Rapid assessment of flood mitigation benefits of dams

1. Introduction

During December 2010 – January 2011, a period of extensive and heavy rainfall occurred over a large part of Queensland, in particular across the catchments of the Fitzroy, Burnett and Condamine-Balonne rivers and in South East Queensland. Flooding occurred throughout the Central, South West and South East areas of Queensland.

The rainfall led to rapid rises in river levels in all of the main tributaries in each catchment resulting in extensive flooding of the major river channels as well as surrounding flood plains, towns, mines and agricultural land. Principal regional highways, including the Bruce Highway, as well as rail lines and Rockhampton airport were flooded resulting in disruption to travel, making it difficult to provide basic supplies to residents, and significant rebuilding requirements.

Flooding in the towns of Theodore and Condamine was so extensive that the entire communities had to be evacuated and temporarily housed elsewhere until flood water receded. In Dalby, flooding damage to the town's water treatment plant reduced its ability to provide all but a minimum volume of treated water to the town's residents resulting in water supply restrictions being imposed by Western Downs Regional Council.

The flooding of mine sites, damage to transport infrastructure, and disruption to properties has caused a significant impact on the production and export of coal from Central Queensland in particular. This situation will impact on supplies of coal to many countries, including China, with a commensurate effect on State and National trade figures.

Toowoomba and the towns of Grantham, Helidon and Withcott received damaging life taking floods from intense local events. The Lockyer Valley including Forrest Hill, Laidley and Gatton has experienced severe flooding.

This report has been prepared as a result of the widespread flooding in Central, Southern and South West Queensland in late 2010 and early 2011 where all major dams have filled.

It needs to be recognised that this is a rapid assessment at a time when access to information and the right people with appropriate skills and background were constrained. Thus, further work will be required to verify assessments particularly in catchments like the Herbert. There may also be other mitigation opportunities identified over time that could be investigated.

2. Objective

The objective of this report is to undertake a high level rapid assessment to ascertain:

- the effectiveness of flood mitigation provided by existing dams; and
- assess the potential for raising existing dams or constructing new dams/retention basins to provide improved flood mitigation benefits.

The aim is to provide an overview of the current flood mitigation benefit situation and identify in a very preliminary sense the prospects of major dams/retention basins (larger than urban scale) being constructed to mitigate floods causing significant damage in Queensland.

The work below only identified where the best opportunities appear to be and would need to be followed up by technical, economic and other assessments to assess the feasibility of the dams/retention basins before proceeding further.

3. Flood Mitigation Strategies

There are a range of structural and non-structural strategies that can be implemented to mitigate the consequences of floods. The preferred solution will depend on the individual circumstances of each situation. In summary, these include:

- The construction of dams or other structures to temporarily store floodwaters to reduce the magnitude of flood discharges flowing past the population at risk.
- The construction of levees or diversion structures to mitigate flood risks for populations at risk. (Levees are a relatively common means of protecting the population at risk from the rising river flood levels. However, the population needs to be aware that relying on levees is also associated with a high level of risk. If levees are overtopped or fail prematurely, the population at risk can be suddenly exposed to rapidly rising high flood levels and velocities with little warning and insufficient time to evacuate. Levees need to be well maintained and regularly monitored during flood events. Drainage pumping or discharge flood gates may also need to be installed. There also needs to be recognition that floods greater than the design flood event for the levees can occur and contingency plans need to be prepared for this eventuality.)
- Maximising the ability of flood channels to pass flood discharges. This can be done by dredging and removing debris from flow paths, enlarging channels or removing constrictions such as levees or embankments which restrict flow paths, subject to consideration of ecological and other impacts.
- Appropriate land planning combined with the development and implementation of floodplain management plans so that the population at risk within the flood plain is minimised or at least the risk of their inundation is reduced to acceptable levels.
- Purchasing and relocation of flood affected dwellings (such as has occurred for example in Northey Street in Brisbane).
- The development and implementation of Emergency Action Plans so that the population at risk can react in an appropriate, coordinated manner in the event of a flood emergency for a wide range of potential floods events. The degree of planning should be more detailed for the more frequent events but should be able to be escalated to the much rarer events if they occur. Such flood plans should include:
    - Consultation with emergency planners and other stakeholders and a detailed assessment of the risks of flooding and the consequences of such floods if they were to occur;
    - The provision of accurate real time flood forecasting and flood monitoring systems to enable reliable predictions of the levels and timing of the expected floods;
    - The provision of appropriate, timely warnings to populations at risk so that they can adequately prepare for incoming floods or evacuate out of the areas at risk;
    - Gathering of adequate survey data and preparation of flood maps to enable all potential populations at risk to accurately interpret flood warnings;

- The establishment of emergency excavation centres above flood levels
- Coordination across all levels of government
- Education of the population at risk so they know what to expect and what to do in emergency situations
- The regular exercising and updating of these plans so that they remain relevant and all parties know what to do in the event of a flood emergency.

The ability of a particular option to mitigate flood risks depends on a large number of parameters. Determining the most appropriate approach can involve detailed hydrologic and hydraulic model studies and assessment of the costs and effectiveness.

The degree of flood mitigation actually provided tends to be a trade-off of objectives, although in some circumstances it might be demonstrably justified on a benefit cost basis. For example, Peter Faust Dam at Proserpine was designed to limit the discharge of the 1970 flood (Cyclone Ada of 1970) to a maximum value. Similarly, the upgraded Hinze Dam has been designed to limit the 1 in 100 AEP flood discharge to a nominated discharge and this provides a specific level of flood mitigation downstream.

4. Methodology

The methodology used in this rapid assessment has been to:

1. Classify the type of existing dams into:
    a. Category 1 Dams – i.e. dams designed to provide flood mitigation for urban centres and surrounding areas -;
    b. Category 2 Dams – i.e. dams which have been developed without intentionally providing for flood mitigation but nevertheless provide some mitigation benefit through their existence;
2. Identify the features and characteristics which impact the effectiveness of flood mitigation provided by each of the Category 1 and 2 dams;
3. Identify the communities in Queensland at risk of flooding;
4. Establish a ranking methodology to assess the effectiveness of the two categories of dams in providing flood mitigation benefits;
5. Rank the flood benefits provided by Category 1 and 2 dams to urban centres and surrounding areas.
6. Identify and rank opportunities for mitigating floods either by raising existing dams or constructing new dams.

Presentation of data in the following sections is in the form that is obtainable at short notice, therefore direct comparisons between the flood mitigation potential of dams and detention basins will not always be possible.

5. Dam Categorisation

Attachment 1 categorises major dams in Queensland into dams with and without specific provision for flood mitigation. Possible future flood mitigation sites are also included in Attachment 1.

The potential for a dam or detention basin to provide flood mitigation benefits depends on many factors including hydrology, catchment area commanded by the dam relative to the area upstream of the community at risk, site geology and design of the structure,

downstream population at risk, antecedent conditions, timing of a flood with respect to dam storage levels and the like.

Category 1 Dams

Category 1 dams are dams in Queensland deliberately designed to mitigate floods.

If a dam can temporarily store a relatively large proportion of an incoming flood event, it may be able to discharge the incoming flow at a lower controlled rate to mitigate the downstream impacts. This is the case with Wivenhoe Dam which has 1 450 000 megalitres of flood storage above design full supply level. Any reduction in this flood storage capacity will reduce its ability to mitigate floods. Wivenhoe Dam has been estimated to reduce the peak flood height of the 1974 flood event by about 1.45 m in central Brisbane. The 1974 flood event was estimated to be about a 1 in 60 year event in central Brisbane(Smith 1998).

Some dams are designed with restrictive spillways so that only relatively small discharges can occur. This means inflows must be stored until sufficient head can be built up to drive the discharge through the spillway. This is how Peter Faust Dam near Proserpine and Ross River Dam near Townsville operate. Peter Faust Dam is estimated to reduce the flood discharge of a 1 in 100 year event by about 95%, thus providing significant flood mitigation protection for Proserpine. The dam has a large storage capacity relative to its catchment area.

It also applies for Hinze Dam but only up to the 1 in 100 annual exceedence probability (AEP) flood event. The recent upgrade of Hinze Dam, at a cost of $395 million, incorporated additional flood storage of 79 000 ML, which has the effect of restoring flood immunity on the Nerang flood plain to about a 1 in 100 year event and reduces the flood height of such an event by about half a metre.

Flood detention basins are special types of dams designed specifically to provide flood mitigation with emergency spillways to prevent overtopping. They are normally kept empty to maximise the flood storage volume. When a flood event occurs, initial discharges are through relatively small outlets until a headwater level is reached such that a larger spillway comes into play. There are now a number of these basins across Queensland in areas such as Ipswich, the Gold Coast and Cairns. They are usually designed to protect (relatively small) downstream urban developments. The Biggera Creek Detention Basin on the Gold Coast is estimated to reduce the flood discharge of a 1 in 100 year event by about 92%.

Category 2 Dams

Category 2 dams are dams in Queensland which do not include specific provision for flood mitigation. Nevertheless, such dams can attenuate floods though the constricting effect of spillways which causes water to bank up above the spillway crest and reduce the flood discharge peak passing through the dam. Such flood mitigation is often referred to as the flood routing effect through a dam. (Flood routing is the process of determining progressively the timing, shape, and amplitude of a flood wave as it moves over the dam spillway and to successive points downstream along a waterway.) Additional protection is provided when the dam is drawn down at the start of an event to, in effect, provide additional flood storage.

Despite Category 2 dams not being designed specifically for flood mitigation, the attenuation effect of the routing of floods through the dam can be significant. The available flood discharge reductions at the dam, assuming that the dam is full at the start for the 1 in

100 year flood event, are listed in Attachment 1. Some examples of flood discharge reductions include:

- 32% for Fairbairn Dam on the Nogoa river which would provide significant benefit for Emerald but minor benefits for downstream communities such as Rockhampton. Fairbairn Dam commands 98% of the catchment area upstream of Emerald but only 12% of the catchment area upstream of Rockhampton.
- 49% for Awoonga Dam on the Boyne River which commands 90% of the catchment area upstream of Gladstone.
- 68% for Bjelke Petersen Dam which commands 62% of the catchment area upstream of Cherbourg and 52% of the catchment area upstream of Murgon.
- 38% for Boondooma Dam on the Boyne River in the South Burnett which commands 76% of the catchment area upstream of Proston but notably has not prevented flooding in downstream Mundubbera in the 2010/11 flood.
- 32% for Borumba Dam on Yabba Creek which commands 75% of the catchment area upstream of Imbil but provides little protection to Gympie on the Mary River.
- 21% for Burdekin Falls Dam which commands 85% of the catchment area upstream of Ayr and Home Hill.

North Pine Dam and Leslie Dam have very little flood storage volumes provided above Full Supply Level so that inflows have to be released as soon as they can. Similarly, because of the relatively flat terrain around Beardmore Dam near St George, the dam is operated to minimise headwater rises and discharges are matched to inflows as closely as possible. For this reason, Beardmore Dam has negligible flood mitigation benefit.

6. Effectiveness of Flood Mitigation by Dams

If a dam is to provide a significant degree of flood mitigation, this requirement needs to be specifically addressed during the initial design or during major upgrades.

The effectiveness of a dam in mitigating floods and its economic viability will be impacted by a number of factors including:

1. Suitability of the **dam site** for raising of an existing dam or construction of a new dam to provide flood storage;
2. The **populations at risk**;
3. The ability to **combine flood mitigation and water supply benefits** to improve benefit-cost outcomes;
4. The percentage of the **catchment** upstream of the populations at risk **commanded by the dam** site:
    - If a dam only controls a small proportion of the catchment above a town, then it cannot have any control over floods originating from the remainder of the catchment. e.g. Wivenhoe only controls about 50% of the catchment of the Brisbane River above Brisbane. It cannot control floods originating in Lockyer Creek or the Bremer River. However the release from Wivenhoe Dam may be timed such that the peak discharge from Lockyer Creek is allowed through the system at a different time to reduce the impact of flooding downstream.
    - Locating the dam close to the community it is designed to protect will provide greater flood mitigation benefit. Locations a long way downstream of a dam are likely to receive less flood mitigation from a dam than locations in closer proximity to the dam. One contributing factor is the natural attenuation (flood mitigation) that occurs as flood peaks travel long distances downstream.

5. The **design of the dam** providing the ability to manage the volumes of water stored:
    - Maximising/optimising the ability of the dam to temporarily store water during flood events. The larger the event, the quicker the available flood storage behind the dam is filled and the degree of flood mitigation provided by the dam is reduced. Thus, a dam is likely to provide a greater degree of flood mitigation for a 1 in 5 AEP flood event than a 1 in 100 AEP event or a 1 in 10,000 AEP flood event of similar duration.
    - Installing gated spillways can provide some flexibility to control discharges. (This was the strategy applied to Wivenhoe Dam in combination with the provision of a significant flood storage capacity. The provision of gates, however, does not always provide flood mitigation.)
6. **Operation of the dam**:
    - Drawing down storage at the start of the event would require fine tuned management where water supplies are placed at risk and could only be used in a limited number of cases. If a dam storage is half empty at the start of an event, this storage would mitigate flood risks as it would have to be filled first before any discharge occurs. For example, consider the experience at Emerald in 2010/11 compared with Emerald in 2008 when Fairbairn Dam started out at 35% of capacity at the commencement of the flood. This operating condition is often extremely difficult to manage due to the uncertain and highly variable weather conditions. Some dams such as the Burdekin Falls Dam can discharge for long periods during the wet season and this practice cannot be assured. Other dams like Tinaroo Falls Dam and Koombooloomba Dam, which involve water entitlements that are not fully utilised, may have the capacity to be drawn down during the period prior to the wet season or impending event. However, if the dam operator deliberately draws the storage down at the start of a 'wet season' and the wet season does not eventuate, there is a risk of not having sufficient water available for future seasons.
    - Where gated structures are provided, controlled releases prior to and during flood events may be possible.

7. Communities at Risk

Attachment 2 (Smith 1998) summarises the results of a flood risk survey in 1998 undertaken by Dingle Smith for the Queensland Government. At the time, it was estimated that some 65 000 buildings (residential including multi-dwelling buildings and non-residential buildings) were liable to flooding in a 1 in 100 year event. At the time, a further 40 000 to 50 000 buildings was estimated to be at risk from extreme storm surge events. In Australia, storm surges are generally only a Queensland development planning issue.

A summary of communities with significant numbers of buildings at risk of flood in a 1 in 100 year event are summarised below in Table 1. These account for two thirds of the State's identified flood prone buildings in 1998.

The 1998 statistics were highly qualified as a result of the paucity of data available at the time. It is unlikely that significant changes have occurred since 1998 due to the duration of the Millennium Drought.

The 2010/11 flood has exposed significant additional risks, also included in the above table. In 1999, Emerald was recorded as having a minor flood risk. The 2010/2011 flood indicates that more than 1 000 residential buildings and 95% of businesses (no building numbers available) are at risk. Other towns included Grantham, Helidon, Withcott, Gatton and

Forrest Hill in the Lockyer Valley Regional Council, Chinchilla and Condamine in Western Downs Regional Council, Bundaberg, and Mundubbera in North Burnett Regional Council. Attachment 3 summarises media reports on flood affected areas in Queensland in 2010/11.

Table 1 - Communities with significant numbers of buildings at risk of flood

Local Government	Number of buildings at risk (1 in 100 event) - 1998	Anecdotal update Number of buildings at risk (1 in 100 event) - 2011
Gold Coast	16 650	
Mackay	8 500	
Brisbane	8 000	15 000 to 20 000+
Western Downs (Dalby)	3 300	
Western Downs (Condamine)		100
Ipswich	3 000	3 500
Logan	2 375	
Hinchinbrook	2 175	
Murweh (Charleville)	1 350 + all commercial	
Rockhampton	1 200	1 300 to 1 500
Central Highlands (Emerald)	25	1 000+ plus 95% commercial
Burdekin	1 000	
Cairns	728	
Caboolture	455	
Banana (Theodore)		300
Lockyer Valley (Laidley, Forrest Hill, Gatton, Grantham, Helidon, Withcott)	290(Laidley)	300 (Forrest Hill)
Total	**48 733**	

While the circumstances in smaller regional centres remained relatively unchanged, there has since been substantial flood plain development in major centres such as Brisbane infill developments, the Bohle River and Ross River areas in Townsville, the Lake Placid areas adjacent to the Barron River areas in Cairns and new developments in Mackay.

8. Rapid Assessment Ranking Methodology

The ranking methodology for flood mitigation purposes assumes that the best dams/retention basins either exist or sites for future development or raising have been identified.

Two rankings have been undertaken:

- the flood mitigation benefits from existing structures; and
- the flood mitigation benefits of identified possible future measures including dam raisings, new dams and retention basins.

The ranking methodology is based on the assessment of the combined effects of:

- likelihood of damaging flood events; and the
- benefit from the flood mitigation works.

Tables 2 and 3 summarise the assessment criteria.

Table 2: Likelihood of damaging flood event

Likelihood criteria	Value	Weighting
Exposure to flooding (without flood protection for existing dam, and current situation for future works)		
Less than 1 in 25 year event	3	4
Less than 1 in 50 year event	2	
Less than 1 in 100 year event	1	
Flood exposure (flash flooding in creeks, river flooding, and tidal effects)		
3 flood exposures	3	2
2 flood exposures	2	
1 flood exposure (flash flooding in creeks OR river flooding OR tidal effects)	1	
Time to respond		
Flash flood (less than 12 hours)	3	3
12 to 24 hours	2	
Greater than 24 hours	1	
Flood mapping, warning systems, and emergency action plans		
1 or less in place	3	2
2 in place	2	
3 in place	1	

Table 3: Benefit from Flood Mitigation Works

Benefit criteria	Value	Weighting
Population benefitting		
Population less than 1 000 persons	1	3
Population between 1 000 and 5 000 persons	2	
Population above 5 000 persons	3	
Catchment command		
Less than 40%	1	2
40 to 70%	2	
> 70%	3	
Dam Design (flood routing storage only (category 2 dam), constricted spillway design, gated structure with flood storage)		
Flood routing storage only (category 2 dam)	1	3
Constricted spillway design – flood storage provides substantial reduction of 1 in 100 event flood peak (>30%)	2	
Gated structure with flood storage providing substantial reduction of 1 in 100 event flood peak (>30%) or retention basin	3	
Social and Economic benefit of reduced flooding		
Impacts able to be met by local community with minimal distress	1	3
Some loss of employment and industry losses	2	
Prevention of major population relocations	3	
Significant industry protection against loss of production and job losses		

The benefits of flood mitigation storages have been classified into significant, moderate and minor.

9. Ranked flood mitigation benefits of existing dams

The ranking matrix for existing dams and retention basins is summarised in Figure 1 below.

Figure 1: Ranking of Existing Dams and Retention Basins

Likelihood of Flooding	Benefits from existing dams and retention basins										
	0	1	2	3	4	5	6	7	8	9	10
1											
2											
3											
4				9	17						
5				6, 5 ,25 30, 36	13, 35	36					
6				23, 27, 29	3	32	8 12			28	
7				1, 2, 7 10, 15 22		20	18		24 34		
8				11, 26	33					16	
9										4 , 21	
10											

NUMBER	SITE	COMMUNITY	NUMBER	SITE	COMMUNITY
1	Awoonga Dam	Benaraby/Tannum Sands	19	Leslie	None
2	Baroon Pocket Dam	Kenilworth	20	Leslie Harrison	Redlands
3	Beardmore Dam	St George	21	Loders Ck Detention Basin	Gold Coast
4	Biggera Ck Detention Basin	Gold Coast	22	Maroon	Beaudesert
5	Bjelke Petersen Dam	Murgon	23	Moogerah	Ipswich
6	Boondooma Dam	Mundubbra	24	Peter Faust	Prosepine
7	Borumba Dam	Gympie	25	Storm King	Stanthorpe
8	Burdekin Dam	Home Hill	26	Tallebudgera	Gold Coast
9	Connolly	Warwick	27	Tinaroo	Mareeba
10	Enoggera	Brisbane	28	Somerset/Wivenhoe	Brisbane
11	Ewen Maddock	Sunshine Coast	29	Wuruma	Eidsvold/Mundubbra
12	Fairbairn	Emerald	30	Cania	Monto
13	Fred Haigh	Bundaberg	31	Eungella Dam	None
14	Glenlyon	None	32	Teemburra Dam	Mackay
15	Gold Creek	Brisbane	33	Copperlode Dam	Cairns (Lake Placid)
16	Hinze Dam	Gold Coast	34	Ross River Dam	Townsville
17	Lake Manchester	Brisbane	35	Coolmunda Dam	Inglewood
18	Lenthalls	Hervey Bay	36	Paradise Dam	Bundaberg

Details of the assessment are included in Attachment 4 which also identifies the main communities benefitting from the existence of the dams.

Water storage infrastructure assessed as providing significant flood mitigation benefits for less than 1 in 100 year events include:

- The Biggera Creek and Loders Creek Detention Basins on the Gold Coast;
- Hinze Dam on the Gold Coast;
- Wivenhoe and Somerset Dams;
- Peter Faust Dam protecting Proserpine; and
- Ross River Dam protecting Townsville.

The common feature with all these structures is that they were designed specifically to mitigate flooding and command significant proportions of the catchment area above the communities at risk. The flood discharge reductions available for the 1 in 100 year event are for the Biggera Creek Detention Basin at 92% and Peter Faust Dam at 95%.

Water storage infrastructure assessed as providing moderate flood mitigation benefits for less than 1 in 100 year events include:

- Fairbairn Dam near Emerald;
- Burdekin Dam upstream of Ayr and Home Hill;
- Lenthalls Dam upstream of Hervey Bay;
- Leslie Harrison Dam at Redlands;
- Borumba Dam upstream of Gympie; and
- Copperlode Falls Dam upstream of the Lake Placid areas in Cairns.

None of these structures were designed specifically for flood mitigation purposes. Nevertheless, these dams can provide significant flood mitigation benefits either due to their proximity to urban development or the extent to which they reduce flood flows. The extent to which flood flows are diminished depends on whether or not the flood emanates within their catchment area, the extent to which the dams are drawn down at the time of the flood and the dam design. The flood discharge reductions available for the 1 in 100 year event are as follows:

- Fairbairn Dam 32%;
- Burdekin Dam 21%; and
- Borumba Dam 32%.

Other structures have minor benefits due to the small populations at risk, the design of the dam, or its lack of catchment command.

10. Ranked flood mitigation benefits of possible measures

Possible flood mitigation projects have been identified as follows:

- Mitigating floods where the populations at risk exceeds 500; or
- Dams or dam raisings that would be possible to constructed in the next 20 years, subject to full impact approval processes.

The ranking matrix for prospects of major dams/dam raisings/retention basins (larger than urban scale) being constructed to mitigate floods causing significant damage in Queensland is summarised in Figure 2 below. Details of the assessment, including communities which would benefit if the works were constructed, are included in Attachment 5.

Figure 2: Ranking of Possible Flood Mitigation Measures

Likelihood of Flooding \ Benefits from Possible Flood Mitigation Measures	0	1	2	3	4	5	6	7	8	9	10
1											
2											
3								9			
4									4		
5							7, 14		10 11	3	
6							19	1 2	8, 13, 16	18	5
7							20, 21			12, 17	
8					6						
9											
10											

NUMBER	SITE	COMMUNITY	NUMBER	SITE	COMMUNITY
1	Raising Beardmore Dam	St George	12	Raising Fairbairn	Emerald
2	Barrackdale	St George	13	Nathan Dam	Theodore/Baralaba
3	Linville	Moore	14	Comet River	(with other storages) Rockhampton
4	Emu Creek	Brisbane	15	Connors River Dam	None
5	Raising Wivenhoe	Brisbane	16	Fitzroy Gap	Rockhampton
6	Murphy's Creek	Helidon/Grantham	17	Black's Creek	Mackay
7	Raising Borumba Dam	Gympie	18	Raising Burdekin Falls Dam	Home Hill
8	Traveston Crossing	Gympie	19	Urannah	Home Hill
9	Amamoor Ck	Gympie	20	Wild River	Ingham
10	Raising Paradise	Bundaberg	21	Flaggy Creek	Ingham
11	Upper Burnett Dam	Bundaberg			

The ranking method identifies the raising of Wivenhoe Dam and Fairbairn Dam and the construction of Black Creek Dam as possibly providing substantial additional flood mitigation benefit.

Wivenhoe Dam could be raised to provide additional water supply permitted under the Moreton Water Resource Plan and to provide additional banked water reserves that could be held for use in a water supply crisis. Additional take from Wivenhoe Dam would be possible as the extractions from the dam have effectively been reduced by the system operating plan designed to meet SEQ's level of service objectives. Thus, while likely to be a costly project with a new spillway and subject to more detailed analysis, the benefit-cost of such work could be high and could defer the construction of a future desalination plant.

The construction of dams/retention basins at Linville and on Emu Creek were assessed as providing lesser benefit because of catchment command and the population at risk. An alternative to the raising of Wivenhoe Dam is to construct a series of smaller dams/retention basins in the Brisbane River, Bremer River, and Lockyer Creek systems. This would need to be assessed further but has some potential as flooding to smaller towns would also be mitigated. Potential dam sites have previously been identified in the Bremer (45 000 ML capacity @70 km), Tenthill Creek (46 000 ML @29.8 km), Lockyer Creek (39 000 ML@ 110.1 km), Laidley Creek (24 000 ML @ 50 km) and Ma Ma Creek (24 000 ML @ 21.2 km). Larger structure may be possible for flood retention purposes, however this would need to be subject to further investigation.

The possible raising of **Fairbairn Dam** could only occur for flood mitigation purposes as the Fitzroy catchment has effectively been fully allocated from a water resource planning perspective. (This possibility needs to be discussed with SunWater.) The project costs would be high, however there would be benefits to both urban flood mitigation at Emerald and to the agricultural and mining sectors. An option would be to further assess the benefits of raising Fairbairn Dam and constructing Connors River, Nathan and Comet River Dams to mitigate floods in Rockhampton. While there would be some benefit, it is expected to be small as the total catchment commanded by the three dams above Rockhampton is relatively small at 36%.

Blacks Creek commands a substantial catchment upstream of Mackay which floods relatively frequently. A dam on **Blacks Creek** has the potential to provide substantial flood mitigation benefits as well as provide additional supplies for Mackay. Water supply for Mackay will need to be upgraded within the next 15 years to meet demand, and additional storage reserves would be desirable to improve water supply security. The possible construction of Blacks Creek Dam could meet the water supply needs of Mackay well into the future. Thus, the benefit-cost of this project could be high, subject to further consideration of ecological and other impacts.

A structure on **Murphy's Creek** upstream of Helidon and Grantham has not rated highly due to the lack of catchment command. It would not protect Withcott which appears to have received much of its flooding from Toowoomba and along the Warrego Highway. Other catchments contributing to flooding in these areas and the Lockyer include among others Rocky, Monkey Water Holes, Flagstone, Ma Ma, Tenthill, Sandy and Laidley Creeks.

The **raising of Burdekin Falls Dam** and construction of **Nathan Dam** rate moderately highly because of the protection provided to Ayr/Home Hill and Theodore and the significant benefits provided to the agricultural and mining sectors.

Paradise Dam provides significant flood routing storage. Consideration could be enhancing this benefit with gates, subject to further investigation of design and other factors. (This possibility needs to be discussed with SunWater.)

The **Traveston Dam site** could be constructed to provide flood mitigation benefits for Gympie and possibly Maryborough, however without the conjunctive benefit of water supply would probably be considered costly.

Raising **Borumba Dam** is being investigated by the QWC. The additional flood mitigation potential of Borumba Dam could be considered as part of this investigation.

Beardmore Dam on the Ballonne River is already near bank full height and is not recommended for raising. The **Barrackdale site** already provides a natural constriction and does not have natural foundations for location of a flood retaining structure. A large flood mitigation structure could be constructed at the **Gap Dam site** on the Fitzroy River

immediately upstream of the existing Eden Bann Weir. It could provide substantial flood mitigation benefit for Rockhampton, however a benefit cost assessment is likely to reveal a significant downside in terms of loss of economic production upstream of the site and relocation expenses.

Details available at this time on the Wild River and Flaggy Creek sites in the Herbert River need further confirmation before a recommendation for further study could be made.

ATTACHMENT 1 (information still to be included)

1A - Existing Dams and Retention Basins

	Location / Site Name	Category	Stream name and distance	Catchment area - km2	FSL Volume ML	Dam Crest Volume ML	Percentage Reduction in AEP 1% Flood Peak	Pop'n at Risk
Boyne	Awonga Dam	2	Boyne River @ 22.7 km	2,230	777,000	1,938,100	-37%	Gladstone ~ 10,000
Balonne	Beardmore Dam	2	Balonne River @ 251.4 km	75,160	81,700	230,000	0%	St George ~ 500
Brisbane	North Pine Dam		North Pine River @ 20.0 km	348	214,302		0%	~ 5,000
	Wivenhoe	1	Brisbane River @ 150.4 km	7020	1,150,000	2,600,000	-35%	Brisbane/Ipswich ~ 50,000
	Somerset	1	Stanley River @ 7.4	1,340	380,000	524,000	-40%	Brisbane/Ipswich ~ 50,000
	Baroon Pocket		Obi Obi Creek @	67	61,000	89,500	-63%	~ 500
	Ewen Maddock		Addlington Ck	21	16,590	32,500		
	Hinz		Nerang River @ 36.4	207	161,073			
	Lake Manchester		Cabbage Tree Creek @	74	26,217			
	Moogerah		Reynolds Creek @	228	83,765	90,000		
	Maroon		Burnett Creek @ 23.5	106	44,300			
	Leslie Harrison		Tingalpa Creek @	87	24,800			
Mary	Borumba Dam	2	Yabba Creek @ 31.1 km	465	46,000	120,000	- 32%	Gympie & Maryborough ~ 1,000
Burnett	Paradise	2	Burnett River @ 131.4 km	30,785	300,000			Bundaberg ~ 1,000
	Wuruma		Nogo R / Burnett @ 23 km	2,320	165,000	320,000	-44%	~ 500
	Bjelke Petersen		Barker Creek @ 1.3 km	1640	134,900	418,500	-68%	~ 500
	Boondooma		Boyne River @ 86.7	4,200	204,200	750,000	-38%	~ 500
	Cania		Three Moon Creek @	280	88,580	156,430	-29%	~ 500
	Fred Haigh		Kolan River @ 76.4	1,300	562,000	1,162,610	-70%	
	Lenthalls		Burrum R @34.2	935	28,400			~ 1000
Fitzroy	Fairbairn	2	Nogoa River @ 685.6 km	16,317	1,301,000	4,200,000	-32%	Emerald ~ 1,000
Pr	Peter Faust		Proserpine River @ 57.7 km	260	491,400			

	Teemburra		Teemburra Creek @ 20.5	66	147,500			
	Tinaroo Falls		Barron River @ 101.4	545	438,900	575,000		
Burdekin	Burdekin Falls Dam	2	Burdekin River @ 159.3 km	114,220	1,860,000	9,000,000	-21%	Home Hill and Ayr ~1,000
Burdekin	Eungella Dam		Broken River @ 71.8	142	112,400			
Burdekin	Ross River Dam		Ross River @	750	233,188			
Leichardt	Julius		Leichardt River @ 390.9 km	3650	107,500	265,355		
Leichardt	Moondarra		Leichardt River @ 465.1 km		106,833			
	Callide		Callide Creek @ 61.1 km	520	136,300			
	Kroombit		Kroombit Creek @ 68.8 km		14,600			
	Leslie		Sandy Ck / Condamine River @ 8.4 km	603	106,200			
	Glenlyon		Pike Ck / Duaresq River @ 6.4	1,295	254,000	523,610	-52%	

1B - Possible future flood mitigation sites

	Location / Site Name	Category	Stream name and distance	Catchment area - km2	Flood Storage - megalitres	Flood Volume 1% AEP - megalitres	Comments	Pop'n at Risk
Balonne	Beardmore Dam Raising	2	Balonne River @ 251.4 km	75,160	(81,700)	2,000,000	Estimated from IQQM daily flow sequence	St George ~ 500
	Barrackdale	1	Balonne River @ 323 km	~ 70,000		2,000,000	Estimated from IQQM daily flow sequence	St George ~ 500
Brisbane	Linville	1	Brisbane River @ 282.4 km	2,000	Up to 307,000	615,000	Estimated from IQQM daily flow sequence	Brisbane/Ipswich ~ 50,000
	Emu Creek	1	Emu Creek @ 10.7 km		Up to 200,000	257,000	Estimated from design flood duration and Peak flow – QH correspondence files	Brisbane/Ipswich ~ 50,000
	Raising Wivenhoe	2	Brisbane River @ 150.4 km	7020	(1,150,000) Up to 3,555,000	1,860,000	Flood Study – QH Internal Report 1994	Brisbane/Ipswich ~ 50,000
	Bremer River	1	Bremer River @ 70 km	171	Up to 60,000	82,000	Estimated from IQQM daily flow sequence	Brisbane/Ipswich ~ 10,000
	Murphy's Creek	1	Lockyer Creek 110.1 km	120	Up to 40,000	45,000	Estimated from IQQM daily flow sequence	~ 400
Mary	Raising Borumba Dam	2	Yabba Creek @ 31.1 km	465	(46,000)	448,000	Estimated from IQQM daily flow sequence	Gympie & Maryborough ~ 1,000
	Traveston Crossing	2	Mary River @ 206.7 km	2,110	Up to 1,130,000	763,000	Flood Study – SunWater Report 2007	Gympie & Maryborough ~ 1,000
	Amamoor Ck	1	Amamoor Creek @ 19.2km	130	Up to 290,000	151,000	Estimated from IQQM daily flow sequence	Gympie & Maryborough ~ 1,000
Burnett	Raising Paradise	2	Burnett River @ 131.4 km	30,785	(300,000)	9,840,000	Flood Study – QH Internal Report 1998	Bundaberg ~ 1,000
	Barambah Creek Dam ban ban		Burnett River @ 35.6	5563		1,064,000	Estimated from IQQM daily flow sequence	Bundaberg ~ 1,000
Fitzroy	Raising Fairbairn	2	Nogoa River @ 685.6 km	16,317	1,301,000	2,260,000	Flood Study – QH Internal Report 1995	Emerald ~ 1,000
	Nathan Dam	2	Dawson River @ 315.3 km	23,000	888,000	2,760,000	Flood Study – QH Internal Report 1997	Theodore/Moura ~ 500
	Comet River	1	Comet River @ 123.3 km	10,188	500,000	2,000,000	Flood Study – QH Internal Report 1995	Comet ~ 200
	Connors River Dam	2	Connors River@ 95.7 km	1,320	367,000	389,000	Flood Study – QH Internal Report 1999	Rockhampton ~ 5,000
	Fitzroy Gap	1	Fitzroy River @ 141.2 km	135,000	Up to 10,000,000	16,000,000	Estimate based on flood peak – QH Internal Report 1990	Rockhampton ~ 5,000
Pioneer	Finch Hatton	1	Finch Hatton Creek @ 3.2 km	36	Up to 98,500	65,000	Estimated from IQQM daily flow sequence	Mackay ~ 5,000
	Black's Creek	2	Blacks Creek Dam at 66.1 km	505	Up to 492,000	509,000	Estimated from IQQM daily flow sequence	Mackay ~ 5,000
Burdekin	Raising Burdekin Falls Dam	2	Burdekin River @ 159.3 km	114,220	Up to 8,700,000	13,600,000	Flood Study – QH Internal Report 2001	Home Hill and Ayr ~1,000
	Hells Gate	1	Burdekin River @ 466.7 km	17,860	Up to 5,720,000	4,104,000	Estimated from IQQM daily flow sequence	Home Hill and Ayr ~1,000

	Mt Fullstop	1	Burdekin River @ 483.0 km	17,420	Up to 5,000,000	4,103,000	Estimated from IQQM daily flow sequence	Home Hill and Ayr ~1,000
	Greenvale	1	Burdekin River @ 552.8 km	8,070	Up to 2,430,000	1,438,000	Estimated from IQQM daily flow sequence	Home Hill and Ayr ~1,000
	Urannah	2	Broken River @ 36.0 km	1,100	Up to 1,500,000	797,000	Estimated from IQQM daily flow sequence	Home Hill and Ayr ~1,000
Herbert	Glen Eagle	1	Herbert River @			1,924,000	Estimated from IQQM daily flow sequence	Ingham ~ 500
Herbert	Wild River	2	Wild River @			278,000	Estimated from IQQM daily flow sequence	
Herbert	Millstream	2	Millstream @ 12.4 km			73,000	Estimated from IQQM daily flow sequence	
Barr	Flaggy Creek	1	Flaggy Creek @ 11.7 km	154	Up to 200,000	209,000	Estimated from IQQM daily flow sequence	Cairns – ~ 5,000
Logan	Glendower	2	Albert River @ 60.2 km	295	(86,000)	181,000	Estimated from IQQM daily flow sequence	Beenleigh
Logan	Albert River Dam	2	Albert River @ 26.6 km			412,000	Estimated from IQQM daily flow sequence	Beenleigh

ATTACHMENT 2
FLOOD PRONE TOWNS IN QUEENSLAND (1998 Data)

Flood Warming Legend: Q = Qualitative Data, N = None, P = Predicted flood heights
Lead Time Legend: A is < 12 hours, B is 12 to 24 hours, C is > 24 hours

Basin	Town	Buildings at Risk	Flood Gauge	Flood Height (m)	Max. Height (m)	Flood Warning System	Flood map	Lead time	Levee
Baroon	Mareeba		Y		11.1	Q		A	
	Cairns		Y		9.5	Q		A	
	Daintree	20?	N			N		A	
Condamine	Killarney		y		8.1	Q		A	
Balonne	Emu Vale		Y		7.3	N		A	
	Warwick	115+	Y	6.2	9.1	Q		A	
	Allora		Y		7.6	N		A	
	Cambooya	20(est)	N			N		A	
	Leyburn		Y	4.6	5.5	Q		A	
	Tummaville		Y	10.4	11.2	Q		A	
	Cecil Plains		Y		9.3	Q		A	
	Oakey		N			N		A	
	Dalby	840+	Y	3.5	4.5	P		A	
	Jandowae		N			N		A	
	Chinchilla		Y	8.0	8.9	Q		A	
	Condamine		y	10.7	14.3	P		A	
	Miles	3?	Y	11.0	13.4	Q		A	
	Yuleba?		N			N		A	
	Wallumbilla		N			N		A	
	Surat	6	Y	12.2	11.7	P		A	
	Roma	40+	Y	6.6	7.3	Q		A	
	Muckadilla		N			N		A	
	Mitchell		Y	7.6	8.1	Q		A	
	Amby		N			N		A	
	St George		Y	12.1	13.1	P		A	
	Dirranbandi	150?	Y		5.3	P		C	Y
	Hebel		Y		2.3	P		C	
	Bollon	3+	Y	1.0	1.5	Q		A	
	Mungallala?		N			N		A	
Border Rivers	Inglewood		Y	10.1	12.5	Q		A	
	Yelarbon		N			N		A	
	Goondiwindi?		Y		10.6	P		C	Y
Moonie	Thallon		Y	5.3	5.4	Q		C	
Warrego	Augathella	65	Y	5.5	7.3	P	Y	A	
	Charleville	1150	Y	5.5	8.5	P	Y	B	
	Wyandra		Y	8.7	10.0	P		C	
	Cunnamulla?		Y	10.3	10.2	P		C	Y
Paroo	Eulo		Y		6.0	P		C	
	Hungerford		Y		3.0	P		C	
Bulloo	Adavale		Y	4.2	5.0	N		A	
	Quilpie?		Y	5.9	7.9	Q		B	
	Thargomindah		Y	6.0	6.8	P		C	
South Coast	Nerang/Latimer		Y		10.2	Q		A	
	Mudgeeraba		Y			Q		A	
	Gold Coast			1.8	3.0	P	Y	A	
Logan/Albert	Canungra		N			N		A	
	Beaudesert		Y	13.0	13.9	Q		A	
	Boonah		Y	7.0	8.5	Q		A	
	Beenleigh		Y	9.0	13.7	Q		B	
	Logan City	3600	Y			Q	Y	B	
	Waterford		Y	9.0	13.0	P		B	

	Eagleby		Y	7.0	7.6	Q		B	
Brisbane-Bremer	Harrisville		Y		8.3	Q		A	
	Amberley		Y		10.2	Q		A	
	Peak Crossing		N			N		A	
	Ipswich		Y	7.4	24.6	P		A	
	Rosewood		Y		7.6	Q		A	
	Walloon		Y		8.7	Q		A	
	Mulgowie		Y	7.1	8.6	Q		A	
	Laidley		Y	8.0		Q		A	
	Helidon		Y		7.5	Q		A	
	Grantham		N			N		A	
	Gatton	20?	Y	7.0	16.3	Q		A	
	Lowood		Y	21.0	26.4	Q		B	
	Cooyar		N			N		A	
	Linville		Y		12.2	Q		A	
	Toogoolawah		N			Q		A	
	Kilcoy		N			Q		A	
	Woodford		Y	10.7	11.7	Q		A	
	Moggill		Y		20.0	P		B	
	Brisbane City	6000+	Y		8.4	P	Y	B	
Pine-Caboolture	Dayboro		N			N		A	
	Bald Hills		N			N		A	
	Strathpine		N			N		A	
	Samford		N			N		A	
	Caboolture		N			N		A	
	Burpengary	120						A	
Sunshine Coast	Nambour		Y		9.3	N		A	
	Maroochydore	225+	N		3.5	N		A	
	Coolum		N			N		A	
	Kawana		N			N		A	
	Tewantin		Y			Q		B	
	Noosaville		Y			Q		B	
	Boreen Point		Y			Q		B	
Mary	Kenilworth		Y	10.1	17(Est)	Q		A	
	Imbil		Y	8.5	11.7	N		A	
	Kadanga		Y			N		A	
	Coorah		Y	9.1	10.7	N		A	
	Gympie	200	Y	12.0	25.5	P		B	
	Woolooga		Y	9.0	12.5	N		A	
	Maryborough		Y	7.6	12.3	P		B	
Burrum / Gregory	Pacific Haven		N	~4	6.2	N	Y	A	
	Howard		N	1	13.4	N		A	
Burnett	Goomeri		N			N		A	
	Abercorn		Y		9.6	Q		A	
	Mundubbera		Y	18.3	23.6	Q		A	
	Gayndah		Y	16.3	19.7	Q		A	
	Bundaberg		Y	6.7	10.3	P		B	
Fitzroy	Injune		N			N		A	
	Taroom		Y	7.6	14.8	P		B	
	Theodore		Y	12.2	14.1	P		B	
	Baralaba		Y			P		B	
	Biloela?		N			N		A	
	Goovigen	2.0	N			N		A	

	Rolleston		Y	7.0		N		A	
	Emerald?		Y	17.1	15.7	Q		B	
	Yaamba		Y	16.8	17.3	P		C	
	Rockhampton	900	Y	7.0	10.1	P		C	
	Nebo?		N			N		A	
	Moranbah?		N			N		A	
	Dysart?		N			N		A	
Pioneer	Finch Hatton		Y	4.6	6.5	Q		A	
	Mirani		Y		16.5	Q		A	
	Mackay	7500	Y	7.3	9.1	P		A	
Proserpine	Proserpine		Y		8.4	Q		B	
Don Elliot	Bowen		Y		7.5	P		B	
	Guthalunga		N			N		A	
Burdekin	Sellheim		Y	18.0	21.8	Q		A	
	Alpha		Y	8.3	10.3	Q		A	
	Clare		Y		18.4	Q		B	
	Home Hill/Ayr		Y	12.1	12.6	P		A	
Haughton	Giru		Y	2.5	2.5	P		B	
Ross-Bohle	Townsville?		N			N		A	
Herbert	Ingham	1450	Y		15.2	P		A	
	Halifax		Y		5.4	P		A	
Tully	Euramo		Y	8.5	9.4	P		B	
Johnstone	Innnisfail	315	Y	6.0	8.1	P		A	
	Mourilyan	64	N			N		A	
	Babinda		N			N		A	
	Gordonvale?		N			N		A	
Cooper	Muttaburra?		Y	8.2	8.7	Q		A	
	Aramac		Y	5.4	5.5	N		A	
	Longreach		Y	5.4	6.0	P		C	
	Stonehenge		Y		6.9	P		C	
	Jundah		Y	4.6	8.4	P		C	
	Jericho	20	Y	3.0	3.2	Q		A	
	Barcaldine		Y		9.0	Q		B	
	Tambo?		Y	5.8	5.8	Q		A	
	Blackall	45	Y	5.5	6.9	Q		A	
Diamantina	Winton		N			N			
Georgina	Camooweal		N			N			
	Urandangle		Y	7.0	7.5	Q			
	Boulia		Y	6.1	6.0	Q			
Gulf Rivers	Hugenden?		Y	4.9	5.5	N			
	McKinlay		N			N			
	Richmond		Y		11.5	Q			
	Cloncurry	25+	Y	11.0		N		A	
	Mt Isa	12+	N			N		A	
	Normanton		Y	7.0	8.8	Q		C	
	Burketown?		N			N		C	
	Georgetown		N			N			
	Einasleigh		N			N			

ATTACHMENT 3
MEDIA REPORTS SUMMARY
QUEENSLAND AREAS AFFECTED BY 2010/2011 FLOODING

Allora
- 12 flooded houses and 1 business.

Brisbane
- More than 15,000 properties in 50 Brisbane suburbs have been affected by floodwaters that peaked at 4.46 meters (14.6 feet) on 13 January.

Bundaberg
- About 400 homes and businesses affected
- 100 homes and two dozen businesses had water above the floorboards.
- About 400 people were evacuated overnight.

Condamine
- The town's 150 residents were evacuated.

Chinchilla
- More than 50 homes and business have been evacuated.

Dalby
- About 200 homes in the regional hub of Dalby have been flooded above their floorboards.
- On 27 December, 100 properties were inundated and 160 people evacuated. (Dalby and Chinchilla, forcing the evacuation of about 250 properties)

Emerald
- 2500 people have been evacuated.

Forest Hill
- More than 300 people, Forest Hill's entire population, were rescued by Black Hawk helicopters.

Gatton
- Residents downstream from the Lockyer Creek area were urged to immediately evacuate on Monday, 10 January 2011.

Grantham
- Parts of the tiny Queensland town, home to 370 people, were literally washed away by flash flooding on Monday, 10 January 2011.
- 12 residents were forced to leave their homes overnight.

Gympie
- Flooding about 80 properties and the CBD.
- About 30 homes have been evacuated and 100 businesses have been swamped by floodwaters at Gympie.

Helidon
- 100 people evacuated.

Ipswich
- As many as 3000 homes had to be evacuated.

Killarney
- 1 house and 8 businesses went under.

Laidley

- Residents were told to get out as rapidly rising water threatened the Lockyer Valley community west of Brisbane.

Maryborough

- up to 20 businesses were inundated.

Mundubbera

- 37 houses evacuated.

Rockhampton

- 2000 affected 200 inundated, 180 evacuated.

Stanthorpe

- (11/01/20111) - About 12 homes were inundated when the creek peaked last night, and further inundations were expected as the creek continued to rise today.
- Two evacuation centres were established to accommodate about 50 displaced residents.

Theodore

- The entire township of 350 residents evacuated.

Warwick

- 50 houses and 15 businesses were flooded.

Withcott

- Hundreds of people had to be evacuated from Withcott on 10 January 2011 after flash flooding left the entire town partly submerged.

Ninety-two state schools, 14 TAFE campuses and about 80 kindergarten and childcare centres were impacted.

More than 30,000 properties were flooded in south-east Queensland from the 10th to the 14th January 2011.

ATTACHMENT 4: Ranking of Existing Dams and P tention Basins

Existing Sites: Likelihood of damaging flood event

			Flood frequency			Flood exposure			Time to respond			Flood mapping, warning systems and emergency action plans				
Number	Location/Site Name	Benefited Community	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Total Likeli-hood	Adjusted Likelihood (out of 10)
1	Awoonga Dam	Benaraby/Tannum Sands	2	4	8	2	2	4	2	3	6	2	2	4	22	7
2	Baroon Pocket Dam	Kenilworth	3	4	12	2	2	4	1	3	3	2	2	4	23	7
3	Beardmore Dam	St George	3	4	12	1	2	2	1	3	3	1	2	2	19	6
4	Biggera Ck Detention Basin	Gold Coast	3	4	12	3	2	6	3	3	9	2	2	4	31	9
5	Bjelke Petersen Dam	Murgon	2	4	8	1	2	2	2	3	6	2	2	4	20	6
6	Boondooma Dam	Mundubbra	2	4	8	1	2	2	1	3	3	1	2	2	15	5
7	Borumba Dam	Gympie	3	4	12	1	2	2	2	3	6	1	2	2	22	7
8	Burdekin Dam	Home Hill	3	4	12	1	2	2	1	3	3	2	2	4	21	6
9	Connolly	Warwick	1	4	4	1	2	2	1	3	3	2	2	4	13	4
10	Enoggera	Brisbane	3	4	12	1	2	2	2	3	6	2	2	4	24	7
11	Ewen Maddock	Sunshine Coast	3	4	12	1	2	2	2	3	6	3	2	6	26	8
12	Fairbairn	Emerald	3	4	12	1	2	2	1	3	3	1	2	2	19	6
13	Fred Haigh	Bundaberg	2	4	8	2	2	4	1	3	3	1	2	2	17	5
14	Glenlyon	None	0	4	0	0	2	0	0	3	0	0	2	0	0	0
15	Gold Creek	Brisbane	3	4	12	1	2	2	2	3	6	2	2	4	24	7
16	Hinze Dam	Gold Coast	3	4	12	3	2	6	2	3	6	1	2	2	26	8
17	Lake Manchester	Brisbane	1	4	4	1	2	2	2	3	6	1	2	2	14	4
18	Lenthalls	Hervey Bay	3	4	12	2	2	4	2	3	6	1	2	2	24	7
19	Leslie	None	0	4	0	0	2	0	0	3	0	0	2	0	0	0
20	Leslie Harrison	Redlands	3	4	12	2	2	4	2	3	6	1	2	2	24	7
21	Loders Ck Detention Basin	Gold Coast	3	4	12	3	2	6	3	3	9	2	2	4	31	9
22	Maroon	Beaudesert	3	4	12	1	2	2	2	3	6	2	2	4	24	7
23	Moogerah	Ipswich	1	4	4	1	2	2	3	3	9	2	2	4	19	6
24	Peter Faust	Prosepine	3	4	12	2	2	4	2	3	6	1	2	2	24	7
25	Storm King	Stanthorpe	2	4	8	1	2	2	1	3	3	2	2	4	17	5
26	Tallebudgera	Gold Coast	3	4	12	1	2	2	3	3	9	1	2	2	25	8
27	Tinaroo	Mareeba	3	4	12	1	2	2	1	3	3	2	2	4	21	6
28	Somerset/Wivenhoe	Brisbane	3	4	12	2	2	4	1	3	3	1	2	2	21	6
29	Wuruma	Eidsvold/Mundubbra	3	4	12	1	2	2	1	3	3	2	2	4	21	6
30	Cania	Monto	2	4	8	1	2	2	1	3	3	2	2	4	17	5
31	Eungella Dam	None	0	4	0	0	2	0	0	3	0	0	2	0	0	0
32	Teemburra Dam	Mackay	1	4	4	2	2	4	3	3	9	1	2	2	19	6
33	Copperlode Dam	Cairns (Lake Placid)	3	4	12	3	2	6	2	3	6	1	2	2	26	8
34	Ross River Dam	Townsville	3	4	12	2	2	4	2	3	6	1	2	2	24	7
35	Coolmunda Dam	Inglewood	2	4	8	1	2	2	1	3	3	2	2	4	17	5
36	Paradise Dam	Bundaberg	2	4	8	1	2	2	1	3	3	1	2	2	15	5

ATTACHMENT 4 continued: Ranking of Existing Dams and Retention Basins

Benefit existing dams and retention basins

			Population benefiting			Catchment Command			Dam Design			Social and Economic Benefit				
Number	Location/Site Name	Benefited Community	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Total Benefit	Adjusted Benefit (out of 10)
1	Awoonga Dam	Benaraby/Tannum Sands	1	3	3	1	2	2	1	3	3	1	3	3	11	3
2	Baroon Pocket Dam	Kenilworth	1	3	3	1	2	2	1	3	3	1	3	3	11	3
3	Beardmore Dam	St George	1	3	3	1	2	2	1	3	3	2	3	6	14	4
4	Biggera Ck Detention Basin	Gold Coast	2	3	6	3	2	6	3	3	9	3	3	9	30	9
5	Bjelke Petersen Dam	Murgon	1	3	3	2	2	4	1	3	3	1	3	3	13	4
6	Boondooma Dam	Mundubbra	1	3	3	1	2	2	1	3	3	1	3	3	11	3
7	Borumba Dam	Gympie	1	3	3	1	2	2	1	3	3	1	3	3	11	3
8	Burdekin Dam	Home Hill	2	3	6	3	2	6	1	3	3	2	3	6	21	6
9	Connolly	Warwick	1	3	3	1	2	2	1	3	3	1	3	3	11	3
10	Enoggera	Brisbane	1	3	3	1	2	2	1	3	3	1	3	3	11	3
11	Ewen Maddock	Sunshine Coast	1	3	3	1	2	2	1	3	3	1	3	3	11	3
12	Fairbairn	Emerald	2	3	6	3	2	6	1	3	3	2	3	6	21	6
13	Fred Haigh	Bundaberg	1	3	3	1	2	2	1	3	3	2	3	6	14	4
14	Glenlyon	None	0	3	0	0	2	0	0	3	0	0	3	0	0	0
15	Gold Creek	Brisbane	1	3	3	1	2	2	1	3	3	1	3	3	11	3
16	Hinze Dam	Gold Coast	3	3	9	2	2	4	3	3	9	3	3	9	31	9
17	Lake Manchester	Brisbane	1	3	3	2	2	4	1	3	3	1	3	3	13	4
18	Lenthalls	Hervey Bay	2	3	6	2	2	4	1	3	3	2	3	6	19	6
19	Leslie	None	0	3	0	0	2	0	0	3	0	0	3	0	0	0
20	Leslie Harrison	Redlands	2	3	6	2	2	4	1	3	3	1	3	3	16	5
21	Loders Ck Detention Basin	Gold Coast	2	3	6	3	2	6	3	3	9	3	3	9	30	9
22	Maroon	Beaudesert	1	3	3	1	2	2	1	3	3	1	3	3	11	3
23	Moogerah	Ipswich	1	3	3	1	2	2	1	3	3	1	3	3	11	3
24	Peter Faust	Prosepine	2	3	6	2	2	4	2	3	6	3	3	9	25	8
25	Storm King	Stanthorpe	1	3	3	1	2	2	1	3	3	1	3	3	11	3
26	Tallebudgera	Gold Coast	1	3	3	1	2	2	1	3	3	1	3	3	11	3
27	Tinaroo	Mareeba	1	3	3	1	2	2	1	3	3	1	3	3	11	3
28	Somerset/Wivenhoe	Brisbane	3	3	9	2	2	4	3	3	9	3	3	9	31	9
29	Wuruma	Eidsvold/Mundubbra	1	3	3	1	2	2	1	3	3	1	3	3	11	3
30	Cania	Monto	1	3	3	1	2	2	1	3	3	1	3	3	11	3
31	Eungella Dam	None	0	3	0	0	2	0	0	3	0	0	3	0	0	0
32	Teemburra Dam	Mackay	3	3	9	1	2	2	1	3	3	1	3	3	17	5
33	Copperlode Dam	Cairns (Lake Placid)	2	3	6	1	2	2	1	3	3	1	3	3	14	4
34	Ross River Dam	Townsville	3	3	9	2	2	4	2	3	6	3	3	9	28	8
35	Coolmunda Dam	Inglewood	1	3	3	2	2	4	1	3	3	1	3	3	13	4
36	Paradise Dam	Bundaberg	2	3	6	3	2	6	1	3	0	2	3	6	18	5

ATTACHMENT 5: Ranking of Possible Flood Mitig..on Measures

Possible Sites: Likelihood of damaging flood event

			Flood frequency			Flood exposure			Time to respond			Flood mapping, warning systems and emergency action plans				
Number	Location/Site Name	Benefited Community	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Total Likelihood	Adjusted Likelihood (out of 10)
1	Raising Beardmore Dam	St George	3	4	12	1	2	2	1	3	3	1	2	2	19	6
2	Barrackdale	St George	3	4	12	1	2	2	1	3	3	1	2	2	19	6
3	Linville	Moore	2	4	8	2	2	4	1	3	3	1	2	2	17	5
4	Emu Creek	Brisbane	1	4	4	2	2	4	1	3	3	1	2	2	13	4
5	Raising Wivenhoe	Brisbane	3	4	12	2	2	4	1	3	3	1	2	2	21	6
6	Murphy's Creek	Helidon/Grantham	2	4	8	1	2	2	3	3	9	3	2	6	25	8
7	Raising Borumba Dam	Gympie	2	4	8	1	2	2	1	3	3	1	2	2	15	5
8	Traveston Crossing	Gympie	3	4	12	1	2	2	1	3	3	1	2	2	19	6
9	Amamoor Ck	Gympie	1	4	4	1	2	2	1	3	3	1	2	2	11	3
10	Raising Paradise	Bundaberg	2	4	8	2	2	4	1	3	3	1	2	2	17	5
11	Upper Burnett Dam	Bundaberg	2	4	8	2	2	4	1	3	3	1	2	2	17	5
12	Raising Fairbairn	Emerald	3	4	12	1	2	2	1	3	3	3	2	6	23	7
13	Nathan Dam	Theodore/Baralabah	3	4	12	1	2	2	1	3	3	1	2	2	19	6
14	Comet River	(with other storages) Rockhampton	2	4	8	1	2	2	1	3	3	1	2	2	15	5
15	Connors River Dam	None	0	4	0	0	2	0	0	3	0	0	2	0	0	0
16	Fitzroy Gap	Rockhampton	3	4	12	2	2	4	1	3	3	1	2	2	21	6
17	Black's Creek	Mackay	3	4	12	2	2	4	2	3	6	1	2	2	24	7
18	Raising Burdekin Falls Dam	Home Hill	3	4	12	2	2	4	1	3	3	1	2	2	21	6
19	Urannah	Home Hill	3	4	12	2	2	4	1	3	3	1	2	2	21	6
20	Wild River	Ingham	2	4	8	2	2	4	3	3	9	1	2	2	23	7
21	Flaggy Creek	Ingham	2	4	8	2	2	4	3	3	9	1	2	2	23	7

ATTACHMENT 5 continued: Ranking of Possible Flood Mitigation Measures

Possible Sites: Benefit from flood mitigation works

			Population benefiting			Catchment Command			Dam Design			Social and Economic Benefit				
Number	Location/Site Name	Benefited Community	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Value	Weighting	Total	Total Benefit	Adjusted Benefit (out of 10)
1	Raising Beardmore Dam	St George	1	3	3	3	2	6	3	3	9	2	3	6	24	7
2	Barrackdale	St George	1	3	3	3	2	6	3	3	9	2	3	6	24	7
3	Linville	Moore	3	3	9	1	2	2	3	3	9	3	3	9	29	9
4	Emu Creek	Brisbane	3	3	9	1	2	2	2	3	6	3	3	9	26	8
5	Raising Wivenhoe	Brisbane	3	3	9	3	2	6	3	3	9	3	3	9	33	10
6	Murphy's Creek	Helidon/Grantham	1	3	3	1	2	2	2	3	6	1	3	3	14	4
7	Raising Borumba Dam	Gympie	2	3	6	1	2	2	2	3	6	2	3	6	20	6
8	Traveston Crossing	Gympie	2	3	6	3	2	6	3	3	9	2	3	6	27	8
9	Amamoor Ck	Gympie	2	3	6	1	2	2	3	3	9	2	3	6	23	7
10	Raising Paradise	Bundaberg	2	3	6	3	2	6	3	3	9	2	3	6	27	8
11	Upper Burnett Dam	Bundaberg	2	3	6	2	2	4	3	3	9	2	3	6	25	8
12	Raising Fairbairn	Emerald	2	3	6	3	2	6	3	3	9	3	3	9	30	9
13	Nathan Dam	Theodore/Baralaba h	1	3	3	2	2	4	3	3	9	3	3	9	25	8
14	Comet River	(with other storages) Rockhampton	2	3	6	1	2	2	3	3	9	1	3	3	20	6
15	Connors River Dam	None	0	3	0	0	2	0	0	3	0	0	3	0	0	0
16	Fitzroy Gap	Rockhampton	2	3	6	3	2	6	3	3	9	2	3	6	27	8
17	Black's Creek	Mackay	3	3	9	1	2	2	3	3	9	3	3	9	29	9
18	Raising Burdekin Falls Dam	Home Hill	2	3	6	3	2	6	3	3	9	3	3	9	30	9
19	Urannah	Home Hill	2	3	6	1	2	2	3	3	9	1	3	3	20	6
20	Wild River	Ingham	2	3	6	1	2	2	3	3	9	1	3	3	20	6
21	Flaggy Creek	Ingham	2	3	6	1	2	2	3	3	9	1	3	3	20	6