee database	The 1998 flood transfer data project collected information on structures including topographic plans of levees, irrigation channels and bridges. Information is now held in the <i>Victorian Flood Database</i> , a GIS database. It can be incorporated into flood modelling projects to assess flood behaviour, and is used to inform emergency response and land use planning. Information updates relate to levee ownership, height (in metres, AHD), condition and modifications.
Database includes levee-like structures?	'Flood structures' (where 'levee' is not the primary function) are included in the dataset of the <i>Victorian Flood Database</i> , as above.
Levee legislation & regulations	<p>Urban levees generally have to be approved as water management schemes under ss213-217 of the <i>Water Act 1989</i>. This is likely to be a condition of future levee funding. Provisions cover assessment and investigation, preparing and implementing schemes, public education and roles of authorities. A community-based committee is central to the process.</p> <p>Private levees generally require permits under local government planning schemes. Permit requirements are guided by <i>Victoria Planning Provisions</i> (VPP) and these cover earthworks in rural zones, construction in floodways and land subject to inundation overlays (FO; LSIO). The <i>Gannawarra Planning Scheme</i> states that permits are not required for FO, LSIO areas where earthworks do not raise ground level topography by more than 300mm. This may not be adequate given that the land around Kerang has a gradient of roughly 1m in 18km and could impact on the free flow of water.</p> <p><i>Practice note 12</i> (guidance for the VPP) states that councils 'should consider' introducing earthworks provisions into their planning schemes (i.e., this is not compulsory). Inadequate application of provisions is also suggested by the DSE (2012) submission to the ENRC Inquiry, which reported that while permits are required, private levee building without a permit occurs, enforcement can be an issue and that flood zones and overlays are inadequate in some planning schemes.</p> <p>Flood mitigation works carried out by local governments and FMAs are exempt from permit requirements (e.g., see VPP clause 44.03-1).</p>
Levee Guidance	<i>Levee Design Construction and Maintenance 2002</i> is a technical guide and is currently under review. It advises that levees should be located on private land rather than river frontages 'as a principle'. This reduces the need for vegetation clearance and means that levees are less likely to restrict floodwater, causing worse flood impacts. A general design standard is provided for urban levees (1 in 100 AEP) and rural areas (1 in 20 to 1 in 30 AEP), and a 600mm freeboard (or greater where there is uncertainty: a

	<p>provision relevant to climate change). Guidelines cover levee design, contracting, maintenance, how to include levees into emergency response plans and community awareness plans. There is no reference to this document in funding guidelines for levee projects. The introduction suggests this document is intended purely as a guide.</p> <p>The draft <i>Victorian Floodplain Management Strategy</i> (released 2014) is a state-wide framework for flood management, including levee management. It anticipates the preparation of management guidelines for flood mitigation infrastructure (p.42) and guidelines for individuals to maintain levees on Crown land (p.46). It outlines the roles of different levels of government and agencies in flood management, with local governments being responsible for determining whether their community needs a levee. It also outlines arrangements for risk-based project prioritisation, cost sharing and the need for contingency planning. Assessment of mitigation options uses the <i>Rapid Assessment Method (RAM) for Floodplain Management</i>, soon to be revised.</p>
Consideration of climate change	<p>The draft <i>Victorian Floodplain Management Strategy</i> (VFMS) states that climate change will be addressed by incorporating revised AR&amp;R tables into flood studies and regional floodplain management strategies (p.24). There is no discussion about how to deal with uncertainty or the type of on-the-ground measures that might prove to be the most adaptive long-term. Current strategies appear limited to flood information (e.g., mapping), flood warning systems, statutory planning and structural mitigation.</p> <p>The <i>Climate Change Action Plan</i> (2013) cautions against maladaptive measures (categorised using Barnett and O’Neill, 2010). Applying the same source, levees have been found to exhibit maladaptive characteristics<sup>1</sup>. According to the plan’s 2014 progress report, \$7.6 million has been spent on the construction of levees and other flood mitigation works (p.6).</p> <p>For most purposes, development planning provisions limit land use planning controls to areas within the 1 in 100 AEP floodplain (Water Act s205). Despite flood review advice that this may be inadequate (Comrie, 2011:197), the draft <i>Victorian Floodplain Management Strategy</i> indicates this policy will remain. However, the incorporation of controls into planning schemes is likely to be enforced (p.30).</p>
Regulation of levee-like structures	<p>Levee like structures are controlled in several ways. The <i>Water Act 1989</i> has licencing provisions for the take and use of water (s51) and for water use (s64 O). Works licences, s67, have limited application to levees as they only relate to in-stream works.</p> <p>Licence conditions can relate to environmental protection and natural drainage regimes (s56, s64Z). Ministerial <i>Policies for managing take and use licences</i> also provides details relating to licence conditions. These can relate to take limits and periods, salinity, biodiversity protection, minimising cumulative effects, groundwater infiltration, and drainage disposal. <i>Irrigation and drainage plans</i> need to be approved and include location and specifications of irrigation works.</p> <p>While licence provisions enable some controls and conditions, potential flood impacts are not considered. This is a local government responsibility under s6(2)(e) of the <i>Planning and Environment Act 1987</i>, which allows planning schemes ‘to regulate or prohibit development in hazardous areas or areas which are likely to become hazardous areas’. Provisions are as for earthworks in rural zones (see section on ‘levee legislation and regulations’, above). <i>Victoria Planning Provisions</i> (VPP) decision guidelines include environmental considerations (e.g., VPP clause 35.07-6) and effect on flood behaviour (e.g., VPP clause 44.04-6).</p>
Catchment <sup>2</sup> planning and cumulative effects assessment	<p>Catchment Management Authorities (CMAs)<sup>3</sup> are appointed under s11 of the <i>Catchment and Land Protection Act 1994</i>, and have a central role in integrated catchment planning, management and coordination in Victoria.</p> <p>s202 of the <i>Water Act 1989</i> gives CMAs the authority to prepare <i>regional floodplain</i></p>

	<p><i>management strategies</i> detailing catchment characteristics and programs for flood damage prevention and mitigation. However, an Authority ‘is not obliged to perform any function...unless the Act expressly provides otherwise’: s124(5). CMA submissions reveal that State funding is not currently provided for this activity. This may be why most regional floodplain strategies are outdated and hard to obtain. Thus while legal provisions support catchment-based flood planning, it can suffer from lack of resourcing. Funding may shortly be forthcoming as regional floodplain management strategies are a feature of the draft <i>Victorian Floodplain Management Strategy</i>.</p> <p>Other regional strategies have content relevant to catchment based flood management<sup>4</sup>. These include regional growth plans, regional strategic plans, regional catchment management strategies and regional waterway strategies. Some North Central strategies identify levees as a key threat to waterways but none suggest ways of addressing the problem.</p> <p>Ministerial Guidelines under the <i>Environmental Effects Act 1978</i> promote cumulative effects assessment as a desirable element of environmental effects statements. However, the application of the Act is limited to public works that are likely to significantly affect assets of regional or state significance, for example, to listed threatened species. It does not apply to ‘works undertaken by or on behalf of municipal councils’ (s2), and is therefore not relevant to most urban levees. The guidelines do not offer a cumulative effects methodology, nor assessment criteria. Wording suggests that existing condition should be used as a baseline; ‘a regional perspective can be helpful’; and qualitative (subjective) assessment should be used due to the impracticality of quantitative assessment (i.e., based on statistical analysis or modelling of environmental variables).</p> <p><i>Regional Directions for Irrigation Development</i> require that <i>water use licences</i> and <i>take and use licences</i> have provisions for minimising (not assessing) cumulative effects. This is achieved through licence conditions and licence review mechanisms, triggered by annual use limits for designated areas. Environmental impacts are also minimised through <i>irrigation and drainage plans</i>. These include arrangements for wildlife and wetlands protection, monitoring and corrective action thresholds.</p> <p>Minimisation of the effect of rural earthworks on flooding is provided for by <i>Victorian Planning Provisions</i> (e.g., clause 35.07-4). Floodplain management plans also assess the offsite impacts of proposed measures. However, regional cumulative effects assessment of levees and levee-like structures on flood behaviour and the environment currently seems lacking.</p>
Programs and grants	<p>Victorian levees are funded through programs run by many different state agencies, including DELWP (previously DEPI), EMV and RDV. Public information is generally lacking about projects funded, eligibility, project assessment and prioritisation.</p> <p>The <i>Building a Climate Resilient Victoria Progress Report</i> (2014) states that since its inception in May 2011, DEPI’s <i>FloodZoom program</i> had spent \$7.6 million on the construction of levees and other flood mitigation works. A request to DEPI for information on application guidelines received no response.</p> <p>Levee projects have also been funded through EMV’s <i>Natural Disaster Resilience Grants Scheme</i> (NDRGS) and regional development funds such as RDV’s <i>Local Government Infrastructure Program</i> (LGIP). No information is available on LGIP other than a list of projects funded and only part of the amount contributed by RDV to the Kerang levee is included. NDRGS funding guidelines provide little information about funding priorities for flood projects, other than noting that risk assessments and warning systems are eligible but urban stormwater projects are not. Grant guidelines only provide generalised information about grants assessment and no specific criteria are provided.</p>

	<p>The <i>Victorian Government’s response</i> to the ENRC inquiry and the draft <i>Victorian Floodplain Management Strategy (VFMS)</i> indicate that decisions to fund flood mitigation infrastructure are to be based on the beneficiary pays principle and the capacity of local beneficiaries to implement schemes and pay ongoing costs. Works need to have a favourable CBA and be supported by a majority of property owners. Prioritisation will use the <i>RAM</i> (to be revised). This is based on a calculation of average annual flood damages (AAD), incorporating discount rating over 30 years. Intangible environmental impacts of structural measures are given weighting factors. Projects need to be justifiable through a <i>local floodplain management plan</i> that considers a number of mitigation options, though options considered worthy of investigation appear limited<sup>5</sup>. Future priorities will be determined using <i>CMA regional Floodplain management strategies</i>, currently due for renewal.</p> <p>Media releases suggest that recent levee funding has been guided by 28 floodplain management studies.</p>
<p>Development controls behind levees</p>	<p>The draft <i>Victorian Floodplain Management Strategy</i> notes that it is a local government responsibility ‘to minimise or avoid the growth in the risk of flooding in the lowest-lying parts of those areas protected by levees’ (pp. 29, 42). This suggests it is acceptable to increase development behind levees except in areas of highest risk.</p> <p>Where an urban levee is not maintained, the council must assume it is not there and apply building controls to land behind the levee using 1% AEP + freeboard (p.45). This implies that development controls, such as floor level, may be relaxed where a levee is in place (leading to higher damages in the event of levee failure).</p> <p>Regional growth strategies can be contradictory. The <i>Loddon Mallee North Regional Growth Plan</i> stresses the need to direct development away from areas of high flood risk. However, the same document supports the consolidation and expansion of the highly flood prone town of Kerang, which is wholly dependent on levees. This is reflected in the <i>Gannawarra Planning Scheme</i> (clause 21.04) which anticipates consolidation and infill of the existing township as well as expansion to the north and south. Following the 2010-11 floods, planning commenced for additional levees to be built to the north and south of Kerang. While upgrading the levee system may be merited, strategies that promote additional development in the town will increase assets at risk and potential damage costs.</p>

<sup>1</sup> Drawing on the same source, levees were identified as having maladaptive characteristics in Wenger, C. (2015). Better use and management of levees: reducing flood risk in a changing climate. *Environmental Reviews*. doi: 10.1139/er-2014-0060

<sup>2</sup> ‘Catchment’ is defined differently according to jurisdiction and agency. It could relate to the land area draining to a particular site or to the land area draining into a stream system. A catchment may also relate to different levels of catchment, from a small sub-catchment of an upper tributary, through to a major drainage basin (e.g., mountain to sea).

<sup>3</sup> Victoria has nine catchment management authorities (CMAs) and Melbourne Water (MW) acts as the authority for the Melbourne metropolitan area. MW is included when referring to CMAs.

<sup>4</sup> Research focused on Gannawarra Shire, an area significantly affected by flooding in 2010-11. It is located in the North Central CMA catchment area and the Loddon Mallee North Region. Victoria also has eight development planning regions (excluding Melbourne). Their boundaries are different to catchment boundaries.

<sup>5</sup> The draft VFMS refers to flood mapping, flood studies, flood warning, structural mitigation and statutory planning. Examples provided in the RAM cover the same activities. Neither document mentions house raising, relocation or ecosystem based approaches. It is not clear whether such activities would be eligible for funding.

**Supplementary Table 2b: Legislative and administrative arrangements for levees in New South Wales**

ISSUE	DESCRIPTION OF INSTRUMENT/TOOL, STATUS, COMMENTS
Levee database	NSW is currently conducting a state-wide urban levee audit which will input into a database. It requires information such as ownership, location, purpose, age, design (e.g., materials, spillways, associated infrastructure), design height and freeboard, length, upgrade and maintenance history, inspection and maintenance schedules, and environmental restrictions. The audit does not include rural levees or levee-like structures. As well as being a tool to manage maintenance, it will be used to inform emergency response agencies about levee condition and reliability.
Database includes levee-like structures?	NSW Office of Water maintains a <i>controlled works database</i> that includes licencing conditions (e.g., relating to height). The <i>healthy floodplains project database</i> , covering five valleys, relies on the controlled works database for most of its data and has also invested in mapping. This will provide baseline information for floodplain management plans, which will aim to limit changes in the distribution of flows, to improve connectivity for environmental assets and to protect farms from flood damage. Maps will not show all works but only areas enclosed by major levees.
Levee legislation, regulations	<p><i>Water Act 1912</i> (to be repealed) has provisions for the assessment of ‘controlled works’, broadly defined to include levees and levee-like structures. Controlled works are currently being transitioned to ‘flood works’ under the <i>Water Management Act 2000</i>. Considerations for approving controlled works include effect on flood behaviour, environmental effects and the contents of floodplain management plans. Plans need to be developed in accordance with the <i>Floodplain Development Manual</i> (s166-167).</p> <p>The <i>Water Management Act 2000</i> definition of flood works includes levees and irrigation infrastructure. However, flood works within town boundaries will be excluded from this definition and will therefore not require environmental assessment under Part 5 of the <i>Environmental Planning and Assessment Act 1979</i>. Other exemptions will include transport networks and (providing not in a floodway), ring levees around farm structures and earthworks no higher than 150mm. Provisions in this Act for developing floodplain management plans (s15; s28-30; s35) do not refer to the <i>Floodplain Development Manual</i>.</p> <p>The <i>Environmental Planning and Assessment Act 1979</i> provides for development approvals and environmental assessment. Requirements depend on the type of development, which include ‘state significant’ and ‘designated’ development.</p> <p>State significant infrastructure (SSI) can include flood mitigation works (s115T) and it needs to be declared by a minister or a <i>State Environmental Planning Policy</i> (SEPP).</p> <p>‘Designated development’ requires environmental assessment under Part 4 of the Act. It is listed in Schedule 3 of the regulation (flood works are not included). Alternatively, designated development can be identified in a SEPP or a <i>Local Environmental Plan</i> (LEP). ‘Flood mitigation works’ are a recognised development type that can be included in a LEP. Various SEPPs relate to levees. SEPP (Coastal wetlands) does not permit levees to be built on specified wetlands without consent. SEPP (Infrastructure) states that flood mitigation work <i>may</i> be carried out by or on behalf of a public authority <i>without consent</i> on any land (noting that this enables it to be declared SSI, which is also subject to environmental assessment). Where consent is not needed and it is not ‘state significant’, environmental impact assessment may still apply: see note EP&amp;A Act s76(1) and Part 5. Development application requirements are in Schedule 1 of the regulation.</p> <p>The <i>Public Works and Procurement Act 1912</i> gives the Minister (as constructing</p>

	authority) the power to acquire land for flood control and build public works, including embankments and other structures (s39-41; s80).
Levee Guidelines	The <i>Local Government Act 1993</i> authorises the development of a Manual: s733(5)(a). <i>Floodplain Development Manual (2005)</i> provides a floodplain risk management framework including guidance on advantages and disadvantages of using levees and how to assess this option (and others) using an option assessment matrix. The need to comply with the Manual is backed by many legal and policy instruments.
Consideration of climate change	<p>Climate change considerations are covered in the <i>Floodplain Development Manual</i> sections E6, F6 and G9.8. While consideration of climate change is required in flood study and management study, G9.8 discourages the consideration of climate change (e.g., when setting flood planning levels (FPL)) beyond a 20-year timeframe (this is the period covered by a floodplain management plan and freeboard is expected to accommodate changes in risk over this time).</p> <p>The Manual recommends the use of Australian Rainfall and Runoff Guidelines (AR&amp;R) when undertaking hydrological analysis (F4). AR&amp;R revisions will incorporate climate change.</p> <p><i>Floodplain Risk Management Guideline: Practical Consideration of Climate Change</i> provides a range of management options to consider when addressing climate change risk, including levees.</p> <p>Incorporation of climate change into FPLs, and the application of development controls above the 1 in 100 AEP flood, are compromised by <i>Planning Circular PS 07-003</i> and <i>Ministerial Direction No. 15 – flood prone land</i>.</p>
Regulation of levee-like structures	<p>NSW regulates levee-like structures including irrigation channel embankments and ring tanks ('turkey nests') through the <i>Water Act 1912</i> (to be repealed) and the <i>Water Management Act 2000</i>.</p> <p>Applications (under WA 1912) use the <i>Application for Approval of a Controlled Work</i> form. This requires information such as: tenure; location; height above ground level; soil type; issues such as erosion; native vegetation; existing works, existing land use, heritage, wetlands or depressions that would be affected, proximity to a watercourse, whether development will affect flows, irrigation and drainage location maps, including in relation to watercourse &amp; floodplain.</p> <p>Similar information is required for assessing applications under the WMA 2000 using the <i>Application for approval for water supply works, and/or water use</i> form. Environmental assessment for this approval uses provisions under Part 5 of the <i>Environmental Planning and Assessment Act 1979</i>.</p> <p>Development Approval and EIS may also be required by councils under a local environmental plan (LEP).</p>
Catchment planning and cumulative effects assessment	<p>The <i>Floodplain Development Manual</i> defines a catchment as the land area draining into a main stream, as well as its tributaries, above a specific site. The Manual does not require flood studies or management studies to cover an entire catchment but it expects that the catchment area contributing to a study be established so that catchment plans, issues, development trends within the catchment, council plans and downstream impacts of proposed works may be considered in floodplain risk management plans. Committees of adjoining councils can be formed in some circumstances to address broader flood problems (D2, E4, E5.1, E5.2.1, E5.2.2, F2, H2, J4).</p> <p>NSW appears to be more rigorous than many states in enabling a catchment approach. However it should be noted that management studies are commonly focused on land within municipal boundaries; processes are locally driven and options are determined locally. This may limit the application of some types of ecosystem-based measures,</p>

	<p>e.g., land use and management to reduce velocity and sediment in the feeder catchments of upper tributaries that may be located in a different municipality to the flood affected area, or payment by lower catchment beneficiaries to landholders for improved management in upper catchments.</p> <p>Cumulative effects of future development (including levees, housing or any other type of development) are expected to be assessed for their effect on flood behaviour and emergency services capacity. It is not clear whether cumulative effects on the environment are also included; the Manual includes this in some parts (p.5, G3) but the main section covering cumulative impacts (G9.1) omits it. No 'significant' impacts on other properties are acceptable (C9.2), but 'significant' is not defined. Permitting 'insignificant' increase in impact could result in incremental change. Methods for determining hazard levels (Appendix L) may provide a basis for acceptable thresholds and limits, but this would apply to impacts on people and property and not explicitly the environment.</p> <p>There is no specific guidance about acceptable cumulative impacts assessment methodology, such as baseline, limits or thresholds, or geographic unit (catchment is defined as the area <u>above</u> a specific location, not below it), and as above, impacts upon 'what' is ambiguous. However, the Manual appears to take 'now' as a baseline (G6, G9.1). 'Now' may form a moving baseline for successive studies, and may not be adequate for preventing incremental change.</p> <p>According to <i>Environmental Planning and Assessment Regulation 2000</i>, environmental assessment under Part 5 of the Act (used where development consent under Part 4 is <i>not</i> required) needs to include cumulative environmental effect (clause 228) unless there are more specific guidelines. Part 4 environmental assessment does not specifically require cumulative impacts assessment (Regulation Schedule 2, Part 3, clauses 5-7). The <i>Threatened Species Conservation Act 1995</i> also provides for cumulative effects assessment on species and populations on a regional level (s110). For development approved under the <i>Water Management Act 2000</i> s2(d) there needs to be consideration of cumulative effects on water sources and dependent ecosystems (flood behaviour is not mentioned).</p> <p>Cumulative effects assessment for the <i>Healthy Floodplains Project</i> models 'greenfields' as well as current development and imposes limits on the percentage redistribution of flood flow. The first plan completed, <i>Draft background document to the floodplain management plan for the Gwydir Valley Floodplain 2015</i>, uses the 2012 1 in 25 AEP flood and the level of development as at 2014 as a baseline. No greater than 5% increase over this baseline is permissible in floodways. It is not clear what role the greenfields model had in setting limits. Nor whether the 5% threshold under the current plan is in addition to the 5% increase allowable under earlier plans that used different baseline dates (e.g. the 2006 <i>Gwydir River Lower Gingham Watercourse FMP</i> used the 1971 1 in 20 AEP event as its design flood).</p>
Programs and grants	<p>Grants are available through the <i>Floodplain Risk Management Grants Scheme</i> (jointly funded with the federal government through the Natural Disaster Resilience Program) and the <i>NSW Floodplain Management Program</i> (\$20.82 million in 2013-14). The Natural Disaster Resilience Program also contributes funds to other NSW emergency service programs.</p> <p>A broad range of measures is eligible, including flood studies and management plans (as per Flood Manual processes) and implementation of a variety of measures including structural, flood warning, evacuation management voluntary purchase and house raising. Proposals are expected to conform to Floodplain Development Manual processes. Environmental, social and economic impacts, costs and benefits are considered when assessing project proposals. Project assessment includes consideration of opportunities for environmental enhancement, which could be</p>

	relevant to ecosystem based measures. While not a funding condition, the level of development planning is assessed, which could reduce the future need for levees.
Development controls behind levees	The <i>Floodplain Development Manual (2005)</i> suggests development controls behind levees should be considered (G-14; J-11), though this is a matter for individual councils.



**Supplementary Table 2c: Legislative and administrative arrangements for levees in Queensland**

ISSUE	DESCRIPTION OF INSTRUMENT/TOOL, STATUS, COMMENTS
Levee database	Currently no levee database (State of Queensland, 2013; QFCI, 2012).
Database includes levee-like structures?	Information relating to irrigation licences to take water or interfere with the course of flow must be retained in accordance with the <i>Public Records Act 2002</i> and may be held on departmental databases.
Legislation, regulations	<p>Levees are defined under <i>Water Act 2000</i> (version 2014), Schedule 4. The definition excludes levee-like structures. Levees need to be assessed to minimise adverse impacts on overland flow water, the catchment, landholders, communities and land planning and emergency procedures. The Act also provides for the development of water resource plans for the sustainable management of water in specified areas (including 3 drainage and embankment areas) which regulate water licensing and environmental management for these areas.</p> <p><i>Water Regulation 2002</i> provides parameters for defining a levee (amount of fill: 50m<sup>3</sup>); categories of levee according to the size of population significantly impacted; 'significant impact' is defined as above floorboard increases in flood height &gt;5cm; velocity &gt;0.2m/s. This fails to consider impacts on the environment (as opposed to human populations) and incremental changes to catchment-wide flooding.</p> <p>Levees are assessable development. Assessment is carried out under the <i>Sustainable Planning Act 2009</i>, using <i>State Development Assessment Provisions</i> (Table 7.3.1), assessment codes and guidelines. The size of off-property population impacted determines the level of assessment: self-assessment, code assessment by local government or state level impact assessment.</p> <p>Levees associated with extractive industries have additional provisions, mostly concerned with preventing water contamination during flood events (covered under the <i>Environmental Protection Act 1994</i>, regulations and guidelines).</p>
Levee Guidelines	<p><i>Guidelines for the construction or modification of category 1 levees</i> is for self-assessable levees in rural areas where there are no-off-site impacts. It explains how to calculate changes in off-site flow path, velocity, area, height of floodwater (not compulsory but recommended for liability reasons). Local government needs to be notified of the location, dimensions, construction material, design height of levee using the <i>Self-assessable code for construction or modification of levees</i>.</p> <p><i>Guidelines for the construction or modification of category 2 and 3 levees</i> guide compliance with the <i>IDAS code for development applications for construction or modification of particular levees</i>. Category 2 affects less than three people and is assessed by local government. Category 3 affects more than three people. It is assessed according to the <i>IDAS code</i> and also undergoes impact assessment under the <i>Construction or modification of levees state code</i> (see <i>State Development Assessment Provisions</i>). Other requirements, e.g., planning schemes may also apply.</p> <p>It is advised but not mandated for Category 3 levee appraisal reports to address social, economic and environmental impacts (section 6.2.3). Levee location and alignment is expected to consider floodplain function (e.g., floodway, flood storage), proximity to water bodies, existing and potential future catchment development, cumulative impacts of the levee and other structures in the catchment (and other factors: see section 6.3.1). It advises set-back to reduce impacts on flooding and vegetation.</p> <p>Guidelines cross-reference Australian and overseas best practice documents including (CIRIA, 2013; NSW Government, 2005; SCARM, 2000; AGD, 2013).</p>
Consideration of climate change	<i>Increasing Queensland's Resilience to Inland Flooding in a Changing Climate</i> provides interim climate change factors, pending the revision of the <i>Australian Rainfall and</i>

	<p><i>Runoff Guidelines</i>. Recent changes to the <i>State Planning Policy</i> and its <i>State interest guideline: natural hazards, risk and resilience</i> remove the expectation of a 1in 100 AEP Defined Flood Level (DFL). DFL is to be based on risk assessment, and technical manuals expect that flood studies will consider a full range of flood scenarios up to PMF. ‘Deregulation’ of the DFL could facilitate development of flood prone areas which, depending on how the new policy is applied, could lead to future demand for flood protection.</p>
<p>Regulation of levee-like structures</p>	<p>Levee-like structures, including roads, irrigation supply channels and ring tanks, are specifically excluded from the levee definition Schedule 4 of the <i>Water Act 2000</i> (version 2014).</p> <p>The <i>Sustainable Planning Act 2009</i> makes provisions for development permits for the taking or interfering with water in accordance with the <i>Water Act 2000</i>. Potentially, this includes levee-like structures associated with irrigation. Interfering with and taking overland flow for any purpose is a general authorisation (<i>Water Act 2000</i>, s.20), which is only regulated under certain circumstances (for example, if it is in a declared drainage and embankment area, of which there are 3 listed in the <i>Water Regulations 2002</i>; if it is in a wild river area; or if it is an area covered by a water resource plan). Where regulated, assessment codes for the taking or interfering of water from any source have to meet general outcomes in module 7 of the <i>State Development Assessment Provisions</i> (includes not adversely affecting riverine ecosystem, other users’ ability to access the resource, or the integrity of the watercourse). Relevant code assessment forms require a sketch plan to locate any area to be irrigated, as well as the distances of works from property boundary, roads and watercourses. However there is no reference to embankments (thus no documentation of dimensions / design standards), floodplain connectivity or impacts on flood behaviour.</p> <p>Some levee-like structures are covered by other legislation, e.g., ring tanks by the <i>Water Supply (Safety and Reliability) Act 2008</i> (version 2014). The Act only applies to ring tanks where they are classified as referable dams: the Act is concerned with safety rather than exacerbated flood damage through loss of floodplain storage.</p> <p>Water quality (including sediment and erosion) in designated ‘Great Barrier Reef catchments’ is regulated by the <i>Environmental Protection Act 1994</i>. Vegetation cover is specified but no mention is made of levees as a potential cause of sediment load.</p> <p>Regarding planning schemes, the model development assessment code for flood hazard is provided in <i>State Planning Policy (SPP) guidelines, State interest guideline: Natural hazards, risk and resilience</i>, (PO4, pp.23-24). It includes consideration of the flood impacts of operational works (‘operational works’ are not defined but are found in Table 4 of the <i>Sustainable Planning Regulation 2009</i> and include both levees and levee-like structures). The model enables assessment of changes to flood behaviour on and off site. ‘Berms/mounds’ (this would include most levees) are ‘undesirable’ and ‘not supported’ in urban areas. 50m is suggested as acceptable setback from natural riparian corridors. The guideline is not mandatory.</p>
<p>Catchment planning and cumulative effects assessment</p>	<p>The <i>Water Act 2000</i> provides for the assessment of new levees or modification of existing levees including their impact on catchments, other landholders in the catchment, and implications for land planning and emergency management procedures (s.969). <i>Water Regulation 2002</i> (version 2014), schedule 15B, requires there to be no ‘unacceptable’ change in impacts (‘unacceptable’ is not defined). s62C of the Regulation defines ‘significant impacts’ in terms of specified increases in <i>above-floor</i> water velocity / depth to off-property structures. This determines the level of levee assessment applicable. As levees can have cascading effects along watercourses, limiting the definition of ‘significant impacts’ to inhabited structures could potentially limit the means of assessing cumulative and catchment-scale impacts.</p>

	<p>The development code used to assess category 2 and 3 levees (schedule 15B of <i>Water Regulation 2002</i>) reflects the Act but does not specifically mention ‘catchments’ or ‘cumulative effects’. It is intended to be used with reference to <i>Guidelines for the construction or modification of category 2 and 3 levees</i>. The guidelines include cumulative / catchment-wide impacts that ‘should’ be considered when determining levee location and alignment (6.3.1). The contents of a detailed design phase hydrological / hydraulic assessment (6.5.1) are to include ‘contribution of levee to cumulative impacts on a catchment or sub-catchment scale’. Methodology is not specified and depending on how it is carried out, the ‘contribution’ of a single levee may appear insignificant on a catchment scale, allowing incremental change.</p> <p>Legal requirements are supported by levee funding guideline assessment criteria that require a regional, catchment approach and evidence of consultation with neighbouring councils.</p> <p><i>State Planning Policy (SPP)</i>, a statutory instrument under the <i>Sustainable Planning Act 2009</i>, identifies state interest. It requires that planning schemes ‘directly, indirectly and cumulatively avoid an increase in the severity of the natural hazard and the potential for damage on the site or to other properties’. It also requires maintenance of natural landforms and vegetation that can mitigate risks. The policy doesn’t specify ‘catchment-wide’ impacts, though this could be implied. The policy includes mitigation infrastructure as a means of achieving tolerable risk in conjunction with other measures.</p> <p>The SPP <i>State interest guideline: Natural hazards, risk and resilience</i> advise on implementation of SPP requirements in planning schemes. They offer a model flood hazard development assessment code and other provisions. Use of this guideline is optional.</p> <p><i>Technical Manual - ‘fit for purpose’ approach in undertaking natural hazard studies and risk assessments</i> expects studies to update catchment changes and incorporate future development scenarios. However, the role proposed by the Queensland Reconstruction Authority (QRA) for (existing) Regional Planning Committees to oversee and guide flood management on a sub-basin level is not reflected in the manual (the QRA noted a good correlation of Regional Planning Committees with natural sub-basin boundaries, but bad correlation with local council boundaries). Responsibilities and study areas remain local.</p>
State programs and grants	<p>The Queensland Government currently has three programs that supply grants money to mitigate local flooding: <i>Royalties for Regions</i>, the <i>Local Government Floods Response Subsidy</i> and the <i>Natural Disaster Resilience Program</i> (funded jointly with the Commonwealth Government). In total these programs allocate \$46.8m towards flood mitigation for 2014-2015. This does not include local government contributions or other Commonwealth government sources.</p> <p>Depending on program, eligible projects include mitigation infrastructure; flood information and planning; and preparedness activities, including community education and volunteer capacity. Despite requiring a broad range of options be looked at to determine the best solution (schedule 6 of the application guidelines), it is not clear what funding support is available if <i>ineligible options</i>, such as house raising or relocation, are found to be more appropriate than structural measures. The lack of funding available for alternatives means they are less likely to be used.</p>
Development controls behind levees	<p>None evident. Rather, it is viewed as appropriate for planning schemes to intensify land use if risks have been mitigated ‘to an acceptable or tolerable level’ (see land use strategies, p.19 of <i>State interest—natural hazards, risk and resilience</i>).</p>

## Abbreviations

<i>AEP</i>	<i>Annual Exceedance Probability</i>
<i>AHD</i>	<i>Australian Height Datum</i>
<i>ARI</i>	<i>Average Return Interval</i>
<i>CBA</i>	<i>Cost Benefit Analysis</i>
<i>CMA</i>	<i>Catchment Management Authority</i>
<i>DEPI</i>	<i>Department of Environment and Primary Industries (former Victorian department)</i>
<i>DSE</i>	<i>Department of Sustainability and Environment (former Victorian department)</i>
<i>DTPLI</i>	<i>Department of Transport, Planning and Local Infrastructure (former Victorian department)</i>
<i>DELWP</i>	<i>Department of Environment, Land, Water and Planning (Victoria)</i>
<i>EIS</i>	<i>Environmental Impact Statement</i>
<i>EMV</i>	<i>Emergency Management Victoria</i>
<i>ENRC Inquiry</i>	<i>Environment and Natural Resources Committee Inquiry into Flood Mitigation Infrastructure in Victoria</i>
<i>FMA</i>	<i>Floodplain Management Authority</i>
<i>FPL</i>	<i>Flood Planning Level</i>
<i>GIS</i>	<i>Geographic Information System</i>
<i>MW</i>	<i>Melbourne Water</i>
<i>NOW</i>	<i>NSW Office of Water</i>
<i>OEH</i>	<i>Office of Environment and Heritage (NSW)</i>
<i>QFCI</i>	<i>Queensland Floods Commission of Inquiry</i>
<i>RAM</i>	<i>Rapid Assessment Methodology (Victoria)</i>
<i>RDV</i>	<i>Regional Development Victoria</i>

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**NB: Documents referenced in tables in italics are listed in the document review, available on the [Bushfire and Natural Hazards CRC website](#).**