QFCI

Date: 27/05/11 - JM

Exhibit Number: 501

EXHIBIT COPY

STATEMENT OF ROBERT KEOGH

WITNESS STATEMENT

OF ROBERT GERARD KEOGH

IN THE QUEENSLAND FLOODS

COMMISSION OF INQUIRY

Table of Contents

Table of Figures

List of Tables

1 Introduction – Rob Keogh

I **ROBERT GERARD KEOGH**, care of SunWater, 179 Turbot Street, Brisbane, am employed by SunWater Limited as Manager, Asset Management.

1.1 Preliminary nature of this statement

This statement has been provided without any knowledge of the content of other evidence that will or may be adduced, or the submissions that have or will be made to the Commission of Inquiry. I will supplement this statement with addendum statements if it is necessary.

I am willing to provide any further information or explanation required by the Commission of Inquiry.

Words that are italicised are defined in the Glossary at section 10.

Documents referenced in this statement can be provided on request.

1.2 CV – qualifications, training,

I hold the following relevant qualifications and memberships:

- Degree in Civil Engineering with first class honours from the University of Technology, Sydney;
- Registered Professional Engineer of Queensland (RPEQ).

1.3 Employment history

I have been employed by SunWater (and its predecessors) since 1989 and have held the position of Manager, Asset Management since July 2007.

My prior roles in SunWater and its predecessor organisations have included:

- Design Engineer for the Burdekin Haughton *Water Supply Scheme*;
- District Engineer for the Biloela district in central Queensland;
- Regional Manager Toowoomba
- Regional Manager Ipswich;
- Technical Services Manager; and
- Project Director for the Asset Management Process Improvement Project

From 1982 to 1989 I was employed by the Water Resources Commission of NSW as a cadet engineer and then civil engineer. My roles included dam design and construction and operations engineer.

1.4 Role at SunWater

My role as Manager, Asset Management, entails overarching responsibility for dam safety, the standard of maintenance and coordination and planning of maintenance and asset refurbishment activities and processes, asset data and systems for SunWater;

I am listed as a point of contact for emergency services in SunWater's Dam Emergency Action Plans.

2 About SunWater

SunWater Limited is a registered 'Large Service Provider for Water Supply and Sewerage Services' under the *Water Supply (Safety & Reliability) Act 2008* and is licensed to provide bulk, irrigation, and retail water services as well as drainage and sewerage services.

SunWater is a company Government Owned Corporation (GOC)[1], operating in a competitive market place on an equal commercial footing with private sector providers. SunWater Limited invests in new infrastructure where it is commercially viable and appropriate.

SunWater has its Corporate Office in Brisbane and has Regional Offices in, Ayr, Mackay, Bundaberg, and Toowoomba. In addition, it has Service Centres in Mareeba, Biloela, Emerald, St George, and Moranbah and Depots at most of its *water supply schemes.* Employees at the Regional Centres are responsible for the overall management of the *water supply schemes* within the centre's designated area, while employees at the depots are responsible for the day-to-day operation and maintenance of the schemes to which they have been assigned.

As from 1 July 2008, SunWater owns and operates 22 *water supply schemes.* All are bulk *water supply schemes* that supply untreated water for irrigation, mining, power generation, groundwater replenishment, and stock watering. Together, the schemes comprise 23 *referable dams* (within the meaning of the *Water Supply (Safety & Reliability) Act 2008)* including 18 major dams (refer Table 3-1), 60 weirs and barrages, 77 major pump stations, 2920km of pipelines and channels, and 690 km of drainage works with an estimated combined replacement value in excess of $6.3 billion (2008)[2]. In addition, SunWater owns and operates 12 small licensed water and sewerage treatment plants to cater for staff and recreational visitors at dam sites and occasionally, for small nearby settlements. SunWater did own a further four *water supply schemes* (Central Lockyer, Lower Lockyer, Logan River and Warrill Valley *water supply schemes*), including five dams (Atkinson Dam, Bill Gunn Dam, Clarendon Dam, Maroon Dam and Moogerah Dam) prior to July 2008. These assets were sold to SEQwater under the provisions of the *South East Queensland Water (Restructuring) Act 2007.*

SunWater provides facility management services to other water infrastructure owners. These services include operations and maintenance, dam safety, flood operations and asset management. Dams managed under these arrangements include Ross River, Scrivener (ACT), and Glenlyon.

SunWater has around 5,000 customers across the mining, power generation, industrial, local government and irrigated agriculture sectors.

SunWater owns a number of subsidiary companies one of which, Burnett Water Pty Ltd, owns Paradise Dam.

[1] SunWater Limited ACN 131 034 985

[2] 2008 valuation

SunWater undertakes a wide range of activities from designing and building dams, managing and operating bulk water infrastructure, conducting environmental impact studies to finding new ways to deliver water to remote locations. SunWater engineers are specialists that industry, mining and government turn to for water infrastructure development, management, operations and maintenance. Our complete offering includes but is not limited to:

- Design and design review services;
- Infrastructure development;
- Asset management, planning and review;
- Flood hydrology, hydraulics and flood management;
- Infrastructure operations and management;
- Customer water account management and billing; and ,
- Water management and policy strategy advice.

2.1 Communication with Stakeholders, community relationships

2.1.1 Customers

SunWater has around 5,000 customers across the mining, power generation, industrial, local government and irrigated agriculture sectors. These customers are mostly allocation holders in *water supply schemes*.

SunWater has a water supply contract with most of its customers. The contracts detail the services provided by SunWater and the obligations of both SunWater and the customer. SunWater has also negotiated and published scheme supply arrangements and service targets for each scheme (scheme rules). The scheme rules are annexed to the water supply contracts. The rules are summarised in the Strategic Asset Management Plan (SAMP). Performance against the service targets are reported each year in the annual SAMP report.

Customers can contact SunWater through either an online service or a central call centre. Outside of normal business hours the call centre provides a 24/7 emergency contact service. Customers, media and the general public can contact SunWater through this service for any form of emergency. This includes service interruptions, pipe breaks and flood events. SunWater's role in emergency communications is described further in Section 7.

As discussed in section 2, SunWater has a regional network of Service Centres and depots. Service Managers in regional centres work and live in the same communities as customers. Most *water supply schemes* have a *Local Advisory Committee* (LAC) made up of elected customer representatives. LACs are engaged by Service Managers to provide advice on operational matters such as the timing of maintenance shutdowns.

SunWater provides an online service for customers that provides water storage and water allocation information, access to customer and water accounts and online transactions, and water ordering.

During 2009 SunWater introduced an SMS message service for its customers. Fifty-five per cent of customers have registered their mobile phones with the service. The SMS service has been used for notifications relating to pipe breaks, shutdowns, temporary transfer approvals, announced allocations and other information announcements. One suggestion from the "lessons learnt" (refer Section 3.1.2) exercise following the 2010-11 flood events is to extend the service to the landholders downstream of dams listed in Emergency Action Plans (refer Section 5.1.2.5.2).

2.1.2 Other Stakeholders

Service and Area Operation Managers have regular contact with Local Disaster Management Groups (LDMG). Staff attended meetings with a number of LDMGs before the 2010-11 wet season to ensure they had knowledge of the lines of communication and knowledge of EAPs. The LDMGs that were contacted by SunWater prior to the wet season included:

- Whitsunday;
- Burdekin;
- Mareeba;
- Emerald;
- Warwick; and
- South Burnett.

The St George and Mackay LDMG were already very familiar with SunWater's EAPs due to earlier events in 2010 and regular communications.

During the 2010-11 flood events SunWater staff remained in contact with LDMGs. SunWater worked with the following LDMGs during the events:

- Whitsunday;
- Burdekin;
- Mareeba;
- Emerald;
- Biloela;
- Warwick;

- Inglewood;
- Bundaberg;
- South Burnett;
- St George; and
- Mackay.

3 SunWater's Assets

3.1 Outline of Dams owned and Operated by SunWater

SunWater and its subsidiary company Burnett Water Pty Ltd own 23[3] referable storages consisting 18 *Category 2* (refer to section 5.1.2.3) dams and 5 *Category 1* dams under the *Water Supply (Safety and Reliability) Act 2008* and *Water Act 2000*. Three of the 23 referable storages are pumped storages that are not located on a *watercourse* and generally do not flood. One *referable dam* is a weir which is completely submerged during major floods. These four storages are noted as minor dams in Table 3-1. The balance of this paper will be limited to the remaining 19 dams designated as major dams in Table 3-1.

Four of SunWater's dams have *spillway gates* installed. The gates store water above the *fixed crest* of the *spillway*. All of SunWater's gated dams have the *full supply level* (*FSL*) near the top of the gates with just a small *freeboard*. The gates are operated to maintain the storage level close to FSL during a flood event. The gates are not designed to regulate flood flows other than to match the *spillway discharge* to the rate of inflow to the storage. The four dams with gated *spillways* are Callide, Coolmunda, EJ Beardmore and Leslie dams.

The other 15 major dams have *ungated* or *uncontrolled spillways*. This means that when inflows occur the storage level rises. When the storage level exceeds the FSL the *spillway* will commence to *discharge*. The rate of *discharge* is a function of the height of the storage above the fixed crest, the width of the *spillway* and the flow characteristics of the design (refer Equation 2 below section 4.4).

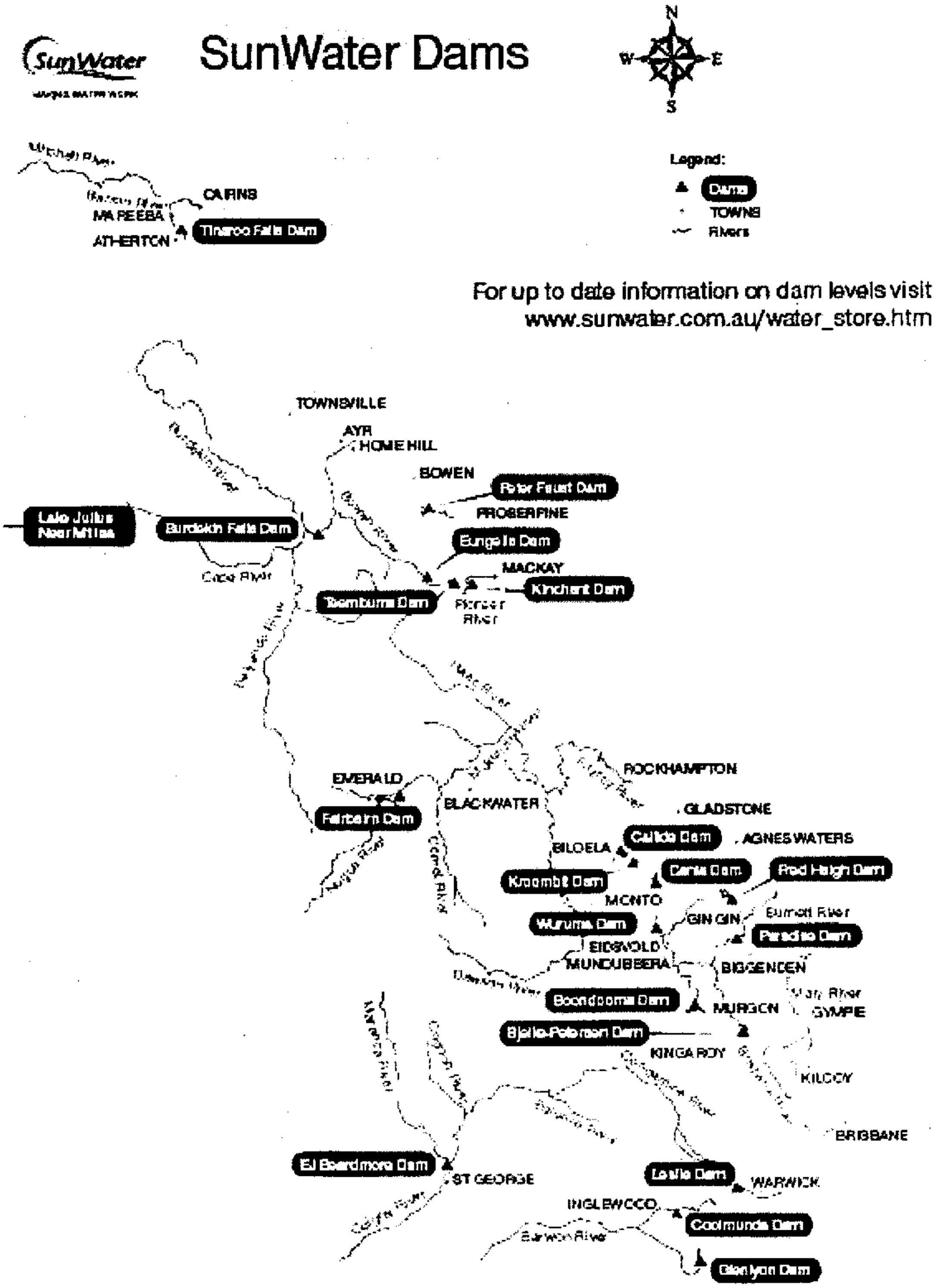
In addition to the dams SunWater owns, the following storages are managed under facility management contracts:

- Glenlyon Dam – (*Category 2* dam) for the Border Rivers Commission;
- Scrivener Dam – (Equivalent to a *category 2* dam) for the National Capital Authority, ACT;
- Ross River Dam – (*Category 2* dam) for the Townsville City Council;

SunWater is the facility manager of Glenlyon and Ross River dams. SunWater operates and maintains these dams in accordance with the approved documentation and SunWater's dam safety management program. SunWater makes recommendations to the dam owner on matters such as major replacements or refurbishments, reviews of documentations or additional investigations that might be considered prudent.

I have not provided any details on the operation of Ross River Dam or Glenlyon Dam in this document. If required by the Commission of Inquiry, a supplementary statement can be provided on these two dams. As Scrivener Dam is not in Queensland no further reference will be made to that dam in this document.

[3] Claude Wharton Weir has an inflatable crest control device that is temporarily out of commission. This reduces the number to 22 by agreement with DERM



3-1 Map of SunWater Dams

Table 3-1 SunWater Dam Statistics

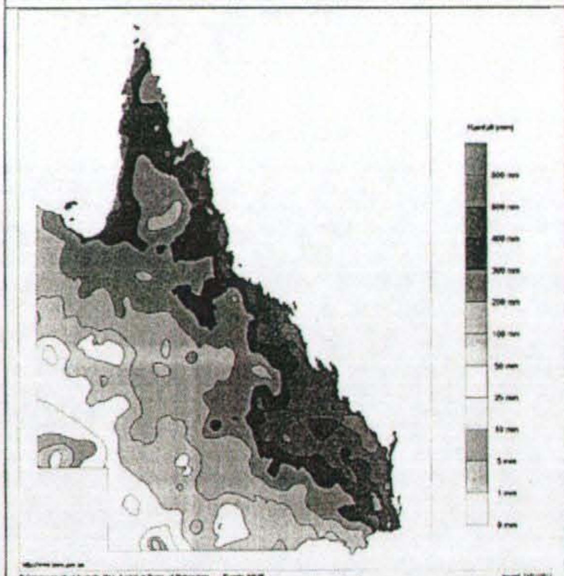
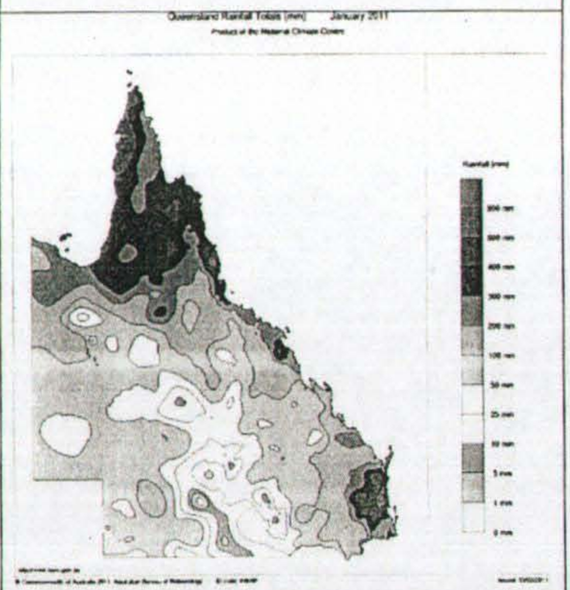
		Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Height (m)	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Major Dams	1	Burdekin Falls	1,860,000	2	Burdekin River	159.3	Mass Concrete with earth and rockfill saddle dams	40	22,000	1987	Water Supply	Ravenswood	Ayr
	2	Fairbairn	1,301,000	2	Nogoa River	685.6	Earthfill	31.7	15,000	1972	Water Supply	Emerald	Emerald
	3	Fred Haigh	562,000	2	Kolan River	76.4	Earth and Rockfill	43	5,345	1975	Water Supply	Gin Gin	
	4	Peter Faust	491,400	2	Proserpine River	57.7	Earth and Rockfill	39.6	4,350	1990	Water Supply & Flood Mitigation	Proserpine	Proserpine
	5	Tinaroo Falls	438,900	2	Barron River	101.4	Post tensioned Mass Concrete	41.8	3,500	1958	Water Supply	Atherton	Mareeba
	6	Paradise	300,000	2	Burnett River	131.4	RCC	31.1	2,951	2005	Water Supply	Biggenden	Bundaberg
	7	Boondooma	204,200	2	Boyne River	86.7	Concrete faced rockfill	64		1982	Water Supply	Proston	Mundubbera
	8	Wuruma	165,400	2	Nogo River	23	Mass Concrete	36.6	1,639	1968	Water Supply	Eidsvold	Eidsvold
	9	Teemburra	147,500	2	Teemburra Ck	20.4	Concrete faced rockfill	57	1,085	1996	Water Supply	Mirani	Mackay
	10	Callide	136,300	2	Callide Ck	80.1	Earthfill & mass concrete with Radial gates	34.8	1,240	1965-1988	Water Supply	Biloela	Biloela
	11	Bjelke-Petersen	134,900	2	Barker Ck	1.3	Earth and Rockfill	26.5	2,150	1988	Water Supply	Murgon	Murgon
	12	Eungella	112,400	1	Sandy Ck	8.4	Earth and Rockfill with sloping core	44.5	848	1969	Water Supply	Eungella	
	13	Julius	107,500	1	Leichardt River	390.9	Overshot Multiple Arch Concrete	25.2	1,415	1976	Water Supply	Mt Isa	
	14	Leslie	106,200	2			Mass concrete with Radial gates	28.9	1,288	1965-86	Water Supply	Warwick	Dalby Chinchilla
	15	Cania	88,500	2	Three Moon Ck	110.1	Earth and Rockfill	40.1	760	1982	Water Supply	Monto	Monto
	16	EJ Beardmore	81,700	2	Balonne River	251.4	Earthfill & mass concrete with vertical lift gates	12.1	2,850	1972	Water Supply	St George	St George
	17	Coolmunda	69,000	2	Macintyre Brook	78	Earthfill & mass concrete with Radial gates	16.1	1,645	1968	Water Supply	Inglewood	Inglewood
	18	Kinchant	62,800	2	Sandy Ck	9.4	Earth and Rockfill	18.1	920	1977-86	Water Supply	Eton	Mackay
	19	Kroombit	14,600	2	Kroombit Ck	68.8	Earth and Rockfill with RCC	23	289	1992	Water Supply	Biloela	Biloela
Minor Dams	20	Claude Wharton Weir	12,800	2	Burnett River	202.4	Mass Concrete with inflatable crest	12		1987-93	Water Supply	Gayndah	Gayndah
	21	Isis Balancing Storage	8,160	1	N/A	N/A	Earthfill	14.2		1986	Irrigation Distribution		
	22	Moura Offstream Storage	2,820	1	N/A	N/A	Earth and Rockfill	10.5		1999	Water Supply	Moura	
	23	Woongarra Balancing Storage	4,605	1	N/A	N/A	Earth & Rockfill	9		1977	Irrigation Distribution		

3.1.1 Performance of SunWater Dams during 2010-11 Wet Season

SunWater's dams are designed to safely handle very large rainfall events; events that far exceed the rainfall that was experienced during the 2010-11 wet season. A sample of the *design rainfall* events for SunWater dams is shown in Table 3-3. Whilst some of SunWater's dams will require a future upgrade to pass some extreme events (refer section 6.2), all of SunWater's dams are very safe and can pass very rare events[4]. The rainfall experienced over the 2010-11 wet season in the catchments for SunWater's dams was up to the range of 400mm to 600mm for the major inflow events (refer Table 3-2). Whilst this level of rainfall was significant it was well short of the rainfall events that the dams are design to safely pass (refer Table 3-3).

The SunWater dams performed very safely during the recent events. Whilst there was some erosion damage downstream of some *spillways*, overall there was little damage. Further, details of the damage to each dam is included in the schedules for each dam at the end of this document.

Table 3-2 2010-11 Wet Season recorded rainfall[5]

Queensland Rainfall Totals (mm) Dec 2010 Product of National Climate Centre	Queensland Rainfall Totals (mm) Jan 2011 Product of National Climate Centre
	

[4] The Dam Safety Guidelines on Acceptable Flood Capacity identify that the Annual Exceedence Probability flood for dams ranges from 1 in 10,000 years to 1:10,000,000 years

[5] www.bom.gov.au/

Table 3-3 Sample of Design rainfall for SunWater dams

Dam	Duration (hr)	Rainfall (mm)
Fairbairn	96	1,070
Peter Faust	120	3,300
Teemburra	36	2,320
Fred Haigh	72	2,160
Boondooma	36	890

3.1.2 Lessons Learnt from the 2010-11 Wet Season.

Following the flood events of the 2010-11 wet season, each SunWater region undertook a review of the events. The purpose of each review was to identify what worked well, what did not work as well and to identify improvement opportunities.

Key learning points included:

- Generally the implementation of the EAPs worked well;
- The dam documentation was found to be a valuable resource for the operators and managers;
- Some refinement of Emergency Action Plans was identified to more clearly define responsibilities and review of trigger levels. This is in progress;
- Some minor updates identified for Operations and Maintenance Manuals. This is in progress;
- Improvements to staff rostering, shift hand over procedures, accommodation and support logistics were identified; and'
- Review some communication systems where issues were experienced such as mobile phone coverage.

Further details of the lessons learnt for each dam are included in the schedules for each dam at the end of this document.

3.2 Water Supply Schemes

A *water supply scheme* is a geographically distinct set of water infrastructure assets. When operated in combination they make it possible to supply water to a group of customers. Each *water supply scheme* has one or more headwork assets in the form of dams and/or weirs. The headwork assets store water and make water available for use when required.

SunWater owns and operates 22 *Water Supply Schemes* plus the Awoonga Callide pipeline. The *water supply scheme* each dam supplies is shown in Table 3-4. An overview of each of SunWater's *water supply schemes* is located in Schedule 1 to this document from page 3.

	Dam	Storage Volume (ML)	Water Supply Scheme
1	Burdekin Falls	1,860,000	Burdekin Haughton
2	Fairbairn	1,301,000	Nogoa Mckenzie
3	Fred Haigh	562,000	Bundaberg
4	Peter Faust	491,400	Proserpine River
5	Tinaroo Falls	438,900	Mareeba Dimbulah
6	Paradise	300,000	Bundaberg
7	Boondooma	204,200	Boyne River and Tarong
8	Wuruma	165,400	Upper Burnett
9	Teemburra	147,500	Pioneer River
10	Callide	136,300	Callide Valley
11	Bjelke-Petersen	134,900	Barker Barambah
12	Eungella	112,400	Bowen Broken Rivers
13	Julius	107,500	Julius Dam
14	Leslie	106,200	Upper Condamine
15	Cania	88,500	Three Moon Creek
16	EJ Beardmore	81,700	St George
17	Coolmunda	69,000	Macintyre Brook
18	Kinchant	62,800	Eton
19	Kroombit	14,600	Callide Valley

Table 3-4 SunWater Dams and Water Supply Schemes

3.3 Communities affected by 2010/11 flooding

Table 3-5 identifies the communities that were significantly affected by flooding during the 2010-11 wet season. The list is limited to those communities in close proximity to SunWater *water supply schemes* or the dams operated by SunWater. It should be noted that a number of communities are not immediately downstream of a dam and therefore not significantly impacted by flows passing through a dam.

Table 3-5 Communities significantly affected by flooding in 2010-11 in SunWater Water Supply Schemes

Communities affected by flooding 2010-11	Dam	SunWater Water Supply Scheme
Emerald Comet	Fairbairn	Nogoa Mackenzie
Bundaberg	Paradise	Bundaberg
Eidsvold	Wuruma	Upper Burnett
Mundubbera Gayndah	Wuruma & Boondooma	Upper Burnett & Boyne River & Tarong
Murgon	Bjelke-Petersen	Barker Barambah
Warwick	Leslie	Upper Condamine
St George Dirranbandi	EJ Beardmore	St George
Inglewood	Coolmunda	Macintyre Brook
Townsville	Ross River	N/A
Goondiwindi	Glenlyon	N/A
Chinchilla	Not immediately below a dam	Chinchilla Weir
Rockhampton		Lower Fitzroy
Maryborough		Lower Mary River
Theodore Moura Baralabah		Dawson Valley

In addition to the communities listed in Table 3-5 SunWater is aware of a number of communities that were not significantly affected but in which there was a heightened concern about the risk of flooding. Communities in this category include Mareeba which is downstream from Tinaroo dam and Proserpine which is downstream from Peter Faust dam. SunWater became aware of these community concerns through media reports and/or direct approaches from members of the community. In these communities SunWater became aware of media and/or community comment which speculated that dams upstream of the communities should be lowered to help mitigate the risk of future floods. I have addressed these concerns in respect to each dam in the schedules at the end of this document.

4 Functions of Dams

Dams can be designed for a number of purposes. These include:

- Water supply;
- Active Flood mitigation;
- Passive flood mitigation;
- Hydroelectric generation;
- Recreation.

All of SunWater dams are designed principally for water supply purposes. Peter Faust Dam has been designed to provide both water supply and *passive flood mitigation* (refer section 4.4). No other SunWater dam has a purpose built flood mitigation role. However all dams will attenuate flood flows to some degree (refer section 4.3)

4.1 Water Supply

A water supply dam is designed to capture water during times of excess flow. The water is then stored and released from the reservoir during times when natural flows are inadequate to meet the needs of water users.[6]

The *yield* of a water supply dam is the volume of water that can be allocated for use each year. The *yield* of a dam is linked to a certain *reliability* of supply and set of operating rules. The *reliability* is a measure of how frequently the full *yield* of a dam will be available for use. Under the regulatory framework the *yield* has been expressed as the water allocations defined in the relevant *Water Resource Plan (WRP)*. The *reliability* of supply has been expressed as *water allocation security objectives* in the *WRP*. Any material deviation from the operating rules established in the relevant *Resource Operations Plan* (refer section 5) could impact on the *reliability* of supply from a dam and have adverse economic effects.

4.2 Dam v weir

Weirs and dams both retain and store water. A dam has a number of components including wall, *spillway* and outlet works. The storage of a dam backs up along the *watercourse* and over land adjacent to the *watercourse*. The *spillway* allows flood flows to safely pass the dam, generally without *overtopping* the main wall. Flows then return to the *watercourse* down stream of the dam.

A weir is in effect a small dam that is constructed wholly within the banks of the water course. Whereas a dam will have a purpose built *spillway* section that is designed to prevent *overtopping* of the main wall, the entire weir structure is designed to be safely overtopped during flood events. During large events weirs are designed to be completely submerged and to have almost no impact on the flood levels within the stream. One design

[6] www.ancold.com.au

criteria that has typically been used for weirs in Queensland is to limit the afflux (increase in upstream level) to no more than 300mm. Typically weirs have no attenuation effect on large flows (refer to section 4.3).

Typically the storage volume of a weir is small relative to the flood flows from the catchment. A weir relies on multiple refills during a year to achieve its water supply *yield*. This contrasts with a dam that typically has a larger storage volume than a weir. A dam's *yield* is often achieved through infrequent fills. A dam may only be expected to fill once every several years so any missed fill opportunities can significantly reduce the *yield* and/or *reliability* of supply.

4.3 Attenuation effect of Dams

Notwithstanding that not all dams are designed as flood mitigation storages, all dams will attenuate flood flows to some extent.

Attenuation is the modifying effect a storage has on the shape of a flood wave or hydrograph[7]. A dam will attenuate a flood in two ways. Firstly the peak *discharge* or *outflow* from a storage will be less than the peak inflow. Secondly the storage will delay the peak so that the peak *outflow* will occur some time after the peak inflow.

The process of determining the *outflow* from a dam during a flood given a particular inflow is known as flood or storage routing. The process for *uncontrolled* or *ungated spillways* is governed by Equation 1.

$$\frac{I_1 + I_2}{2} \cdot dt - \frac{O_1 + O_2}{2} \cdot dt = S_2 - S_1$$ [8]

Where O_2 & S_2 are determined as a function of the storage above the spillway.

Equation 1 - Storage Routing Equation

An uncontrolled or *ungated spillway* on a dam is designed to allow flood flows to pass a dam unhindered in accordance with the above formula. The *full supply level (FSL)* of SunWater's ungated dams is equal to the *spillway* crest[9] (refer Figure 4-3). The dam will behave in such a way that as the inflow increases the storage level will rise and drive the *outflow* in accordance with the *spillway discharge* formula for that particular dam (refer Equation 2). A key characteristic of an ungated *water supply* dam is that the flood level in the storage can be significantly higher than *FSL*.

Spillway gates are sometimes installed on a *water supply* dam to maximise the available storage volume whilst minimising upstream flood levels. Often upstream flood levels will be a constraint on the design of the dam. An example might be where there is some

[7] Water Resource Engineering, RK Linsley & JB Franzini, 3rd edition 1984, p60

[8] Water Resource Engineering, RK Linsley & JB Franzini, 3rd edition 1984, p60 (3-13)

[9] Kinchant Dam is an exception to this rule where the spillway crest is 1m higher than the FSL

development upstream of a proposed dam. If avoidance of flooding of this upstream development is a design criteria then a larger storage could be achieved with a gated structure rather than an ungated structure. In this case the *FSL* would be located near the top of the gates (refer Figure 4-2). The gates are operated in a manner whereby the *outflow* is balanced with the inflow to maintain the storage level within a narrow band close to the FSL (i.e Match O_2 with I_2 in Equation 1 so that $S_2 \sim S_1$). This arrangement is typical of SunWater's gated storages.

The gated *water supply* dam contrasts with the design and operation of a gated *active flood mitigation* dam such as Wivenhoe (refer Figure 4-1). The FSL of a gated *active flood mitigation* dam is typically well below the top of the gates and the objective is not necessarily to minimise upstream flooding but rather manage a flood to maximise the downstream attenuation. In effect S_2 is maximised to minimise O_2 in Equation 1. SunWater does not own any *active flood mitigation* dams.

4.4 Mitigation v Water Supply

Using a dam for flood mitigation is the process of reducing the impact of flooding below a dam. Flood mitigation deliberately enhances the attenuation affect of the dam. Flood mitigation can be either active or passive i.e. if the dam operator can exert some control on the flow it is active flood mitigation. Flood mitigation will not prevent all downstream flooding: The larger an inflow event the less capacity a dam has to mitigate the effect of flooding.

In order for a dam to provide flood mitigation there must be a provision to make air space available to temporarily store flood inflows. This is demonstrated by examining Equation 1. The more the storage volume (S_2) is allowed to increase the lower the *outflow* (O_2) will be.

An *active flood mitigation* storage usually has *spillway gates* where the FSL of the water supply component (if any) is well below the top of the gates (refer Figure 4-1). The air space between FSL and the top of the gates (less some allowance for *freeboard*) is available to the operator to temporarily store inflows. The operator of such a storage is able to make decisions during a flood event about how quickly this storage is filled subject to any operating rules. The objective of *active flood mitigation* is to fill the storage volume during the peak of the inflow to maximise the attenuation of the *outflow*. An *active flood mitigation* dam can reduce and delay the peak of a flood. It cannot completely prevent a flood where the total volume of water in the event is greater than the available storage volume. *Active flood mitigation* requires two key factors. First, the availability of air space to store flood water. Secondly the ability to release significant volumes of water to manage the event and return the storage level to FSL as quickly as possible after an event in case there is a second event shortly after the first event. Water supplies cannot be stored in the flood mitigation partition.

A *passive flood mitigation* storage such as Peter Faust Dam creates the air space for temporary storage through a different mechanism. For example, Peter Faust Dam has a *fixed crest spillway* with no *spillway gates* (refer Figure 4-3) i.e. the *spillway* is *uncontrolled*. Peter Faust Dam has two key aspects. Firstly the width of the *spillway* is relatively narrow. Secondly the crest of the dam is high relative to the *fixed crest* of the *spillway*. Equation 2 defines the *discharge* of water through an *uncontrolled spillway*. It is noted that the *discharge* is a function of the *spillway* width. Peter Faust Dam is designed to provide greater attenuation by virtue of the smaller *spillway* width (38.9m)[10]. The dam has a relatively high crest to reduce the risk of *overtopping* and any dam safety issue. The flood mitigation partition for Peter Faust exists above the *fixed crest* of the *spillway* as a temporary storage. The flood mitigation provided by Peter Faust is passive in that the operator has no discretionary control of the flows.

$$Q=C_w * {}^{2}/_{3} * \sqrt{(2g)} * H^{3/2} * W$$ [11]

Where

Q = *Discharge*
H = height of water in the storage above the fixed crest of the spillway
C_w = the coefficient of *discharge* for the spillway
W= width of the spillway

Equation 2 Spillway *Discharge* Formula

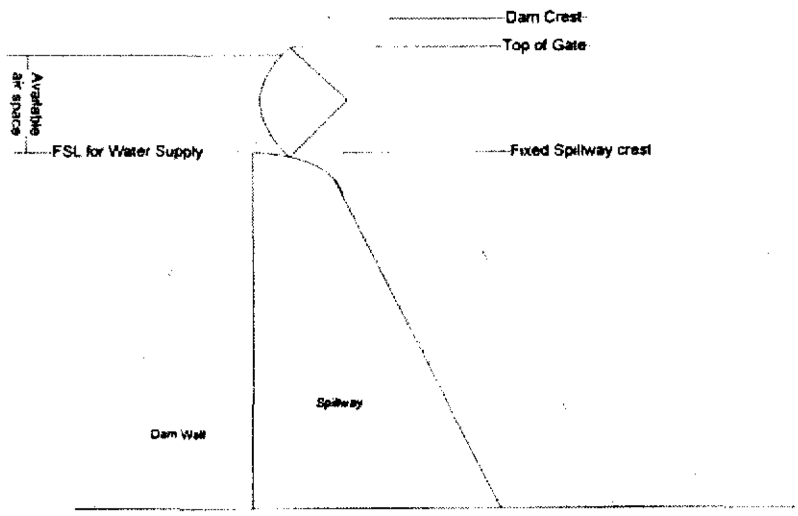


Figure 4-1 Cross Section of Gated Dam with active flood mitigation

[10] Contrast with other spillway widths – Burdekin 504m, Fairbairn 158.5m, Tinaroo 76.3m

[11] Elementary Fluid Mechanics, Vennard & Street, 6ed, eq 11.20, p540

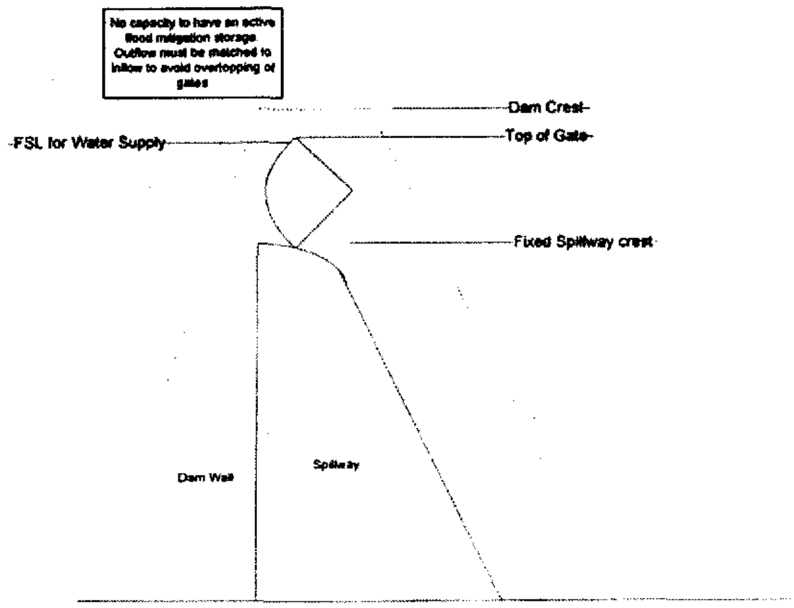


Figure 4-2 Cross Section of Gated Water Supply Dam – no flood mitigation

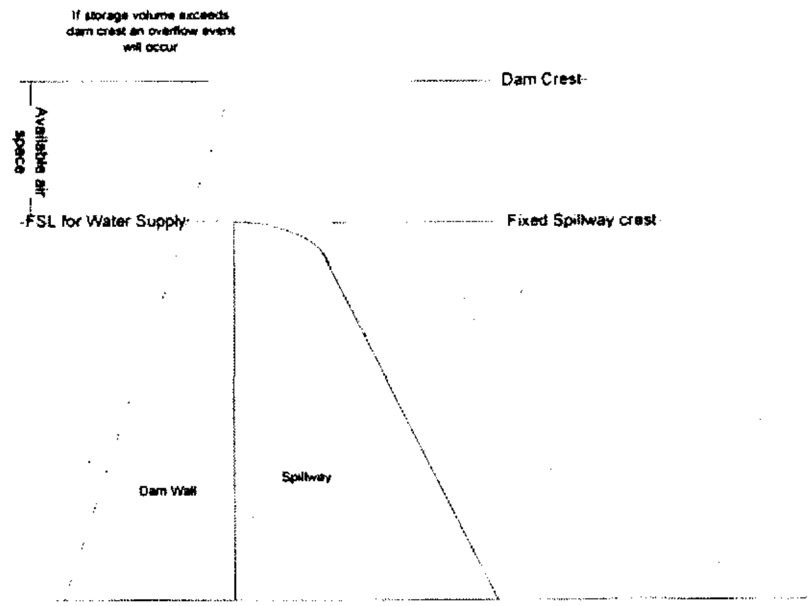


Figure 4-3 Cross Section of Water Supply Dam with ungated or uncontrolled spillway – May have passive flood mitigation

4.5 Mitigation Opportunities for SunWater Dams

SunWater has recently undertaken a review of the operations of a number of the dams that experienced significant flood events during the 2010-11 wet season. The purpose of the review was to assess whether the existing dam infrastructure could be operated in such a way that further attenuation to *spillway discharge* could be achieved. The details of the assessment for each dam are included in Schedules 2 to 20.

The key findings of the assessment are as follows:

- Flood mitigation could only be provided from the existing configuration by lowering the water supply *FSL* to create air space (refer section 4.4), however for reasons set out in point 3 below this would have been ineffective.
- The flood volumes over the *2010-11 wet season were generally many times* greater than the storage volume of the dams. For example the full storage volume of Paradise dam is 300,000ML. The total flow into the dam over a 20 day period was 22 times the full storage volume.
- If the *FSL* had been drawn down significantly prior to 1 December 2010 the peak *discharge* from the dam and hence flood levels would have been unchanged in most cases. The dam in which lowering the water level would have had the greatest reduction to the peak *discharge* is Fairbairn dam. For example, if the dam had been at 50% on 1 December 2010 then the peak storage level would have been 5.32m over the *spillway*. This is just 260mm lower than the actual level. The flood levels downstream of Fairbairn dam would still have exceeded the 2008 flood levels. In 2008 large parts of Emerald were still inundated.
- Even if the benefits of lowering the *FSL* were not insignificant or non-existent, it is not practical to lower the *FSL* as:

    1. The capacity of the outlet works is very small relative to the storage volume. It would take several months to lower the storage level to any significant extent for most SunWater dams and weather forecasting is not accurate enough to predict flooding several months beforehand. In the case of Fairbairn Dam it would take 12 months to lower the dam to 50%, even if there was no inflow in that time.

    2. Lowering of the *FSL* would be a breach of the *ROP because the ROP* does not allow for pre-flood releases.

- The cost of infrastructure modifications would be very substantial and in addition would change the purpose of the dams from being water supply dams. It would appear that the flooding risk below SunWater dams is already at a level that would be considered *as low as reasonably practical* (ALARP).
- Even if the extreme measure of emptying dams were possible prior to the wet season (in most cases this is not feasible in practice for the reasons discussed above) there would have been no change to the peak *discharge* for some dams such as Burdekin Falls Dam.

5 Water Regulation

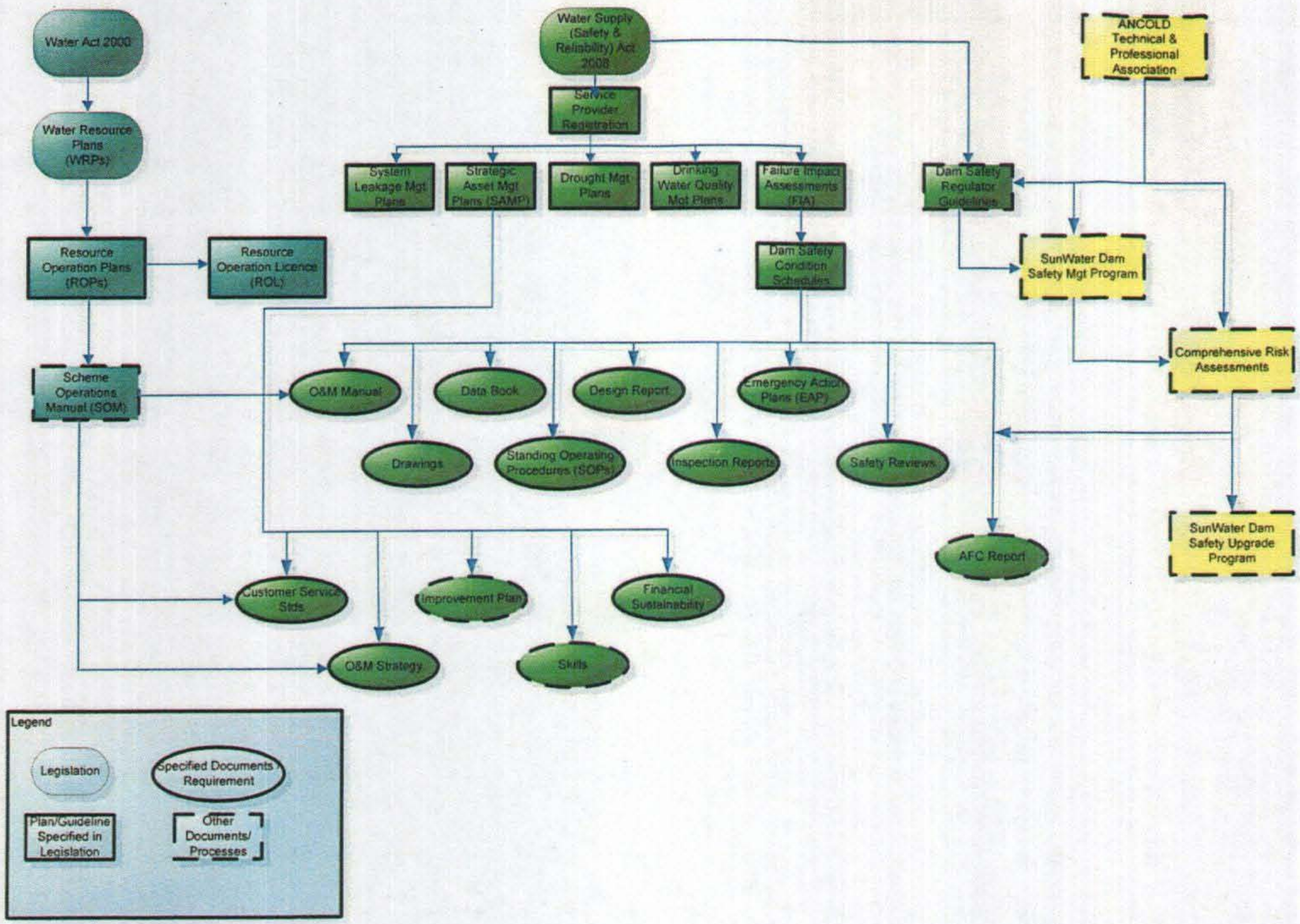
5.1 General regulatory framework

The water industry in Queensland is regulated by a number of legislative instruments impacting on matters concerning operations, dam safety and emergency management. In terms of the operation of bulk *water supply schemes* and dams there are two key pieces of legislation, the *Water Act 2000* and the *Water Supply (Safety and Reliability) Act 2008*. There is also an array of subordinate legislation and referenced documents that combine to form the general regulatory framework. In addition to legislation are industry standards that provide a technical basis for behaviour and decision-making. In the case of dams the major source of these technical standards is the Australian National Committee on Large Dams (ANCOLD) and the Queensland dam safety regulator.

Figure 5-1 provides an overview of the regulatory framework that applies to SunWater dams.

SunWater has systems in place to ensure that full compliance with the framework is achieved. In some cases SunWater aims to exceed the minimum standards specified in the framework.

By way of background as to SunWater's systems in respect to dam safety and emergency management, set out below is a description (taken largely, and in some cases directly, from the DERM website) of the relevant legislation, regulations and standards that govern water and dam management.



5-1 Regulatory Framework

5.1.1 Water Act 2000

The Act sets out the Minister for Environment and Resource Management's responsibility to plan for the State's future needs by securing supplies for social and economic needs—like towns, industry, irrigation and mines—while setting out strategies to support river health. To achieve this, the Act allows for *WRPs* to be developed for any part of the state to ensure that water is equitably managed for each area's unique balance of water uses for the ensuing 10 years[12].

5.1.1.1 Water Resource Plans

The water resource planning process is governed by the *Water Act 2000*. *WRPs* strive to achieve a sustainable balance between meeting human needs and those of the environment. *WRPs* are strategic in nature and establish an overall framework for the management of water resources in a catchment.

The water resource planning process aims to ensure that the health of Queensland rivers and groundwater reserves is maintained so that the needs of future generations are provided for in a fast-changing world. They are a framework for striking the correct balance. Each plan has an expected life of 10-years. Plans are developed to complement parallel state and national initiatives such as regional water supply strategies, the Reef Water Quality Protection Plan and the Caring for Our Country program. They are also consistent with the principles and goals of the National Water Initiative, agreed to in 2004 to replace the 1994 National Water Reform Agenda.[13]

5.1.1.2 Resource Operations Plans

Resource Operations Plans (ROPs) are concerned with the day-to-day management of water resources, in a way that meets the *WRP* goals. A *ROP* outlines how a *Water Resource Plan* (*WRP*) will be implemented in specified areas. The *ROP* puts into effect strategies which support the objectives of the *WRP*. The *ROP's* provisions ensure that water in the plan area is managed for consistency with the *WRP's* overall goals for water entitlement security and ecological health.

A *ROP* sets out:[14]

- The process under which water allocations can be traded and the areas where trading can occur. Rules will ensure that *water allocation security objectives* and environmental flow objectives specified in the *WRP* are protected from the effects of trading;
- The process for making available any unallocated water identified in the *WRP*;

[12] www.derm.qld.gov.au

[13] www.derm.qld.gov.au

[14] www.derm.qld.gov.au

- Rules for accessing water in areas where entitlements do not convert to water allocations in a way that recognises local flow variability patterns. In some plans, rules may be set out for limited trading of water taken under licences;
- Detailed operating rules for infrastructure operators to ensure the management of dams and weirs complies with the *WRP*; and
- Monitoring and reporting requirements as specified in the *WRP*. Monitoring and regular reporting ensure that emerging issues can be identified and addressed and will also contribute to the plan's renewal at the end of its 10-year life.

The main implication of *ROPs* for SunWater in the context of this paper is specification of operating rules for infrastructure and water sharing rules.

5.1.1.3 Resource Operations Licence

A *resource operations licence* is issued under the *Water Act 2000* and authorises the holder of the licensee to interfere with the flow of water to the extent necessary to operate the water infrastructure to which the licence applies.

5.1.2 Water Supply (Safety & Reliability) Act 2008

The purpose of *Water (Safety & Reliability) Act 2008* is to provide for the safety and *reliability* of *water supply*. The purpose is achieved primarily by providing for a regulatory framework for water and sewerage services, the regulation of *referable dams*, flood mitigation responsibilities, and protecting the interests of customers of service providers.[15]

5.1.2.1 Water Service Provider Registration

The *Water Supply (Safety and Reliability) Act 2008* requires certain owners of infrastructure that supply water or sewerage services to be registered as service providers. Registered organisations include local governments, water authorities and other entities, that intend to charge for supplying water or sewerage services.[16] SunWater is a registered water service provider under the Act (service provider ID: 204). SunWater is registered to provide bulk, irrigation, and retail water services as well as drainage and sewerage services.

5.1.2.2 Strategic Asset Management Plan (SAMP)

The *Water Supply (Safety and Reliability) Act 2008* requires service providers to prepare a strategic asset management plan (SAMP). A SAMP focuses on continuity and sustainability of supply of each of the service provider's registered services. A SAMP must be certified by a registered professional engineer (RPEQ) (see *Professional Engineers Act 2002* (Qld)).[17]

A SAMP must have regard to best practice industry standards and include [18]

---

[15] *Water Supply (Safety & Reliability) Act 2008 s3*

[16] www.derm.qld.gov.au/factsheets/pdf/water/w95.pdf

[17] www.derm.qld.gov.au/factsheets/pdf/water/w99.pdf

[18] www.derm.qld.gov.au/factsheets/pdf/water/w99.pdf

- Details of the services provided:
- The infrastructure for supplying those services:
- Standards for appropriate levels of service, including customer service and performance indicators for the service:
- A strategy that demonstrates how each standard will be achieved. This strategy must consider the issues of operation, maintenance and renewal of relevant infrastructure: and
- The provider's proposed arrangements for financing the implementation of the SAMP.

SunWater has had a number of versions of its SAMP submitted to and approved by DERM. SunWater's current approved SAMP is version 3A and is dated June 2009.

5.1.2.3 Failure Impact Assessments (FIA)

A failure impact assessment evaluates the population at risk if failure of a water dam was to occur. A dam is considered to have failed, if there is a physical collapse of all or part of the dam or an uncontrolled release of any of its contents. The assessment is required to be certified under the *Water Supply (Safety and Reliability) Act 2008*[19] and may give the assessed dam a failure impact rating, based on the population at risk:

- Less than two people—no failure impact rating.
- Two to 100 people—*category 1* rating.
- More than 100 people—*category* 2 rating

Water dams given a *category 1* or a *category 2* failure impact rating are, where the regulator has accepted the assessment, classified as "*referable dams*" under the *Water Supply (Safety & Reliability) Act 2008.* SunWater's *referable dams* and their failure impact category ratings are listed at Table 3-1. It should be noted that downstream development can alter the failure impact rating of a dam as the population at risk increases.

5.1.2.4 Dam Safety Conditions Schedules

Construction of or modification to a *referable dam* is 'assessable development' under the *Sustainable Planning Act 2009* (SPA). A development permit is required for these works under the SPA. SunWater's dams that were in existence at the time the *Water Act 2000* was proclaimed were deemed by the *Water Regulation 2002* to have a prescribed failure impact rating. The *Water Supply (Safety and Reliability) Act 2008* deems a dam that does not otherwise have a development permit to have a development permit once the dam safety regulator has applied safety conditions to that dam[20].

[19] S. 342

[20] S. 353 (3) *Water Supply (Safety and Reliability) Act 2008.*

The dam safety regulator (who is currently Peter Allen of DERM) issues safety conditions for *referable dams*. Safety conditions are taken to be conditions attached to the permit.

The dam safety regulator has issued safety conditions to SunWater for *each of its referable dams*.

5.1.2.5 Standing Operating Procedures

Dams are normally designed to operate within a range of operating criteria. A good dam safety management program will ensure that[21]:

- These operating criteria are known;
- The dam is operated within these criteria; and
- The dam is maintained so that it can perform within the established criteria.

This is done through Standing Operating Procedures (SOPs). These procedures should[22]:

- Define responsibilities for actions critical to the safety of the dam;
- Identify procedures for particular daily activities, which ensure that these activities are done safely, in the same way each time and in accordance with development permit conditions; and
- Ensure appropriate people are notified when unforseen or unusual events occur.

SunWater has in place a full set of SOPs for each of its dams in hardcopy form as a controlled document (meaning that it cannot be amended, except by a set procedure involving detailed review).

The SOP for each dam is located in the office occupied by the dam operator at the dam and also in SunWater's Brisbane office. Some of the hardcopy SOP documents have been superseded by electronic maintenance schedules and work instructions in SunWater's electronic work maintenance system or as procedures in the corporate quality system. Where there are electronic procedures the hard copy is noted as superseded and the new procedure is referenced. Operators have access to the electronic documents.

5.1.2.5.1 Operations and Maintenance Manuals

Detailed Operations and Maintenance Manuals address how to operate, maintain and overhaul individual pieces of equipment for a dam and its associated structures (eg the operation, maintenance and replacement of valves and motors for the gates). The dam owner should operate and maintain the dam in accordance with the O&M manuals[23].

---

[21] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_05.pdf

[22] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_05.pdf

[23] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_05.pdf

The manuals contain the following[24]:

- Work Instructions, which detail the way in which equipment should be operated and outline the steps involved in performing a task. For example, a work instruction may be developed for the use of the gantry crane for placement of bulkheads gates;
- Maintenance Schedules, which detail the asset, description of task and the frequency of maintenance;
- Special requirements for servicing and maintaining the equipment. For example, a maintenance schedule should be developed for maintaining and servicing all mechanical and electrical equipment; and
- Equipment data sheets or Manufacturer's Manuals which comprise technical information needed for maintenance, repair and overhaul of equipment. For example, an equipment data sheet or manufacturer's manual should exist for the operation, maintenance, repair and overhaul for the emergency generating set.

SunWater has in place a full set of O&M manuals for each of its dams in hardcopy form as a controlled document. These documents are located in the office occupied by the dam operator and in the Brisbane office. The O&M manuals are also located on the SunWater intranet system for easy access by operators and maintainers.

5.1.2.5.2 Emergency Action Plans

An Emergency Action Plan (EAP) is a formal plan that[25]:

- Identifies emergency conditions which could endanger the integrity of the dam and which require immediate action;
- Prescribes procedures which are followed by the dam owner and operating personnel in the event of an emergency; and
- Provides timely warning to appropriate emergency management agencies for their implementation of protection measures for downstream communities.

SunWater has in place a full set of EAPs for each of its dams in hardcopy form as a controlled document. These documents are located in the office occupied by the dam operator and in the Brisbane office. A controlled copy is also issued to each staff member in the management structure of SunWater who has direct responsibilities under the EAP. Controlled copies are also issued to local and district disaster coordinators and Emergency Management Queensland.

[24] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_05.pdf

[25] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_09.pdf

SunWater's EAPs have evolved over time under a continuous improvement process. Most dam EAPs have had a number of issues (i.e., versions) of the documents. The notification and emergency communication list is reviewed annually and reissued when changes occur.

5.1.2.5.3 Inspections

Dam safety inspections are conducted to determine the status of the dam and its features relative to its structural and operational safety. Different types of dam safety inspections should be undertaken for different purposes[26]. These include:

- Routine inspections/surveillance - to identify physical deficiencies of the dam;
- Periodic inspections - generally carried out by a dams engineer with the purpose of identifying physical deficiencies of the dam by visual examination and review of surveillance data against prevailing knowledge. Generally undertaken on an annual basis;
- Special inspections – the examination of a particular physical feature of operational aspect of a dam for some special reason, for example, where a dam has been identified as having a possible deficiency or has been subject to abnormal loading conditions; and
- Comprehensive inspections - a periodic inspection of the dam and a review of the owner's whole dam safety management program. Generally with a frequency of five years.

The minimum frequency of periodic and comprehensive inspections is specified in the dam safety conditions schedule for each dam. Periodic inspections are not required for some lower hazard dams, however under SunWater's dam safety management systems, periodic inspections are undertaken annually for all dams.

Any recommendations arising from periodic and comprehensive inspections are included in the SunWater SAP maintenance system to ensure the assignment and follow-up of actions required as a result of the recommendations.

5.1.2.5.4 Design Report

A Design Report is compiled once the design and construction stages are completed. Design reports are an important reference for the operation of the dam because they provide an overview of the design assumptions and dam safety features. The designer should document the design and construction of the dam including:[27]

- Designer's Operating Criteria (DOC), e.g. gate operating rules and cone valve operation protocols
- Design parameters adopted and assumptions made (and their bases)

[26] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_06.pdf

[27] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_04.pdf

- Methods of analyses
- Results of analyses and investigations (numerical and physical)
- Hydraulic model testing of final *spillway* arrangements
- Complete set of drawings and specifications
- Summary of As-Constructed documentation and other construction information
- The Design Report must contain sufficient information so that in the event of any safety problems relating to the dam, information can be quickly and easily obtained to resolve the problem.

SunWater also produces a design report for any major upgrades or modification of a dam.

5.1.2.5.5 Data Book

Dam owners should compile and maintain a Data Book[28]. A Data Book is a convenient source of information summarising all pertinent records and history. It should include documentation in respect to investigation, design, construction, operation, maintenance, surveillance, remedial action as well as monitoring measurements. A Data Book may be large and consist of several documents e.g. drawings, electronic data files and printed reports or smaller depending on the type and complexity of the dam.

SunWater has an up to date data book for each of its dams. Volume 1 of the SunWater data books is effectively a catalogue of the documents for the dam. The data book lists all reports, studies and other relevant documents for each dam.

5.1.2.5.6 Safety Reviews

A safety review is a procedure for systematically assessing the safety of a dam after its original construction. It is a fresh engineering assessment of the integrity of all elements of a dam. It usually incorporates a[29]:

- Current failure impact assessment;
- Detailed review of structural, hydraulic, hydrologic and geotechnical design aspects;
- Review of historical operational performance;
- Review of surveillance reports;
- Comprehensive inspection of the dam; and
- Comparison of the standards used for building and upgrading the dam against current design standards.

[28] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_04.pdf

[29] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/chapter_07.pdf

The frequency (generally 20 years) of safety reviews is specified in the safety conditions schedule for each dam.

SunWater undertook a program of safety reviews from about 1998 to 2002. The next round of safety reviews will commence from about 2018 (refer Table 6-4).

5.1.2.6 Flood mitigation

Under the provision of Chapter 4, Part 2 of the *Water Supply (Safety and Reliability) Act 2008*[30], the dams safety regulator may nominate the owner of a dam as an owner who must prepare a flood mitigation manual (the nomination is set out in a regulation). A flood mitigation manual ensures that such dams make controlled releases of water for flood mitigation purposes in accordance with pre-agreed conditions[31]. No regulation has yet been made under this section of the Act, however manuals for three dams were approved under the *Water Act 2000*. These dams were Wivenhoe, Somerset and North Pine. These dams are owned by Seqwater. There are no flood mitigation manuals for any of SunWater's dams.

5.1.2.7 Dam Safety Regulator Guidelines

The Queensland dam safety regulator (DERM) may issue guidelines on various dam safety topics. The guidelines are issued to assist dam owners understand and exercise their responsibilities for the safety of dams. The regulator has issued the following guidelines:

- The Queensland Dam Safety Management Guidelines (February 2002)
- Guidelines for Failure Impact Assessment of Water Dams (April 2002)[32]
- Acceptable Flood Capacity (AFC) for Dams (February 2007)
- Flood mitigation manual for dams (October 2010)

SunWater has incorporated the first three of these guidelines into its dam safety system (refer section 6.1). The guideline for flood mitigation manual for dams applies to the implementation of Chapter 4, Part 2 of the *Water Supply (Safety and Reliability) Act 2008* (the Act)[33]. As previously discussed, this guideline does not currently apply to SunWater dams.

5.2 Allocation and ownership of water

An important consideration in the management of dams and other water infrastructure is the issue of ownership of the water supplies from that infrastructure. As stated in section 5.1.1 the *Water Act 2000* sets responsibility to plan for the state's future needs by securing supplies for social and economic needs. A key concept here is water security. The water

---

[30] www.derm.qld.gov.au/about/policy/documents/3991/wir_2009_3991.pdf

[31] Explanatory Note to the Water Supply (Safety and Reliability) Bill p122

[32] www.derm.qld.gov.au/water/regulation/guidelines_refer_dams.html

[33] www.derm.qld.gov.au/about/policy/documents/3991/wir_2009_3991.pdf

resource planning process is designed to plan for the allocation and sustainable management of water to meet Queensland's future water requirements[34]. The process provides for water entitlements to be converted to tradeable allocations. In SunWater's *water supply schemes*, these tradeable allocations are generally owned by individual customers. The security of these allocations is dependant, in part, on the water infrastructure being operated in accordance with the rules established in ROPs.

The implications of this framework for SunWater can be summarised as follows:

- SunWater does not generally own the water allocations. The allocations are primarily owned by SunWater's customers;
- SunWater has a duty to operate its water infrastructure in accordance with the arrangements and supply requirements detailed in the *ROP*.

5.3 ANCOLD

The Australian National Committee on Large Dams Inc. (ANCOLD) is an Australian based non-government, non-profit and voluntary association of organisations and individual professionals with a common technical interest in dams. ANCOLD currently has 53 member companies covering all aspects of the dams industry, and 153 individual associate members.

Individual associate members are typically specialist professional civil, mechanical, electrical and environmental engineers working in the dam industry. Corporate members comprise a range of public and private sector dam owners, consultants, contractors, government agencies and other organisations with a professional interest in dams. SunWater is a corporate member of ANCOLD.

ANCOLD members may participate in the work of a variety of ANCOLD technical working groups. Technical working groups prepare reports and papers for publication by ANCOLD. SunWater actively participates in working groups.

5.4 Additional risk/safety management

SunWater has established systems (refer section 6.1) aimed at ensuring full compliance with the regulatory framework.

Compliance with regulations and standards is a minimum position. SunWater, as a prudent dam owner, has carefully considered its position on risk in the context of being a leading corporate citizen. As a government owned company, the community may hold SunWater to a higher standard than say a small private dam owner. In a number of areas SunWater has adopted a standard that is higher than the minimum standard imposed by regulation. Areas in which SunWater has adopted a higher standard include the following:

- SunWater undertakes annual periodic inspection of its *category 1* dams. Generally condition schedules for *category 1* dams do not require annual periodic inspections;

[34] www.derm.qld.gov.au/water/strategy/index.html

- SunWater instigated a program of comprehensive risk assessments for each of its dams a number of years in advance of the regulator issuing guidelines on acceptable flood capacity;

- The regulators guideline on *acceptable flood capacity* (AFC) allows dam owners to adopt risk based assessments to determine AFC of a dam. A risk based assessment will usually result in a lower standard than a standards based assessment. It is SunWater's policy to adopt a standards based assessment except where the cost of the standards based approach is grossly disproportionate to the benefits gained (refer Figure 6-3);

- An important consideration for dam safety upgrade decisions is the determination of whether or not an *As Low as Reasonably Practicable* (ALARP) position for AFC has been reached. When considering the risk based acceptable flood capacity, the dam safety regulator's guideline considers that ALARP is satisfied once a cost to benefit ratio of 1 is reached. SunWater considers this to be too low a hurdle. SunWater does not consider that ALARP has been satisfied until a higher ratio of 3 is obtained; and

- Dam deformation surveys to monitor movement are conducted annually by SunWater for most dams regardless of the hazard category of the dam. ANCOLD recommends a minimum frequency of annual surveys for extreme hazard category dams only and 2 yearly survey for high hazard category dams.

6 Dam Safety

All of SunWater dams are designed principally for *water supply* purposes. Peter Faust dam has been designed to provide both *water supply* and *passive flood mitigation*. One of SunWater's principle objectives is to operate its dams and other infrastructure to provide reliable *water supply* to the water allocation holders. SunWater achieves this objective by:

- Operating the dams and other infrastructure to the established rules defined in the ROPs;
- Ensuring that the dams are at *FSL* at the end of each spill event. This is achieved by closing *spillway gates* where they exist and/or only releasing water through the outlet works in accordance with the *ROP*;
- Releasing water from the dams on a "just-in-time" basis to meet demands whilst minimising any *discharge* from the end of the *water supply schemes*.

An objective of equal importance is to minimise the risk of harm. That is to make sure that each dam remains safe. This also appears to be the underlying objective of chapter 4, part 1 of the *Water Supply (Safety & Reliability) Act* 2008. If a medium to large dam were to fail[35] there could be a large population down stream whose safety would be at risk. A failure could result in the loss of life.

Whilst SunWater has a number of processes and programs in place to manage infrastructure (including dams) to ensure reliable water supplies, there are two specific programs related to ongoing dam safety that should be specifically addressed:

- The dam safety management program; and
- The dam safety upgrade program.

The dam safety management program seeks to ensure that all dams owned or managed by SunWater (refer 6.1 below):

- perform safely to their current design standard;
- are operated safely;
- have their condition evaluated on a regular basis;
- are maintained to an appropriate standard;
- are prepared for an emergency situation;
- comply with the regulatory framework; and
- have the risk of failure minimised.

---

[35] Dam Failure is the uncontrolled release of water due to physical collapse or component failure

The dam safety upgrade program is a program whereby the risks of dams owned by SunWater have been fully evaluated against current engineering standards. Where deficiencies exist the dams are upgraded as soon as practicable on a priority basis. The dam safety upgrade decision criteria is outlined in section 6.2.2. Although a number of dams either have been upgraded or are programmed to be upgraded, SunWater's dam safety management program ensures that all of SunWater's dams are safe under normal conditions. The upgrades are required to satisfy extreme, low probability events.

6.1 Dam Safety Management Program

The safety management of each of SunWater's storages is guided by a Dam Safety Condition Schedule issued by the office of the Dam Safety Regulator which sits within the Department of Environment and Resource Management (DERM) (refer section 5.1.2.4). These schedules outline SunWater's minimum compliance requirements in terms of inspections (annual and 5 yearly), design, incident management and documentation, and have been incorporated into SunWater's dam safety management program which is based on industry best practice.

The dam safety management program is incorporated into the SunWater SAP PM[36] maintenance schedules and maintenance items. This means that work orders for inspections and document revisions are automatically generated by the system on a monthly basis which then creates a controlled document trail that requires actioning and closing out. The recommended work is also programmed in SAP in advance and the work order number is included in the inspection report.

The dam safety management program procedures have been documented in a quality system[37]. The system has 15 procedures (DS Procedures) which are notated "DS01" through to "DS 15". These procedures are:

- DS01 – Dam Safety Management Program Overview;
- DS02 – Dam Safety Management Structure and Responsibilities;
- DS03 – Operations and Maintenance Manuals for Referable Dams;
- DS04 – Standing Operating Procedure for Referable Dams;
- DS05 – Emergency Action Plans for Referable Dams;
- DS06 – Data Books for Referable Dams;
- DS07 – Safety Reviews;

[36] SAP PM – SAP Plant Maintenance module that is SunWater's corporate maintenance system that is fully integrated into the enterprise wide business system

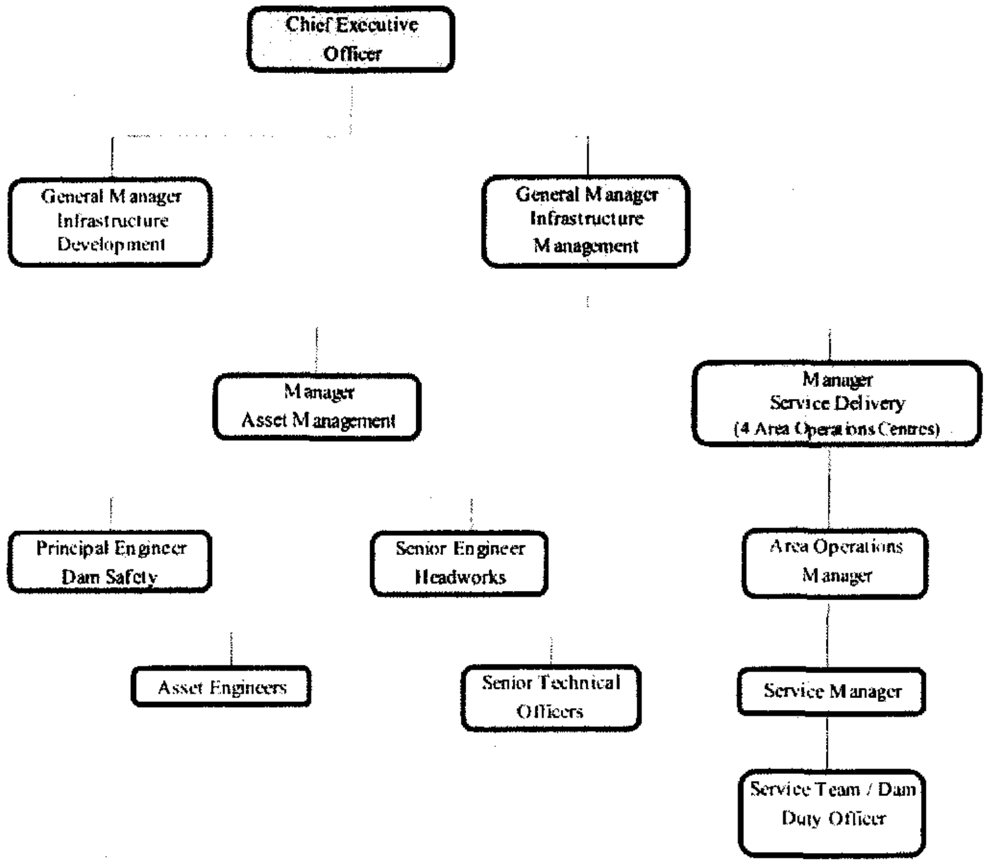
[37] The dam safety system is based on international quality business system standards, however the certification process for the system is not yet complete.

- DS08 – Impact Failure Assessments;
- DS09 – Acceptable Flood Capacity and Risk Assessments;
- DS10 – Annual Inspections;
- DS11 – 5 Yearly Comprehensive Inspections;
- DS12 – Dam Safety Training Program;
- DS13 – Dam Inspection Techniques;
- DS14 – Documentation Control and Review; and
- DS15 – Instrumentation Monitoring Program.

SunWater also has in place a dam safety upgrade program which has evolved over the last seven years as each study or review has added to the information base and broader understanding of the structures and their behaviour. The dam safety upgrade program is explained in section 6.2 below

6.1.1 Roles and Responsibilities:

DS02 clearly defines and assigns responsibility for dam safety within SunWater (refer Table 6-1). The SunWater Infrastructure Management Division is responsible for the portfolio of dams. SunWater manages its portfolio of referable structures through four (4) Area Operations Centres, each responsible for the dam safety management program for the operation and maintenance infrastructure under its management control. SunWater has a centralised asset management function. The Asset Management group is responsible for asset planning, inspection, maintenance governance and the dam safety management program.



6-1 SunWater Staff Structure

Set out in Table 6-1 below is a summary of the various functions and responsibilities under Sunwater's dam safety management program, together with the position title of the person responsible for the matters.

Table 6-1 SunWater Dam Safety Functions & Responsibilities

Role and Responsibilities	Current Position Title
Owner	
• Approve the suite of Dam Safety Management Standards after review and recommendation by the Owner's Head Office Representative • Approve funding for the Area Operations Centres' 'Dam Safety Management Programmes'	1 General Manager Infrastructure Management 2 Chief Executive Officer

Role and Responsibilities	Current Position Title
Owner's Head Office Representative – Assets	
• Authorise the issuing of EAPs, SOPs and O&M Manuals and amendments • Review the suite of Dam Safety Management Standards to ensure that they reflect the current SunWater Management structure and business practices before recommending for approval by the Owner.	1 Manager Asset Management 2 Principal Engineer Dam Safety
Owner's Head Office Representative – Service Delivery	
• Ensures that necessary resources are made available to the Area Operations Centres so that the Owner's Area Representatives and Service Teams can execute the required Dam Safety responsibilities as outlined in the individual Condition Schedules and the respective Area Operations Centre's Dam Safety Management Programme • Liaise with the Owner's Representative – Headworks who manages the Dam Safety management Program and advises on priorities	1 Manager Service Delivery
Owner's Representative - Headworks	
• Manage the Dam Safety Program • Day-to-day control and updating content of Dam Safety documentation including the Emergency Action Plans (EAPs), Standing Operating Procedures (SOPs) and Operations and Maintenance Manuals (O&M Manuals) • Ensure requirements of the Dam Condition Schedule are met • Undertake 5 Yearly Comprehensive Inspections with suitably qualified personnel in conjunction with the Principal Engineer Dam Safety within the timeframes specified in the Condition Schedule • Prepare the 5 yearly Comprehensive Inspection Reports within the time specified in the Condition Schedule • Undertake Annual Inspections and prepare reports within the time frames specified in the 'Condition Schedule'. • Prepare notifications to the Regulator (DERM), for proposed inspection dates; and when inspections are completed – as per the Condition Schedule • Maintain a Dam Safety Instrumentation Database for all dams being managed and evaluate data to verify the structural integrity of the dams on a regular basis and maintain a log book for this verification for audit and quality control • Ensure the work instructions are correct and the Log Books, SOPs, Data Books, and EAPs are reviewed annually as per the Condition Schedule • Facilitate 20 Year Safety Reviews • Prepare Condition Assessments using trained personnel as per the Asset Management Guidelines	1. Senior Engineer Headworks 2. Asset Engineer Headworks

Role and Responsibilities	Current Position Title
Owner's Area Representative • Ensure that the Service Team Leader has adequate resources to carry out responsibilities • liaise with the Service Team Leader and arrange responsibilities and duties of the Emergency Event Co-ordinator's (EEC) role for the Area, and train the nominated officers for this role • Prepare an EEC roster (as outlined in DS05) and arrange a dedicated mobile phone for the EEC position • Attend LDMG meeting and provide regular updates on dam status during emergency events. • Ensure visual inspections and instrumentation monitoring frequencies conform to ANCOLD Guidelines (any variations to be formally approved by **Owner's Head Office Representative – Assets**) • Ensure competent, trained and accredited personnel operate the storages • Prepare Event Reports as specified in the Condition Schedule • Overall responsibility for water supply in the Area Operations Centre Area *Operations Centre* • Deliver the Dam Safety Program in the Area Operations Centre • Ensure these Standards are applied in the Area Operations Centre and the work conform to the requirements in Dam Safety Condition Schedule for all the dams managed by the Area Operations Centre	1 Area Operations Manager 2 Service Manager
Owner's Area Service Delivery Team Leader • Annually update the EAP notification list (Section 3 of the EAP) and issue to PEDS and other controlled copy holders • Update and issue of work instructions • Activate EAPs and ensure instructions specified in EAPs are followed during an event. • Following an emergency event or major deficiency, debrief the Owner's Area Representative, Owner's Representative – Headworks and the Dam Duty Officer (DDO), regarding any issue with the SOP, EAP and O&M manual. If the documents need improvement, suggestions for improvements should be recorded and ensure their implementation • Make staff aware of the purpose and the contents of the Dam Safety Documentation, and ensure that all changes to these are implemented immediately • Ensure competent, trained and accredited personnel operate the storages • Participate in the Dam Safety training programmes, 5 Yearly Comprehensive Inspections, and Annual Dam Safety Inspections • Advise the Owner's Representative – Headworks of changes to SOPs, EAPs, and O&M Manuals due to update and replacement of equipment, change in work processes or safety issues • Ensure any amendments are inserted into Controlled copies of documents held at the dam sites and/or at the Area Operations Centres and Area Depots.	1 Service Manager 2 Dam Duty Officer

Role and Responsibilities	Current Position Title
Dam Safety Technical Manager • Develop and maintain the suite of Standards that outline SunWater's Dam Safety Management Program • Ensure that all the Standards conform to the requirements of the Queensland Dam Safety Management Guidelines, Feb. 2002 and reflect the current SunWater Management structure and business practices • Coordinate and audit the Dam Safety Management Program to ensure it is consistent throughout the State for each dam • Internal auditing to ensure Dam Safety documentation, Dam Safety library, monitoring database and annual and 5 yearly inspection reports are up-to-date • Attend and certify 5 Yearly Comprehensive Inspections to ensure that each Area Operations Centre is up-to-date and operating within the requirements of the Queensland Dam Safety Management Guidelines (2002) • Portfolio Dam Safety Management – Liaise with Regulator (DERM) • Facilitate Dam Safety Training Courses for Area Operations Manager, Service Manager and Dam Operators	1 Principal Engineer Dam Safety
Dam Safety Technical Advisor • Provide expert technical advice in relation to Dam Safety • Respond to any incident or emergency and provide guidance and advice to **Owner's Area Service Delivery Team Leader and EEC** • Provide technical advise when necessary to the Crisis Manager	1 Principal Engineer Dam Safety 2 Manager Asset Management 3 Chief Civil Engineer 4 Senior Engineer Headworks
Flood Operations Centre • Undertake predictive flood modelling for selected dams • Provide flood modelling reports to the EEC and dam duty officer on a timely basis • Respond to adhoc requests for information from EEC • Liaise with BOM on flood model predictions and data	1 Senior Engineer Headworks 2 Asset Engineer Headworks

6.1.2 Emergency Action and Event Reporting

Emergency Action Plans (EAPs) have been developed for all of SunWater's dams. The EAPs have a clear set of actions, responsibilities and communications that are to be undertaken in a range of emergency scenarios.

The emergency scenarios expressly considered in the EAPs include:

- Flood Operation
- Rapid Drawdown
- Sunny Day Failure (Earthquake or Piping)
- Chemical /Toxic Spill
- Terrorist Activity

The response framework includes a range of incidents from local incidents, through to emergencies and crisis. The framework also assigns lead accountability (refer Table 6-2).

Table 6-2 SunWater Emergency Response Framework

Category	**Lead Accountability**
Localised Incident/Near Miss (EAP ACTION 1) These are managed by routine procedures and existing resources available on site, and are locally contained with a short-term impact. Generally, these will not escalate to an emergency	**Duty Operator** (Storage Supervisor, Supervisor or Operator)
Emergency (EAP ACTION 2) These require a coordinated regional response together with overview, advice and action from an expert on subject matter who is usually located in the Brisbane Office. Emergency Action Plans, which typically apply during Flood Events, require the Dam Duty Operator to phone the Emergency Event Coordinator (EEC) who will then initiate the relevant ACTION 2 emergency procedure. An emergency may or may not result in the activation of the Crisis Management Plan	**Emergency Event Coordinator** (EEC) (Area Operation Manager, Service Manager, Manager or Project Manager)
Crisis (EAP ACTION 3) A crisis relates to a situation that imminently threatens or has actually resulted in critical or catastrophic consequences (based on SunWater's standard risk definitions) or is considered to be a critical infrastructure security event	**Crisis Manager** (General Manager or Senior Manager)

The EAPs also provide a framework whereby those individuals with lead accountability are provided with technical advice from senior and experienced engineering staff. The latest EAP version also outlines predictive flood modelling from the Flood Operations Centre (FOC) for certain high hazard dams. The SunWater dams currently serviced by the FOC include:

- Tinaroo Falls;
- Burdekin Falls;
- Fairbairn;
- Paradise;
- Fred Haigh;
- Coolmunda; and
- EJ Beardmore

The SunWater EAPs are not static documents. A number of versions (noted as Issue 1, 2 etc) have been released over a period of time. The EAPs have been subject to continuous improvement from reviews[38], exercises and lessons learnt (refer section 3.1.2) from events. Most dams operated under Issue 2 of the EAP over the 2010-11 wet season. Tinaroo Falls dam had Issue 3 prior to the 2010-11 wet season. Issue 3 includes a number of improvements such as clearer roles and responsibilities following a recent restructure of SunWater, inclusion of the FOC role and an emergency response framework consistent with the most recent Crisis Handbook for the organisation.

The dams operating under Issue 2 were issued with a supplementary notice prior to the 2010-11 wet season to clarify roles and responsibility in light of the developments described above.

All EAPs set out communications that are required during an emergency. This includes communication with the Local Disaster Management Group and landholders immediately downstream of the dam. The EAP notification and communication lists are reviewed and updated annually. All EAP notification lists were reviewed and updated in November 2010, prior to the 2010-11 wet season.

EAPs are issued as controlled documents (meaning they can only be altered through a defined process) to a number of stakeholders who have a role in emergency management. By way of example the distribution list for Tinaroo Falls Dam is shown in Table 6-3.

[38] Including an externally facilitated exercise for Leslie Dam and Coolmunda Dam and subsequent review.

Table 6-3 Sample EAP Controlled Document Distribution (Tinaroo Falls)

Copy Number	Position	Location
1	Storage Supervisor, Tinaroo Falls Dam	SunWater – Tinaroo Falls Dam
2	Service Manager/ EEC	SunWater – Mareeba Depot
3	Area Operations Manager	SunWater - Area Operations Centre – Far North (Clare)
4	Manager, Asset Management	SunWater, Brisbane
5	Director, Dam Safety (Water Supply), Office of the Water Supply Regulator	DERM (Dept of Environment and Resource Management), Brisbane
6	Senior Advisor – Disaster Management Local Disaster Management Group - Tablelands	Tablelands Regional Council
7	Coordinator – Disaster Management Local Disaster Management Group - Cairns	Cairns Regional Council
8	District Disaster Coordinator (Mareeba)	Police, Mareeba
9	District Disaster Coordinator (Cairns)	Police, Cairns
10	Director Disaster Management Services, Emergency Management Queensland	State Disaster Coordination Centre - Department of Community Safety, Brisbane
11	Regional Director Emergency Management Queensland	Department of Community Safety, Cairns

Training exercises on specific dam EAPs are typically conducted as part of the 5 yearly comprehensive inspections. Regional management also conduct pre-wet season training/review exercises as part of wet season preparations. Awareness training in 2010 was extended to the Executive Management and the Chairman of the SunWater Board.

EAPs were activated for all the dams during 2010-11 wet season. Brief event reports will be forwarded to the Regulator in due course when the events are completed.

6.1.2.1 Flood Operations Centre (FOC) for SunWater Dams

SunWater has maintained a flood operations centre for a number of years. Prior to the 2010-11 wet season the FOC generally provided services for externally owned dams. Services were provided for Wivenhoe, Somerset, North Pine, Ross River and Scrivener dams. These are all gated dams with significant populations at risk. The FOC is located in a secure room in SunWater's head office. The room has independent and redundant power supplies, communication and computer networks. The FOC has gathered rainfall and runoff data prior to and during events to run rainfall/runoff flood routing models. The models are used to monitor automatic systems (where they exist), inform decisions regarding gate operations and provide information to disaster management groups.

Prior to 2010 SunWater did not generally utilise a real time flood modelling service for its portfolio of dams. The reason was that as SunWater did not provide an active flood operation service, its gated dams mostly operated in an automatic mode[39] and SunWater had engineering staff located in each region. One of the lessons learnt following the February 2008 Fairbairn dam flood[40] was that there was a community and LDMG expectation that SunWater had more information available for its dams and could work more closely with the Bureau of Meteorology (BOM) on flood predictions.

In 2010 SunWater developed runoff routing models for a number of its dams. The modelling of the dams was prioritised by reference to criteria such as hazard rating, population at risk, frequency of flooding and type of structure. Technical staff use the models with flow data from the BOM published data to provide a prediction of the height and time of the peak *discharge* from the dam. This is aimed at assisting the dam duty officer (DDO) on dam operations and the emergency event coordinator (EEC) in discussions with LDMG. SunWater is moving towards a virtual FOC model rather than a dedicated flood room. A virtual FOC means one whereby the models are installed on a laptop that can download data over the web from almost any location.

The FOC operated successfully over the 2010-11 wet season for the following SunWater operated dams:

- Burdekin Falls
- Fairbairn
- Tinaroo Falls
- Paradise
- EJ Beardmore
- Coolmunda
- Ross River

6.1.3 Comprehensive (5 yearly) Dam Safety Inspections

Comprehensive inspections incorporate detailed inspections to identify any physical deficiencies of a dam along with a review of the whole of the dam's safety management program. Inspections are conducted by a multidisciplinary engineering team. The team is lead by a registered professional engineer of Queensland (RPEQ). Detailed reports of each inspection are compiled and submitted to the regulator. SunWater's inspections are taking place according to schedule. Recommendations from the inspections are incorporated into

[39] EJ Beardmore dam gates are a manual system

[40] February 2008 was the flood of record for Fairbairn. This has since been exceeded in December 2010

formal work programs. Progress on the implementation of recommendations is reviewed at each periodic (annual) inspection.

6.1.4 Periodic (Annual) Inspections

Periodic inspections are visual inspections carried out to identify any deficiencies and to monitor the existing condition of a dam. Engineering staff undertake the inspections. A report is produced following each inspection. The reports address the behaviour of the structure and contain detailed recommendations for modified maintenance strategies and general opportunities for improvement. These recommendations are included in the SAP maintenance system to ensure assignment and follow-up of action. The report also tracks progress of recommendations from previous comprehensive and annual inspections and from DERM audits. Where the recommendations of these reports change the procedures in the O&M Manual, EAPs, SOPs or data books, it will be programmed to amend the documents.

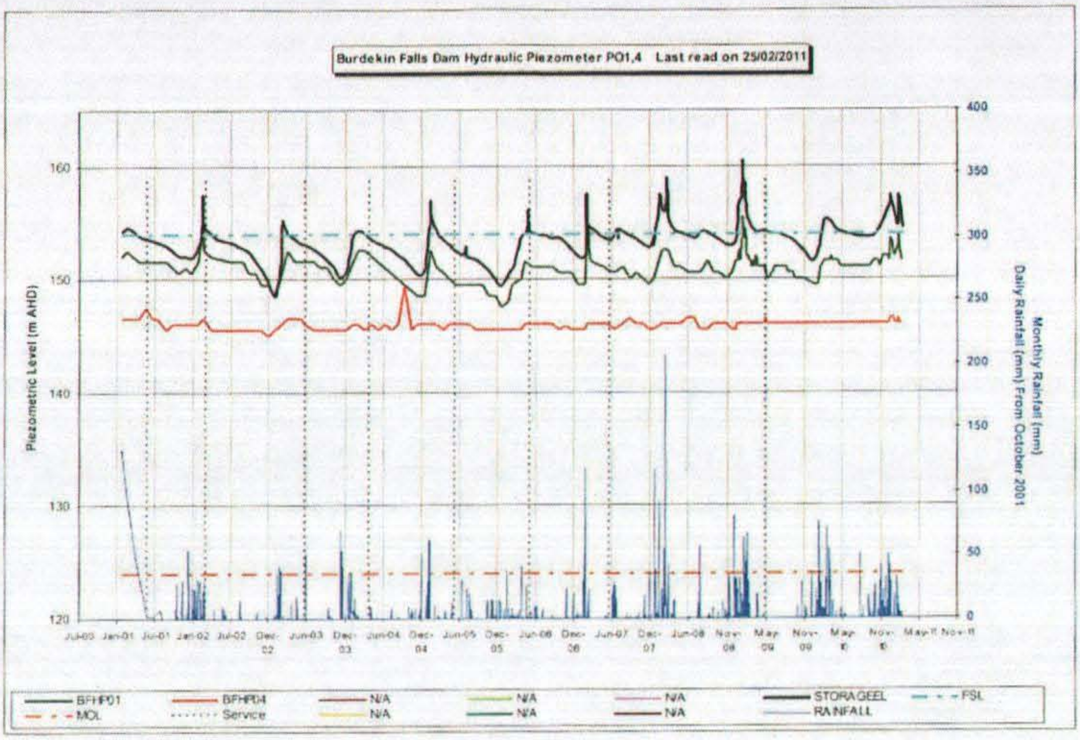
All of SunWater's dams are in a satisfactory condition. This opinion is based on inspections, instrumentation and other aspects of SunWater's dam safety management program.

6.1.5 Dam Safety Instrumentation Database and Plots

SunWater maintains an instrumentation database and plots. The database is available online to all SunWater staff. The database presents data as either data or plots. A sample of a plot is displayed in figure 6-2. The database captures reports and displays information on:

- Piezometers
- Seepage
- Settlement
- Rainfall
- Storage level

The plots are available to staff as part of routine surveillance. The data is formally reviewed by engineering staff as part of the inspections program. The data provides value by assisting a quick response to any emerging issues. Data can provide early indications of a worsening dam safety situation. The data can be assessed for any abnormal behaviour. Such abnormalities can be a trigger for remedial action.



6-2 Sample Instrumentation Plot - Burdekin Falls Dam

6.1.6 Operator Training and Accreditation

SunWater runs a comprehensive training course for dam operators and other staff working on dam infrastructure. The course is highly regarded by industry and many other dam owners enrol their staff in the SunWater course. The course is very similar to one run in NSW by some members of the NSW Dam Safety Committee.

SunWater aims to have every dam operator successfully complete the training task every 5 years. During each comprehensive inspection the operators or the particular dam are assessed on their knowledge of that dam. If found to be competent they are provided with an internal accreditation for that dam.

The dam safety training course is held regularly. The next training course is planned in June 2011 in Proserpine.

6.1.7 Continuing Professional Development of Engineering staff

SunWater is a corporate member of ANCOLD. A significant number of staff attend the annual conference each year to present papers and undertake professional development. SunWater encourages its engineering staff to maintain their competence through recognised continuing professional development programs.

6.1.8 20 Year Dam Safety Reviews

A Safety review is a procedure for assessing the safety of a dam against current standards, and comprises a detailed study of structural, hydraulic, hydrologic and geotechnical design aspects and review of the records and reports from surveillance activities.

The initial safety reviews for SunWater dams were carried out in 1998 and the next review will be in the year 2018 (refer Table 6-4).

6.1.9 Failure Impact Assessments (FIAs)

FIAs are required to be completed for all the *Category 1* structures and for structures with flow control devices on their crest. They have to de done initially and then at 5 yearly intervals. This is to ensure that there are no developments since the previous FIA, increasing the population at risk (PAR). SunWater has completed FIAs for its dams. The outputs are used in the EAPs (refer section 6.1.2) and CRAs (refer section 6.1.10)

6.1.10 Comprehensive Risk Assessments (CRAs) and the Portfolio Risk Assessment (PRA)

A Comprehensive Risk Assessment is a risk assessment study conducted for a particular dam in accordance with the ANCOLD risk assessment Guidelines. It is a study intended to enable SunWater to evaluate the deficiencies and available risk reduction options.

The initial CRA program is now complete. The information in the CRAs has now been compiled into a Portfolio Risk Assessment document (PRA) and forms the basis for SunWater's Dam Safety Upgrade Program (refer section 6.2 below).

6.1.11 Documentation

SunWater maintains a full suite of documentation for each dam as defined in figure 5-1. The documents are reviewed on a regular basis, usually as part of the periodic (annual) inspection. When material deficiencies are identified a new issue or revision is issued through the controlled document process. Table 6-4 details the last Issue or revision release date for each document for each dam.

Documentation is held in a secure dam safety library in Brisbane with a duplicate for the relevant dam stored in the office that the dam operator works from. Uncontrolled copies of documents are also available electronically to staff.

SunWater has two significant projects underway to review and update its documentation. Firstly the EAPs are being updated to Issue 3. Issue 3 includes a number of improvements such as:

- clearer roles and responsibilities;
- inclusion of the role of the FOC;
- lessons learnt from 2010-11 wet season; and
- an emergency response framework consistent with the most recent Crisis Handbook for the organisation.

The second project is a review and update as necessary of the O&M Manuals.

Table 6-4 Last Issue/revision date of Dam Safety Documentation

	Dam	Storage Volume (ML)	Data Book	EAP	O&M Manual	SOP	Annual Inspection	Comprehensive (5yr) Inspection	Safety Review	Comprehensive Risk Assessment
1	Burdekin Falls	1,860,000	Dec-10	Nov-10	Jun-05	Jun-05	Jun-10	Jun-07	Apr-01	Jun-06
2	Fairbairn	1,301,000	Dec-10	Nov-10	Nov-06	Jun-09	Jul-10	Aug-07	Sep-99	Nov-09
3	Fred Haigh	562,000	Dec-10	Nov-10	Jun-09	Jun-06	Aug-10	Jul-06	Apr-99	Jun-05
4	Peter Faust	491,400	Dec-10	Nov-10	Jun-05	Jun-05	May-10	Jun-08	May-01	Oct-08
5	Tinaroo Falls	438,900	Dec-10	Nov-10	Jun-02	Dec-06	Aug-10	Nov-08	Dec-98	Dec-08
6	Paradise	300,000	Dec-10	Nov-10	Dec-05	May-09	Mar-09	Nov-10	N/A	Oct-09
7	Boondooma	204,200	Dec-10	Nov-10	Jun-09	Jun-09	Apr-10	Apr-09	Dec-00	Jun-06
8	Wuruma	165,400	Dec-10	Nov-10	Oct-09	Oct-09	Oct-10	Nov-06	Apr-00	Mar-08
9	Teemburra	147,500	Dec-10	Nov-10	Jun-05	Jun-05	Sep-09	Aug-10	Feb-02	Aug-09
10	Callide	136,300	Dec-10	Nov-10	Dec-05	Dec-05	May-09	Apr-10	Mar-99	Jun-06
11	Bjelke-Petersen	134,900	Dec-10	Nov-10	Jun-09	Jun-09	Apr-10	Apr-08	Mar-01	Oct-09
12	Eungella	112,400	Dec-10	Nov-10	Jun-05	Jun-05	Oct-10	Sep-09	Jun-00	Apr-07
13	Julius	107,500	Dec-10	Nov-10	Jun-05	Jul-09	Sep-10	Aug-09	Jun-00	Jan 10
14	Leslie	106,200	Dec-10	Nov-10	Dec-06	Jun-05	Apr-10	May-09	Jun-99	Nov-08
15	Cania	88,500	Dec-10	Nov-10	Mar-06	Mar-10	Mar-10	Jun-09	May-01	Feb-05
16	EJ Beardmore	81,700	Dec-10	Nov-10	Jun-05	Jun-05	Aug-10	Oct-07	May-00	Jun-09
17	Coolmunda	69,000	Dec-10	Nov-10	Dec-06	Jun-05	Oct-10	Nov-10	Jun-00	Nov-09
18	Kinchant	62,800	Dec-10	Nov-10	May-04	Jun-05	Oct-10	Oct-07	Mar-99	Nov-09
19	Kroombit	14,600	Dec-10	Nov-10	Mar-06	Sep-00	May-09	Apr-10	Dec-01	Nov-09

6.2 Dam Safety Upgrade Program

6.2.1 Dam Safety Upgrade Policy

Over the last fifty years there has been significant development of the methodologies used to estimate extreme rainfall events. These have resulted in substantial increases in probable maximum flood (PMF) estimates for most of SunWater's dams. SunWater's dams are already designed to safely handle very large rainfall events. Whilst some of SunWater's dams will require a future upgrade to pass some of the most recent extreme rainfall estimates, all of SunWater's dams are very safe and can pass very rare events[41].

For a number of years, SunWater has been implementing a process of assessment and upgrades to its portfolio of dams because of the changes mentioned above. This process has included peer review of assessments and consultation with shareholding Ministers and the Queensland Dams Regulator (the Regulator) on upgrade programs. The intent has been to lead to a comprehensive and thorough portfolio approach to dam safety.

In 2007, the Regulator produced Guidelines on Acceptable Flood Capacity for Dams issued pursuant to the *Water Supply (Safety and Reliability) Act 2008* (Qld) and *Water Act 2000* (Qld). The Regulator has established a timetable for *referable dams* to meet the minimum requirement based on the proportion of the Acceptable Flood Capacity (AFC) that a dam can safely pass.

SunWater is also very mindful of the dam safety standards and guidelines issued by the ANCOLD. This is an authoritative and well-established source of dam safety guidance. ANCOLD recommends what is termed a traditional Standards Based Approach (SBA) while acknowledging that a generally lesser standard Risk Based Approach (RBA) is a valid approach in support of the SBA.

[41] The Dam Safety Guiedelines on Acceptable Flood Capacity identify that the Annual Exceedence Probability of the design flood for dams ranges from 1 in 10,000 years to 1:10,000,000 years

SunWater has considered its approach to dam safety upgrades with due regard to these two sources of guidance.

In September 2008, the Board of SunWater (the Board) resolved to adopt the following policy:

"That SunWater's referable dams shall be upgraded to 100% of Acceptable Flood Capacity as determined by the traditional standards based approach, except where it can be demonstrated that the cost of an individual dam upgrade is grossly disproportionate to the benefit gained.

SunWater will consider each dam on a case by case basis. Where it can be demonstrated that the cost of an individual dam upgrade is grossly disproportionate to the benefit gained, SunWater will determine the extent of the required upgrade, which will at least achieve 100% of Acceptable Flood Capacity as determined by the risk assessment approach, in consultation with shareholding Ministers. The upgrade of SunWater's dam portfolio will be prioritised based on overall risk."

The development and adoption of this policy was the culmination of a number of studies and consideration of a wide range of information and publications.

6.2.2 Dam Safety Upgrade Decision Criteria

In order to meet the dam safety upgrade policy (refer section 6.2.1), the Board requested that management develop a process which facilitates the review, assessment and prioritisation of dam safety upgrades. A higher standard than that required by the Regulator has been proposed to be adopted to reflect the Board's reliance upon the Standards Based Approach which is described in the ANCOLD *Guidelines on Risk Assessment, October 2003*.

The decision to upgrade a dam will, following Board approval, follow a stepped approach as described below and illustrated in Figure 6-3.

Step 1: Determine Acceptable Flood Capacity – Standards Based Approach

SunWater will initially determine both:

(a) the *Acceptable Flood Capacity* (AFC) of a dam using the *Standards Based Approach* (SBA) – the "AFC_{SBA}"; and

(b) the existing Safe Discharge Capacity (SDC) of a dam.

This will provide a baseline with which to progress the assessment and allow a "first cut" filter to be applied.

A comprehensive risk assessment study will then be conducted for each *referable dam* and include other contributory risk factors such as adequacy of filters, stability etc.

An upgrade to dam safety to meet 100% of *Acceptable Flood Capacity* using the *Standards Based Approach* is referred to as a standards based upgrade.

If the current SDC of a dam is greater than the AFC_{SBA}, no upgrade is required unless the risk assessment shows intolerable risks. In the case of the latter, the dam will be upgraded to reduce risks to a tolerable level (step 3), if physically possible, under the guidelines. This is referred to as a risk based upgrade and the AFC referred to as AFC_{RBA}. In this case, the AFC_{RBA} will be greater than the AFC_{SBA}.

If the AFC_{SBA} is greater than the SDC, the decision process progresses to Step 2.

Step 2: Determine the cost of a standards based upgrade and assess whether the cost is grossly disproportionate to benefits gained;

This step occurs if the SDC is less than the AFC_{SBA}.

The work required to upgrade the dam to a 100% of *Acceptable Flood Capacity* (SBA) and rectify any deficiencies will be defined and costed.

Once the costs have been established, the estimated cost of the upgrade works will be assessed against the benefits gained to determine whether or not the costs are grossly disproportionate to the benefits. Risks must be reduced *as low as reasonably practical* (ALARP), and measures to reduce risk can be ruled out only if the sacrifice involved would be grossly disproportionate to the benefits gained.

The test for gross disproportionality will include benefit assessments of life safety (societal) risks and business risks. SunWater will apply the following criteria to determine if the costs are grossly disproportionate to the benefit:

(a) Where an upgrade is being considered to address a scenario where there are **Life safety risks,** upgrade costs will be considered grossly disproportionate to the benefits (societal and business) gained if:

   (i) The *Cost to Save a Statistical Life* (CSSL) **exceeds $100 million**; or

   (ii) The *Cost to Benefit Ratio* (C/B Ratio) **exceeds 3.**

(b) Where an upgrade is being considered to address a scenario where there are no life safety risks but there is **Business Risk**, upgrade costs will be considered grossly disproportionate if the *Cost to Benefit Ratio* (C/B Ratio) is greater than 1. Benefits, in this case, are defined as the net present value of business risk costs saved over the life of the dam by the upgrade.

If the cost is ***not*** grossly disproportionate on ***any one*** of the above criteria, an upgrade will be recommended to the traditional AFC_{SBA}; or the AFC_{RBA} if the risks assessed for the AFC_{SBA} are determined to be intolerable. If the cost is grossly disproportionate on all three criteria, the decision process progresses to Step 3.

Step 3: Determine if life safety risks meet the minimum standard expected by society (Limits of Tolerability)

For those dams where the upgrade costs are assessed as being grossly disproportionate to the benefit, but still retain life safety risks, the decision process will then assess life safety risks against *Limits of Tolerability* established by the Regulator and ANCOLD. If the existing life safety risks are on or above the *Limits of Tolerability,* an upgrade is recommended if physically possible. The upgrade will be to the risks based standard to AFC_{RBA}. If there is no risk based option to achieve tolerability other than SBA, the AFC_{SBA} will be adopted.

If in Step 3 the life safety risks satisfy the *Limits of Tolerability*, the decision process progresses to Step 4.

Step 4: Determine if the cost of a proposed upgrade is relatively small;

If the costs of an upgrade are assessed as grossly disproportionate and life safety risks are tolerable, an upgrade will still be recommended if the cost of that upgrade is considered small relative to the annual refurbishment and maintenance budget. The cost limit for "relatively small" determination is $1 million. For those dams progressing to Step 4, if the cost is between $1 million and $5 million, SunWater will consider and decide on a case by case basis if the upgrade will be implemented.

For dams where an upgrade is not recommended from Step 4, the decision process progresses to Step 5.

Step 5: Determine Acceptable Flood Capacity – Risk Based Approach;

If, as a result of an assessment against the above criteria outlined in steps 1 through 4, an upgrade to a standards based Acceptable Flood Capacity (AFC_{SBA}) is not justified, then the risk based Acceptable Flood Capacity of the dam will be determined by the Risk Based Approach (RBA). This calculation determines the AFC_{RBA}.

If the existing ***Safe Discharge Capacity*** of the dam is less than the risk based ***Acceptable Flood Capacity*** (AFC_{RBA}), the work required to upgrade the dam to 100% of the risk based ***Acceptable Flood Capacity*** will be defined and scheduled.

Step 6: Determine the relative priority and timing of an upgrade;

Following the five step process for every dam, the prioritisation process to establish an upgrade program will be as follows:

1. Assign the greatest priority to upgrades that address life safety risks over and above projects that only reduce business risks;

2. Of those dams that have been assessed as having a life safety risk and warrant an upgrade, the highest priority will be assigned to those dams that have a life safety risk higher than the Limit of Tolerability (social or individual) as defined by the Regulator;

3. For dams with intolerable life safety risks, prioritise the dam upgrades on the basis of overall life safety risk in descending order;

4. Following on from the completion of upgrades on all dams with intolerable life safety risks, those remaining dams that have been assessed as requiring an upgrade will be prioritised in descending order of overall life safety risk;

5. The scheduling (timing) of upgrades will occur in priority order and be based on resource constraints assuming one each of design and construction teams which results in an overlapping sequential program. Scheduling may also be constrained by the availability of funding;

6. The scheduling (timing) of upgrades will need to consider the target dates specified in the Queensland Government's guideline on Acceptable Flood Capacity for *Referable Dams.* This constraint may result in lower priority upgrades being bought forward in the program in order to satisfy regulatory requirements.

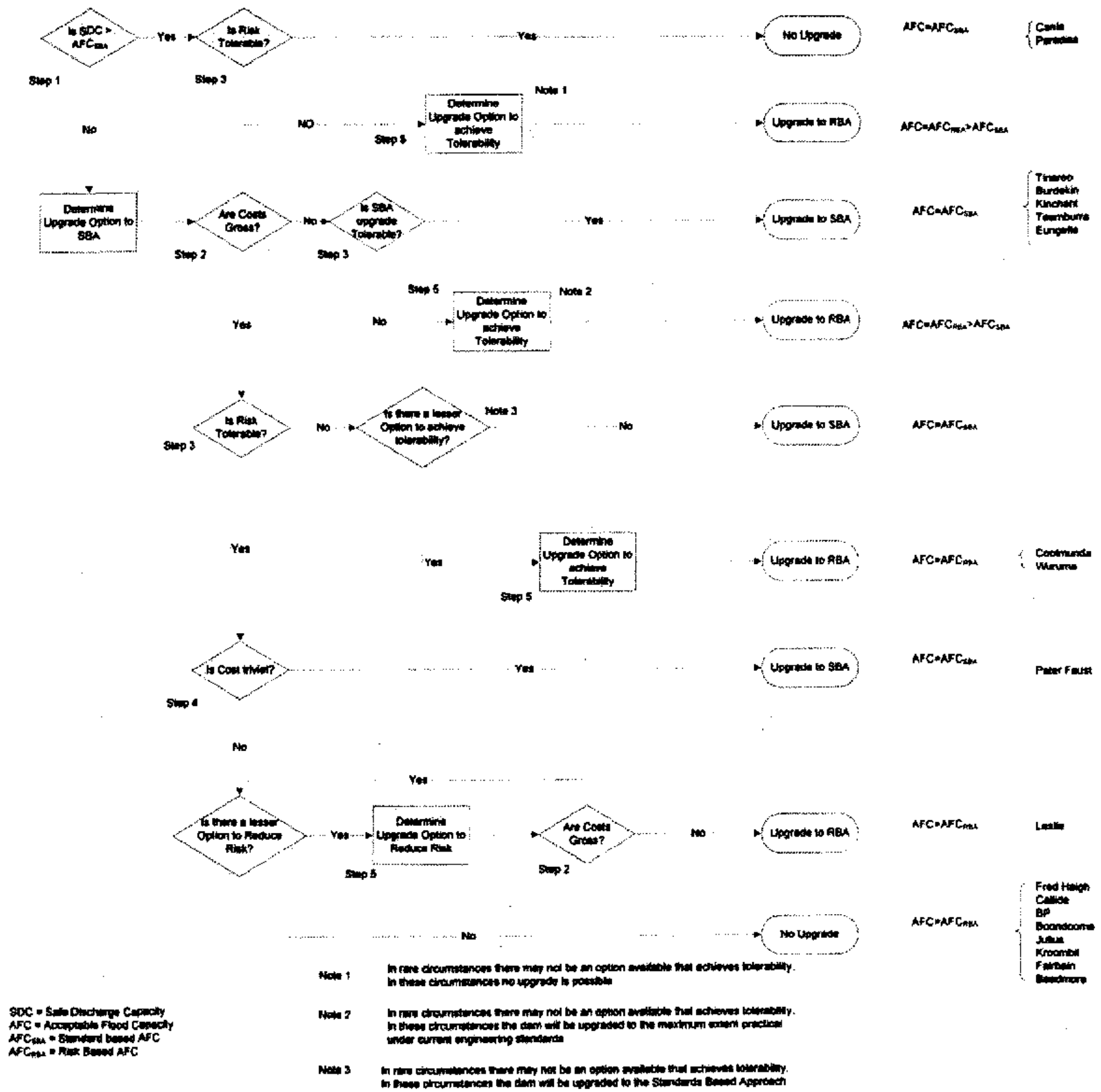


Figure 6-3 Dam Safety Upgrade Decision Criteria Process Flow

6.2.3 Dam Safety Upgrade Program

SunWater commenced an upgrade program in 2005. To date the following upgrade projects have been completed

- Fred Haigh Stage 1
- Bjelke Petersen
- Tinaroo Falls

The upgrade of Fred Haigh Dam involved the installation of a 2.02m high reinforced concrete wave wall along the downstream edge of the embankment crest and a similar increase of the upstream *spillway* training walls. A 2m deep cutoff wall connects the wave wall to the central clay core. A further upgrade to the saddle dam will be required to satisfy full AFC requirements.

The upgrade of Bjelke Petersen involved the installation of a 1.8 to 2.4m high reinforced concrete wave wall along the downstream edge of the embankment crest. A 0.5m to 0.7m deep cutoff wall connects the wave wall to the central clay core.

The upgrade of Tinaroo involved:

- Installation of post tension anchors in the concrete monoliths of the main wall and *spillway*;
- Erosion protection slabs to the toe of the main wall;
- Passive anchors in the *spillway* apron slabs;
- A crest wave wall; and
- Raising of the saddle dam

The upgrade of Kinchant Dam is in progress. This upgrade will be completed in 2013.

A number of other dams will be progressively upgraded, however a final decision on these projects has not yet been made.

6.2.4 The development of SunWater's approach to changing standards and circumstances

SunWater's approach to dam safety upgrades and acceptable flood capacities developed over a period of time as discussed below.

6.2.4.1 Changes in Flood Hydrology and PMP Estimation[42]

The major dams that SunWater owns were constructed over a fifty-year period commencing from the mid-1950's. Whilst there may be an expectation in the community that the majority of these assets would conform to contemporary design standards this is not necessarily so. Hydrometeorological assessment techniques during this same time frame have evolved considerably in line with technological and computing capability.

For the design of SunWater's first dam during the 1950's, (Tinaroo Falls Dam), the Myer empirical relationship was used as the basis to derive the original design *spillway* capacity. This particular technique did not necessarily use storms relevant to the particular catchment of the dam.

Many of the SunWater dams designed and constructed during the 1960's utilised the US Weather Bureau 'Insitu-maximisation' method of Probable Maximum Precipitation (PMP) extreme *design rainfall* estimation, which was based only upon the maximisation of storms located within the catchment of the dam. Adjustment was made to the rainfall depth recorded in the largest observed storms, by the ratio of the highest observed atmospheric moisture content in the area of the catchment to that observed in the storm event. This approach led to somewhat inconsistent assessments of catchments located within relatively close proximity due to the differences in the available records.

To overcome this problem, during the late 1960's and early 1970's, the concept of 'maximisation and transposition' was gradually introduced. It improved the consistency of PMP estimates within regions and also led to a general increase in PMP depth estimates. However, this method did have its drawbacks. The choice of storms for transposition introduced a significant level of subjectivity to the method and the temporal and spatial distribution patterns adopted for the design assessment was still relatively arbitrary.

The US Weather Bureau and the World Meteorological Organization developed 'Generalised Methods' during the late 1970's and early 1980's. These methods incorporate storm events recorded over large regions to enable the transposition of storms over large areas.

The Australian Bureau of Meteorology (BoM) developed the earliest generalised method for Australia in the early 1980's. Interestingly, four of the seven extreme storms used in the derivation of this technique were events that were observed in Queensland. This technique is referred to as the Generalised Tropical Storm Method, (GTSM). This method defines spatial and temporal patterns for use in design that are largely independent of individual storm event characteristics. Other generalised methods that have subsequently been developed by the BoM including the Generalised Short Duration (or Thunderstorm) Method (GSDM).

Around half of SunWater's dams were designed using the GTSM or GSDM of PMP estimation. It was noted that when these methods were introduced, comparisons with estimates based on the earlier techniques such as 'insitu-maximisation' and 'maximisation-

[42] Rob Ayre, Headworks Design Manager, SunWater

transposition' showed significant increases. Increases in the order of 150 to 250 % were not uncommon.

The Bureau of Meteorology maintains a database of extreme storm events that provides a basis for PMP estimates. Extreme events such as the Rainbow Beach 2007 event are added to the database and have the potential to increase future estimates of PMP. The Flood hydrology group in SunWater is informed of any changes through regular events such as the Hydrology and Water Resources Symposium. Although increased assessments of PMP are possible, such revisions are not expected to be issued in the next few years.

The Bureau of Meteorology last revised PMP estimates in 2003. In response to this revision SunWater has revised the flood estimates for all dams. These revised estimates are a key input to the dam safety upgrade program.

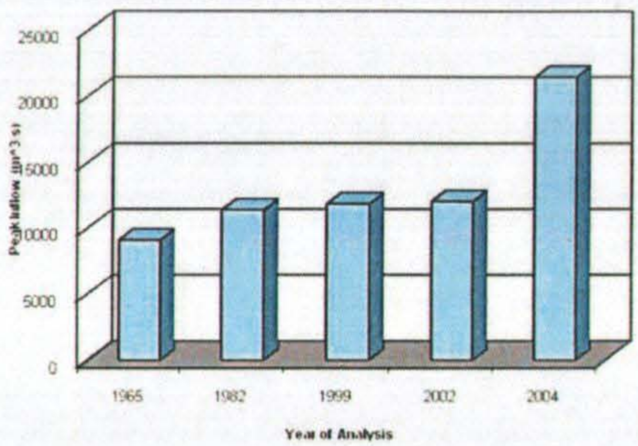


Figure 6-4 Comparison in the estimation of PMP Design Flood inflow estimates for Fred Haigh Dam over time

6.2.4.2 Chronology of the development of SunWater's Approach

The following table provides a chronology of SunWater's development of its approach to dam safety upgrades.

Table 6-5 Chronology of the development of SunWater's Approach

Date	Action
2002	20 year dam safety reviews completed
2003-2005	Design flood hydrology review based on Revised PMP estimates (GTSMR 2003)
Oct 2003	ANCOLD Risk Assessment Guidelines Published
2003 - 2005	Dam break analysis based on flood hydrology – 2003.
2004-2005	Spillway adequacy assessment

Date	Action
June 2004	Board considers consequences of reviewed PMFs. Actions => Stage 1 program to meet 50% AFC(fall-back) and limit of tolerability on societal risk. Stage 2 program for all CRAs, final design and upgrade to full AFC all dams
Oct 2004	Stage 1 Spillway Upgrades program for SunWater Dams. Included Fred Haigh, Bjelke Petersen, & Tinaroo
Dec 2004	Report on Spillway Upgrades to AFC for SunWater Dams (SBA)
2005 to 2010	Program to undertake comprehensive risk assessments of individual dams
2005 to 2006	Fred Haigh Stage 1 Upgrade
June 2006	CSO agreement includes 3 stage 1 upgrades
2006 to 2007	Bjelke Petersen Upgrade
June 2007	Report on Portfolio Risk Assessments of SunWater Dams (mainly flood based)
Sep 2007	NRW requests both updated fall back program and Risk based program
Nov 2007	Independent review of Wuruma CRA highlighted imminent changes to the design criteria for uplift pressures as a result of the new ANCOLD Guidelines on Concrete Gravity Dams which increases cost of concrete gravity structures such as Wuruma, Tinaroo and Burdekin.
2007	Failure Impact Assessments were undertaken on the dams deemed as Category 1 in 2002 in accordance with the NRW Guidelines for Failure Impact Assessment of Dams – April 2002.
Feb 2008	Estimated cost of Tinaroo Falls Dam upgrade increases from due mainly to changes in the design criteria for uplift pressures in light of the new ANCOLD Guidelines on Concrete Gravity Dams.
April 2008	Independent review of Portfolio Risk Assessments of SunWater Dams
May 2008	Report *SunWater Dam Safety Upgrades – Based on Risk Assessments*
September 2008	Adoption of Dam Safety Upgrade Policy
Feb 2009 – Feb 2011	Development, review and adoption of Dam Safety Upgrade Criteria
Ongoing	Dam safety upgrades

7 Emergency Management Frameworks

7.1 Roles and Functions of Various Agencies in Emergency Management

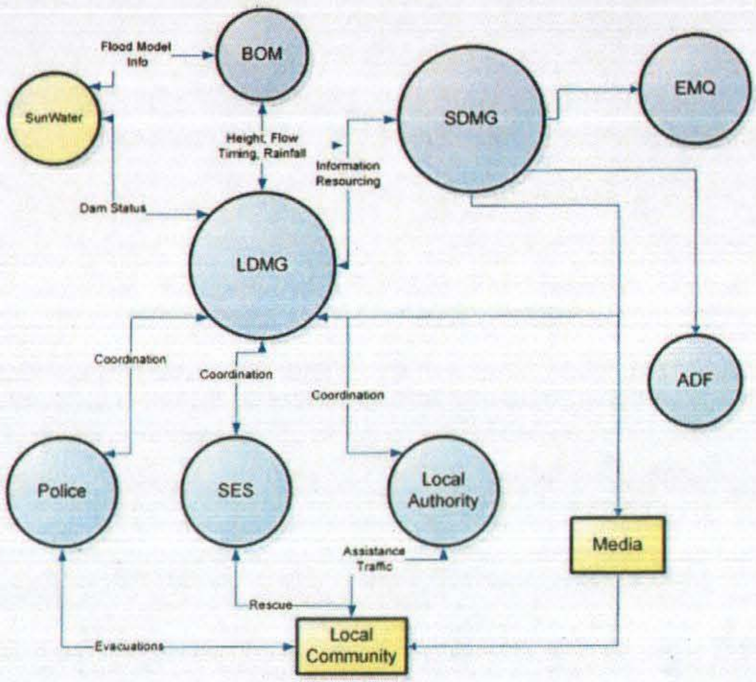
Queensland has a tiered disaster management arrangement. It is based on local, district and state levels. The structure enables a progressive escalation of support and assistance through each tier as required. The Australian government is also included in the arrangements as a fourth level, recognising that Queensland may need to seek federal support in times of disaster.[43]

Figure 7-1 Queensland Disaster Management Arrangements

7.1.1 Players in emergency management

Figure 7-1 below is a graphic representation of the lines of communication for emergency management organisations in respect to flood emergencies. SunWater's role in those communications is described in section 7.1.2 below.

[43] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf



District disaster level omitted for clarity

Figure 7-2 Relationship of Emergency Management Organisations

7.1.1.1 Local Disaster Management Group (LDMG)

The Local Disaster Management Group (LDMG) is a group established for each Local government area in the State to carry out a number of functions relating to disaster management, the primary ones of which are:[44]

- To ensure that disaster management and disaster operations in the district are consistent with the State group's strategic policy framework for disaster management for the State;
- To develop effective disaster management, and regularly review and assess disaster management arrangements; and
- To help the Local government for its area to prepare a local disaster management plan.

7.1.1.2 District Disaster Management Group (DDMG)

The *District Disaster Management Group* (DDMG) is a group established for each Disaster district in the State to carry out a number of functions relating to disaster management, the primary ones of which are[45]:

[44] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf

[45] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf

- To ensure that disaster management and disaster operations in the district are consistent with the State Group's strategic policy framework for disaster management for the State; and

- To develop effective disaster management for the district, including a district disaster management plan, and regularly review and assess disaster management arrangements.

DDMGs are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management. The DDMG is responsible to the SDMG for all aspects of the State government's capabilities in disaster management for their district.[46]

7.1.1.3 State Disaster Management Group (SDMG)

The State group is the peak policy and planning group for disaster management in Queensland. It is established under the *Disaster Management Act 2003* (section 17) as the principal organisation for the purposes of disaster management throughout the State. In particular, the State group is responsible for disaster mitigation and disaster planning and preparation at a State level and for coordinating whole-of-government response and recovery operations prior to, during and after an event. This includes accessing interstate and/or Australian government assistance when local and State resources are exhausted or not available.[47]

7.1.1.4 Emergency Management Queensland (EMQ)

The functions of EMQ as described in the *Disaster Management Act 2003*, include;[48]

- Provision of advice and assistance to all agencies within Queensland's disaster management arrangements;

- Provision of advice to disaster managers at all levels of the state's disaster management arrangements;

- Ensuring that disaster management activities within the State are consistent with the strategic policy framework;

- Facilitation of the development and maintenance of the State's Disaster Management Plan;

- Operation and maintenance of the SDMG;

- The maintenance of arrangements between the State and Australian government about matters relating to effective disaster management; and the coordination of

---

[46] www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

[47] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf, p19

[48] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf p31

State and Australian government assistance for disaster management and disaster operations;

- Training of disaster management stakeholders; and
- Review of District and Local Plans.

7.1.1.5 Police

The role of the police during a disaster include:[49]

- Preservation of peace and good order;
- Prevention of crime;
- Maintenance of any site as a possible crime scene;
- Coronial investigation procedures;
- Traffic control, including assistance with road closures and maintenance of road blocks;
- Crowd control;
- Coordination of evacuation operations;
- Coordination of rescue operations;
- Security of evacuated areas;
- Security of damaged premises;
- Registration of evacuated persons;
- Tracing or coordination of search for missing members of the community;
- Traffic, rail and air accidents; and
- Guidance on Counter-Terrorism Issues.

7.1.1.6 State Emergency Service (SES)

The functions of the SES are:[50]

- To perform rescue or similar operations in an emergency situation;
- To perform search operations in an emergency or similar situation;

[49] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf p31

[50] www.emergency.qld.gov.au/ses/aboutses/

- To perform other operations in an emergency situation to -
  1. Help injured persons; or
  2. Protect persons or property from danger or potential danger associated with the emergency;
- To perform other activities to help communities prepare for, respond to and recover from an event or a disaster.

7.1.1.7 Local Authority

The role of the local authority during a disaster include:[51]

- Maintenance of Local government functions (via Local government business continuity and recovery Planning);
- Maintenance of normal Local government services to the community and critical infrastructure protection;
- Development and maintenance of disaster management plans for the shire;
- Development and maintenance of a public education/awareness program;
- Establishment, maintenance and operation of a LDMG including the training of sufficient personnel to operate the centre;
- Coordination of support to emergency response agencies;
- Maintenance of warning and telemetry systems;
- Collection and interpretation of information from telemetry systems;
- Reconnaissance and post impact assessments for the shire;
- Debris clearance of roads and bridges;
- Issuance of public information prior to, during and post disaster impact events;
- Recommendations with regard to areas to be considered for authorised evacuation;
- Public advice with regard to voluntary evacuation;
- Provision of locally based community recovery services in conjunction with other recovery agencies; and
- Evacuation centre management.

[51] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf p34

7.1.1.8 Bureau of Meteorology (BOM)

The Bureau's flood forecasting and warning service uses rainfall and streamflow observations, numerical weather predictions and hydrologic models to forecast and warn for possible flood events across Australia. [52]

This information provides the basis for flood response by emergency services and other flood managers and is vital for water resource managers responding to large inflows of water into their dams and rivers.

The role of the BOM during a disaster includes:[53]

- Forecasting of weather and the state of the atmosphere;
- Issue of warnings for gales, storms and other weather conditions likely to endanger life or property, including weather conditions likely to give rise to floods;
- Supply of meteorological information;
- *Publication of meteorological reports and bulletins; and*
- Provision of advice on meteorological matters.

7.1.1.9 Australian Defence Force (ADF)

The SDMG may request the Federal Government to make the ADF available to assist with disaster cleanup and recovery activities. The ADF may also be called upon to provide additional resources for search and recovery activities.

7.1.2 SunWater's role

During flood events SunWater undertakes the following activities:

- Monitor water inflows into the dam and notify stakeholders as per the EAP;
- Provide regular inflow updates to LDMG;
- Pass water inflows through the dam's *spillway* or outlet works in accordance with established operational guidelines and manage and maintain water levels in gated dams: and
- Undertake predictive flood modelling for selected dams and liaise with BOM to share information and ensure the veracity of the modelling. The SunWater modelling is not catchment wide and is limited to dam inflows and *outflows*. SunWater uses the information for operational purposes. The BOM modelling is catchment wide and has the responsibility to provide the modelling predictions to the emergency management groups.

[52] www.bom.gov.au/water/floods/index.shtml

[53] www.disaster.qld.gov.au/publications/pdf/State%20Disaster%20Man%20Plan%20A050908.pdf p32

a prediction of the height and time of the peak *discharge* from the dam. This is aimed at assisting the dam duty officer (DDO) on dam operations and the emergency event coordinator (EEC) in discussions with the LDMG. SunWater liaises with the BOM to share information and ensure the veracity of the modelling. The BOM modelling is catchment wide and BOM has the responsibility to provide the modelling predictions to the emergency management groups.

The FOC operated successfully over the 2010-11 wet season for the following SunWater operated dams:

- Tinaroo Falls;
- Burdekin Falls;
- Fairbairn;
- Paradise;
- Coolmunda; and
- EJ Beardmore

7.1.2.3 Wet season preparation

A significant amount of SunWater's infrastructure is located in areas prone to frequent and/or large flood events. SunWater routinely undertakes preparations in advance of the wet season. Preparations prior to the 2010-11 wet season included:

- Development and release of Issue 3 of the Tinaroo Falls dam EAP. Issue 3 includes a number of improvements such as clearer roles and responsibilities following a recent restructure of SunWater, inclusion of the FOC role and an emergency response framework consistent with the most recent Crisis Handbook for the organisation;
- The dams operating under Issue 2 of the EAPs were issued with a supplementary notice prior to the wet season to clarify roles and responsibility;
- All EAP notification and Communication Lists were updated and issued;
- Briefings were conducted with a number of LDMGs (refer section 2.1.2);
- A number of staff training and awareness exercises were conducted;
- Rosters for the EAP roles of Emergency Event Coordinators (EEC), and Dam Duty Officers (DDO) and other roles were developed and issued;
- The Executive, senior management, and the Chairman were put through an EAP awareness training exercise;
- Routine preparatory maintenance of critical equipment which included:

1. Servicing & Testing of generators;

2. Full stock of fuel supplies;

3. Testing of Gates and SCADA (supervisory control and data acquisition) systems;

- Placement of an additional emergency backup generator for *spillway* gates at EJ Beardmore Dam; and

- Development and issue of a revised *Crisis Handbook* was developed and issued (*refer section* 7.1.2.4).

Not all of the above preparations were undertaken for all dams. Schedules 2 onward detail the specific preparations at each dam.

7.1.2.4 Crisis Management

The EAPs for SunWater's dams are designed to deal with incidents, emergencies and crisis at a specific dam. Since 2007 SunWater has also had in place a formal incident, emergency, crisis and disaster management framework. During 2010 SunWater undertook a review of that framework. The review considered learnings from previous events.

In December 2010 SunWater published the 2011 edition of the Crisis Handbook. The handbook provides a structure for a crisis management team (refer to Figure 7-3) and roles for each member of that team.

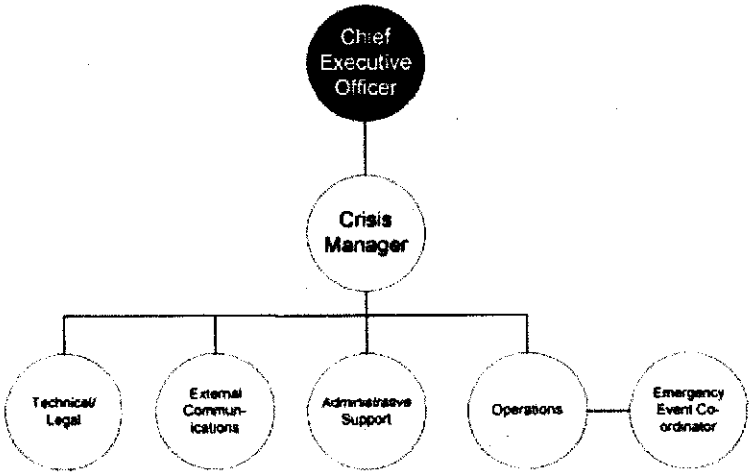


Figure 7-3 SunWater's Crisis Management Structure

The Crisis Handbook includes:

- A listing of emergency contact numbers;

- Definition of SunWater's emergency response framework;

- Key SunWater contacts including senior managers and subject matter experts;

- A tool kit of forms for use by crisis team members during an event;
- Duty cards for each member of the crisis team.

The handbook was provided to all staff along with necessary instruction prior to the 2010 Christmas holiday period.

8 Overview of SunWater Dams during the 2010-11 wet season

Set out in the schedules at the rear of this document is information in respect to each of SunWater's major *referable dams* and, in particular, information in respect to any flood event at each dam during the 2010-11 wet season.

At the time of submission of this statement schedules for a number of the dams in SunWater's portfolio were not complete. I will supplement this statement with addendum statements as those schedules are completed.

9 Conclusions

SunWater, together with its subsidiary Burnett Water, owns 19 major dams across the State. All of these 19 dams are principally for the purpose of providing water supplies. Peter Faust has been designed for a dual role of *water supply* and *passive flood mitigation*.

SunWater and its subsidiaries do not own any dams that provide *active flood mitigation*.

Notwithstanding that SunWater's dams are generally not designed to provide a flood mitigation service, SunWater's dams do attenuate the peak flood *discharge*.

The rainfall across the catchment areas of SunWater's dam during the 2010-11 wet season, although significant, was much less than the extreme rainfall events that SunWater's dams are designed to safely pass.

SunWater has in place a rigorous dam safety management system. Emergency and operations & maintenance procedures are well documented. The processes are well understood by staff. SunWater took the steps required by the relevant procedures to prepare for the 2010-11 wet season at each of its dams. That preparation, compliance with operating procedures during flood events and SunWater's systems ensured that SunWater's dams performed safely during the 2010-11 wet season. SunWater's approach to dam management meets or exceeds the minimum standards set down by the regulatory framework.

SunWater plays a limited role in the Queensland disaster management framework. SunWater works closely with local disaster management groups in accordance with emergency management procedures and ensures that those groups are kept informed of the status of SunWater's dams.

SunWater has reviewed the operation of its dams in the context of whether SunWater dams could provide a flood mitigation benefit from the existing asset configuration. The review concluded that there are no opportunities to provide flood mitigation services from SunWater's existing dams for the following reasons:

- The regulatory framework within Queensland prevents SunWater from pre releasing water from dams for flood mitigation purposes;
- On a practical level, significant reductions in dam levels prior to a wet season would be very difficult to achieve. It would take several months in most cases to release significant volumes of water from the outlet works of SunWater dams. The outlet works are designed to only release sufficient water to satisfy downstream demands;
- A significant reduction in dam levels prior to a wet season could compromise the very purpose for which Sunwater Dams are designed, namely *water supply*;
- The flood volumes in moderate to major floods are typically very large relative to the storage capacity of SunWater dams. For example, the volume that passed Paradise Dam in a 20 day period was 22 times the full storage volume of the dam.

- Even if the dam levels could have been lowered significantly before the commencement of the 2010-11 wet season (by say 25% to 50%) (which is not viable for the reasons outlined above) there would have been insignificant mitigation of any major flood.

10 Glossary of Terms

As Low as Reasonably Practicable (ALARP)

The principle which states that risk to life, lower than the *limit of tolerability* (- a risk within a range that society can live with so as to secure certain net benefits), are tolerable only if risk reduction is impractical or if its cost is grossly disproportionate to the improvement gained[54].

Design rainfall

Design rainfall information is generally expressed in terms of point rainfall intensity, which is the rainfall depth (mm) at a location per hour. However, for flood estimates of large catchments, an estimate of the average areal rainfall intensity across the catchment is required. This is the mean rainfall depth per hour over the entire catchment[55].

Discharge

The flow of water out of water supply infrastructure, such as a dam, weir or pipeline.

District Disaster Management Group

District Groups comprise representatives from regionally based Queensland government agencies which can provide and coordinate whole-of-government support and resource gap assistance to disaster-stricken communities. The District Groups perform a 'middle management' function within the disaster management arrangements by coordinating the provision of functional agency resources when requested by Local Groups on behalf of local governments[56].

Flood Classification

A description by the Bureau of Meteorology of the severity of flooding - minor, moderate or major - according to the effects caused in the local area or in nearby downstream areas[57].

Flood mitigation - Active

Design function of a dam built for the purpose of reducing the impact of flooding downstream of a dam where the dam operator can exert some control on the discharge from the dam, usually by the operation of spillway gates included in the

---

[54] www.derm.qld.gov.au/water/regulation/pdf/guidelines/dam_safety/flood_capacity/accept_flood_capacity.pdf

[55] www.gmat.unsw.edu.au/currentstudents/ug/projects/howell/howell.htm

[56] www.disaster.qld.gov.au/about/

[57] www.bom.gov.au/hydro/flood/qld/brochures/georgina/georgina.shtml#FloodClassifications

	dam design, e.g., Wivenhoe Dam.
***Flood mitigation* – Passive**	Design function of a dam built for the purpose *of reducing* the impact of flooding downstream of a dam where the operator cannot control the discharge from the dam, e.g., Peter Faust Dam.
Freeboard	The distance between normal water level in a structure and the top of the structure, such as a dam, that impounds or restrains water.
FSL (Full Supply Level)	For a dam, means the level of the water surface when the water storage is at maximum operating level when not affected by flood[58].
iROL (interim Resource Operations Licence)	Authorises the holder of the licence to interfere with the flow of water to the extent necessary to operate the water infrastructure to which the licence applies[59] where a ROP is not in place for the infrastructure.
Local Advisory Committee	Also know as Irrigator Advisory Committees - a group of SunWater's customers within a water supply scheme who have been elected by other customers to represent the interests of the broader customer base in relation to scheme operations and water supply issues and improvements with SunWater. There is a local irrigator advisory committee in most of SunWater's water supply schemes.
Local Disaster Management Group	Local Groups established to support local government disaster management activities. The Local Group is supported by the relevant District Disaster Management Group if and when disaster management activities exceed the capacity of a Local Group[60].
Overtopping	The flow of water over a dam wall or embankment
Outflow	The flow of water out of a dam or water storage.
Referable dam - Category 1	In Queensland, a water storage with a failure impact rating accepted by the dam safety regulator as having a population at risk in the

[58] Sch. 3, *Water Supply (Safety and Reliability) Act* 2008

[59] S. 167A *Water Act 2000*

[60] www.disaster.qld.gov.au/about/

	event of failure of the dam of 2 or more persons and not more than 100 persons[61].
Referable dam - Category 2	In Queensland, a water storage with a failure impact rating accepted by the dam safety regulator as having a population at risk in the event of failure of the dam of more than 100 persons[62].
Reliability	A measure of how frequently the full yield of a dam will be available for use.
ROL (Resource Operations Licence)	Authorises the holder of the licence to interfere with the flow of water to the extent necessary to operate the water infrastructure to which the licence applies[63] where a *ROP* is in place for the infrastructure.
ROP (Resource Operations Plan)	A plan, approved by the regulator under the *Water Act 2000*, concerned with the day-to-day management of water resources in a way that meets the WRP goals, outlining how a WRP will be implemented in specified areas.
Spillway	A channel or other structure used to provide for the controlled release of flows from a dam or water storage into a downstream area, typically being the watercourse that has been dammed.
Spillway – fixed crest	The height of the spillway without any operable gates or other mechanisms to allow for human control of the flow of flood water over the spillway.
Spillway gates	Mechanisms to allow for operator control the rate of flow of flood water over the spillway of a dam.
Spillway – Uncontrolled	A spillway with no operable gates or other mechanisms for controlling the flow of water over the spillway – the rate of discharge is controlled only by the depth of water within the water storage.
Spillway – Ungated	See ***Spillway - Uncontrolled***.

[61] S. 346 *Water Supply (Safety and Reliability) Act* 2008

[62] S.346 *Water Supply (Safety and Reliability) Act* 2008

[63] S. 170A *Water Act 2000*

Watercourse	A river, creek or other stream, including a *stream in which* water flows permanently or intermittently, regardless of the frequency of flow events and includes artificial channels that have changed the course of the stream. For further details see section 5 of the *Water Act 2000*
Water allocation security objective	An objective that may be expressed as a performance indicator and is stated in a water resource plan for the projection of the probability of being able to obtain water in accordance with a water allocation[64].
Water Supply	In Queensland, the capture, storage and distribution of water for use in accordance with the *Water Act 2000*.
Water Supply Scheme	Water infrastructure or other works for the supply of water or the storage, distribution or treatment of water[65].
WRP (Water Resource Plan)	Subordinate legislation prepared by the Minister responsible for the administration of the *Water Act 2000* to advance the sustainable management of water.
Yield	The volume of water in a dam or water storage that can be allocated for use each year.

[64] Sch. 4 *Water Act 2000*

[65] Sch.4 *Water Act 2000*

SIGNED BY:

[redacted]

Robert Gerard Keogh

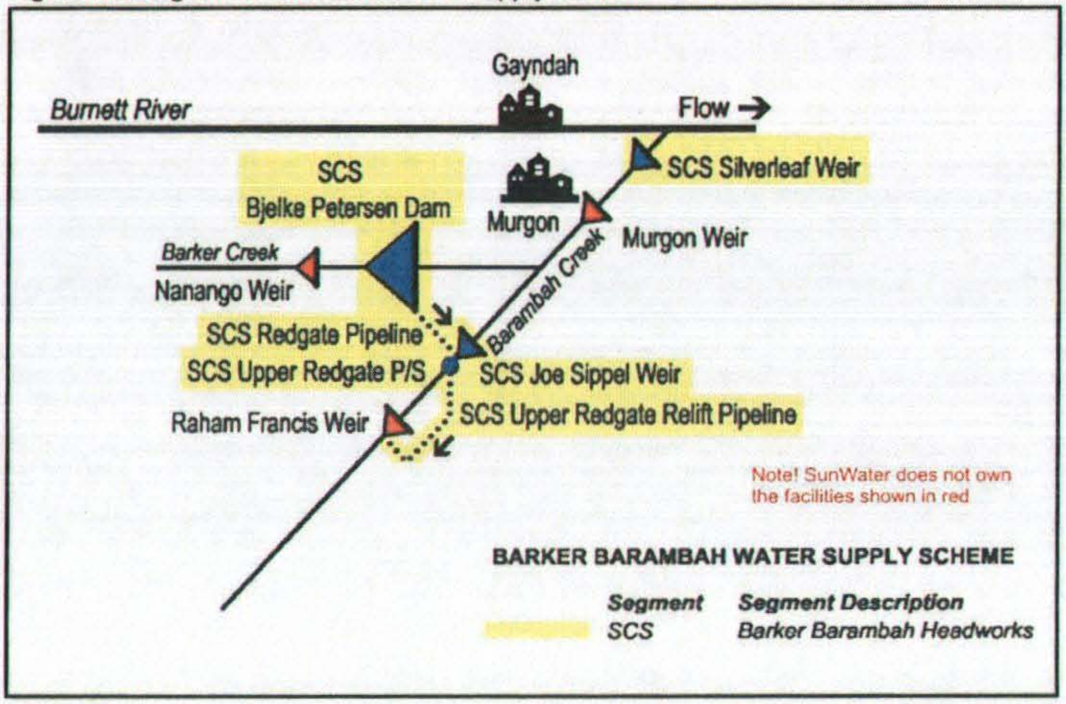
11-3-2011

Date

Schedule 1: Overview of SunWater's Water Supply Schemes

1.1 Barker Barambah Water Supply Scheme

Figure 1-1 Diagram of Barambah Water Supply Scheme



The Barker Barambah *Water Supply Scheme* is located west of Gympie near Murgon. Its main source of supply is Bjelke Petersen Dam located on Barker Creek. The scheme includes several weirs, but SunWater only owns the Joe Sippel and Silverleaf Weirs.

The Barker Barambah *Water Supply Scheme* (Figure 1-1) supplies water to irrigators along sections of Barker and Barambah Creeks, Murgon and Wondai Shire Councils, the Merlwood Water Board, and the Cherbourg Community Council.

Water levels in Silverleaf Weir are maintained through releases from the Bjelke Petersen Dam's river outlet, and the Joe Sippel Weir through the Redgate Diversion Pipeline. The scheme includes the Upper Redgate Relift Pipeline, which diverts water from the Joe Sippel Weir to the Francis Weir. SunWater owns the relift pipeline, but not the Francis Weir.

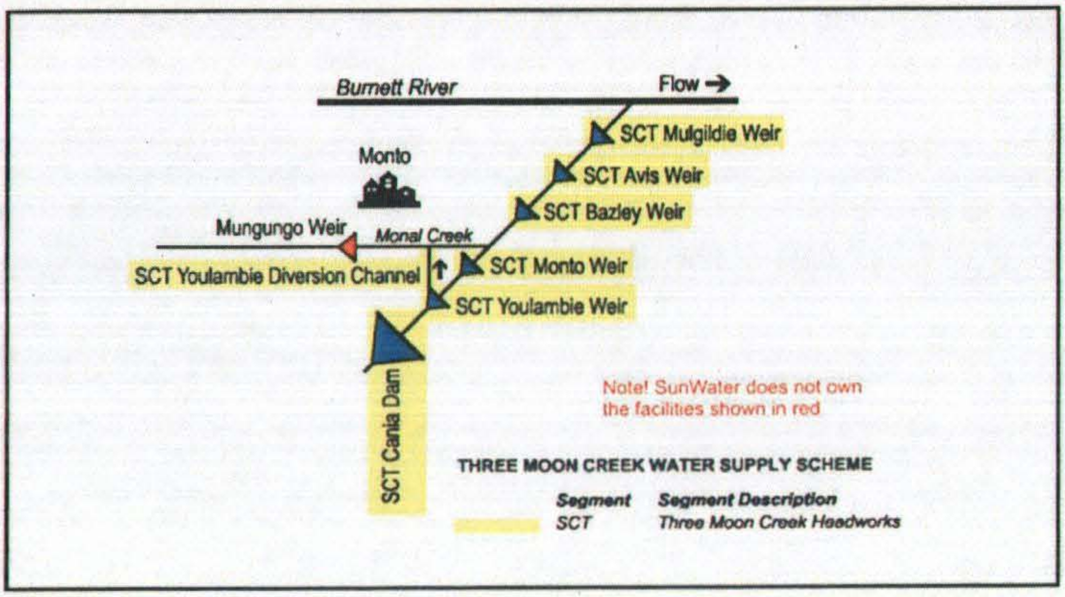
Table 1-1 Main Facilities of Barker Barambah Water Supply Scheme

Facility	Function	Capacity
Bjelke Petersen Dam	Head works for Barker Barambah Scheme. Supplies Joe Sippel and Silverleaf Weirs	134,900 ML
Joe Sippel Weir	Ponds water for irrigators along Barambah Creek and Upper Redgate Pump Station	710 ML
Silverleaf Weir	Ponds water for irrigators along Barambah Creek	620 ML

Facility	Function	Capacity
Upper Redgate PS	Pumps water from Joe Sipple Weir into Francis Weir.	20 ML/d

1.2 Three Moon Creek Water Supply Scheme

Figure 1-2 Diagram of Three Moon Creek Water Supply Scheme



Three Moon Creek *Water Supply Scheme* supplies riparian users along Three Moon Creek and the town of Monto, recharges groundwater supplies, and replenishes in-stream storages. The scheme centres on Cania Dam on Three Moon Creek 125 km west of Bundaberg and 36 km northwest of Monto.

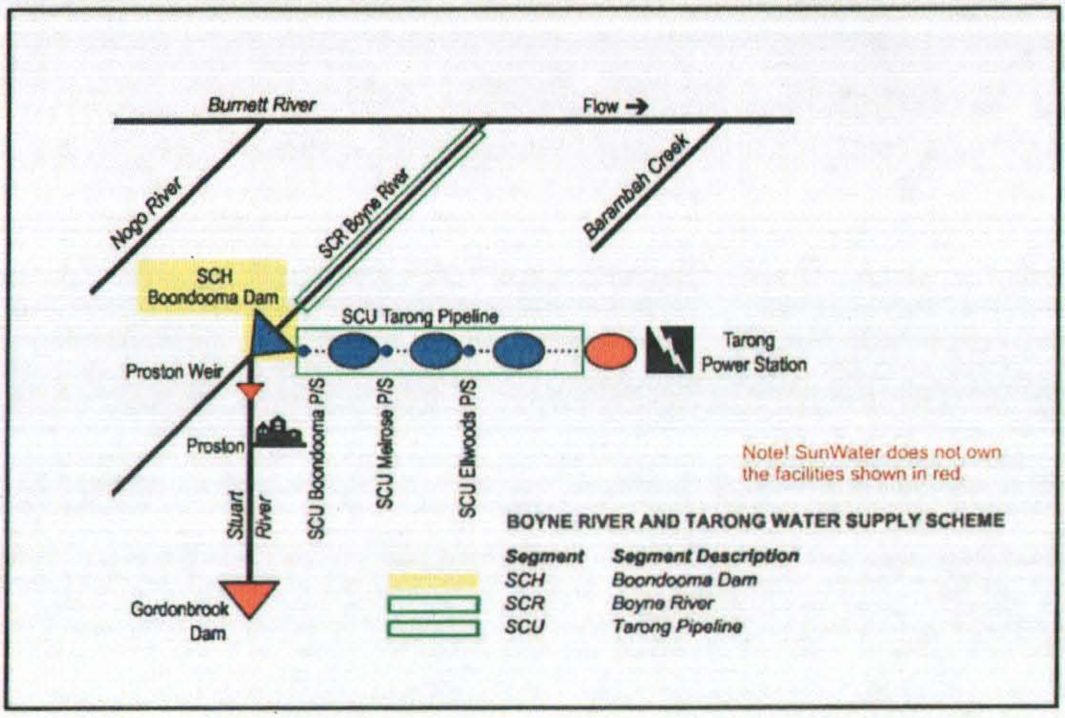
Water released from Cania Dam successively fills the ponded areas formed by the Three Moon Creek weirs.

Table 1-2 Main Facilities of Three Moon Creek Water Supply Scheme

Facility	Function	Capacity
Cania Dam	Headworks for Three Moon Creek Water Supply Scheme	88,500 ML
Youlambie Weir	Ponds water for irrigators and GW recharge	143 ML
Monto Weir	Ponds water for irrigators and GW recharge	27 ML
Bazley Weir	Ponds water for irrigators and GW recharge	75 ML
Avis Weir	Ponds water for irrigators and GW recharge	270 ML
Mulgildie Weir	Ponds water for irrigators and GW recharge	330 ML

1.3 Boyne River and Tarong Water Supply Scheme

Figure 1-3 Diagram of Boyne River and Tarong Water Supply Scheme



The Boyne River and Tarong *Water Supply Scheme* (Figure 1-3) is centred on Boondooma Dam on the Boyne River northwest of Kingaroy. It is designed to supply water to the Tarong Power Station and to downstream landholders along the Boyne River.

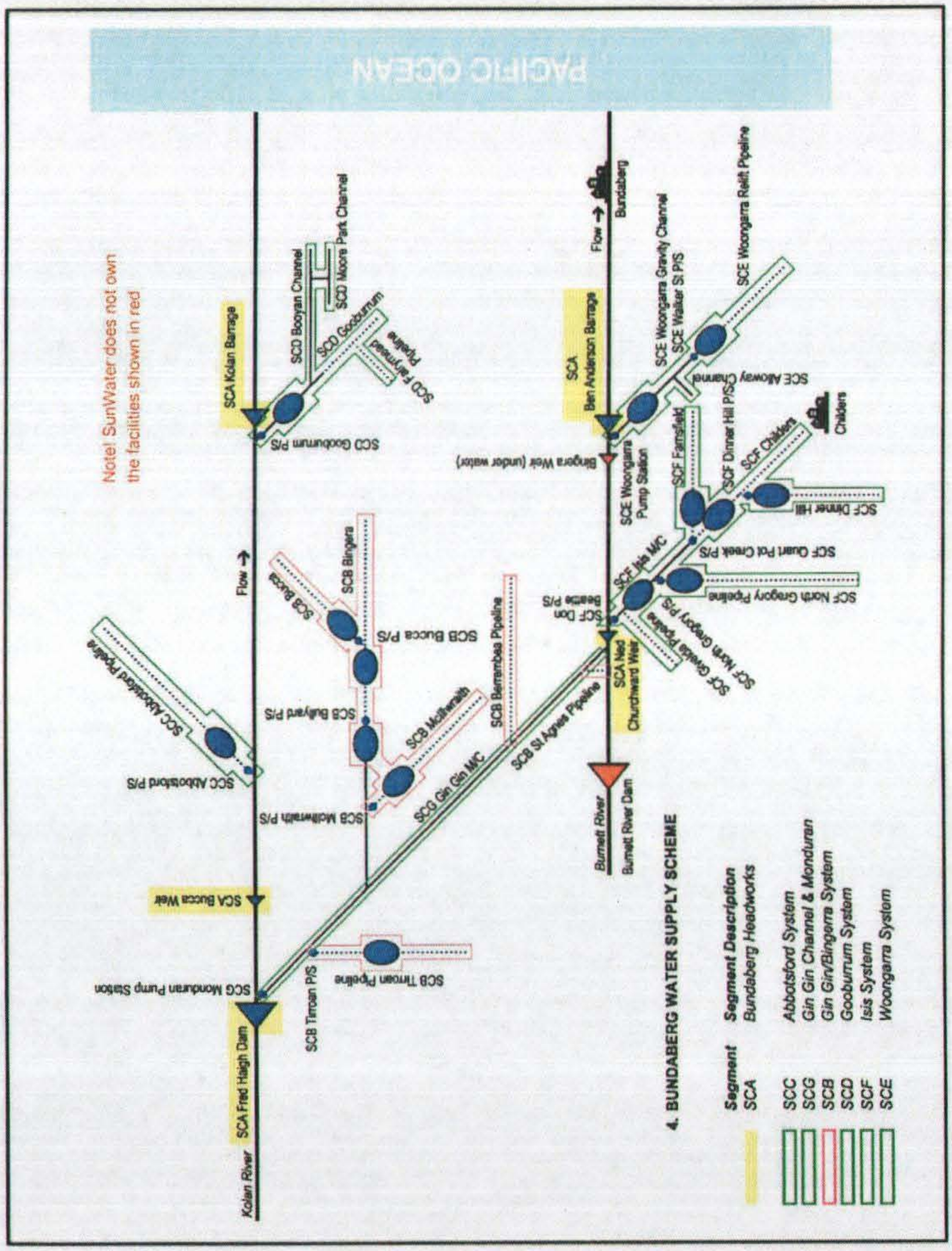
The Tarong Pipeline – that supplies the Tarong Power Station – is the scheme's other main feature. It is 94 km long and incorporates 3 pump stations and 3 balancing storages.

Table 1-3 Main Facilities of Boyne River and Tarong Water Supply Scheme

Facility	Function	Capacity
Boondooma Dam	Supplies Boyne River and Tarong Water Supply Scheme	204,200 ML
Boondooma PS	Tarong Pipeline	136 ML/d
Melrose PS	Tarong Pipeline	136 ML/d
Ellwoods PS	Tarong Pipeline	136 ML/d

1.4 Bundaberg Water Supply Scheme

Figure 1-4 Diagram of Bundaberg Water Supply Scheme



The Bundaberg *Water Supply Scheme* (Figure 1-4) is located near Bundaberg. It supplies irrigation, industry, and urban communities through two linked river systems: One system is served from the Kolan River (Fred Haigh Dam, Bucca Weir and Kolan Barrage) and the other system is served from the Burnett River (Paradise Dam, Ned Churchward Weir and Ben Anderson Barrage). Each system consists of a series of sub-systems supplied through a network of pump stations, balancing storages, channels, and pipelines which delivers water to customers.

Table 1-4 Main Facilities of Bundaberg Water Supply Scheme

Facility	Function	Capacity
Fred Haigh Dam	Supplies Kolan Barrage and Gin Gin Main Channel	562,000 ML
Paradise Dam	Supplies Burnett River, Ned Churchward Weir	300,000 ML
Bucca Weir	Regulates flow and supplies riparian landholders	11,600 ML
Kolan Barrage	Supplies Abbotsford and Gooburrum systems	3,810 ML
Ned Churchward Weir	Stores water for release into Ben Anderson Barrage and riparian landholders	29,500 ML
Ben Anderson Barrage	Supplies Woongarra and Isis systems	30,300 ML
Abbotsford PS	Supplies Abbotsford System	24 ML/d
Bucca PS	Supplies Bucca Pipeline	60 ML/d
Bullyard PS	Supplies Bingera Pipeline	415 ML/d
Dinner Hill PS	Supplies Dinner Hill Pipeline	160 ML/d
Don Beattie PS	Supplies Isis System	648 ML/d
Gooburrum PS	Supplies Gooburrum System	300 ML/d
McIlwraith PS	Supplies McIlwraith Pipeline	60 ML/d
Monduran PS	Supplies Gin Gin Main Channel	1100 ML/d
North Gregory PS	Supplies North Gregory Pipeline	63 ML/d
Quart Pot PS	Supplies Childers and Farnfield Pipelines	250 / 275 ML/d
Tiroan PS	Supplies Tirroan Pipeline	72 ML/d
Walker St PS	Supplies Woongarra Relift Pipeline	226 ML/d
Woongarra PS	Supplies Woongarra System	400 ML/d

1.5 Burdekin Haughton Water Supply Scheme

The Burdekin Haughton *Water Supply Scheme* (Figure 1-5) is located west of Ayr. It supplies raw water for irrigation, towns and industry, stock watering, and aquifer recharge.

The scheme extends north from the Burdekin Falls Dam on the Burdekin River to the Giru Weir on the Haughton River and supplies water to farms spread over 9 sub-systems. Six of these 9 sub-schemes incorporate drains designed to intercept irrigation runoff.

The Burdekin Falls Dam is the main water storage facility of the scheme. Other controlling facilities are the Gorge, Blue Valley, Clare, and Val Bird Weirs. Water from the storages created by the weirs is distributed through networks consisting of pump stations, pipelines, balancing storages, channels, creeks, and metered outlets.

A recent addition (2007) is the Burdekin Moranbah Pipeline, which draws from the Gorge Weir. The Burdekin Moranbah pipeline joins with the Eungela Pipeline to supply the Balancing Storage at Moranbah which in turn supplies the expanding coalfields of Queensland's Bowen Basin

Figure 1-5 Diagram of Burdekin Haughton Water Supply Scheme

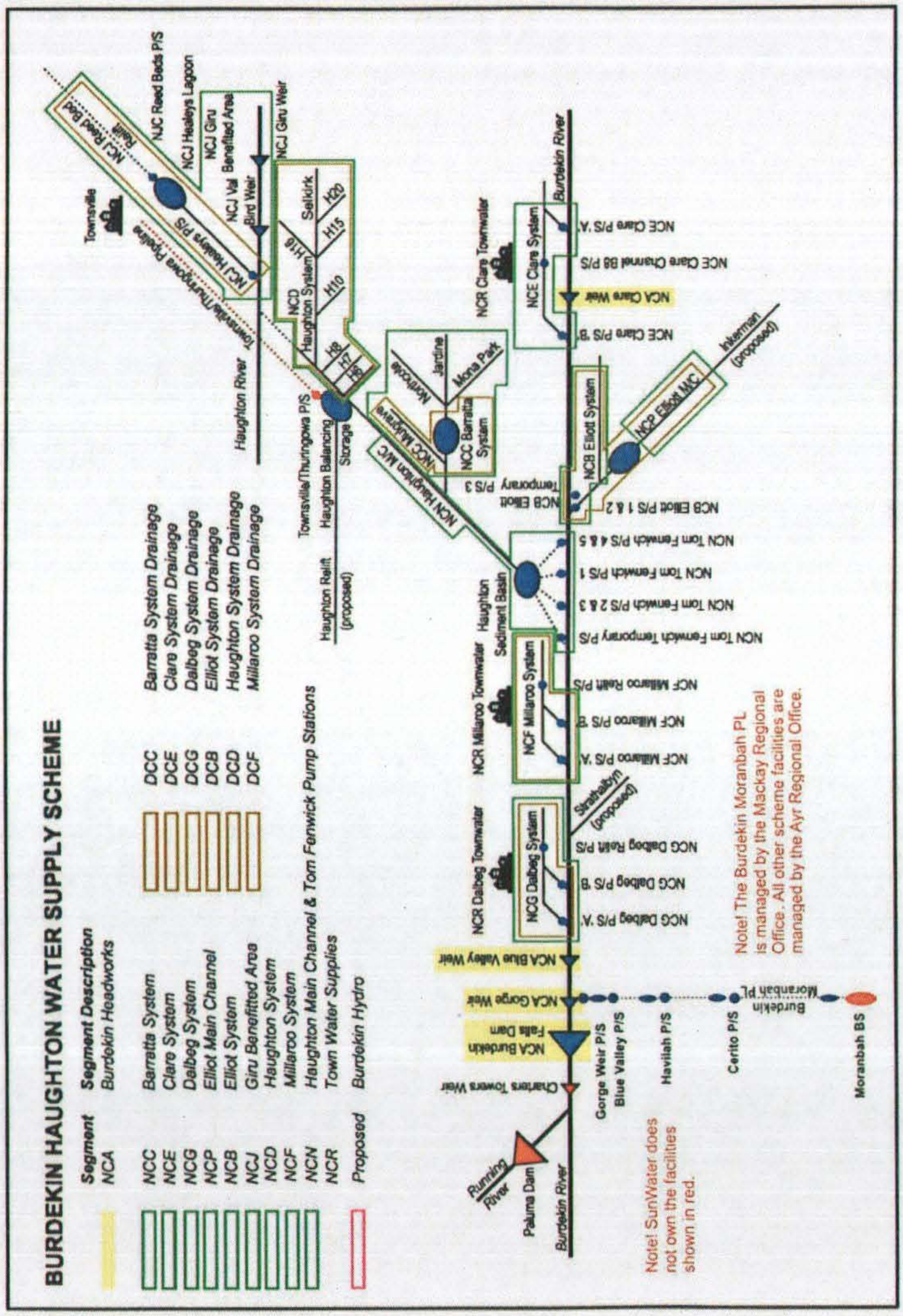
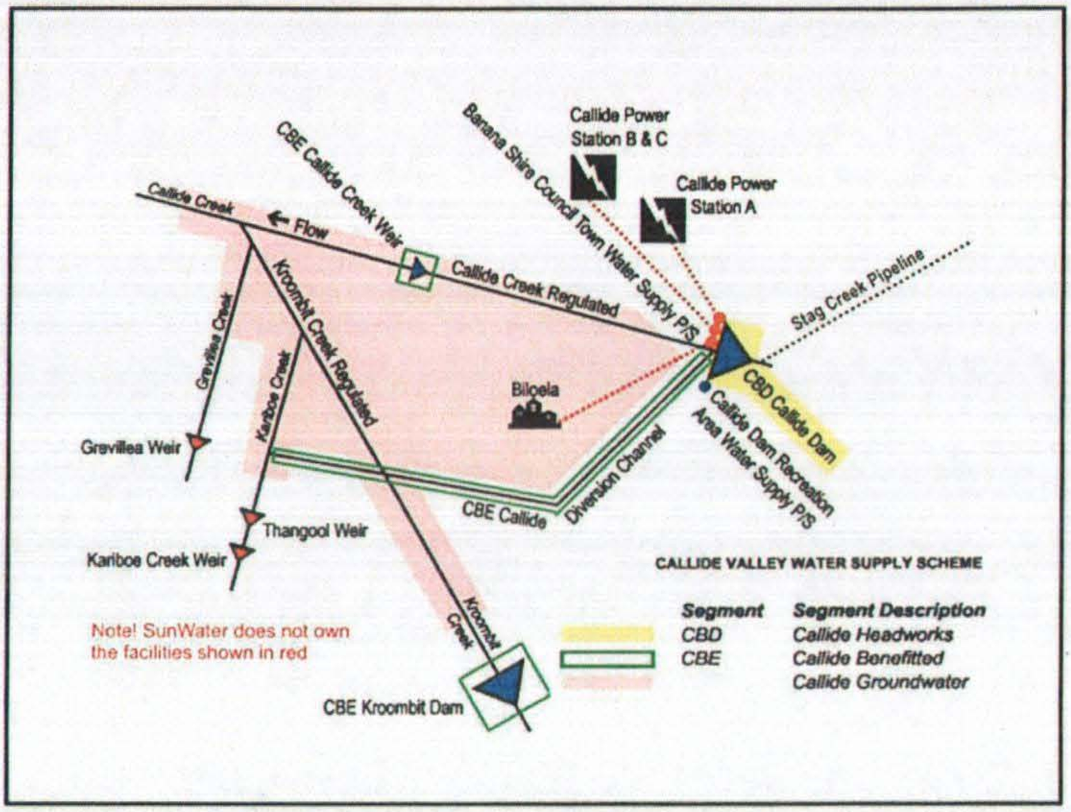


Table 1-5 Main Facilities of Burdekin Haughton Water Supply Scheme

Facility	Function	Capacity
Burdekin Falls Dam	Supplies the Burdekin River based part of the water supply scheme including Gorge, Blue Valley, and Clare Weirs	1,860,000 ML
Gorge Weir	Pond water downstream of Burdekin falls dam	9.095 ML
Blue Valley Weir	Pond water downstream of Gorge Weir	3,820 ML
Clare Weir	Ponds water for Dalbeg, Millaroo, Haughton, Barratta, Elliott and Clare Systems	15,900 ML
Val Bird Weir	Supplies the Giru System	2, 055 ML
Giru Weir	Supplies the Giru System	1, 025 ML
Clare Channel B8 PS	Supplies Clare System	21 ML/d
Clare PS 'A'	Supplies Clare System	166 ML/d
Clare PS 'B'	Supplies Clare System	122 ML/d
Dalbeg PS 'A'	Supplies Dalbeg System	74 ML/d
Dalbeg PS 'B'	Supplies Dalbeg System	74 ML/d
Dalbeg Relift PS'	Supplies Dalbeg System	18 ML/d
Elliot PS 1/2	Supplies Elliot System	180 ML/d
Healeys PS	Supplies Giru Benefited Area System	98 ML/d
Millaroo PS 'A'	Supplies the Millaroo System	180 ML/d
Millaroo PS 'B'	Supplies the Millaroo System	111 ML/d
Millaroo Relift PS	Supplies the Millaroo System	34 ML/d
Reed Beds PS	Supplies Giru Benefited Area System	45 ML/d
Tom Fenwick PS 1	Supplies the Haughton and Barratta Systems	605 ML/d
Tom Fenwick PS 2/3	Supplies the Haughton and Barratta Systems	1209 ML/d
Tom Fenwick PS 4/5	Supplies the Haughton and Barratta Systems	1209 ML/d
Tom Fenwick Temp PS	Supplies the Haughton and Barratta Systems	180 ML/d
Gorge Weir PS	Supplies the Burdekin Moranbah Pipeline from Gorge Weir	47 ML/d
Blue Valley PS	Booster Pump Station on Burdekin Moranbah Pipeline	47 ML/d
Havilah PS	Booster Pump Station on Burdekin Moranbah Pipeline	47 ML/d
Cerito PS	Booster Pump Station on Burdekin Moranbah Pipeline	47 ML/d

1.6 Callide Valley Water Supply Scheme

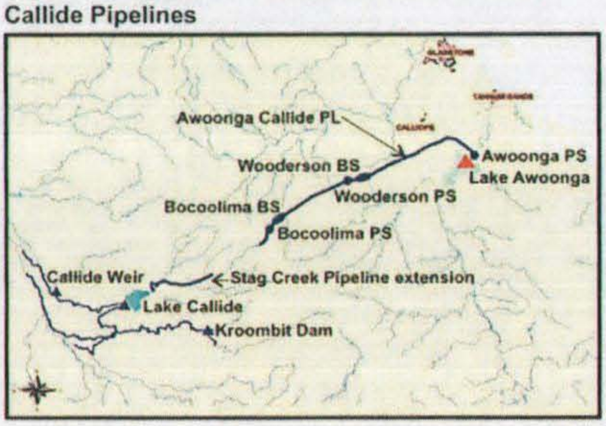
Figure 1-6 Diagram of the Callide Valley Water Supply Scheme



The Callide Valley *Water Supply Scheme* (Figure 1-6) supplies bulk water for the Town of Biloela and the Callide Power Station and recharges the area's aquifer for the benefit of local irrigators and industry. The scheme comprises the Kroombit and Callide Dams, Callide Creek Weir, and the Callide Diversion Channel.

In addition to holding water for the Callide Valley *Water Supply Scheme*, Callide Dam also acts as a temporary storage for water owned by the Callide Power Station supplied via the Awoonga Callide and Stag Creek Pipelines from the Awoonga Dam near Gladstone (Figure 1-7). Although the Awoonga-Callide and Stag Creek Pipeline are not formally included in any *IROLS ROP* issued by DERM, they are included here because they are an integral part of the operation of the Callide Dam.

Figure 1-7 Diagram of Stag Creek and Awoonga-Callide Pipelines



The Awoonga-Callide Pipeline is 54 km long and has three pump stations, Awoonga, Wooderson, and Bocoolima. The Awoonga Pump Station pumps directly from Awoonga Dam (owned by GAWB). The Wooderson and Bocoolima Pump Stations pump from balancing storages.

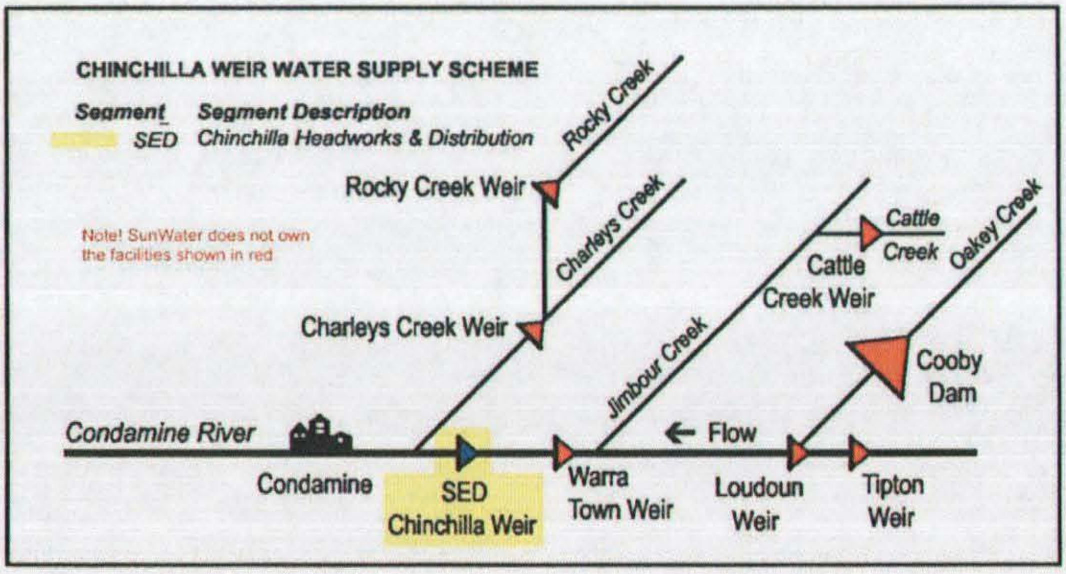
The Awoonga Callide Pipeline *discharges* into Stag Creek Gorge from where it flows into the Stag Creek weir andPipeline that ends just upstream of Callide Dam.

Table 1-6 Main Facilities Callide Valley Water Supply Scheme and Awoonga Callide Pipeline

Facility	Function	Capacity
Callide Valley WSS		
Callide Dam	Supplies Callide Valley Water Supply Scheme and pump pool for Callide Power Stations and Banana Shire Council Town water Supply	136,370 ML
Kroombit Dam	Supplies Callide Valley Water Supply Scheme for irrigators and GW recharge	14,600 ML
Callide Weir	Ponds water for irrigators and GW recharge	506 ML
Awoonga-Callide PL	(54 km long rising main)	90 ML/d
Awoonga PS	Awoonga Callide Pipeline	90 ML/d
Wooderson PS	Awoonga Callide Pipeline (Relift)	90 ML/d
Bocoolima PS	Awoonga Callide Pipeline (Relift)	90 ML/d
Stag Creek PL	(15 km long gravity main)	90 ML/d

1.7 Chinchilla Weir Water Supply Scheme

Figure 1-8 Diagram of Chinchilla Weir Water Supply Scheme



The Chinchilla Weir *Water Supply Scheme* (Figure 1-8) consists of Chinchilla Weir on the Condamine River south of the Town of Chinchilla. The weir supplies local irrigators upstream and downstream of the weir as well as the Town of Chinchilla. Under the arrangement, upstream irrigators pump directly from the pond created by the weir and downstream irrigators from the flows regulated by releases from the weir.

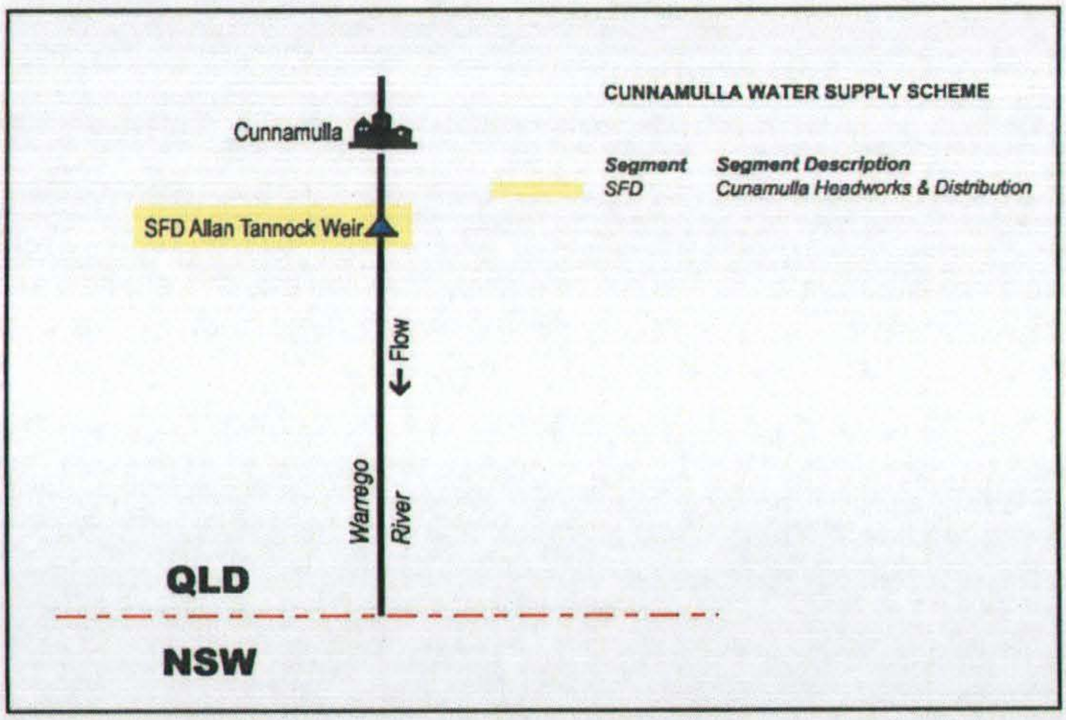
Table 1-7 Main Facilities of Chinchilla Water Supply Scheme

Facility	Function	Capacity
Chinchilla Weir	Headworks for the Chinchilla Weir Water Supply Scheme	9780 ML

There is no dam in this scheme

1.8 Cunnamulla Weir Water Supply Scheme

Figure 1-9 Diagram of Cunnamulla Weir Water Supply Scheme



The Cunnamulla Weir *Water Supply Scheme* (Figure 1-9) comprises Allan Tannock Weir on the Warrego River just south of the Town of Cunnamulla. It supplies water to landholders along its ponded area and downstream of the weir, as well as bulk water for Cunnamulla to supplement the town's bore *water supply scheme*.

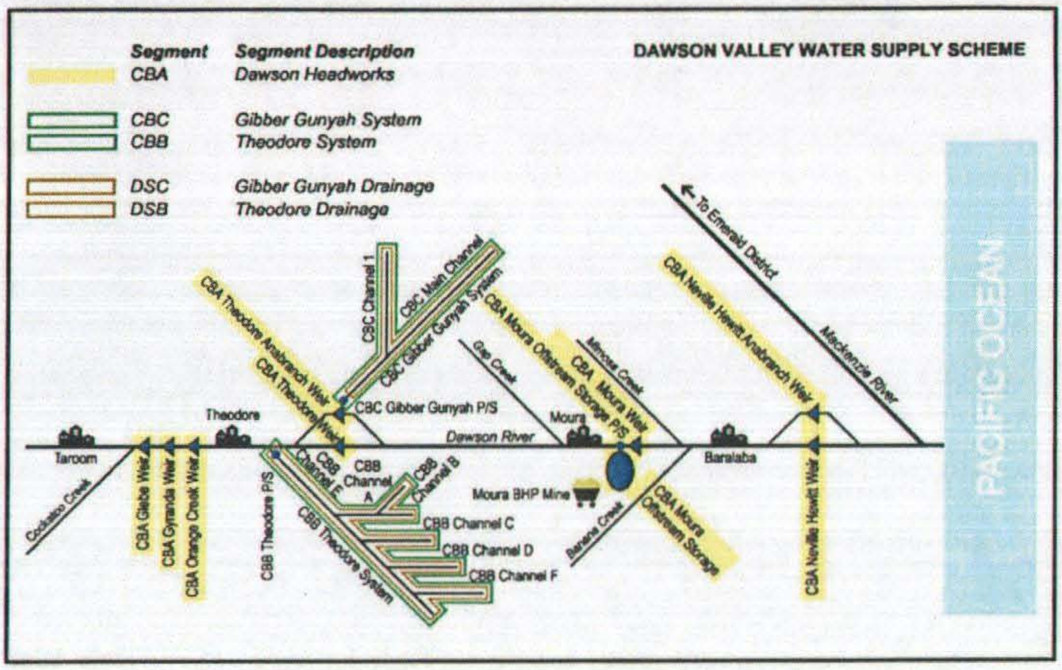
Table 1-8 Main Facilities of Cunnamulla Weir Water Supply Scheme

Facility	Function	Capacity
Allan Tannock Weir	Headworks for the Cunnamulla Weir Water Supply Scheme	4772 ML

There is no dam in this scheme.

1.9 Dawson Valley Water Supply Scheme

Figure 1-10 Diagram of Dawson valley Water Supply Scheme



The Dawson Valley *Water Supply Scheme* (Figure 1-10) is centred on Town of Theodore, and covers regulated sections of the Dawson River controlled by Glebe Weir, Gyranda Weir, Orange Creek Weir, Theodore Weir, Moura Weir, Neville Hewitt Weir and the Moura Offstream Storage. The scheme supplies untreated water for irrigators, mines, other industries, and urban authorities.

The scheme also incorporates the Theodore and Gibber Gunyah irrigation distribution systems that consist of a combination of open channels and pipelines. Both systems draw from Theodore Weir through Pump Stations named after the sections they serve.

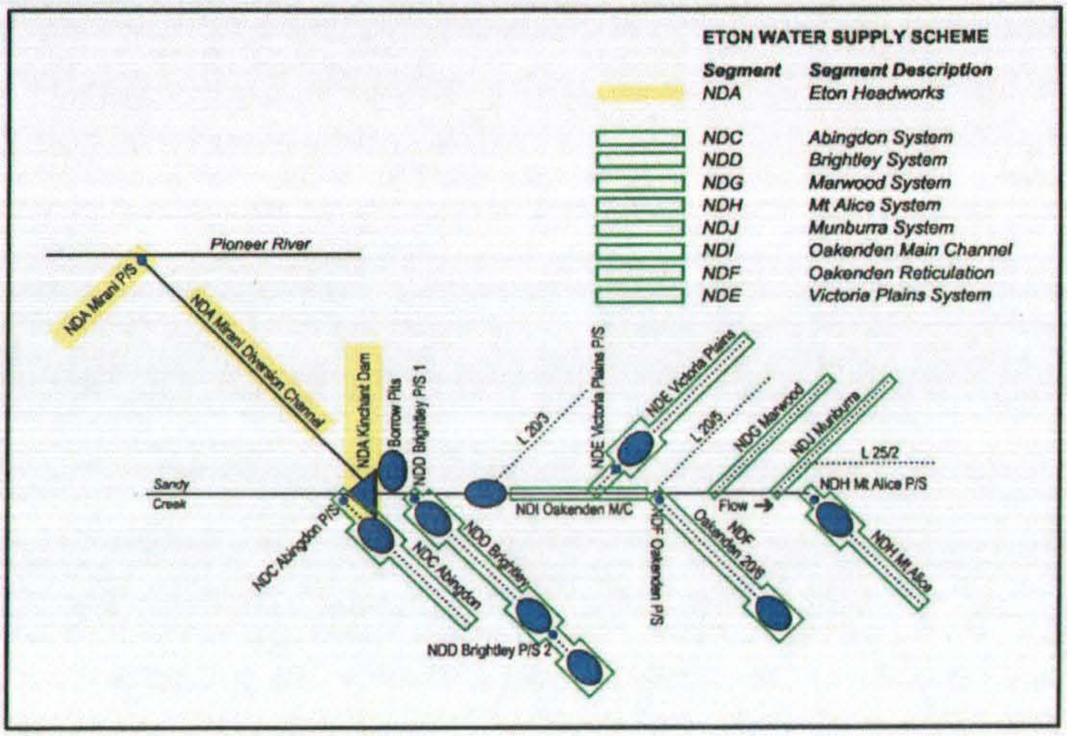
Table 1-9 Main Facilities of Dawson Valley Water Supply Scheme

Facility	Function	Capacity
Glebe Weir	Supplies Dawson River riparian landholders + Taroom	17,700 ML
Gyranda Weir	Supplies Dawson River riparian landholders	16,400 ML
Orange Creek Weir	Supplies Dawson River riparian landholders	6,780 ML
Theodore Weirs	As above + pump pool for Theodore and Gibber Gunyah PS	4760 ML
Moura Weir	Supplies Dawson River riparian landholders + Moura +industry	7,700 ML
Neville Hewitt Weirs	Supplies Dawson River riparian landholders + Barabala	11,300 ML
Moura OS Storage	Provides additional storage capacity adjacent to Moura Weir	2,820 ML
Theodore PS	Supplies Theodore System	102 ML/day
Gibber Gunyah PS	Supplies Gibber Gunyah System	121 ML/day
Moura OS PS	Fills Moura OS Storage	173 ML/day

There is no dam in this scheme.

1.10 Eton Water Supply Scheme

Figure 1-11 Diagram of Eton Water Supply Scheme



The Eton *Water Supply Scheme* (Figure 1-11) is located near Mackay. It supplies water to irrigators, stock and domestic water users, and the Haypoint Coal Loading Facilities near Sarina. Kinchant Dam on Sandy Creek is the main storage.

During periods of high flow in the Pioneer River, the Mirani Pump Stations pump water from the river into Kinchant Dam via the Mirani Diversion Channel. From there, water is progressively released into Oakenden Main Channel for distribution through a network of sub-systems, pipelines, small pump stations, and balancing storages.

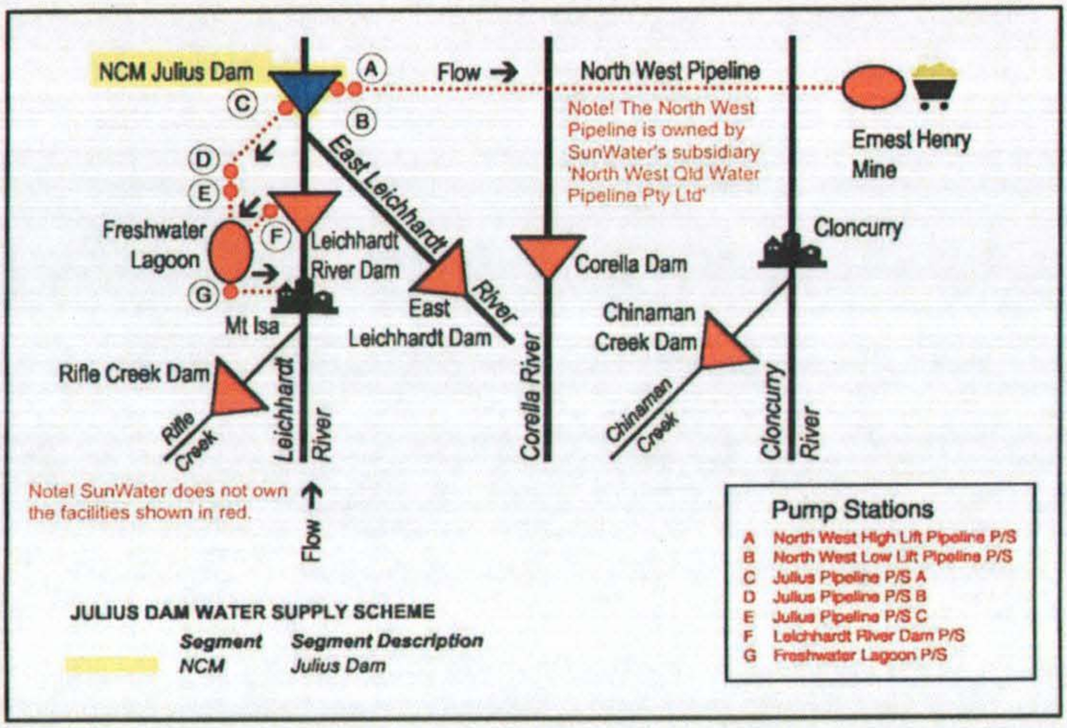
Table 1-10 Main Facilities of Eton Water Supply Scheme

Facility	Function	Capacity
Mirani PS	Supplies Kinchant Dam	860 ML/d
Kinchant Dam	Supplies Eton Water Supply Scheme	62,800 ML
Abingdon PS	Supplies Abingdon System	32 ML/d
Brightley PS '1'	Supplies Brightley System	62 ML/d
Brightley PS '2'	Supplies Brightley System (Relift)	19 ML/d
Mt Alice PS	Supplies Mt Alice System	121 ML/d
Oakenden PS	Supplies Oakendon System	31 ML/d
Victoria Plains PS	Supplies Victoria Plains System	82 ML/d

1.11 Julius Dam Water Supply Scheme

The Julius Dam *Water Supply Scheme* (Figure 1-12) is located on the Leichhardt River 60 km north of Mount Isa.

Figure 1-12 Diagram of Julius Dam Water Supply Scheme



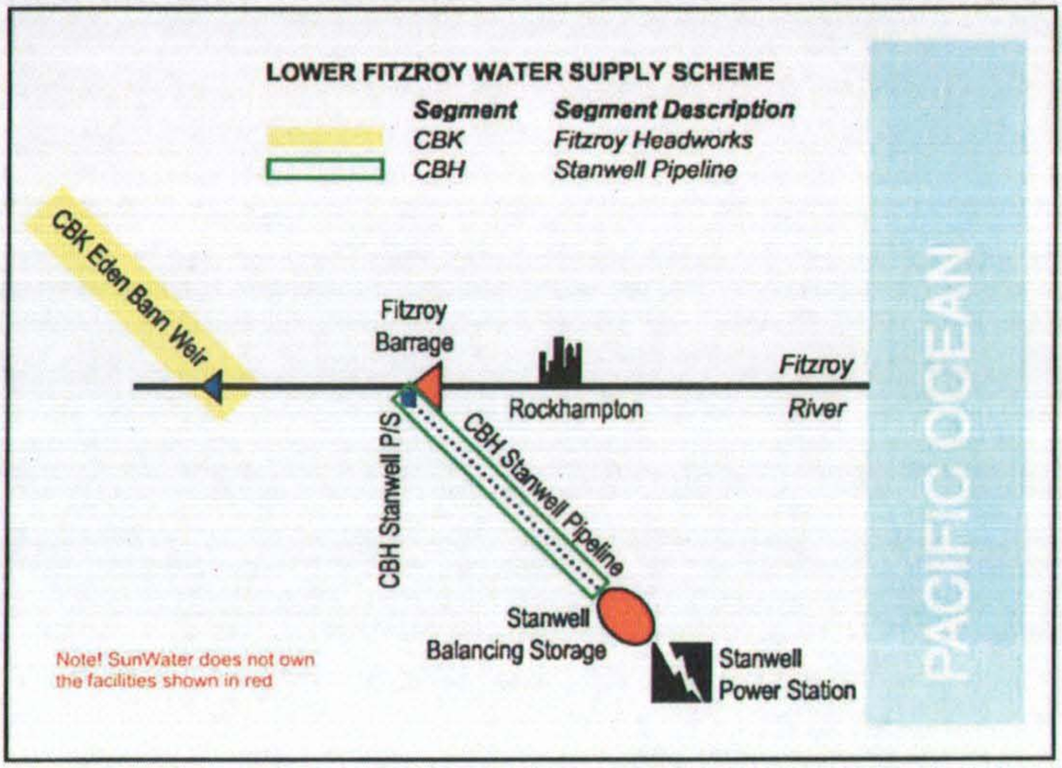
Julius Dam is the water source for the North West Pipeline owned by the North West Queensland Water Pipeline Company Pty Ltd and is used by the Mount Isa Water Board as a backup for Lake Moondarra near the City of Mount Isa.

Table 1-11 Main Facilities of Julius Dam Water Supply Scheme

Facility	Function	Capacity
Julius Dam	Supplies water for Mt Isa Water Board and North West Qld Water Supply Pipeline Company P/L	107,500 ML

1.12 Lower Fitzroy Water Supply Scheme

Figure 1-13 Diagram of the Lower Fitzroy Water Supply Scheme



The Lower Fitzroy *Water Supply Scheme* (Figure 1-13) comprises Eden Bann Weir on the Fitzroy River and Stanwell Pipeline. The scheme supplies the Stanwell Power Station, riparian landholders on the Fitzroy River downstream of the weir, and landholders along the Stanwell pipeline. The scheme is operated in conjunction with the Fitzroy Barrage, which is owned and operated by Rockhampton Regional Council.

Flows in the Fitzroy River are stored by Eden Bann Weir from where it is progressively released to maintain water levels in the Fitzroy Barrage from which the Stanwell Pipeline draws its supply.

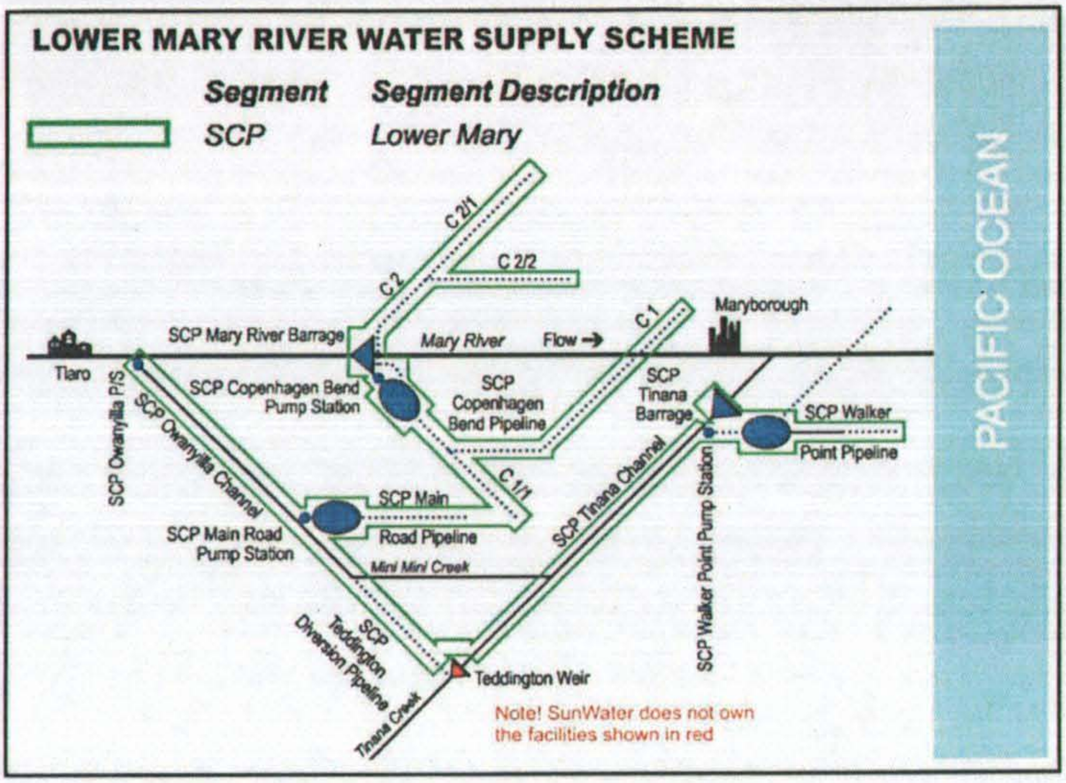
Table 1-12 Main Facilities of Lower Fitzroy Water Supply Scheme

Facility	Function	Capacity
Eden Bann Weir	Headworks for Lower Fitzroy WSS and Fitzroy Barrage	35,900 ML
Stanwell PS	Supplies Stanwell Power Station through Stanwell Pipeline	79 ML/day

There is no dam in this scheme.

1.13 Lower Mary River Water Supply Scheme

Figure 1-14 Diagram of Mary River Water Supply Scheme



The Lower Mary *Water Supply Scheme* (Figure 1-14) supplies water for irrigation, urban and industrial use around Maryborough and for irrigators. It is divided into Owanyilla, Copenhagen Bend, and Walker Point distribution systems; utilising regulated streams, pump stations, channels, and pipelines. Owanyilla and Copenhagen Bend draw from the Mary River Barrage. Walker Point draws from the Tinana Creek Barrage.

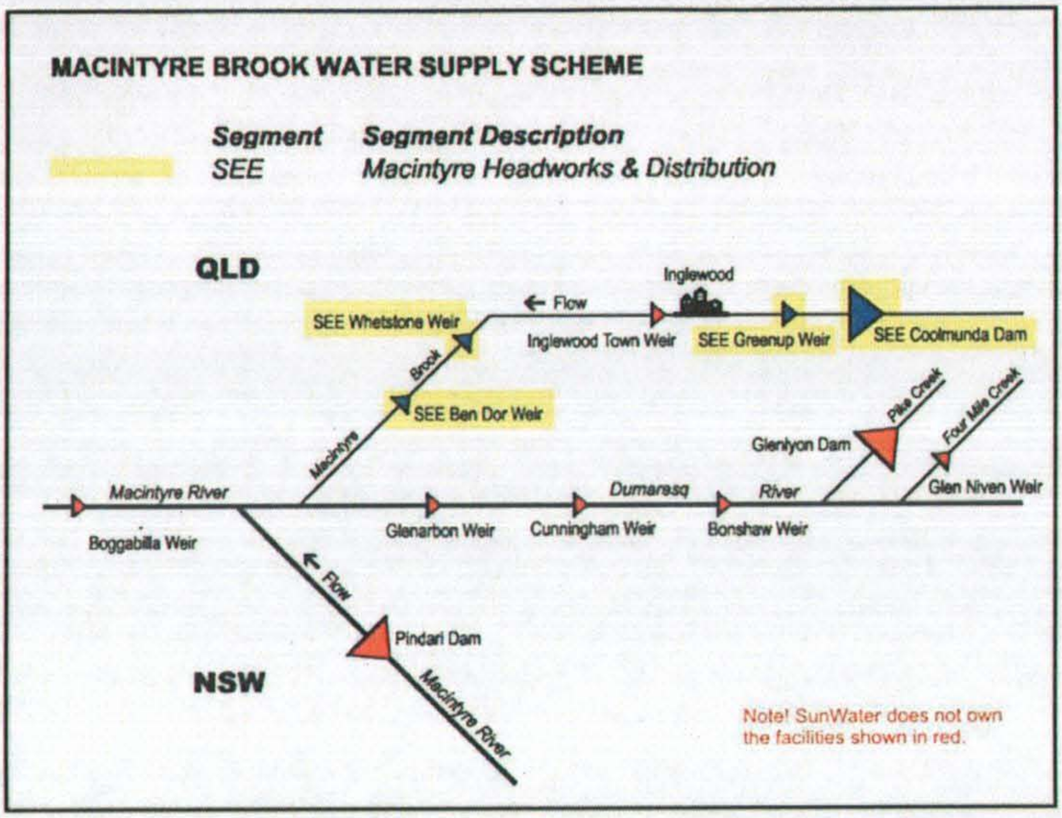
Table 1-13 Main Facilities of Mary River Water Supply Scheme

Facility	Function	Capacity
Mary Barrage	Ponds water for Mary River riparian users and Owanyilla and Copenhagen Bend PS	12,000 ML
Tinana Barrage	Storage and pumping pool for Walker Point PS	4,700 ML
Owanyilla PS	Pumps from Mary River Barrage into Owanyilla Channel	230 ML/day
Main Road PS	Supplies Main Roads Pipeline in Lower Mary System	70 ML/day
Copenhagen Bend PS	Pumps from Mary River barrage into Copenhagen Bend Balancing Storage	65 ML/day
Walker Point PS	Pumps into Walker Point Balancing Storage	81 ML/day

There is no dam in this scheme.

1.14 Macintyre Brook Water Supply Scheme

Figure 1-15 Diagram of Macintyre Brook Water Supply Scheme



Macintyre Brook *Water Supply Scheme* (Figure 1-15) is centred on Coolmunda Dam east of Inglewood. The dam provides raw water for irrigators along the lower reaches of Macintyre Brook and for the Inglewood Town and bulk water for the Dumaresq River Irrigation Project.

Water is progressively released from Coolmunda Dam to Greenup Weir, Whetstone, Inglewood Town, and Ben Dor Weirs to the junction with the Dumaresq River near the Town of Yelarbon. Customers pump directly from the regulated sections of Macintyre Brook. SunWater does not own the Inglewood Town Weir

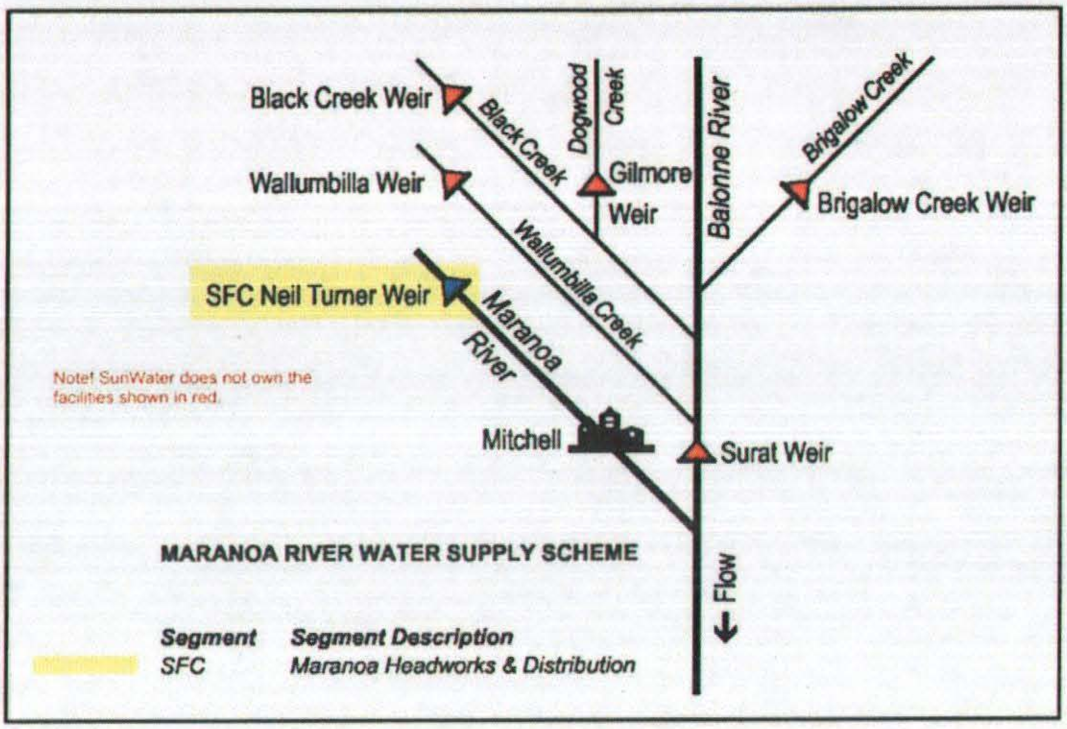
Table 1-14 Main Facilities of Macintyre Brook Water Supply Scheme

Facility	Function	Capacity
Coolmunda Dam	Headworks for Macintyre Brook Water Supply Scheme	69,000 ML
Greenup Weir[66]	Ponds water in MacIntyre River for riparian users	370 ML
Whetstone Weir	Ponds water in MacIntyre River for riparian users	506 ML
Ben Dor Weir	Ponds water in MacIntyre River for riparian users	734 ML

[66] Greenup Weir is an old timber piled structure that is not essential for the effective operation of the scheme. It will not be refurbished or replaced

1.15 Maranoa River Water Supply Scheme

Figure 1-16 Diagram of Maranoa River Water Supply Scheme



The Maranoa River *Water Supply Scheme* (Figure 1-16) centres on Neil Turner Weir near Mitchell in South Western Queensland. It was designed to provide water for the Town of Mitchell and for irrigators.

Table 1-15 Main Facilities of Maranoa River Water Supply Scheme

Facility	Function	Capacity
Neil Turner Weir[67]	Headworks for Maranoa River Water Supply Scheme	1,110 ML

There is no dam in this scheme.

1.16 Mareeba Dimbulah Water Supply Scheme

The Mareeba Dimbulah *Water Supply Scheme* (Figure 1-17) comprises Tinaroo Falls Dam, a number of regulating weirs on the Barron and Walsh river systems and a network of channels and pipelines delivering water for irrigation, urban and industrial use. The dam's outlet is channelled through a SunWater owned and operated hydro power station, which helps to offset the scheme's electricity use and reduce SunWater's carbon foot print.

The scheme is predominately a gravity supply scheme, but also includes five small pump stations. Five balancing storages – Nardello's Lagoon, East Barron, Arriga, Biboohra, and Jabiru Lagoon – regulate the daily variances between supply and demand along the channel system.

[67] Neil Turner Weir used to hold 1960 ML, but is slowly sanding up

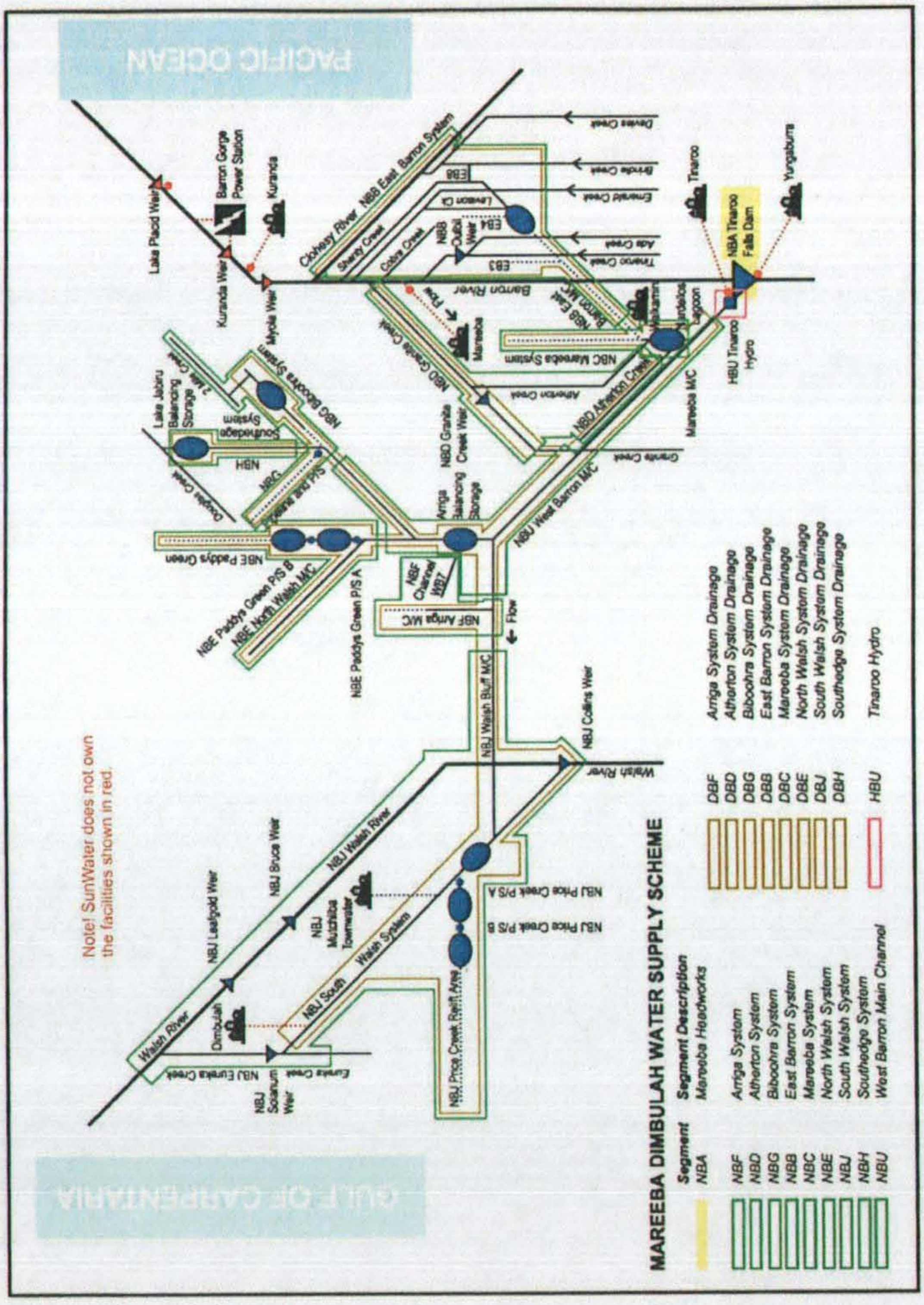
Tinaroo Falls Dam regulates flow along the Barron River downstream to Kuranda to supply water for irrigation, urban and hydro power generation. The channel system also supplements *watercourses* throughout the area to provide irrigation supplies to riparian landholders.

The scheme includes drains to capture run-off from irrigated land, but does not include the Kuranda, Dulbil, and Granite Creek Weirs.

Table 1-16 Main Facilities of Mareeba Dimbulah Water Supply Scheme

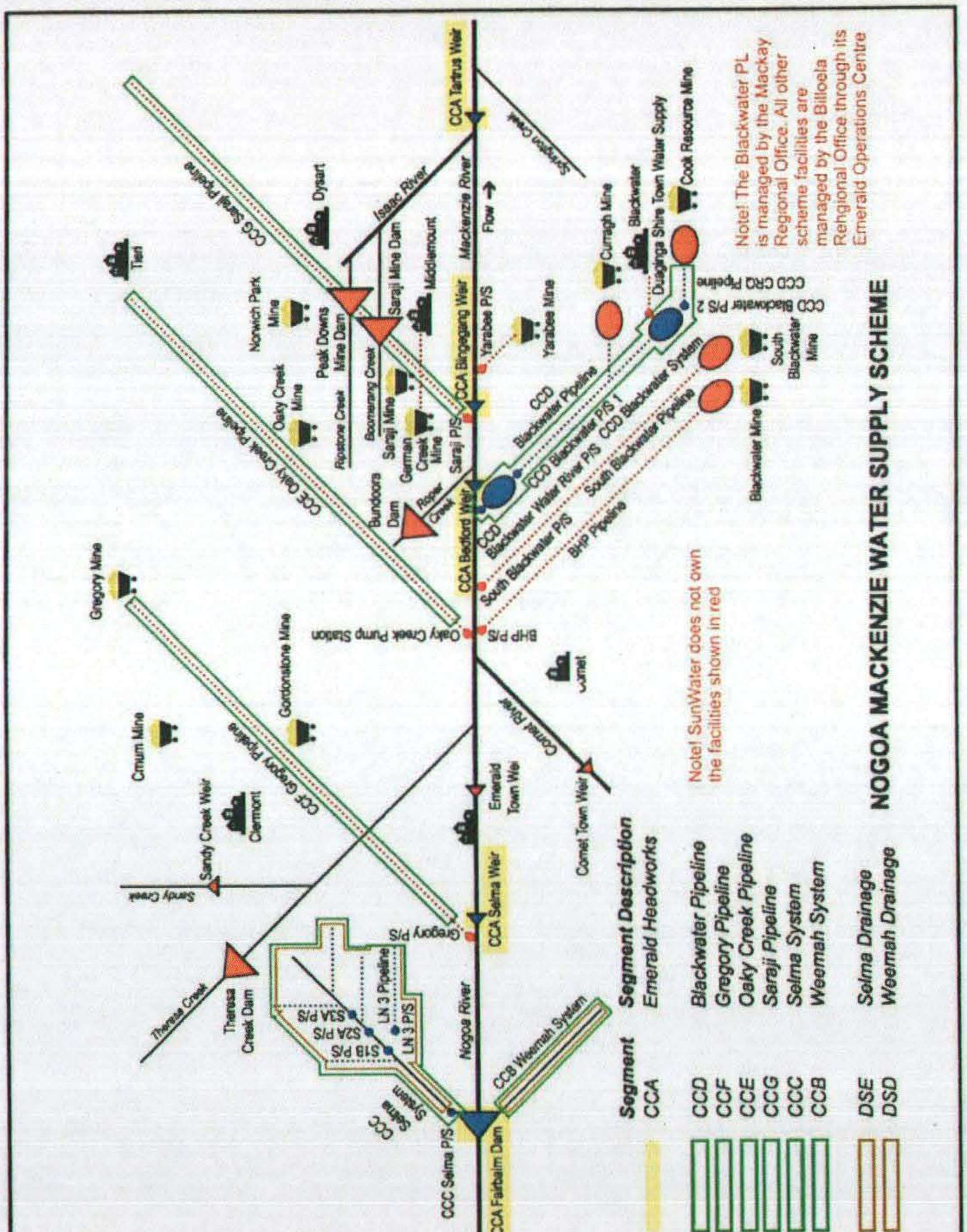
Facility	Function	Capacity
Tinaroo Falls Dam	Headworks for Mareeba Dimbullah Water Supply Scheme	438,920 ML
Collins Weir	Supplies South Walsh System from Walsh River	600 ML
Bruce Weir	Supplies South Walsh System from Walsh River	970 ML
Leafgold Weir	Supplies South Walsh System from Walsh River	260 ML
Solanum Weir	Supplies South Walsh System from Eureka Creek	68 ML
Granite Creek Weir	Ponds water in Granite Creek	244 ML
Dulbil Weir	Ponds water in Tinaroo and Ada Creek	270 ML
Price Creek PS A	Supplies Price Creek Relift in South Walsh System	34 ML/day
Price Creek PS B	Supplies Price Creek Relift in South Walsh System	24 ML/day
Paddys Green PS A	Supplies Paddys Green Relift in North Walsh System	58 ML/day
Paddys Green PS B	Supplies Paddys Green Relift in North Walsh System	44 ML/day
Biboohra PS	Supplies Biboohra System	5 ML/day

Figure 1-17 Diagram of the Mareeba Dimbulah Water Supply System



1.17 Nogoa Mackenzie Water Supply Scheme

Figure 1-18 Diagram of Nogoa Mackenzie Water Supply Scheme



Fairbairn Dam – located approximately 18 km south of Emerald – is the main source of supply for the Nogoa Mackenzie *Water Supply Scheme*. The dam is operated in conjunction with Selma, Bedford, Bingegang and Tartrus Weirs to regulate supplies along the Mackenzie

River and downstream to the Springton Creek junction. The dam also releases into the Selma and Weemah channel systems to supply irrigators.

The scheme is also the source of supply for six industrial water supply pipelines serving the Central Queensland coalfields area. Only one of these, the Blackwater Pipeline is owned by SunWater.

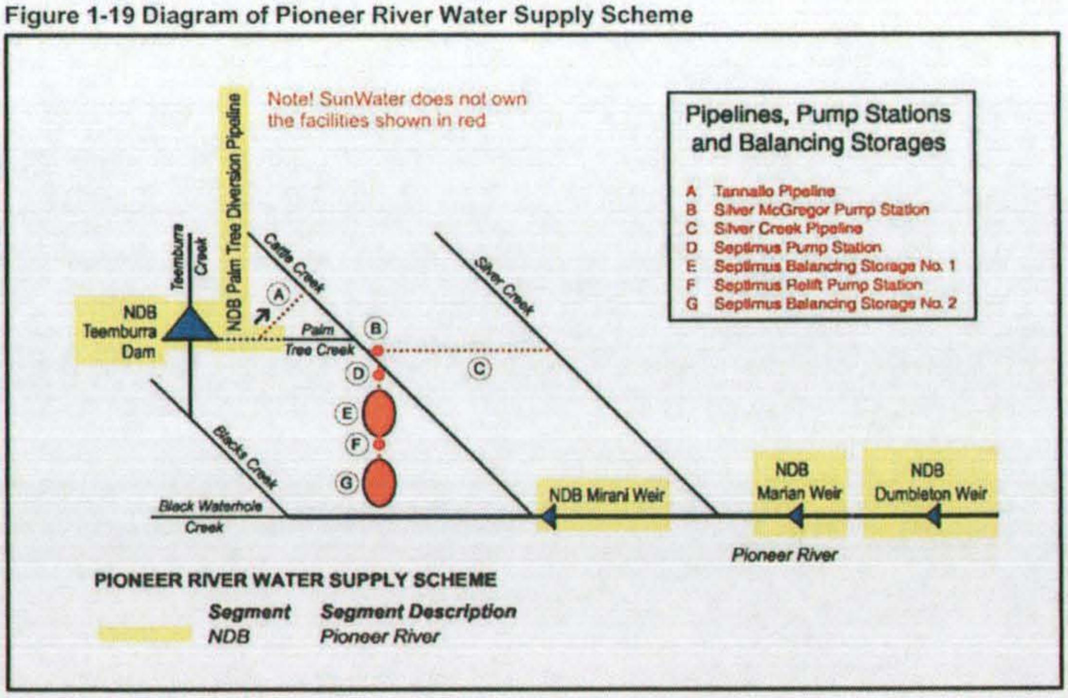
A system of drains in the Selma and Weemah distribution systems intercept overland runoff.

Table 1-17 Main Facilities of Nogoa Mackenzie Water Supply Scheme

Facility	Function	Capacity
Fairbairn Dam	Headworks for Nogoa Mackenzie Water Supply Scheme	1,301,130 ML
Selma Weir	Nogoa River riparian users + pump pool for Gregory Pipeline	1,180 ML
Bedford Weir	Mackenzie River riparian users + pump pool for Oakey Creek, BHP, South Blackwater and Blackwater Pipelines	22,980 ML
Bingegang Weir	Mackenzie River riparian users + pump pool for Seraji Pipeline	8,060 ML
Tartrus Weir	Mackenzie River riparian users + pump pool for Yarabee Pipeline	12,000 ML
Selma PS	Pumps from Fairbairn Dam when dam level is low	770 ML/day
Blackwater River PS	Pumps from Mackenzie River into Blackwater BS storage	56 ML/day
Blackwater PS 1	Relift for Blackwater pipeline	32 ML/day
Blackwater PS 2	Pumps water to mine sites	14 ML/day

1.18 Pioneer River Water Supply Scheme

Figure 1-19 Diagram of Pioneer River Water Supply Scheme



The Pioneer *Water Supply Scheme* (Figure 1-19) supplies water for urban and industrial use around Mackay and irrigation water for rural users. Mirani, Marian, and Dumbleton Weirs regulate flows along the Pioneer River, supplemented by releases from Teemburra Dam. The dam also supplies the Pioneer Valley Water Board via Palm Tree Creek Pipeline.

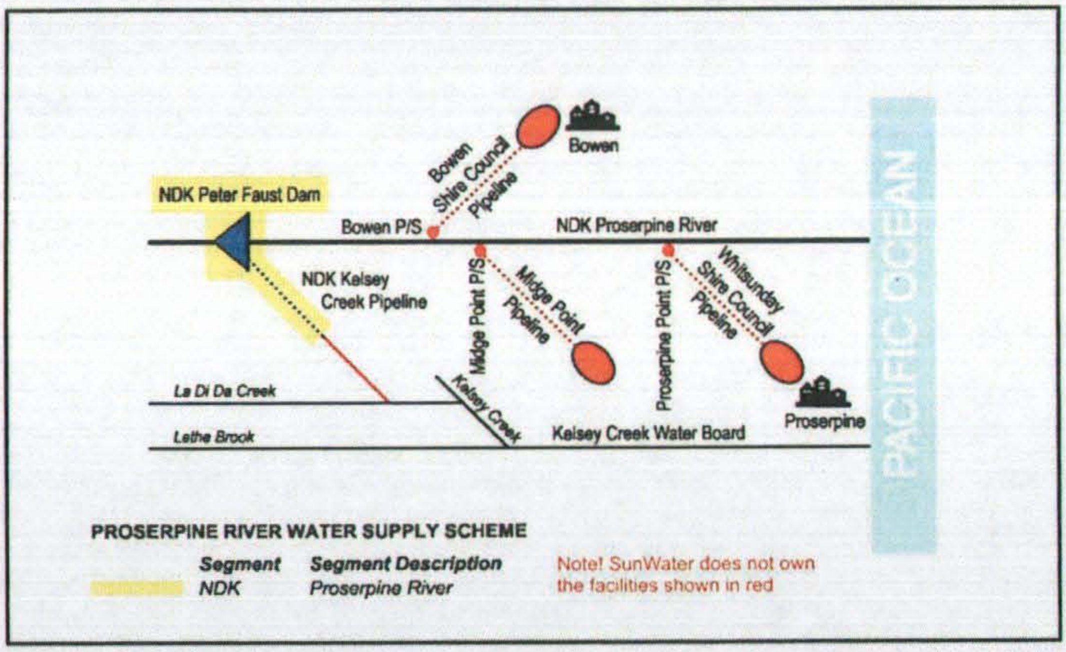
The Eton *Water Supply Scheme* is supplied from Mirani Weir.

Table 1-18 Main Facilities of Pioneer River Water Supply Scheme

Facility	Function	Capacity
Teemburra Dam	Headworks for Pioneer River Water Supply Scheme	147,500 ML
Mirani Weir	Ponds water for riparian landholders, urban and industrial	4,600 ML
Marian Weir	Ponds water for riparian landholders, urban and industrial	3,900 ML
Dumbleton Weir	Ponds water for riparian landholders, urban and industrial	8,700 ML

1.19 Proserpine River Water Supply Scheme

Figure 1-20 Diagram of Proserpine Water Supply Scheme



The Proserpine *Water Supply Scheme* comprises Peter Faust Dam which regulates flows along the Proserpine River for urban and irrigation use. The dam also provides passive flood mitigation benefits for the Town of Proserpine.

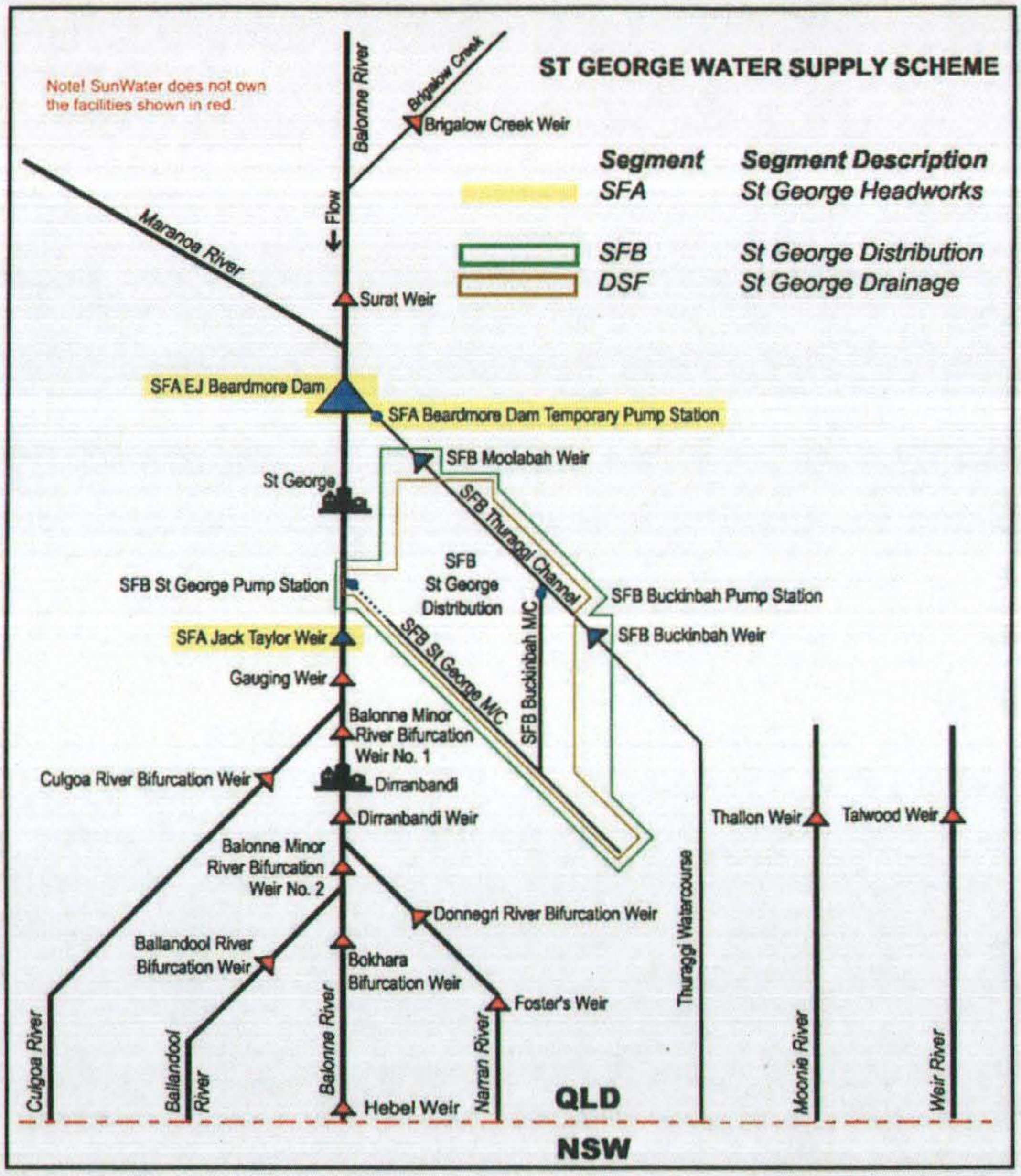
The Peter Faust Dam has two outlets; one for Proserpine River, the other for Kelsey Creek Pipeline which serves the Kelsey Creek Water Board.

Table 1-19 Main Facilities of Proserpine River Water Supply Scheme

Facility	Function	Capacity
Peter Faust Dam	Headworks for Proserpine River Water Supply Scheme	491,400 ML

1.20 St George Water Supply Scheme

Figure 1-21 Diagram of St George Water Supply Scheme



Beardmore Dam north of St George and the Jack Taylor Weir at St George are the main sources of supply for the St George *Water Supply Scheme* (Figure 1-21).

The Buckinbah section of the scheme is supplied from Beardmore Dam via the Thuraggi Channel, Moolabah and Buckinbah Weirs, while the St George section of the scheme is supplied through St George Pump Station just upstream of the Jack Taylor Weir.

The scheme also regulates water along the Balonne River for 175 kilometres.

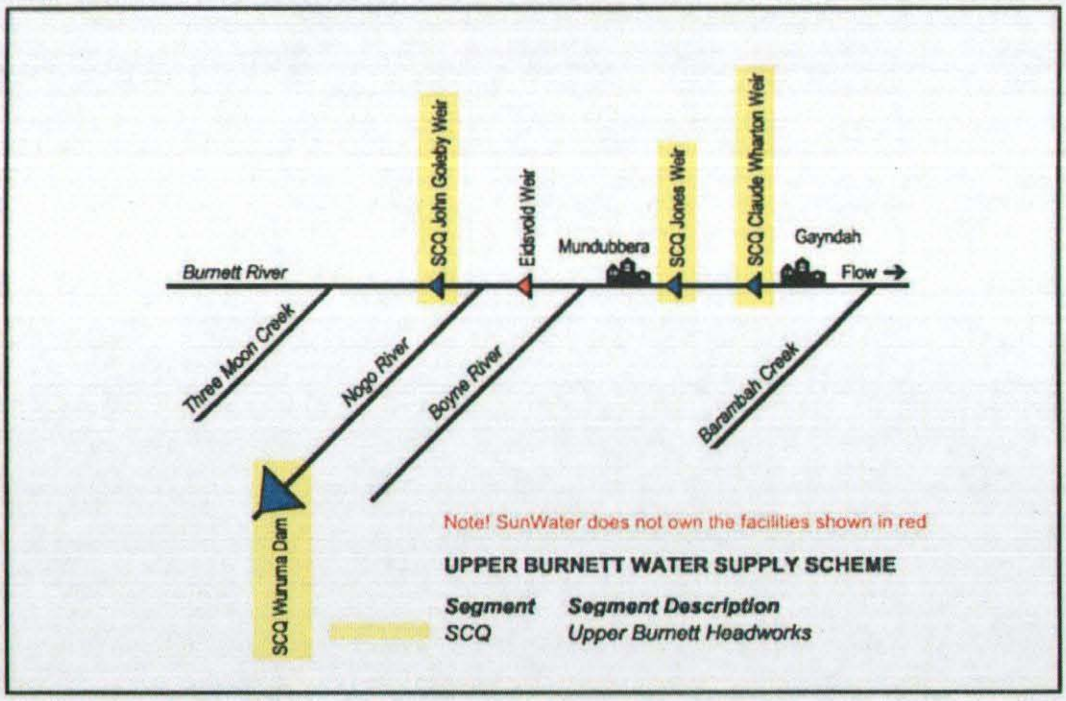
A system of drains provides drainage services for irrigators in the *Water Supply Scheme.*

Table 1-20 Main Facilities of St George Water Supply Water Supply Scheme

Facility	Function	Capacity
Beardmore Dam	Headworks for St George Water Supply Scheme	81700 ML
Jack Taylor Weir	Ponds water for irrigators and St George PS	10,100 ML
Moolabah Weir	Ponds water for irrigators and St George irrigators	2,580 ML
Buckinbah Weir	Ponds water for irrigators and St George Irrigators	5,120 ML
St George PS	Pumps from Balonne River into St George main Channel	110 ML/d
Buckinbah PS	Pumps from Thuraggi Channel into Buckinbah MC when levels are low	490 ML/d
Beardmore Dam Low Level PS	Pumps from Beardmore Dam into Thuraggi Channel when dam levels are low	440 ML/d

1.21 Upper Burnett Water Supply Scheme

Figure 1-22 Diagram of Upper Burnett Water Supply Scheme



The Upper Burnett *Water Supply Scheme* (Figure 1-22) supplies irrigators and raw water for the town water supplies of Mundubbera, Eidsvold, and Gayndah. The main source of supply is Wuruma Dam on the Nogo River, which regulates supplies along the Nogo and Burnett Rivers, in conjunction with John Goleby, Kirar, Jones and Claude Wharton Weirs. Kirar Weir is owned by Burnett Water.

Table 1-21 Main Facilities of Upper Burnett Water Supply Scheme

Facility	Function	Capacity
Wuruma Dam	Headworks for Upper Burnett Water Supply Scheme	165,400 ML

Kirar Weir	Pump pool for irrigators along Burnett River	9,540 ML
John Goleby Weir	Pump pool for irrigators along Burnett River	1,600 ML
Jones Weir	Pump pool for irrigators along Burnett River and Mundubbera	3,700 ML
Claude Wharton Weir	Pump pool for irrigators along Burnett River and for Gayndah	12,800 ML

1.22 Upper Condamine Water Supply Scheme

The Upper Condamine *Water Supply Scheme* (Table 1-22) centres on Leslie Dam and a regulated section of the Condamine River near the Town of Pittsworth approximately 80 km southwest of Toowoomba. It supplies water for irrigation, and supplements the town water supplies of Warwick and Cecil Plains.

Water released from Leslie dam flows down from Sandy Creek into the Condamine River to Talgai, Yarramalong, and Lemon Tree Weirs down to Cecil Plains Weir. The ponded area at Yarramalong Weir is used as a pump pool for diverting water to the North Branch controlled by the Melrose, Wando, and Nangwee Weirs.

Table 1-22 Main Facilities of Upper Condamine Water Supply Scheme

Facility	Function	Capacity
Leslie Dam	Headworks for Upper Condamine Water Supply Scheme	106,200 ML
Talgai Weir	Supplies Condamine River riparian landholders	640 ML
Yarramalong Weir	As above + pump pool for Yarramalong Pump Station	390 ML
Lemon Tree Weir	Supplies Condamine River riparian landholders and irrigators	300 ML
Cecil Plans Weir	Supplies Condamine River riparian landholders and irrigators	700 ML
Melrose Weir	Supplies irrigators in North Branch System	160 ML
Wando Weir	Supplies irrigators in North Branch System	310 ML
Nangwee Weir	Supplies irrigators in North Branch System	80 ML
Yarramalong PS	Pumps from Yarramalong Weir into North Branch System	346 ML/d

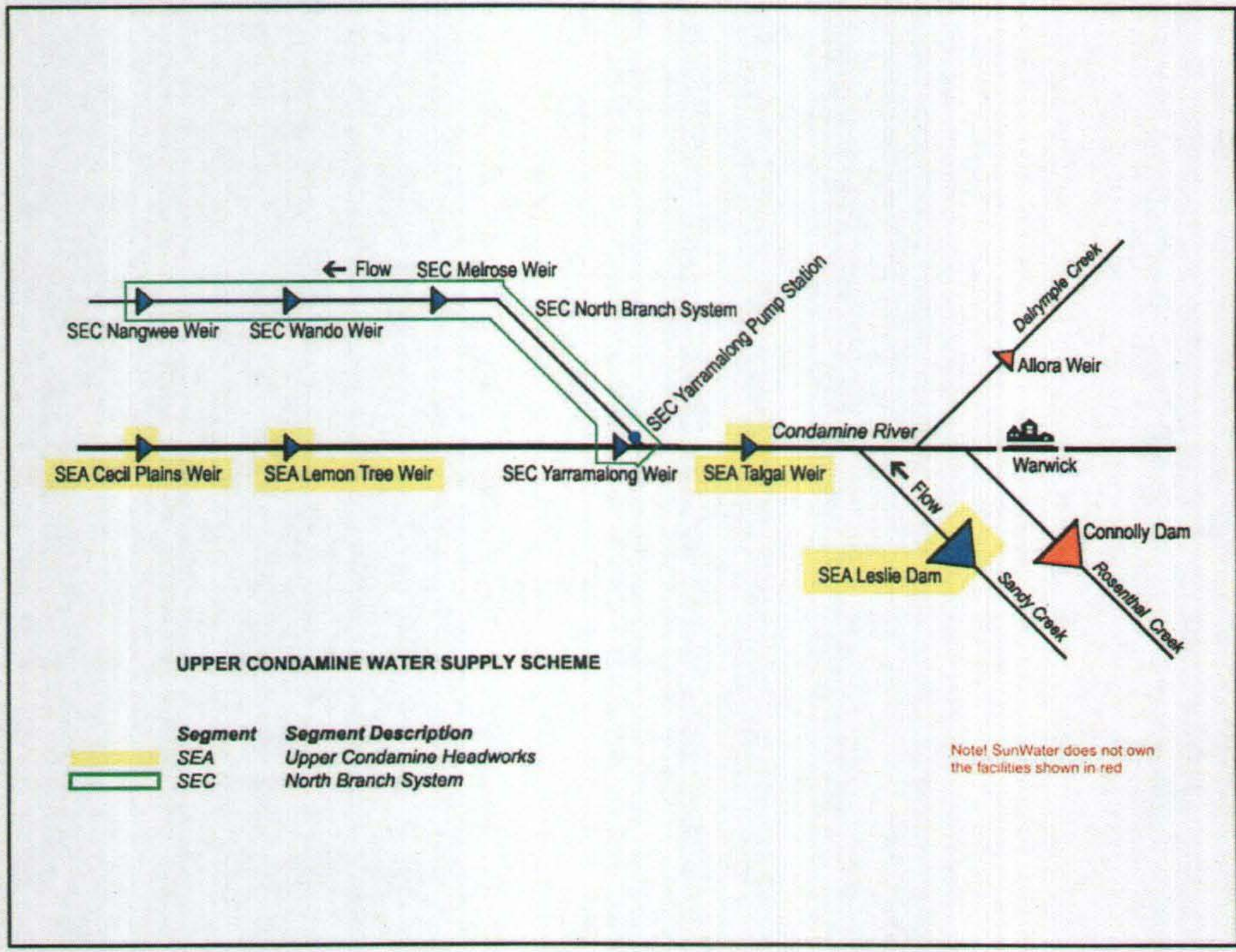


Figure 1-23 Diagram of Upper Condamine Water Supply Scheme

Schedule 2: Burdekin Falls Dam

2.1 Burdekin Falls

Burdekin Falls dam has been spilling continuously since the beginning of the 2010-11 wet season. However the flows have remained at minor68 or below minor level throughout.

2.1.1 Overview

The Burdekin River is one of the largest rivers in Queensland with a length of 731.4 km and a catchment area of approximately 13 million hectares, equating to nearly 7% of the entire area of the state (Refer figure 2-1)69.

Burdekin Falls Dam is a major asset in the Burdekin Haughton Water Supply Scheme's delivery infrastructure. The dam, combining with a series of weirs down the Burdekin River, supplies the scheme with the water needed for the water supply scheme.

Burdekin Falls Dam is situated at Adopted Middle Thread Distance (AMTD) 159.3 km on the Burdekin River, approximately 210 km by road SSW of Townsville. The dam has a catchment of 114,200 km2. The 22,400 ha lake formed by the dam is called Lake Dalrymple. The lake covers 22,400 ha starting 50 km upstream of the dam wall

The dam's design allows for the storage to be in increased to 8,500,000 ML by raising the wall to increase the FSL to 168.60 m AHD.

The CRA for Burdekin Falls Dam concludes that upgrade to the Standard-based approach ANCOLD Fallback AFC be undertaken. The proposed dam safety upgrade would involve:

- Raising of the Left Bank and Mt Graham North and South saddle dams by 1.5m;
- Strengthening of the main dam spillway and non-overflow monoliths by installing post tensioned anchors; and
- Raising of the North Abutment Saddle Dam to maintain access during extreme flood events.

The upgrade is expected to be undertaken in two stages.

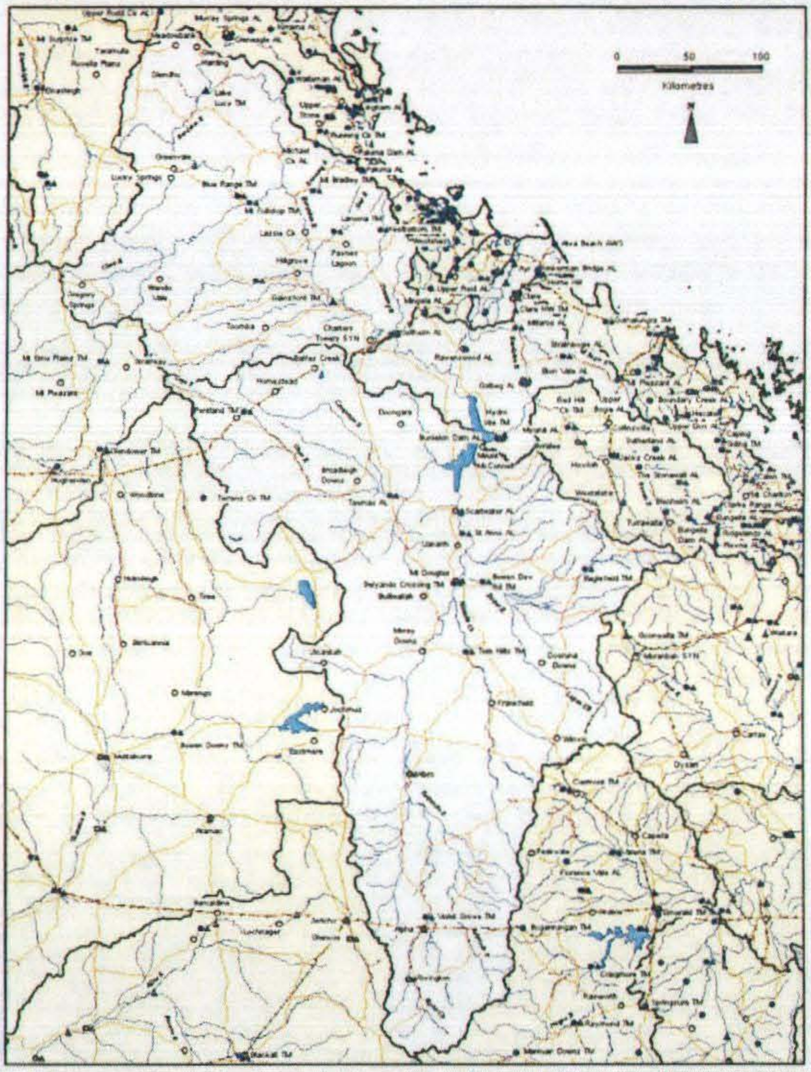
Dam	Storage Volume (ML)	Stream	Stream Distance (km)	Type	Height (m)	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Burdekin Falls	1 860,000	Burdekin River	159.3	Mass Concrete with earth and rockfill saddle dams	40	22,000	1987	Water Supply	Ravenswood	Ayr

[68] Flood Classification levels by BOM as Minor, Moderate or Major

[69] www.bom.gov.au

MAP 120.1

Australian Government
Bureau of Meteorology



o Daily Reporting Rainfall Station △ Manual River Station • Telemetry Rainfall Station ▲ Telemetry River Station	**BURDEKIN RIVER** **FLOOD WARNING NETWORK**	Major Roads Railway *Revised Jan 2010*

2-1 Burdekin River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- The Burdekin Falls Dam Operations and Maintenance Manual
- Burdekin Falls Dam: Standing Operating Procedures

- Emergency Action Plan: Burdekin Falls Dam
- Burdekin Falls Dam: Data Book Part 1 – Text
- Burdekin Falls Dam: Data Book Part 2 – Drawings
- Burdekin Falls Dam: Dam Safety Review (April 2001)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

Type

The dam itself is constructed of mass concrete and is nearly 876m long. The dam has central spillway that is 504m long with a crest height of EL 154.0 m AHD, providing a maximum storage volume of 1.86 million ML. Construction of the dam commenced in 1982 and was completed in 1987.

The Burdekin Falls Dam system includes three earth and rockfill saddle dams: Mt Graham South, Mt Graham North, and Left Bank.

Main Dam[70]

- Type Mass concrete
- *Full Supply Level (FSL)* 154.00 m AHD
- Storage capacity at FSL 1,860,000 ML
- Storage area at FSL 22,000 ha
- Dead storage 7,860 ML (at 124.00m AHD)
- Dam Crest Level (DCL) 169.2 m AHD
- Maximum height of the dam 57.0 m
- Crest length along axis (main embankment) 876.0 m
- Crest Width 7.0 m
- Total Quantities 650,000 m^3 concrete

Spillway

- Spillway type Central Ogee Crest ending at a flip bucket
- Spillway crest level 154.00 m AHD

[70] Burdekin Fall Dam O&M Manual

- Crest length 504 m
- Spillway design capacity 64,600 m3/s
- Spillway capacity for DCF 69,800 m3/s

Outlet Works

- Description Three Outlet Chutes with radial gates
- Radial Gate Dimensions 3.0 m x 2.0 m
- Outlet Chute Design Velocity 30.0 m/s

At FSL each of the three outlets can release 12000 ML/day (140 m3/s), but the combined release is not allowed to exceed 8640 ML/day (100 m3/s) to prevent downstream flooding and erosion.

Saddle Dams

Mt Graham North Saddle Dam

- Earth and rock fill with central clay core. Length 1,200 m. Max height 11.0 m. Crest width 10.0 m

Mt Graham South Saddle Dam

- Earth and rock fill with central clay core. Length 2,100 m. Max height 11.0 m. Crest width 10.0 m

Left Bank Saddle Dam

- Earth and rock fill with central clay core. Length 1,200m. Max Height 36.0 m. Crest width 10.0 m (Typical), 23.2 m at Headrace Channel

Purpose

The foreword of the Burdekin Basin *Resource Operations Plan* (*ROP*) notes that:

> *The provisions in this plan incorporate a number of powerful drivers that will foster new standards of innovation and efficiency to help the community maximise the benefits it derives from these vital resources. Foremost of these is the conversion of more than 800 entitlements to tradeable water allocations.*
>
> *In addition, the plan sets out rules that will guide supplemented water management in the two water supply schemes, flow access rules and volumetric limits for unsupplemented water, and how water allocations can be traded and changed in other ways.*

The plan also implements strategies to support a range of ecological outcomes and the water and ecosystem monitoring requirements that will be used to assess the effectiveness of the implemented water resource plan.

The purpose of the Burdekin Falls Dam is to supply water for irrigation and for rural, urban, and industrial water supplies. In 2009-10, 543,000ML was supplied to agricultural users, Water Boards, and towns.

The operational objectives [71]of the Burdekin Falls Dam are as follows:

- The Burdekin Falls Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with
    a) Burdekin Falls Dam Operations and Maintenance Manual;
    b) SunWater policies and approved practices;
    c) Burdekin Basin *Resource Operations Plan*; and
    d) Sound engineering and water management standards and practices.
- Water releases from Burdekin Falls Dam must be scheduled to comply with
    a) Schedule 2 of the Burdekin Haughton *Water Supply Scheme Interim Resource Operations Licence* (November 2000);
    b) SunWater's Customer Charter; and
    c) All applicable supply agreements and licences.

The Burdekin Falls Dam Operations and Maintenance Manual notes that the dam also provides a level of flood attenuation to the Burdekin River flood plains. The presence of the dam reduces the severity and incidence of low-level flooding.

2.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

2.1.1.1 Pre-wet season EAP reviews/training

The EAP was reviewed as part of annual inspection June 2010

The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.

A supplementary notice for Issue 2 of the EAP was issued in October 2010 by the Principal Engineer Dam Safety.

[71] Burdekin Falls Dam O&M Manual

2.1.1.2 Emergency Preparedness/Actions/Redundancy/ back up systems

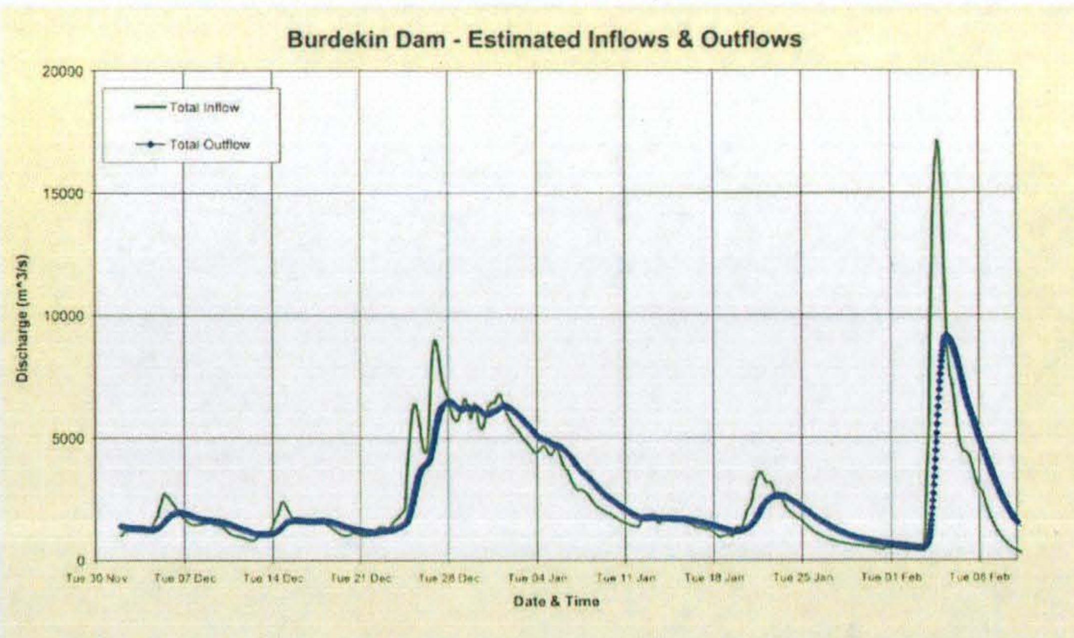
The EAP was first activated on 6th October 2010 and remains active to after the end of February 2011. The landholders identified in the EAP were also notified on 6th October 2010.

The dam is equipped with a 325kVA standby diesel alternator to enable the operations at the dam to continue in the event of failure of mains power. The alternator is tested on a monthly basis

2.1.3 Outline of flood event 2010/2011

The Burdekin Falls dam has been over 100% of capacity for several months. Figure 2-2 outlines the recorded inflows and *outflows* from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The highest peak occurred in early February following cyclone Yasi. The plot in figure 2-2 demonstrates how a dam behaves during different events. The February event was a short duration event. The dam significantly attenuated this event. This is in contrast with the December-January event which was a longer duration. The amount of attenuation of this event was smaller.

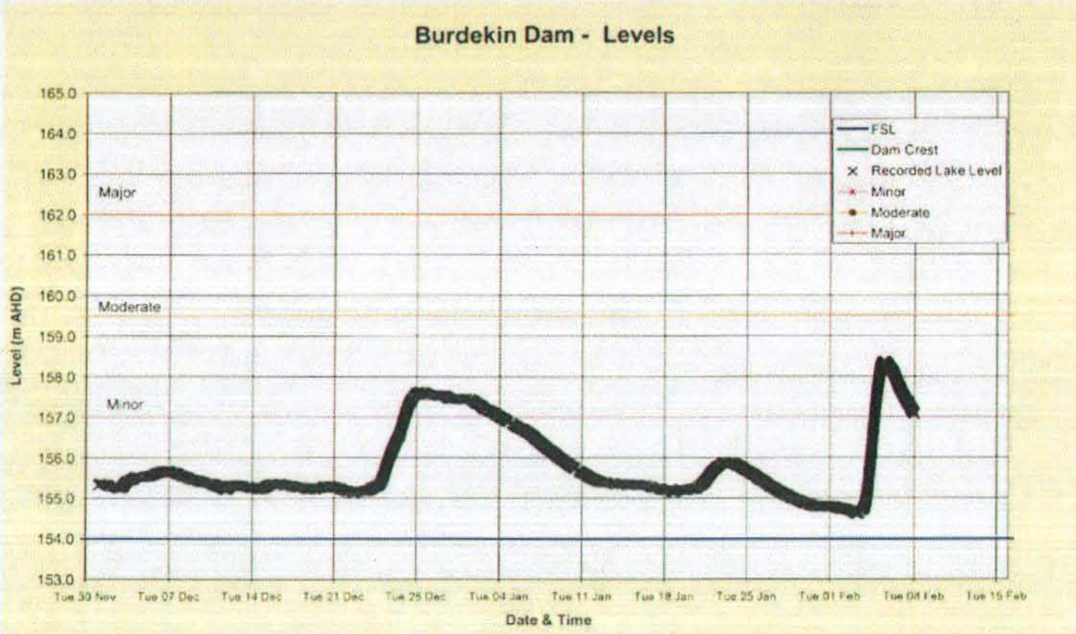
The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 15,682,000ML or 8.4 times the full storage volume of the dam.



2-2 Burdekin Falls Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 2-3 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the *flood classification* levels[72]. Both the December-January and February events were reported as minor[73] floods.

[72] www.bom.gov.au



2-3 Burdekin Falls Dam recorded flood levels

2.1.4 Communities that were affected

No downstream communities were significantly affected by flooding.

2.1.5 Damage and response to damage

There has been no reported damage to Burdekin Falls dam following the flood events.

2.1.6 Gauging stations – effect on data collection

Figure 2-1 shows the location of gauging stations. The key stations remained available through the BOM web page throughout the event. This data was used for predictive flood modelling.

2.1.7 Community inquiries

Although SunWater did receive a small number of inquiries from the public concerning Burdekin Falls dam, those inquiries did not relate to the safety of the dam or downstream flooding impacts. The inquiries received related to recreation facilities and conditions or road conditions.

2.1.8 Media Coverage

An article was published in The Advocate, "Dam policy questioned" on 7 January 2011. The article reported that the management of the dam's water resources had been questioned as the Burdekin Falls Dam was at 100% capacity. SunWater had responded that earlier releases would not have eased water levels and that the dam had operated in accordance with the Resource Operation Plan. SunWater further stated that the dam had been spilling

[73] www.bom.gov.au

since October and even if it had been emptied at the beginning, it would have refilled within 3 days.

2.1.9 Previous flood events

The February event is ranked as the fifth largest flood through the dam since it was constructed.

Table 2-1 Burdekin Falls Dam Historic Floods

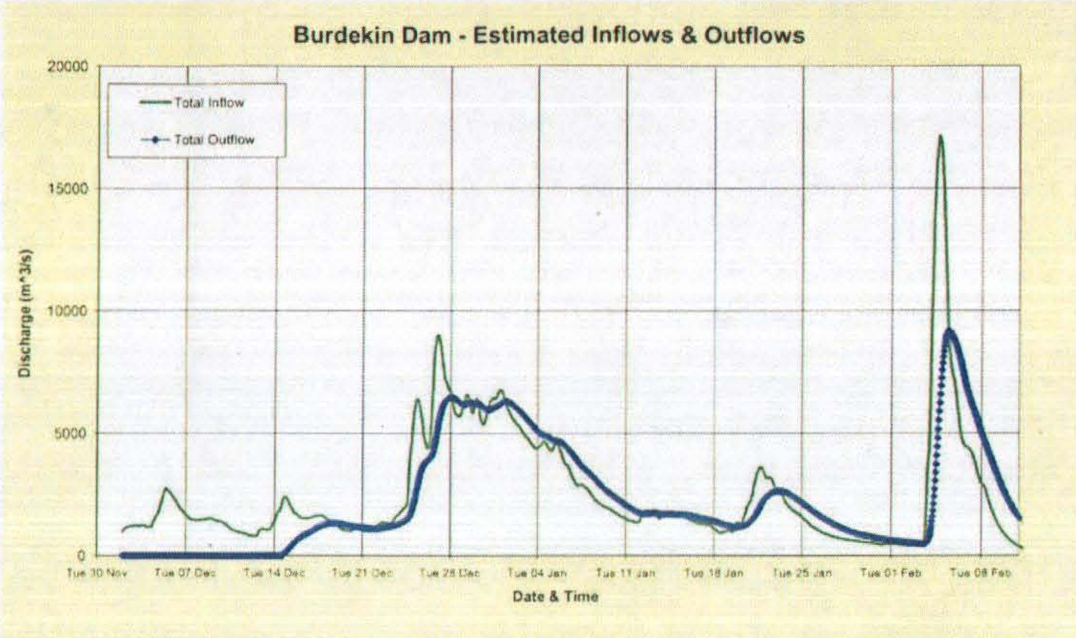
		FSL	154 m
		Peak Height	
Flood Rank	Date	EL	Above Crest
1	Feb-91	160.85	6.85
2	Feb-09	160.73	6.73
3	Feb-08	159.05	5.05
4	Jan-98	158.867	4.87
5	Feb-11	158.37	4.37
6	Feb-07	157.73	3.73
7	Feb-02	157.64	3.64
8	Mar-97	157.59	3.59
9	Feb-00	157.563	3.56
10	Jan-01	157.32	3.32
2010-11 Flood			
5	Feb-11	158.37	4.37

2.1.10 Flood mitigation opportunities/ upgrade or communities potentially affected

The maximum release rate from the dam is limited to $100m^3/s$[74]. At this rate it would take several months to significantly lower the storage notwithstanding any regulatory restrictions on such a release.

SunWater's predictive flood model for Burdekin Falls Dam has been used to evaluate how the dam, in the current configuration, might operate to mitigate flood events. There is no flood mitigation storage in Burdekin Falls dam. The only air space would be if the dam was below the *full supply level* prior to an event. The maximum benefit would be if the dam was empty at the beginning of the wet season. Figure 2-4 shows the hypothetical scenario of the actual inflows from 1 December 2010 into an empty dam as at 1 December. If compared with figure 2-2 it is noted that there is no difference from about 20 December onwards. There would be no flood mitigation benefit in modifying the outlet works and/or amending the operating rules.

[74] Burdekin Falls Dam O&M Manual



2-4 BFD Simulated Behaviour if empty on 1 December

Schedule 3: Fred Haigh Dam

3.1 Fred Haigh

3.1.1 Overview

Fred Haigh Dam is situated on the Kolan River at AMTD 76.4 km, approximately 30kms north of Gin Gin. The purpose of the dam is to supply irrigation water for agricultural purposes in the Bundaberg Water Supply Scheme as well as water for urban and industrial development in the region. Construction of the dam was completed in 1974. Fred Haigh Dam is owned and operated by SunWater. The dam has a storage of 562,045ML and a catchment area of 1,308 km^2.

The 2005 Comprehensive Risk Assessment Report of Fred Haigh Dam recommended immediate Stage 1 upgrade of the dam spillway capacity to 50% of PMPDF[75] in order to satisfy the ANCOLD Limit of Tolerability for Societal and Individual Risk. The Stage 1 upgrade construction was completed in 2006 with the addition of a 2.02m high reinforced concrete wave wall along the downstream edge of the embankment crest and a similar increase of the upstream spillway training walls. A further upgrade will be required to satisfy AFC requirements. The final upgrade will entail the installation of filters on the saddle dam. This final upgrade has not yet been scheduled but is likely to occur around 2018-2019.

	Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Dam Completed	Purpose	Nearest town	Significant down stream Communities
3	Fred Haigh	562,000	2	Kolan River	76.4	Earth and Rockfill	5,345	1975	Water Supply	Gin Gin	

[75] PMPDF – Probable Maximum Precipitation Design Flood.

Figure 3-1 Kolan River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- The Fred Haigh Dam Operations and Maintenance Manual
- Fred Haigh Dam: Standing Operating Procedures
- Fred Haigh Dam: Operation & Maintenance Manual
- Emergency Action Plan: Fred Haigh Dam

- Fred Haigh Dam: Data Book Part 1 - Text
- Fred Haigh Dam: Data Book Part 2 – Drawings
- Fred Haigh Dam: Dam Safety Review (June 2001)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

3.1.1.1 Type

Fred Haigh Dam is an earth and rock fill embankment dam with an 11m high Earth fill saddle dam and a 47m wide spillway. The spillway is an uncontrolled ogee crest tapering into a concrete chute and flip bucket dissipater. The dam is 592m long and has a storage capacity of 562,000 ML. The dam was designed and constructed by the Queensland Water Resources Commission and construction was completed in 1974.

Table 3-1 Overview of Fred Haigh Dam Details

Overview[76]

Dam Name	Fred Haigh Dam
Nearest Town	Gin Gin
Stream and AMTD	Kolan River 76.4m
Catchment Area	1,308 km^2
Construction Period	1971-1974

Main Dam

Type	Central core earth and rock fill
Full Supply Level (FSL)	75.56 m AHD
Storage capacity at (FSL)	562,045 ML
Reservoir surface area at FSL.	5,345 ha
Dam Crest Level (DCL)	84.09 m AHD
Maximum height of the dam	52 m from lowest level
Crest length	445.8 m
Submerged surface area at FSL	9,292 ha

Spillway

Spillway type	Uncontrolled Ogee Crest with flip bucket
Spillway crest level	75.56 m AHD
Crest length	47.2 m
Spillway capacity for DCF	2,464 m^3/s

[76] FredHaigh Dam O&M Manual Table 1-1

Saddle Dam

Type	Zoned Earth and Rock fill
Crest Elevation	84.09 m AHD
Total Length	144 m
Total Crest Width	11 m

Outlet Works

Description of main outlet	2 x 1200 mm guard valves 2 x 762 mm cone valves 1 x 300 Cone valve
River outlet works capacity	4.5 m^3/s

3.1.1.2 Purpose

The foreword of the Burnett Basin Resource Operations Plan (ROP) notes that:

> *The WRP and the ROP are complementary parts of a water planning process that will ensure that the basin's rivers are sustainably managed. The WRP strives to strike a balance between human needs and those of the environment. The resource operations plan is concerned with the practical business of sharing and managing the basin's water resources from day to day in a way that meets the water resource plan objectives.*[77]

The purpose of the Fred Haigh Dam is to supply water for irrigation and for rural, urban, and industrial water supplies. In 2009-10 the Bundaberg water supply scheme supplied 111,000ML to agricultural users, Industry and towns

The operational objectives [78]of the Fred Haigh Dam are as follows:

1. Fred Haigh Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
   - Fred Haigh Dam Operations and Maintenance Manual;
   - SunWater policies and approved practices;
   - The Burnett Basin ROP; and
   - Good engineering and water management standards and practices.
2. Water releases from Fred Haigh Dam must be scheduled to comply with:
   - The Burnett Basin ROP
   - SunWater's Customer Charter.
   - All applicable supply agreements and licences.

[77] Burnett Basin Resource Operations Plan, Forward

[78] Fred Haigh Dam O&M Manual

3.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

3.1.2.1 Pre-wet season EAP reviews/training

The EAP was reviewed as part of an annual inspection in August 2010.

The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.

A supplementary notice for Issue 2 of the EAP was issued in October 2010 by the Principal Engineer, Dam Safety.

Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers prior to the wet season.

3.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The EAP was first activated on 15th December 2010 and remained active until after the end of February 2011. The Fred Haigh dam EAP does not identify downstream landholders required to be notified of an event.

3.1.2.3 Outline of flood event 2010/2011

Figure 3-2 outlines the recorded inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak discharge occurred in late December.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 690,900ML or 1.2 times the full storage volume of the dam.

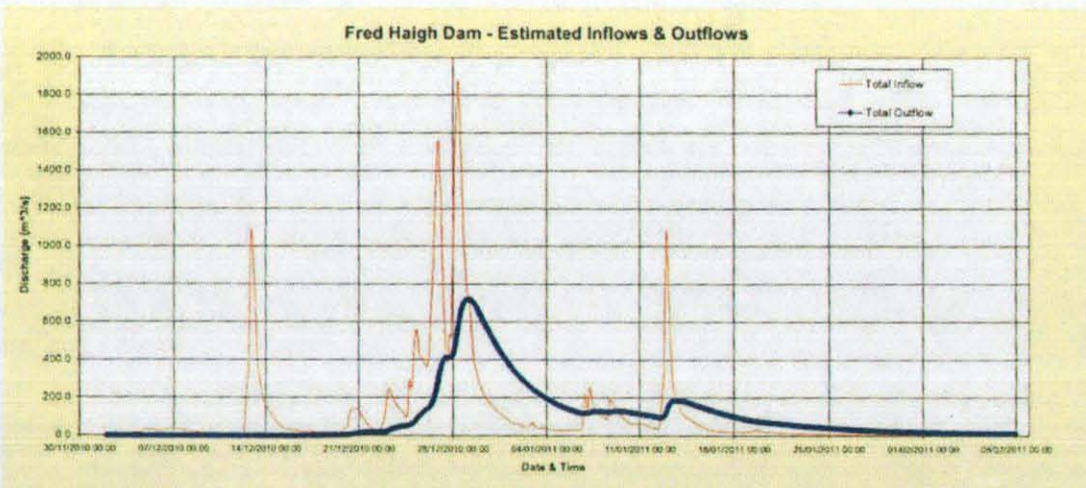


Figure 3-2 Fred Haigh Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 3-3 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[79]. The event was reported as a major flood.

[79] www.bom.gov.au

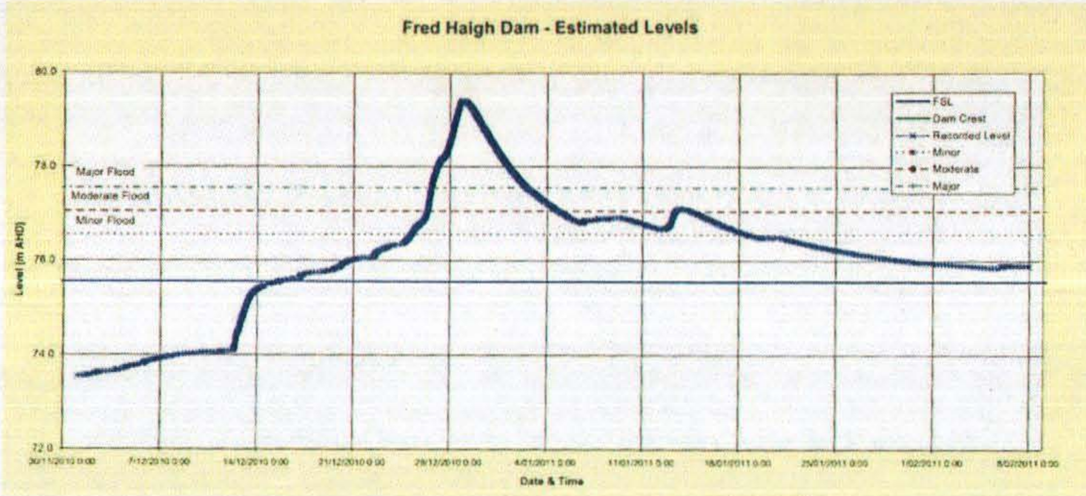


Figure 3-3 Fred Haigh Dam recorded flood levels

3.1.2.4 Communities that were affected

No downstream communities were significantly affected by flooding; however access was disrupted to the Bucca township.

3.1.2.5 Damage and response to damage

There was no significant damage to Fred Haigh Dam. Some minor slumping and erosion of the river bank downstream of the dam was noted. This has been inspected and will be repaired in due course.

3.1.2.6 Gauging stations – effect on data collection

Figure 3-1 shows the location of gauging stations in the catchment. The key stations remained available through the BoM web page throughout the event.

3.1.2.7 Community inquiries

SunWater received a small number inquiries from the general public seeking information on water levels and flows at Fred Haigh Dam.

SunWater staff worked closely with the LDMG and attended briefings as required.

3.1.2.8 Media Coverage

There are no specific references to Fred Haigh Dam in the media reports.

3.1.2.9 Post Event Review

SunWater undertook a review of the event across the Central Region. The review found that:

- The EAP was generally adequate, however some updating is required;
- Some difficulties were experienced with continuity of communication networks. NextG communications in addition to land lines at some dams is being investigated;
- Site facilities for staff were found to be inadequate where staff were on duty and isolated for prolonged periods; and,
- The EEC role across the Bundaberg service centre was found to be too demanding for one person. The role will be split into different sub areas for future events.

3.1.2.10 Previous flood events

The February event is ranked as the largest flood through the dam since it was constructed.

Table 3-2 Fred Haigh Dam - Ranking of historic events

		FSL	73.36 m
Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Dec-10	79.41	6.05
2	Mar-77	77.34	3.98
3	Mar-92	77.24	3.87
4	May-83	76.70	3.34
5	Apr-89	76.67	3.31
6	Feb-91	76.26	2.90
7	Mar-82	76.14	2.78
8	Apr-10	73.49	0.13
9			
10			
2010-11 Flood			
1	Dec-10	79.41	6.05

3.1.3 Flood mitigation opportunities/ upgrade or communities potentially affected

The maximum release rate from the dam is limited to $5.3m^3/s$[80]. At this rate it would take several months to significantly lower the storage notwithstanding any regulatory restrictions on such a release.

SunWater's predictive flood model for Fred Haigh Dam has been used to evaluate how the dam might operate to mitigate flood events. There is no flood mitigation storage in Fred Haigh dam. The only air space would be if the dam was below the full supply level prior to an event. The maximum benefit would be if the dam, hypothetically was empty at the beginning of the wet season. Figure 3-4 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December, however this would not be practical for the reasons set out above. If compared with Figure 3-2 it is noted that the peak outflow would have reduced to 130 m^3/s. This would have been a height over the spillway of

[80] Velocity limited to prevent damage to conduit

1.3m which is minor flood level. Figure 3-5 simulates the behaviour of the dam had it been at 50% on 1 December. Under this scenario major flood levels would still have been reached. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Fred Haigh Dam without a significant loss of water supply to the local community. It is noted that any form of flood mitigation is likely to be of only marginal benefit to the community given the limited towns impacted downstream of Fred Haigh Dam.

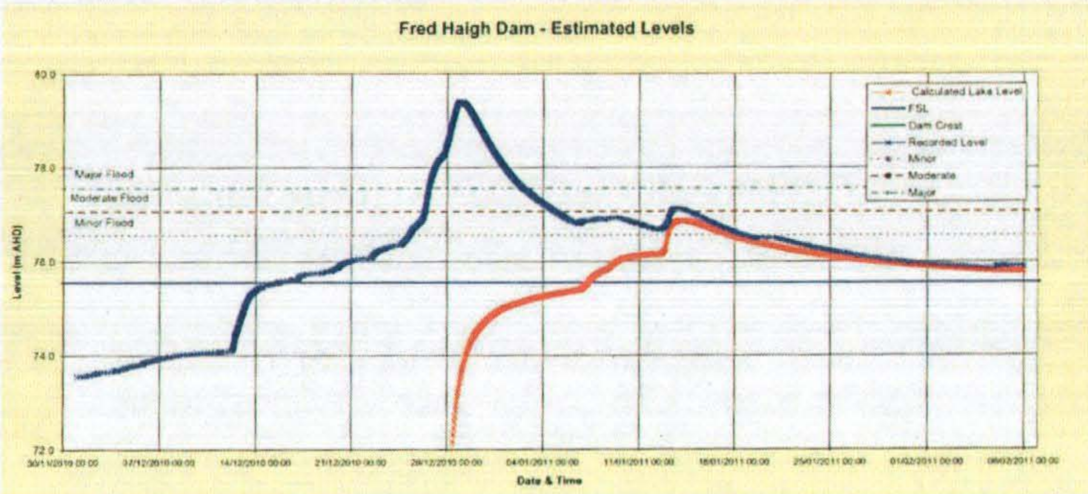


Figure 3-4 Fred Haigh Dam Simulated Behaviuor if empty on 1 December

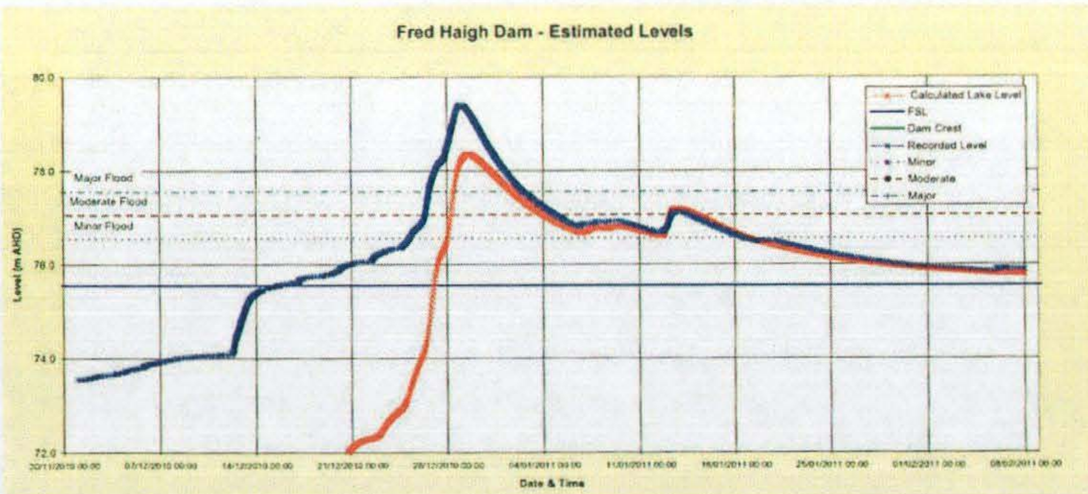


Figure 3-5 Fred Haigh Dam Simulation if at 50% on 1 December

Schedule 4: Fairbairn Dam

4.1 Fairbairn

4.1.1 Overview

The Nogoa catchment is part of the larger Fitzroy basin. The catchment area of the basin at Rockhampton is over 140,000km^2. The catchment area of the Nogoa River at Fairbairn dam is 16,320 km^2

Fairbairn is the main source of supply for the Nogoa Mackenzie Water Supply Scheme. The dam is operated in conjunction with Selma, Bedford, Bingegang and Tartrus Weirs to regulate supplies along the Mackenzie River and downstream to the Springton Creek junction. The dam also releases into the Selma and Weemah channel systems to supply irrigators. The scheme is also the source of supply for six industrial water supply pipelines serving the Central Queensland coalfields area.

Fairbairn Dam – formerly known as Maraboon Dam – is located on the Nogoa River, approximately 17 km southwest of Emerald. It was built in 1972.

Fairbairn dam is capable of safely passing AFC as defined by the dam safety regulator. No upgrade of Fairbairn dam is programmed.

	Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
3	Fairbairn	1 301 000	2	Nogoa River	685.6	Earthfill	15 200	1972	Water Supply	Emerald	Emerald

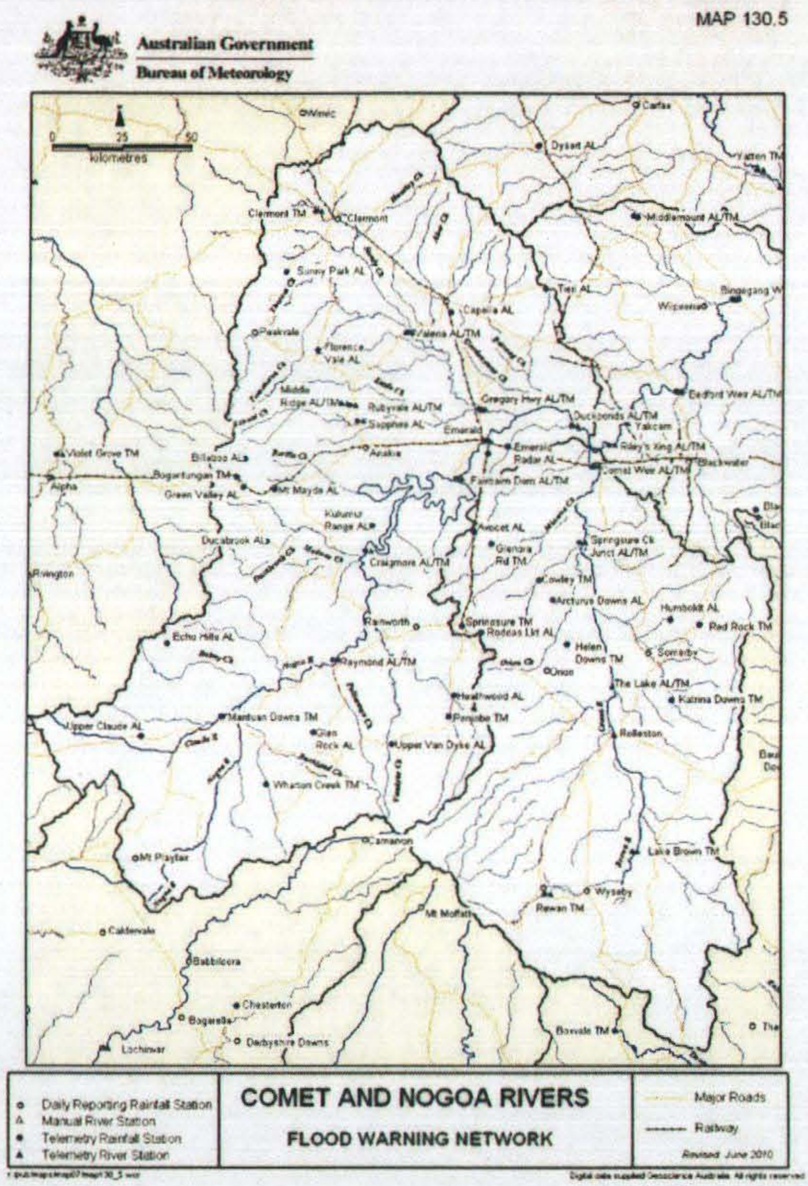


Figure 3-1 Nogoa River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- Fairbairn Dam: Standing Operating Procedures
- Fairbairn Dam: Operation & Maintenance Manual
- Emergency Action Plan: Fairbairn Dam
- Fairbairn Dam: Data Book Part 1 - Text
- Fairbairn Dam: Data Book Part 2 - (Volumes 1, 2, and 3) Drawings
- Fairbairn Dam: Dam Safety Review (September 1999)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

4.1.1.1 Type

The dam itself is constructed of zoned earth and rockfill embankment with a concrete chute spillway with uncontrolled ogee-type crest. The main wall is 823m long with a maximum height above foundations of 46.3m. The spillway is 163m wide.

The dam has 6 earthfill saddle dams with a combined length of 8.4 km.

Table 3-1 Fairbairn Dam Details

Type of dam	Zoned earth and rockfill embankment
Length across crest	823 m
Height above foundation	46.33 m
Embankment crest level	218.86 m AHD
Spillway crest level	204.23 m AHD
Full Supply Level FSL	204.23 m AHD
Spillway type	Chute with uncontrolled ogee-type crest
Full Spillway width	163.07 m
Effective Spillway width	158.50 m
Spillway discharge at DCF	21,400 m^3/sec
Storage capacity/area at FSL	1 301 133 ML / 15,000 ha
Commandable storage	1 288 890 ML
Catchment area	16 320 km^2
Saddle Dams	6 earthfill dams with a combined length of 8.4 km
Right Bank Outlet	Intake tower with outlets into the Nogoa River and the Weemah Channel
Left Bank Outlet	Dual inlet (Channel inlet and Selma Pump Station) with a combined outlet into Selma Channel
Left bank Outlet capacity	770 ML/day
Mean annual rainfall	635 mm

4.1.1.2 Purpose

The Fitzroy Basin Resource Operations Plan (ROP)[81] notes that:

> *"The strategies specified in the WRP are designed to meet environmental flow objectives and water allocation security objectives ..... The Resource Operations Plan (ROP) has been developed to ensure that these objectives are satisfied. The management arrangements in the ROP for supplemented water supply schemes and associated infrastructure, and those for unsupplemented water are dealt with in Chapter 4 and Chapter 5 respectively.*
>
> *The assessment program will check for compliance with the management arrangements in the ROP and, over the long term, will assist in determining how effectively the strategies in the WRP are achieving the WRP outcomes."*

The purpose of the Fairbairn Dam is to supply water to the Emerald Irrigation Area, and to local industrial and urban users. In 2009-10 the scheme supplied 197,000ML to agricultural users, Industry, and towns

The operation of the Fairbairn Dam must meet the following criteria[82]:

- The Fairbairn Dam and all associated structures, facilities, and spaces are operated, monitored, and maintained in accordance with generally accepted engineering and water management practices, SunWater policies, and all applicable legislated requirements
- Water releases from Fairbairn Dam must be scheduled to comply with the Resource Operating License and Resource Operations Plan for the Fitzroy basin and SunWater's customer charter, and supply agreements

4.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

4.1.2.1 Pre-wet season EAP reviews/training

The EAP was reviewed as part of an annual inspection in July 2010.

The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.

A supplementary notice for Issue 2 of the EAP was issued in October 2010 by the Principal Engineer, Dam Safety.

4.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The EAP was first activated on 10th September 2010 and remained active until after the end of February 2011. The landholders identified in the EAP were also notified on 10th September 2010.

[81] Fitzroy Basin Resource Operations Plan, Ch 3

[82] Fairbairn Dam O&M Manual

4.1.3 Outline of flood event 2010/2011

Figure 3-2 outlines the recorded inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak discharge occurred on 31 December.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 2,800,000ML or 2.2 times the full storage volume of the dam.

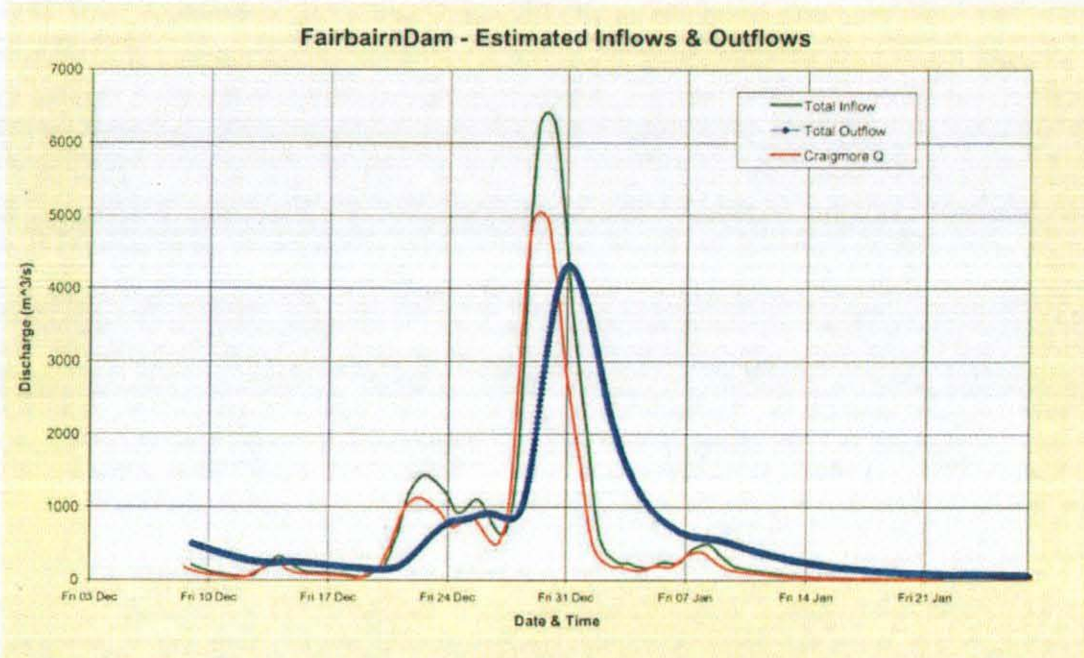


Figure 3-2 Fairbairn Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 3-3 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[83]. The December event was reported as a major flood. Emerald was significantly impacted by flooding. It is noted from Figure 3-2 that Fairbairn dam attenuated a peak inflow of 6,422m^3/s to a peak outflow of 4,324m^3/s. An attenuation factor of 33%.

[83] www.bom.gov.au

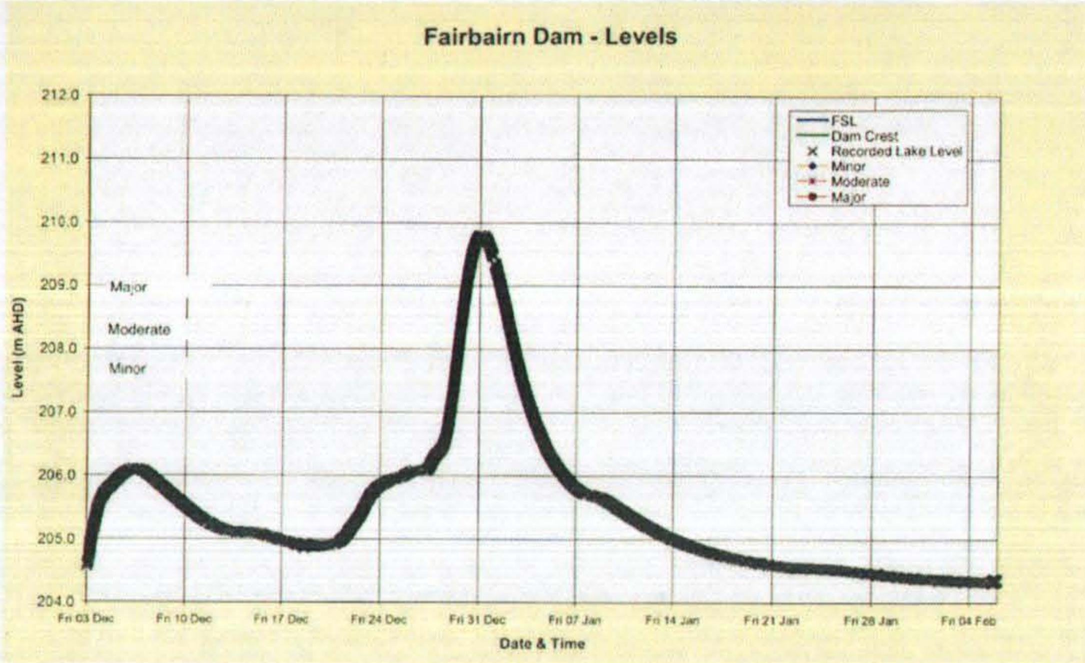


Figure 3-3 Fairbairn Dam recorded flood levels

4.1.3.1 Communities that were affected

The town of Emerald experienced significant flooding. Both residential and commercial areas were inundated.

4.1.3.2 Damage and response to damage

A detailed inspection of all areas of the dam has not yet been possible due to continued spillway flows. However the areas that have been inspected have performed well with no major damage. There was some damage when the lower instrumentation hut was inundated and there is some minor repair required to some concrete slabs in the spillway chute.

4.1.3.3 Gauging stations – effect on data collection

Figure 3-1 shows the location of gauging stations in the catchment. The key stations remained available through the BoM web page throughout the event. This data was used for predictive flood modelling. The only issue of note was that the recorded height at Craigmore, the key inflow gauge for the dam, exceeded the extent of the rating table. The table was extended during the event using model calibrations and engineering judgement.

4.1.3.4 Media Coverage

An article on 8 January 2011 in the Financial Review "The $10bn question – what's with the weather?" by Matthew Dunkley reports that Fairbairn did not spare Emerald from severe flooding however the president of a local lobby group said that it would have been worse if not for the dams.

4.1.3.5 Community inquiries

SunWater received a small number inquiries from the general public seeking information on water levels and flows at Fairbairn Dam.

Throughout the event SunWater staff worked closely with the LDMG and attended daily briefings. The LDMG did approach SunWater just after the peak of the event seeking a forecast of when the flows might drop to a level where the main highway bridge into town might be able to be reopened. SunWater provided them a verbal response giving an indicative 24 hour window of when the water level at the dam would be at a level that might correspond to a water level below the bridge.

4.1.3.6 Post Event Review

SunWater undertook a review of the event. The review found that:

- The EAP and O&M Manual were adequate and provided an excellent guide during the event. Only minor amendments are required to reflect current reporting arrangements;
- A good working relationship was established and maintained with the LDMG;
- SunWater had adequate staff resources to respond to the event; and'
- Access to all of the saddle dams was difficult with staff resorting to horses to access some areas

4.1.3.7 Previous flood events

The February event is ranked as the largest flood through the dam since it was constructed.

Table 3-2 Fairbairn Dam - Ranking of historic flood events

		FSL	204.228
Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Dec-10	209.80	5.57
2	Feb-08	208.67	4.44
3	Feb-78	207.02	2.79
4	May-83	206.67	2.44
5	Apr-90	206.641	2.41
6	Dec-75	206.17	1.94
7	May-77	205.92	1.69
8	Mar-10	205.66	1.43
9	Feb-74	205.49	1.26
10	Sep-10	205.46	1.23
2010-11 Flood			
1	Dec-10	209.80	5.57

4.1.4 Flood mitigation opportunities/ upgrade or communities potentially affected

The maximum release rate from the dam is approximately 2,000ML/d. At this rate it would take several months to significantly lower the storage notwithstanding any regulatory restrictions on such a release. For example, it would take over twelve months to lower the dam to 50%.

SunWater's predictive flood model for Fairbairn Dam has been used to evaluate how the dam might operate to mitigate flood events. There is no flood mitigation storage in Fairbairn dam. The only air space would be if the dam was below the full supply level prior to an event. The maximum benefit would be if hypothetically the dam was empty at the beginning of the wet season. Figure 3-4 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December, however this would not have been practical for the reasons set out above. If compared with Figure 3-2 it is noted that the peak outflow would have reduced to 2,766 m^3/s. This would have been a height over the spillway of 4.24m which is a moderate flood level. Figure 3-5 simulates the behaviour of the dam had it been at 50% on 1 December. Under this scenario major flood levels would still have been reached. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Fairbairn Dam without a significant loss of water supply to the local community.

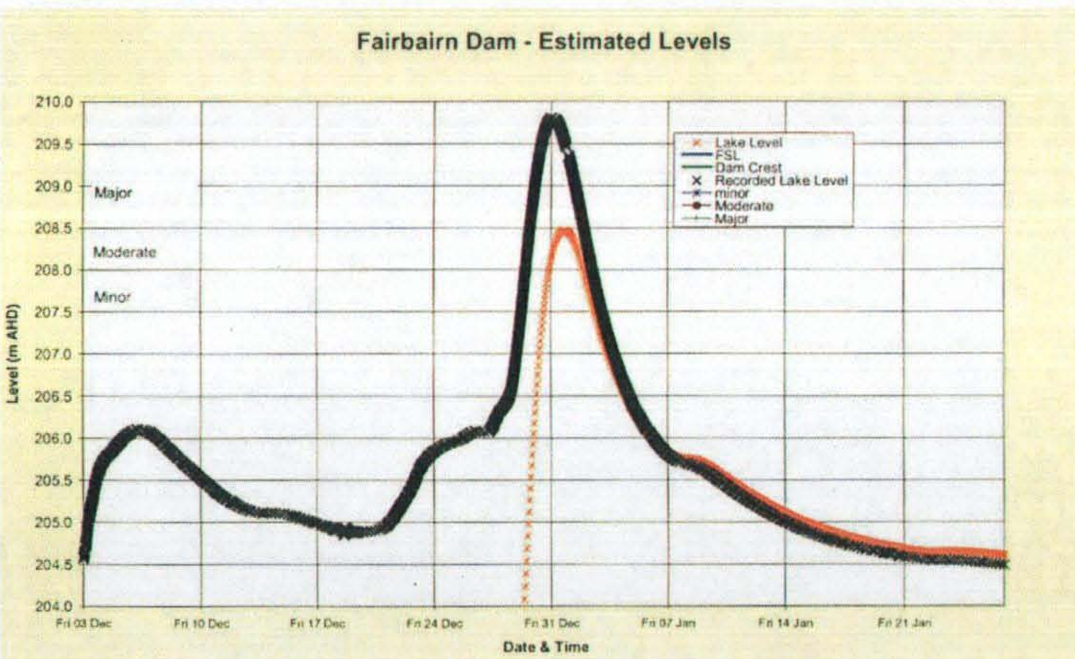


Figure 3-4 Fairbairn Dam Simulated Behaviour if empty on 1 December

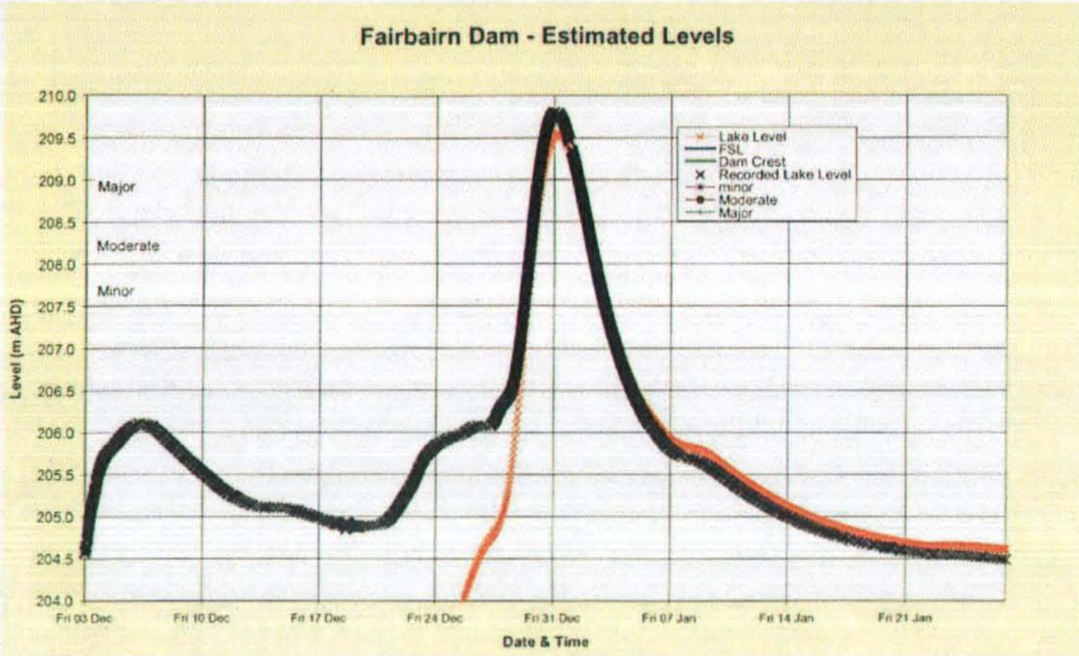


Figure 3-5 Fairbairn Dam Simulated Behaviour if at 50% on 1 December

Schedule 4: Fairbairn Dam - Supplementary

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

4.1 Fairbairn

The flood event at Fairbairn Dam commenced on 10th September 2010 and concluded 1st March 2011. The total wet season inflow to the dam from 1 December 2010 to 7 February 2011 was 2.2 times the total storage volume of the dam. Communities along the Nogoa and McKenzie Rivers experienced major flooding during the peak of the flood event. The town of Emerald is in close proximity to Fairbairn Dam. Emerald experienced major flooding.

4.1.1 Overview

The Nogoa catchment is part of the larger Fitzroy basin. The catchment area of the basin at Rockhampton is over 140,000km^2. The catchment area of the Nogoa River at Fairbairn dam is 16,320 km^2

Fairbairn is the main source of supply for the Nogoa Mackenzie Water Supply Scheme. The dam is operated in conjunction with Selma, Bedford, Bingegang and Tartrus Weirs to regulate supplies along the Mackenzie River and downstream to the Springton Creek junction. The dam also releases into the Selma and Weemah channel systems to supply irrigators. The scheme is also the source of supply for six industrial water supply pipelines serving the Central Queensland coalfields area.

Fairbairn Dam – formerly known as Maraboon Dam – is located on the Nogoa River, approximately 17 km southwest of Emerald. It was built in 1972.

A comprehensive risk assessment of Fairbairn Dam (November 2009) has concluded that Fairbairn dam is capable of safely passing AFC as defined by the dam safety regulator and therefore no upgrade to meet a higher flood capacity is required. A final decision on this recommendation has not yet been made (refer to paragraph 6.2.3 of the statement). SunWater finalised its comprehensive risk assessment (CRA) program across its portfolio in 2010. The SunWater Board will consider the recommendations of each CRA and finalise the dam safety upgrade program during 2011.

A copy of the comprehensive risk assessment for Fairbairn Dam can be provided on request.

	Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
2	Fairbairn	1,301,000	2	Nogoa River	665.6	Earthfill	15,000	1972	Water Supply	Emerald	Emerald

[redacted]

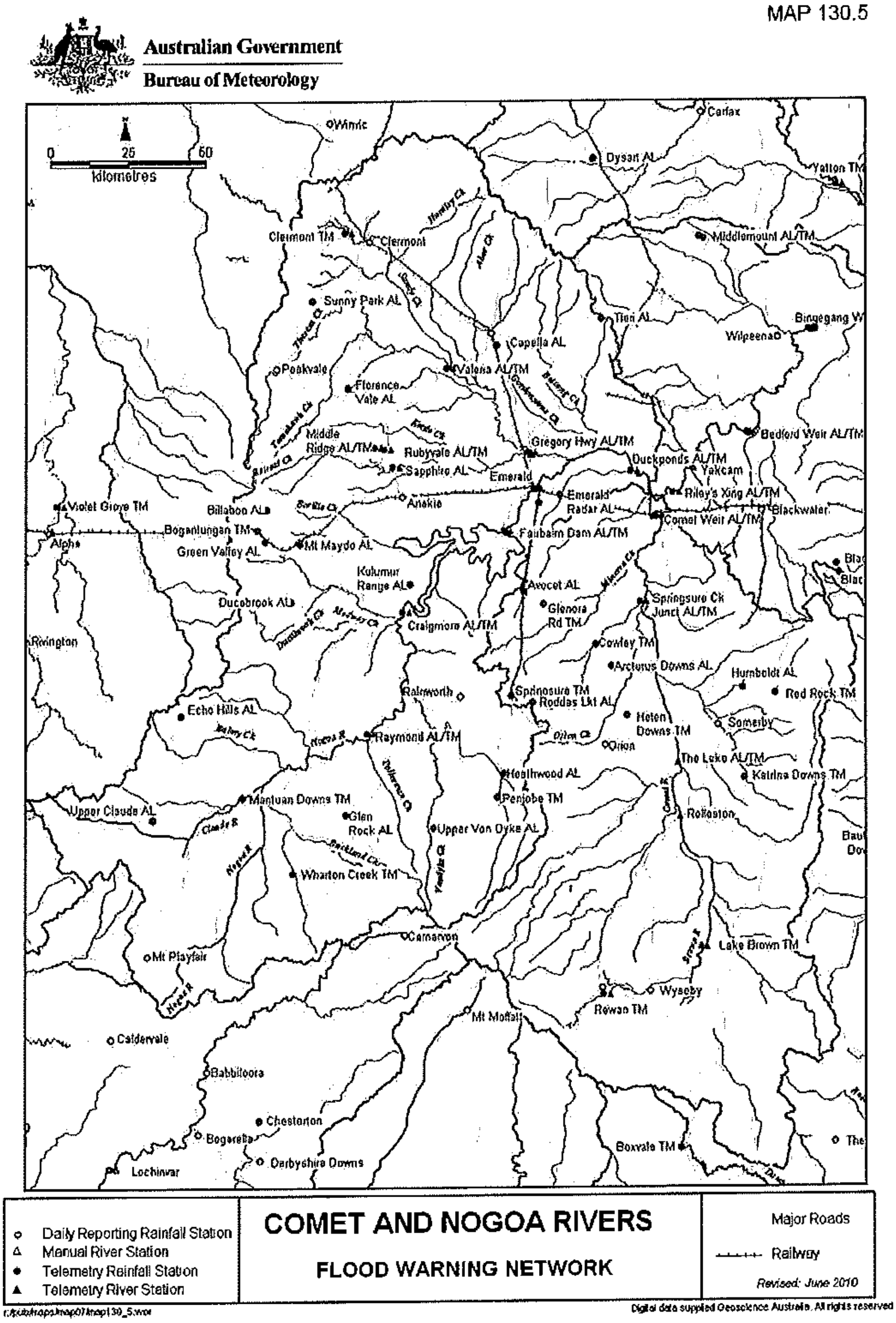


Figure 4-1 Nogoa River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

[redacted]

- Fairbairn Dam: Standing Operating Procedures
- Fairbairn Dam: Operation & Maintenance Manual
- Emergency Action Plan: Fairbairn Dam
- Fairbairn Dam: Data Book Part 1 - Text
- Fairbairn Dam: Data Book Part 2 - (Volumes 1, 2, and 3) Drawings
- Fairbairn Dam: Dam Safety Review (September 1999)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

4.1.1.1 Type

The dam itself is constructed of zoned earth and rockfill embankment with a concrete chute spillway with uncontrolled ogee-type crest. The main wall is 823m long with a maximum height above foundations of 46.3m. The spillway is 163m wide.

The dam has 6 earthfill saddle dams with a combined length of 8.4 km.

Table 4-1 Fairbairn Dam Details

Type of dam	Zoned earth and rockfill embankment
Length across crest	823 m
Height above foundation	46.33 m
Embankment crest level	218.86 m AHD
Spillway crest level	204.23 m AHD
Full Supply Level FSL	204.23 m AHD
Spillway type	Chute with uncontrolled ogee-type crest
Full Spillway width	163.07 m
Effective Spillway width	158.50 m
Spillway discharge at DCF	21,400 m^3/sec
Storage capacity/area at FSL	1 301 133 ML / 15,000 ha
Commandable storage	1 288 890 ML
Catchment area	16 320 km^2
Saddle Dams	6 earthfill dams with a combined length of 8.4 km
Right Bank Outlet	Intake tower with outlets into the Nogoa River and the Weemah Channel
Left Bank Outlet	Dual inlet (Channel inlet and Selma Pump Station) with a combined outlet

	into Selma Channel
Left bank Outlet capacity	770 ML/day
Mean annual rainfall	635 mm

4.1.1.2 Purpose

The Fitzroy Basin Resource Operations Plan (ROP)[1] notes that:

> *"The strategies specified in the WRP are designed to meet environmental flow objectives and water allocation security objectives ..... The Resource Operations Plan (ROP) has been developed to ensure that these objectives are satisfied. The management arrangements in the ROP for supplemented water supply schemes and associated infrastructure, and those for unsupplemented water are dealt with in Chapter 4 and Chapter 5 respectively.*
>
> *The assessment program will check for compliance with the management arrangements in the ROP and, over the long term, will assist in determining how effectively the strategies in the WRP are achieving the WRP outcomes."*

The purpose of the Fairbairn Dam is to supply water to the Emerald Irrigation Area, and to local industrial and urban users. In 2009-10 the scheme supplied 197,000ML to agricultural users, industry, and towns.

The operation of the Fairbairn Dam must meet the following criteria[2]:

- The Fairbairn Dam and all associated structures, facilities, and spaces are operated, monitored, and maintained in accordance with generally accepted engineering and water management practices, SunWater policies, and all applicable legislated requirements.
- Water releases from Fairbairn Dam must be scheduled to comply with the Resource Operating License and Resource Operations Plan for the Fitzroy basin and SunWater's customer charter, and supply agreements.

4.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

4.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Fairbairn Dam:

- The EAP was reviewed as part of periodic (annual) inspection on 26th to 27th July 2010. The inspection team was led by Keith Ehm (RPEQ). Other members of the

[1] Fitzroy Basin Resource Operations Plan, Ch 3

[2] Fairbairn Dam O&M Manual

 [redacted]

team were Michael Costa (Senior Engineer Headworks), Peter Collettt (Service Manager), and Mark Constable (Storage Supervisor). The inspection team noted that the current version of the EAP was not available at the dam. This was rectified prior to December. The team considered whether or not the instructions in the current EAP were adequate and, through inquiry, confirmed that the instructions were understood by the dam staff. The findings of the review were documented in the draft *Fairbairn Dam Annual Inspection Report 26-27 July 2010* (page 6). The team concluded that the instructions were understood. However it was noted that changes were required to the EAP to reflect the changes to SunWater's business structure in 2010. These changes were addressed in the supplementary notice issued by the Principal Engineer Dam Safety (PEDS) described below;

- The notification and emergency communication list (EAP section 3) was revised and reissued on 25th November 2010. The notification and emergency communication was issued as a controlled document to the distribution list (Section 1, page 2 of 3 of the EAP). A transmittal advice was issued with each controlled copy. The transmittal advice included instructions for updating the EAP;
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety (Mal Halwala). The notice was principally designed to address changes to the roles and responsibilities that occurred as part of an internal reorganisation within SunWater. The notice was based on the Tinaroo Falls Dam EAP that had been updated to Issue 3 and was to be used as the template for Issue 3 for all SunWater dams. The supplementary notice was issued by email on 29 October 2010 to all of the Area Operations Managers and Service Managers who all fulfil the role of EEC for the dams in their respective areas
- The Area Operations Manager Mr Tom Wallwork, two of the nominated EECs for the Emerald service area, Mr Robin Boon and Mr Neil Farrell and the Storage Supervisor Mr Mark Constable met with the Emerald LDMG on 1st December 2010 to discuss possible emergency scenarios and raise awareness of the EAP. The meeting was held at the CHRC Emerald Council Chambers. The minutes for the meeting that can be made available if required. The minutes note that SunWater provided a brochure to explain SunWater's role in flood event management.

4.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The O&M Manual notes that the actual maintenance schedules and work instructions are obtained from SunWater's SAP system. This means that work orders for maintenance, document revisions and other activities such as emergency preparations are automatically generated by the SAP system on a monthly basis This creates a controlled document trail that requires actioning and closing out. A work order is issued for each scheduled or corrective maintenance item (refer Figure 4-2 for sample work order header). The work orders are issued to the appropriate supervisor. Scheduled maintenance items would include such items as:

- EIA-1M-Cond Mont-Fairbairn Dam & Weirs
- EIA-1M-Measure Seepage-Faibairn Dam
- EIA-1M-Read Piezometers-Faibairn Dam
- EIA-12M-Condit Monitoring-Faibairn Dam

[redacted]

- EIA-12M-Mech Serv-RBK GHouse-Fairb Dam

A detailed work instruction is issued with each work order. Each work instruction includes a detailed check list of tasks to be performed to complete the work order Refer Figure 4-3 for sample extract from completed work instruction.

Once the work on an order and in an instruction has been competed it is signed off as complete, dated and verified by the supervisor (refer Figure 4-4)

MC

SunWater

PM01-Preventive - Day to Day Work Order 5106443

Printed By: BOATHA On: 29.06.2010 Page: 1 Original

Job Description: ***EIA-12M-Cond Mntrng-Faibairn Dam JUL10***
Work Instruction:

Functional Location:	*EIA-FAI*	*FAIRBAIRN DAM AMTD (685.60)*	
Equipment:			
Location:		*at:*	
General Location	*NOGOA RIVER-LAKE MARABOON - NEAR EMERALD*		
Planner:	*320 Biloela Planner*	*Main work center:*	*3205OP Operations - OMS Emerald*
Priority:	*5 Priority 5 < 1 month*	*Status :*	*REL MSPR NMAT PRC SETC*

Notifications:
10124307 EIA-12M-Condit Monitoring-Faibairn Dam EIA-FAI

Figure 4-2 Sample Work Order Header

			Cranes & Winches – 6 monthly	✓
3.			Note all cranes and winches (total 15) are tested – report filed. Check shackles, compliance plates and condition of all lifting straps &/or chains. Remove & dispose of deteriorated lifting equipment. Log inspection in relevant crane log book.	✓
			Emergency Action Plan – 6 monthly	
4.			Note EAP updated names and phone numbers etc current. Actually phone the list ensuring details are current and include any land sales. Check with Water Officer for further advice. Once changes are determined, send corrections to Neville Ablitt (Dam Safety Advisor) and CC to Business Improvements Coordinator	✓
			Settlement Points – yearly	
5.			Note surveyor monitor and records – settlement points on main embankment	✓
			Piezometer Maintenance – yearly	
6.			Note Technical Officer – Rocklea, Brisbane carries out work annually	✓
			Infrastructure Inspection – yearly	
7.			• Main Embankment	✓

Figure 4-3 Sample of Work Instruction for Work Order 5106443

[redacted]

COMPLETION INFORMATION

Please complete the attached work instructions and record all non-conformances, issues
and any additional information at the end of these instructions in the additiona comments section.

Job Completed By : M. Constantine Date: 2-3-11

Supervisor Verification [redacted] Date: 1-3-11

Data Entry Completed : Andrew Boath Scheduler Date: 16 MAR 2011

Figure 4-4 Sample Work Order Completion

Emergency preparations prior to the wet season included:

- Testing and servicing of the generator sets;
- Filling of all fuel stores;
- Weekly dam surveillance as evidenced by weekly reports;
- Testing of portable equipment; and
- Desilting of LN1 Drainage system in late November 2010 to ensure the drain was capable of carrying its design capacity (as evidenced by desilting activities form #1077003);

Section 5 of the Fairbairn Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the dam will be continuously manned and the emergency controlled from the Service Centre. The EAP identifies the roles for the dam duty officer (DDO) and emergency event coordinator (EEC), however, in all cases the EAP identifies that the O&M Manual and SOPs are to be followed. Within section 5 of the EAP, actions for a number of stage or alert levels are defined. The alert levels are defined by certain storage levels and catchment conditions.

The first alert level is noted as *flood operations stage 1* where the reservoir reaches EL204.23m (FSL), and reservoir is rising slowly and there is general heavy rain or storms in the catchment. This stage is largely preparatory. At this level there is communication between the DDO, EEC and standby officers. Local radio stations are contacted to broadcast an advice to irrigators.

The next alert level in the EAP is *flood operations stage 2*. This stage is triggered when the water level in the dam is above 204.23m (FSL) and the dam begins to spill. The main focus at this stage is to monitor the event. At this stage the EEC provides notification to the counter disaster executive, police and the Central Highlands Regional Council. The EAP notes a number of road access problems at a storage level of 206.2m

The next alert level in the EAP is *flood operations stage 3*. This stage is triggered at a storage level of 206.67. This corresponds to a discharge exceeding 95,700ML/d up to 147,000ML/d. The main focus at this stage is to monitor the event and dam surveillance of

 [redacted]

the main embankment. At this stage the EEC provides further notification to the counter disaster executive, police and the Central Highlands Regional Council (CHRC).

The next alert level in the EAP is *flood operations stage 4*. This stage is triggered at a storage level of 207.4m. This corresponds to discharges exceeding 147,000ML/d up to about 500,000ML/d. The main focus at this stage is to monitor the event and dam surveillance of the main embankment and saddle dams. At this stage the EEC provides further notification to the counter disaster executive, police and the Central Highlands Regional Council.

There is a further *flood operations stage 5* that was not reached during this event. This stage is triggered at a storage level of 211m. The main focus at this stage is increased surveillance of the dam as the water level approaches the crest of the dam.

The Fairbairn Dam EAP is consistent with the State Emergency Management framework described in section 7 of my statement dated 11 March 2011. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the LDMG using the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

4.1.3 Outline of flood event 2010/2011

The EAP was first activated as defined in SOP 40 for Fairbairn Dam on 10th September 2010 and concluded on the 1st March 2011

The landholders identified in the EAP were notified on 10th September 2010.

Figure 4-5 outlines the recorded inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak discharge occurred on 31 December. The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 2,800,000ML or 2.2 times the full storage volume of the dam.

Water spilled from Fairbairn Dam on an almost continuous basis from 10th September 2010 through to the 1st March 2011. There were a number of events or peaks during this period. The most significant period where Fairbairn Dam reached stage 4 of the EAP between 29 December 2010 and 4th January 2011 with a peak on 31st December 2010. The peak discharge from the dam for this event is estimated at over 4,300m^3/s. This appears as the large peak in Figure 4-5. Refer to Table 4-2 for details of how the flood event progressed at Fairbairn Dam.

[redacted]

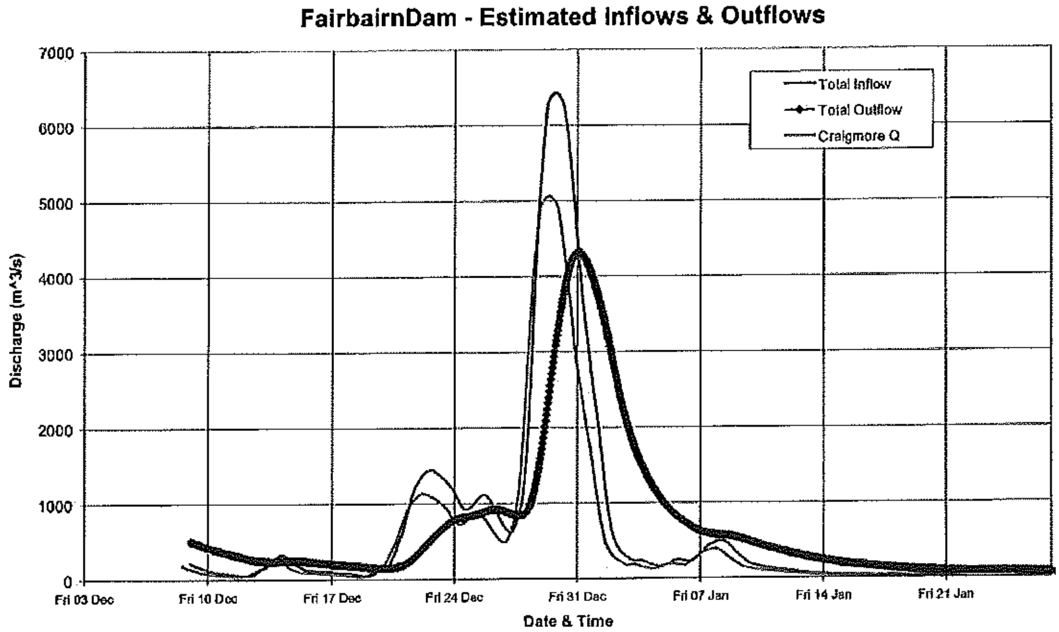


Figure 4-5 Fairbairn Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Table 4-2 Fairbairn Dam EAP Status

Date	EAP Stage
10-Sep-10 11-Sep-10	Stage 1
11-Sep-10 27-Dec-10	Stage 2
27-Dec-10 29-Dec-10	Stage 3
29-Dec-10 04-Jan-11	Stage 4
04-Jan-11 05-Jan-11	Stage 3
05-Jan-11 28-Feb-11	Stage 2
28-Feb-11 01-Mar-11	Stage 1

SunWater provided updates to the contacts identified in the EAP on numerous occasions during the event. These communications are logged in the Emergency Event Report and in the communication logs and diaries of various members of staff.

The Fairbairn Dam EAP identifies that landholders are notified of overflows from the dam via announcements on local radio stations. Figure 4-6 is a transcript of a radio announcement read on ABC Local Radio which is based on information within the initial EAP activation media release issued by SunWater to media outlets by email. The media release was issued at 0730 on 10th September 2010. The original media release can be made available on request. SunWater provided further media releases on 20th September, 21st September,

[redacted]

19th December and 31st December 2010. These media releases are included in the Emergency Event Report.

The EAP also identifies that the local Irrigator Advisory Committee (IAC) be notified of an event. The Service Manager, Peter Collett (acting as the EEC) provide a pre-emptive email notification to the IAC members on 7 September 2010. The IAC was then advised of the spill event on 10th September via email. The IAC were then provided with regular email updates throughout the event.

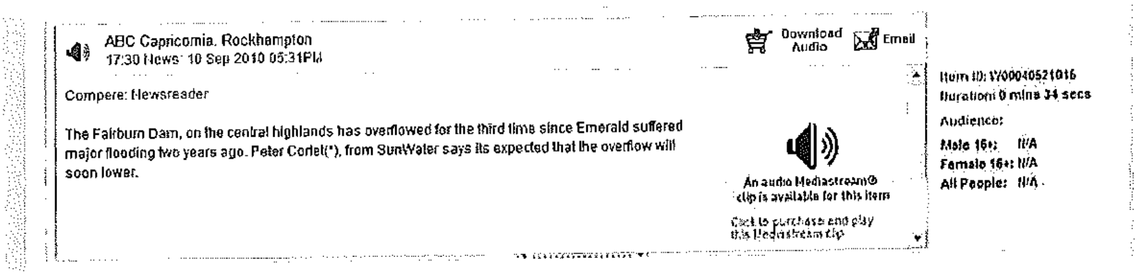


Figure 4-6 Media Clip of Fairbairn EAP Announcement

SunWater provided updates to the contacts identified in the EAP on numerous occasions during the event. These communications are logged in the Emergency Event Report and in the communication logs and diaries of various members of staff. SunWater formally notified or updated disaster management contacts (refer Figure 4-7) and BoM on the following occasions:

- 7th September 2010
- 10th September
- 13th September
- 20th September
- 27th September
- 5th October
- 18th November
- Daily from 3rd December to 9th December
- Daily from 22nd December to 4th January

[redacted]

Counter Disaster Groups					
TITLE/NAME	Phone Business	Phone Mobile	Phone A/H	Fax	Controlled Copy Holder Addresses
Disaster management group chairman - Central Highlands regional Council. (Peter Maguire) 6	[redacted]				P.O. Box 21 Emerald QLD 4720
Coordinator – Disaster Management Central Highlands Regional Council (Bill Wilkinson / Bryan Ottone) 7					P.O. Box 21 Emerald QLD 4720
Emergency Management Queensland State Disaster Management Group 11					GPO Box 1425 Brisbane Q 4001
Regional Director Emergency Management Queensland (Duty Officer) 10					EMQ P.O. Box 1397 Rockhampton Q 4700
Chemical Hazards Local Fire Brigade Unit	000	112	000	-	
Police					
Police Communication Centre – [redacted]					
District Disaster Coordinator (Rockhampton) 9	[redacted]				P.O Box 1161 Rockhampton QLD 4700
Emerald Police 8 (Duty Officer)					P.O.Box 67 Emerald QLD 4720
State Emergency service Emerald					P.O. Box 21 Emerald QLD 4720
State Emergency Service Blackwater					

Figure 4-7 Fairbairn EAP Notification List Counter Disaster Group

The communications listed above were via email however each email was preceded with a phone conversation between the SunWater EEC and either Mike Flannigan or Bill Wilkinson of the Central Highlands Regional Council (CHRC). Typically the communication provided the current storage level and volume and spillway discharge rate.

As noted in section 4.1.2.1 above the Area Operations Manager Mr Tom Wallwork, two of the nominated EECs for the Emerald service area, Mr Robin Boon and Mr Neil Farrell and the Storage Supervisor Mr Mark Constable met with the Emerald LDMG on 1st December 2010 to discuss possible emergency scenarios and raise awareness of the EAP. SunWater also attended LDMG meetings on a number of occasions during the flood event. Neil Farrell (Acting Service Manager) represented SunWater at the LDMG in Emerald on:

- Daily from 2nd December to the 5th December 2010
- Daily from the 27th December to the 5th January 2011

Neil provided dam status updates at these LDMG meetings.

[redacted]

Mr Robin Boon (Service Supervisor) has worked at the Emerald office of SunWater (and its predecessors) for many years. Over that time Mr Boon has developed a very good working relationship with the CHRC, in particular with Mr Bill Wilkinson (Manager of Corporate Governance CHRC). Messrs Boon and Wilkinson routinely share intelligence on catchment conditions and weather events. From about 20th to 26th December Messer Boon and Wilkinson discussed the situation on a daily basis each morning at about 8am. On the morning of the 26th December Mr Wilkinson sent Mr Boon an SMS informing of a large rainfall event in the catchment. On the morning of the 27th December (0610) the two agreed to use their respective network of contacts in the catchment to gather as much information as possible. The summary of this information gathering was that there had been between 200 to 300mm of rain across the catchment and that there was a major flood in the river and the rain was continuing. Messrs Boon and Wilkinson held discussions twice daily at 0800 and 1400 each day from 27th December to the 30th December 2010. The dam peaked early on the 31st December.

The SunWater FOC provided regular updates to the EEC and dam DDO during the major stream rises during the flood event. Generally updates were provided on a daily basis. FOC *Rainfall and Flood Status* reports were issued on the following days:

- 24 December 2010
- 25th December
- 26th December
- 27th December
- 28th December 0800 — Forecast peak 207.15
- 28th December 1600 — Forecast peak 207.7
- 29th December 0800 — Forecast peak 208.4
- 29th December 1530 — Forecast peak 209.3
- 29th December 1930 — Forecast peak 209.8
- 30th December 0730 — Forecast peak 209.9
- 30th December 1500 — Forecast peak 209.9
- 31st December

The actual peak was 209.804m

On Friday the 31st December 2010, shortly after the peak of the flood, the SunWater FOC received a request from the Emerald LDMG for a prediction of when Fairbairn Dam might drop to a level where the Capricorn Highway bridge into Emerald might reopen. The Advice provided to the LDMG was that the flood recession was very unpredictable at the time, however an indication of between 12pm on the 3rd January and early on the 4th January were the best estimate that could be provided. It is understood that the bridge reopened to limited traffic on morning of the 3rd January.

The *Rainfall and Flood Status* provided the EEC and DDO with a forward look at likely changes in inflow and outflows over the next 24 hours. A prediction of the ultimate peak of the flood was not offered until the report of 28th December.

[redacted]

Generally Fairbairn Dam operated to expectations with very few issues recorded.

Figure 4-8 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[3]. The December event was reported as a major flood. Emerald was significantly impacted by flooding. It is noted from Figure 4-5 that Fairbairn dam attenuated a peak inflow of 6,422m^3/s to a peak outflow of 4,324m^3/s. An attenuation factor of 33%.

If Fairbairn Dam had not been in existence the peak inflow of 6,422m^3/s would not have been significantly attenuated. A preliminary assessment has indicated that a flow of approximately 6,400m^3/s at Emerald would have resulted in a flood peak approximately 1.4m higher than that recorded.

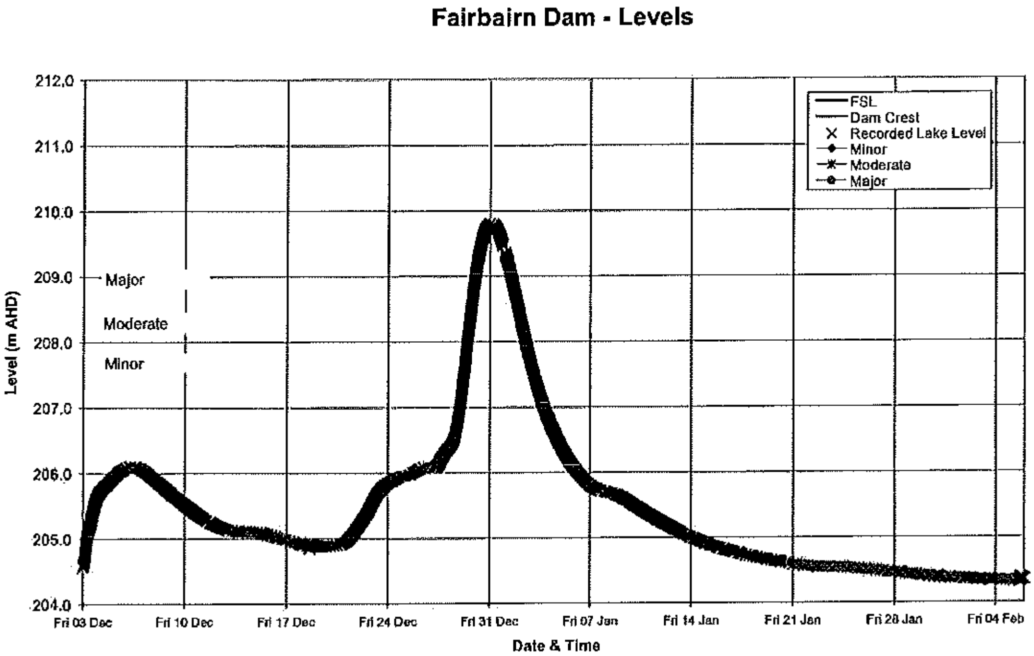


Figure 4-8 Fairbairn Dam recorded flood levels

4.1.3.1 Communities that were affected

The town of Emerald experienced significant flooding. Both residential and commercial areas were inundated. Figure 4-9 shows flood waters in Emerald approximately one day after the peak of the flood.

[3] www.bom.gov.au

[redacted]

Figure 4-9 Flood Waters in Emerald on 1 January 2011

[redacted]

SunWater owns and operates a drainage network in the Emerald irrigation area. The drains are designed to convey irrigation tailwater and storm runoff from farm land to the Nogoa River. The LN1 drain system is in close proximity to the town of Emerald. The LN1 drain system does convey some runoff from the Emerald Town area. SunWater is aware that there is a view in the Emerald community that the local drainage network contributed to flooding in Emerald. In Figure 4-9 it is noted that flood waters have encircled the town. The water in the vicinity of LN1 shown in Figure 4-9 is generally not local runoff. Based on an examination of aerial photography and the limited amount of local rainfall in the three days leading up to the peak of the flood it is concluded that the water in LN1 is mostly flood water from the Nogoa River. Flood water breaks out of the river on the left bank between Fairbairn Dam and the town of Emerald. This conclusion is supported by a report by WRM Water and Environment Pty Ltd titled *Overview of the December 2010/January 2011 Flood at Emerald Qld*. This report was produced for various insurance companies and was provided to SunWater by a resident of Emerald

4.1.3.2 Damage and response to damage

A detailed inspection of all areas of the dam has not yet been possible due to continued spillway flows. However the areas that have been inspected have performed well with no major damage. There was some damage when the lower instrumentation hut was inundated and there is some minor repair required to some concrete slabs in the spillway chute.

4.1.3.3 Gauging stations – effect on data collection

Figure 4-1 shows the location of gauging stations in the catchment. The key stations remained available through the BoM web page throughout the event. This data was used for predictive flood modelling. The only issue of note was that the recorded height at Craigmore (owned by DERM), the key inflow gauge for the dam, exceeded the extent of the rating table. The table was extended during the event using model calibrations and engineering judgement.

4.1.3.4 Media Coverage

An article on 8 January 2011 in the Financial Review "The $10bn question – what's with the weather?" by Matthew Dunkley reports that Fairbairn did not spare Emerald from severe flooding however the president of a local lobby group said that it would have been worse if not for the dams. A preliminary assessment has indicated that flood levels at Emerald would have been approximately 1.4m higher than that recorded if the dam was not in existence.

4.1.3.5 Community inquiries

SunWater received a small number of inquiries from the general public seeking information on water levels and flows at Fairbairn Dam (refer section 2.1.1 of my statement re provisions for 24/7 emergency contact with SunWater through the call centre).

Throughout the event SunWater staff worked closely with the LDMG and attended daily briefings. The LDMG did approach SunWater just after the peak of the event seeking a forecast of when the flows might drop to a level where the main highway bridge into town might be able to be reopened. SunWater provided a verbal response giving an indicative 24 hour window of when the water level at the dam would be at a level that might correspond to

[redacted]

a water level below the bridge. Further details of these conversations are provided at paragraph 4.1.3 above.

4.1.3.6 Post Event Review

SunWater undertook a review of the event. The review found that:

- The EAP and O&M Manual were adequate and provided an excellent guide during the event. Only minor amendments are required to reflect current reporting arrangements. The amendments to these documents are in progress;
- A good working relationship was established and maintained with the LDMG;
- SunWater had adequate staff resources to respond to the event; and'
- Access to all of the saddle dams was difficult with staff resorting to horses to access some areas

4.1.4 Local Disaster Management – SunWater Relationship

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[4] The Operational Planning Guidelines for Local Disaster Management Groups[5] identifies the role of the LDMG during an event as coordination of support to response agencies, reconnaissance and impact assessment, and provision of public information.

The Fairbairn Dam EAP is consistent with the State Emergency Management framework described above and in section 7 of my statement dated 11 March 2011. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the premise that the LDMG will use the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

During this recent event the dam performed to expectations. The stream flows, although significant, were not extreme in a dam safety sense. If circumstances had been more extreme or serious operational problems had been experienced, SunWater staff would have given primacy to protection of life and safety of the dam. The focus of SunWater staff should not be diverted from this priority. It is for this reason that SunWater supports the Queensland Government District Disaster Management framework. In the frame work is that SunWater provides the necessary communications to LDMG who take the lead in provision of information to the public. SunWater focuses on operating and managing the safety of the dam.

---

4 http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

5 http://www.disaster.qld.gov.au/publications/pdf/Operational%20Planning%20Guidelines%20for%20Local%20Disaster%20Management%20Groups.pdf

[redacted]

The model described above worked well for Fairbairn dam. The LDMG invited SunWater to attend each meeting of the group and accepted reports from each agency. The LDMG then coordinated responses and took a lead to provide consistent accurate and relevant information to the public and media.

4.1.5 Previous flood events

The February event is ranked as the largest flood through the dam since it was constructed.

Table 4-3 Fairbairn Dam - Ranking of historic flood events

		FSL	204.228
Flood Rank	Date	Peak Height EL	Peak Height Above Crest
1	Dec-10	209.80	5.57
2	Feb-08	208.67	4.44
3	Feb-78	207.02	2.79
4	May-83	206.67	2.44
5	Apr-90	206,641	2.41
6	Dec-75	206.17	1.94
7	May-77	205.92	1.69
8	Mar-10	205.66	1.43
9	Feb-74	205.49	1.26
10	Sep-10	205.46	1.23
	2010-11 Flood		
1	Dec-10	209.80	5.57

4.1.6 Flood mitigation opportunities/ upgrade or communities potentially affected

The maximum release rate through the outlet works from the dam is approximately 2,000ML/d. At this rate it would take several months to significantly lower the storage notwithstanding any regulatory restrictions on such a release. For example, it would take over twelve months to lower the dam to 50%.

SunWater's predictive flood model for Fairbairn Dam has been used to evaluate how the dam might operate to mitigate flood events. There is no flood mitigation storage in Fairbairn dam. The only air space would be if the dam was below the full supply level prior to an event. The maximum benefit would be if hypothetically the dam was empty at the beginning of the wet season. Figure 4-10 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December, however this would not have been practical for the reasons set out above. If compared with Figure 4-5 it is noted that the peak outflow would have reduced to 2,766 m^3/s. This would have been a height over the spillway of 4.24m which is a moderate flood level. Figure 4-11 simulates the behaviour of the dam had it been at 50% on 1 December. Under this scenario major flood levels would still have been reached. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Fairbairn Dam without a significant loss of water supply to the local community.

[redacted]

Fairbairn Dam - Estimated Levels

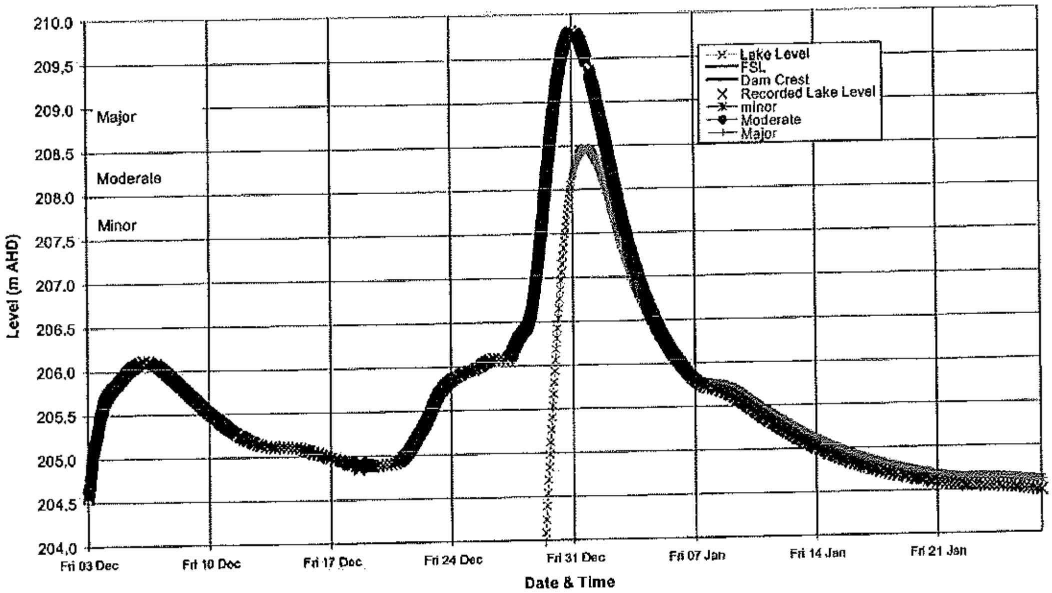


Figure 4-10 Fairbairn Dam Simulated Behaviour if empty on 1 December

Fairbairn Dam - Estimated Levels

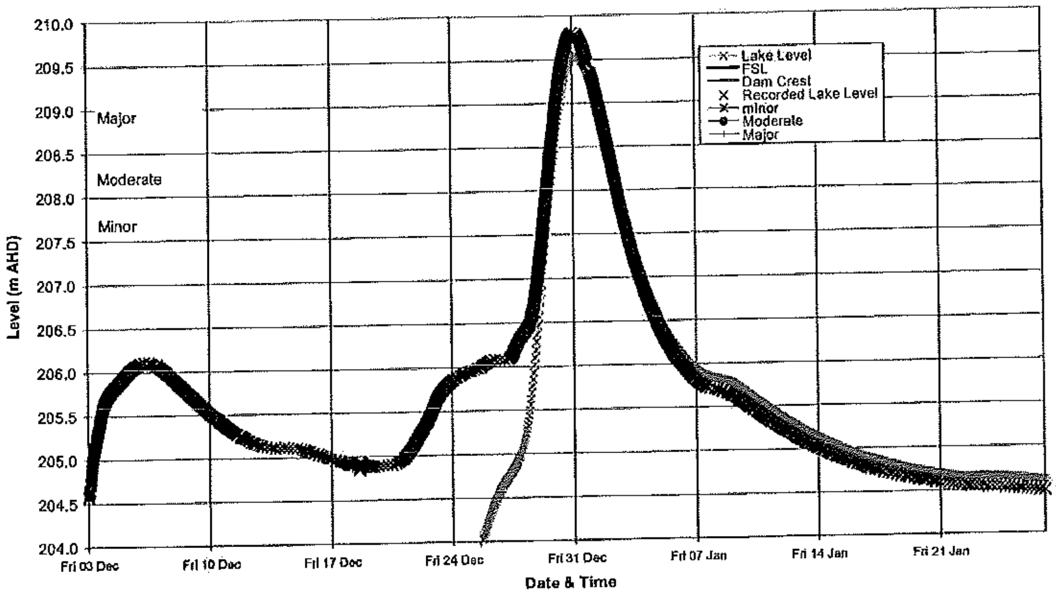


Figure 4-11 Fairbairn Dam Simulated Behaviour if at 50% on 1 December

[redacted]

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.

Sworn and Declared at Brisbane)

this 10th day of May 2011 in the)

presence of:)

[redacted]

Signature of the declarant

[redacted]...

~~Justice of the Peace~~/ Solicitor/

~~Commissioner for Declarations~~

Schedule 4: Fairbairn Dam – Supplementary Number 2

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

4.1 Fairbairn Dam

4.1.1 Communications with Mr Geoff Kavanagh

The Commission has requested particulars of any contact with the CHRC Hydrologist, Mr Geoff Kavanagh.

SunWater had not (prior to the Commission of Inquiry's request for a supplementary statement) been notified that Mr Kavanagh was a hydrologist for the CHRC.

SunWater personnel know Mr Kavanagh as an irrigator and SunWater customer.

I have been informed by Mr Robin Boon of SunWater (who I have referred to at page 12 of my statement titled *Schedule 4: Fairbairn Dam – Supplementary*) that, although Mr Boon was not aware that Mr Kavanagh was a hydrologist, he was aware that Mr Kavanagh had developed a computer program which modelled rainfall and inflows and that the program produces peak flow forecasts.

Despite the fact that SunWater personnel were not informed that Mr Kavanagh was a hydrologist for the CHRC, as set out below, SunWater had numerous communications with Mr Kavanagh as a result of his membership of the local Irrigator Advisory Committee (IAC), which was kept informed by SunWater of spill events during the wet season.

In respect to communications in general, I have previously provided a statement titled *Schedule 4: Fairbairn Dam – Supplementary.* In that statement I detailed the communications SunWater had during the flood event at Fairbairn Dam.

As set out in that statement, the Fairbairn Dam EAP requires that the IAC be notified of a spill event.

SunWater's Service Manager, Peter Collett (acting as the EEC) provided a pre-emptive email notification of a possible spill event to the IAC members (including Mr Kavanagh) on 7 September 2010.

The IAC (including Mr Kavanagh) was then advised of the spill event on 10th September via email. The IAC were then provided with regular email updates throughout the event.

[redacted]

Attachment "A" to this statement is a copy of the email advices to the IAC on the 13th, 20th and 27th September 2010 and the daily email updates from 22 December 2010 to 4 January 2011. Mr Kavanagh's email address appears on the list of recipients in these emails.

I have also been informed by Mr Robin Boon, that Mr Boon sent further email updates to the IAC (including Mr Kavanagh) on 5 October 2010, 18 November 2010 and daily from 3 to 9 December 2010; however, Mr Boon can no longer locate copies of those emails. Mr Boon has informed me that these emails provided information on the status of the dam storage and current discharge as at the time they were sent.

Attachment "B" to this statement is a copy of minutes of the LDMG Meetings on 27 & 28 December 2010 and 2 January 2011. The minutes list Mr Kavanagh as having attended a number of the LDMG meetings that were also attended by SunWater staff.

In my statement titled *Schedule 4: Fairbairn Dam – Supplementary* I referred to communications between Mr Robin Boon of SunWater and Mr Bill Wilkinson (Manager of Corporate Governance CHRC). Those communications included exchange of information about rainfall and flooding.

I have been informed by Mr Boon that Mr Kavanagh was also involved in a number of the discussions that Mr Boon had with Mr Wilkinson between 27th and 30th December (which are the conversations referred to at page 12 of *Schedule 4: Fairbairn Dam – Supplementary.*

[redacted]

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.

Sworn and Declared at Brisbane	)	
this 20th day of May 2011 in the	)	[redacted]
presence of:	)	
		Signature of the declarant

[redacted]...

~~Justice of the Peace~~/ Solicitor/
~~Commissioner for Declarations~~

Renée Gae Butterfield
Solicitor

Schedule 4: Fairbairn Dam – Supplementary Number 2 – Attachment A

[redacted]

Keogh, Rob

From: Collett, Peter
Sent: Monday, 9 May 2011 1:49 PM
To: Keogh, Rob
Subject: FW: Fairbairn Dam EAP Stage 1 - Flood Event

IAC update

Regards,

[redacted]

Area Operations Manager - South
SunWater
[redacted]

From: Collett, Peter
Sent: Monday, 13 September 2010 9:36 AM
To: Carl Morawitz (IAG); Dougall Millar (NMIAG); Geoffrey Kavanagh (IAG); Glenn Pearmine (IAG); Ian Burnett (IAG); Les Fluerty (IAG); Peter Galea (IAG); Robert Ingram (IAG); Wallwork, Tom
Cc: Wallwork, Tom
Subject: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good Morning,

At 0600 this morning the discharge over the Fairbairn Dam Spillway remained at one cm. The discharge flow has varied over the weekend between 36ML and 50ML per day. The flow at 0600 this morning was 40ML.

Inflows from Craigmore have reduced to 439ML.

The weather in the Fairbairn Dam catchment has been fine over the weekend with no rain forecast for the next 48 hours.

The situation at 0600 today was:

- Dam EL 204.24 – 100.3% of capacity – 1,305,036ML
- 24 hour change +0.0% / +150ML
- Discharge over Spillway – one cm – 40.6ML
- Craigmore – 439.4ML

The discharge from the spill event is anticipated to be small.

Water Officer will be commencing meter reading today. These readings will be used to reconcile the carry-over accounts and also for the end of September quarter reading for invoicing.

Please give me or one of the Water Officers a call if you have any questions.

[redacted]

Regards,

[redacted]

Service Manager, Emerald
SunWater

[redacted]

20/05/2011 [redacted]

Keogh, Rob

From: Collett, Peter
Sent: Monday, 9 May 2011 1:51 PM
To: Keogh, Rob
Subject: FW: Fairbairn Dam EAP Stage 1 - Flood Event

IAC update

Regards,

[redacted]

Area Operations Manager - South
SunWater
[redacted]

From: Collett, Peter
Sent: Monday, 20 September 2010 8:18 AM
To: Carl Morawitz (IAG); Dougall Millar (NMIAG); Geoffrey Kavanagh (IAG); Glenn Pearmine (IAG); Ian Burnett (IAG); Les Fluerty (IAG); Peter Galea (IAG); Robert Ingram (IAG)
Cc: Wallwork, Tom
Subject: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good Morning,

At 0630 this morning the discharge over the Fairbairn Dam Spillway had increased to 24 cm / 2,824ML/day.

There were good rains over the weekend generally in excess of 40mm across the catchment with 93mm recorded at Craigmore. Inflows from Craigmore have increased to 1,976ML/day.

The weather in the Fairbairn Dam catchment is cloudy with a 70%+ chance of 10-20mm of rain each day for the next week.

The situation at 0630 today was:

- Dam EL 204.47 – 103.0% of capacity – 1,333,258ML
- 24 hour change +2.7% / +35,364ML
- Discharge over Spillway – 24 cm – 2,824ML
- Craigmore – 1,976ML

Please give me or one of the Water Officers a call if you have any questions.

Regards,

[redacted]

[redacted]

Service Manager, Emerald
SunWater
[redacted]

[redacted]

20/05/2011

Keogh, Rob

From: Collett, Peter
Sent: Monday, 9 May 2011 1:52 PM
To: Keogh, Rob
Subject: FW: Fairbairn Dam EAP Stage 1 - Flood Event

IAC update

Regards,

[redacted]

Area Operations Manager - South
SunWater
[redacted]

From: Collett, Peter
Sent: Monday, 27 September 2010 11:34 AM
To: Carl Morawitz (IAG); Dougall Millar (NMIAG); Geoffrey Kavanagh (IAG); Glenn Pearmine (IAG); Ian Burnett (IAG); Les Fluerty (IAG); Peter Galea (IAG); Robert Ingram (IAG)
Cc: Wallwork, Tom
Subject: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good Morning,

At 0600 this morning the discharge over the Fairbairn Dam Spillway was 1.06m / 26,468ML/day and rising.

There were good rains over the weekend generally in excess of 20mm across the catchment with 39mm recorded at Craigmore. Inflows from Craigmore have increased to 46,957ML/day.

The weather in the Fairbairn Dam catchment is cloudy with a chance of Thunderstorms today and tomorrow, generally clear until the weekend and 80% chance of 40mm+ on the weekend.

The situation at 0600 today was:

- Dam EL 205.29 – 112.90% of capacity – 1,465,792ML
- 24 hour change +0.9% / +11,958ML
- Discharge over Spillway – 1.06m – 26,468ML
- Craigmore – 46,957ML

Please give me or one of the Water Officers a call if you have any questions.

Regards,

[redacted]

[redacted]

Service Manager, Emerald
SunWater
[redacted]

20/05/2011

[redacted]

Keogh, Rob

From: Boon, Robin
Sent: Tuesday, 4 January 2011 10:15 AM
To: [redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Good morning.
Fairbairn Dam at 5am EL 206.74 = 131% or 1,706,590ML/day. Discharging 99,705ML/day at 2.51m over the spillway.
This will be the last E Mail for this flood event.

Robin

From: Boon, Robin
Sent: Monday, 3 January 2011 10:29 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Good morning.
Fairbairn Dam at 6am EL 207.38 = 140% or 1,819,412Ml/day. Discharging 145,258ML/day at 3.15m over the spillway.

Robin

From: Boon, Robin
Sent: Sunday, 2 January 2011 9:26 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Good Morning.
Fairbairn Dam at 6am EL 208.20 = 151 % or 1,970,384 ML. Discharging 213,846 ML/day at 3.97m over the spillway,
Falling 0.04 m/hr

Robin

From: Boon, Robin
Sent: Saturday, 1 January 2011 7:22 AM
To: [redacted]

 [redacted]

[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Good Morning.
Fairbairn Dam at 6am EL 209. 16 = 166 % or 2,156,633 ML. Discharging 305,931ML/day at 4.93m over the spillway,
Falling 0.03m/hr

Robin

From: Boon, Robin
Sent: Friday, 31 December 2010 9:34 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Good morning.
Rainfall again was minimal .
Fairbairn Dam is at EL 209.78 or 5.55 above the spillway and falling 0.01m/hr .
Peak at midnight last night was 209.81 =176% or 2,289,129ML, 5.58m above the spillway. Discharging 373,016ML/day.
Craigmore is falling 0.14m/hr.
The currant situation.
Fairbairn Dam at 6am EL 209. 78 = 175 % or 2, 282 ,899 ML. Discharging 370,650ML/day at 5.55m over the spillway.
Craigmore at 6am 13.751 discharging 208,239 ML/day.

Robin

From: Boon, Robin
Sent: Thursday, 30 December 2010 2:54 PM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Good Afternoon.
Rainfall again was minimal with the next weeks forecast looking the same.
Fairbairn Dam is at EL 209.35 or 5.12m above the spillway and rising 0.05m/hr
Craigmore peaked at 18.16 9am yesterday 29/12/10, est discharge 442,000ML/day.
The currant situation.
Fairbairn Dam at 6am EL 209.35 = 168% or 2,194,826ML. Discharging 325,271ML/day at 5.12m over the spillway.
Craigmore at 6am 16.82 discharging an est of 364,000ML/day.
Forecast is now for a discharge of around 5.6 m. (2008 = 4.44m)

Robin

[redacted]

From: Boon, Robin
Sent: Wednesday, 29 December 2010 10:13 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 4 - Flood Event

Sorry people this should be Fairbairn Dam EAP Stage 4 - Flood Event

From: Boon, Robin
Sent: Wednesday, 29 December 2010 9:37 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 2 - Flood Event

Good morning
Rainfall over the catchment in the last 24hrs was minimal.
Fairbairn Dam is at EL 207.52 or 3.29m above the spillway and rising 0.09m/hr
Raymond is probably around 9.0m and falling
Craigmore is rising 0.01m/hr.
The currant situation.
Fairbairn Dam at 6am EL 207.52 = 142% or 1,844,683ML. Discharging 155,819ML/day at 3.29m over the spillway.
Raymond est at 9.0m discharging an est of 100,000 to 150,,000ML/day
Craigmore at 6am 18.11 discharging an est of 440,000ML/day.
Forecast is now for a discharge of around 5.0m. (2008 = 4.44m)

Robin

From: Boon, Robin
Sent: Tuesday, 28 December 2010 10:22 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 2 - Flood Event

Good morning
Rainfall over the catchment in the last 24hrs was 5mm to 45mm.
Fairbairn Dam is at EL 206.4 or 2.17m above the spillway and rising 0.01m/hr
Raymond probably peaked at 12.2m
Craigmore is rising 0.27m/hr.
The currant situation.
Fairbairn Dam at 6am EL 206.40 = 127% or 1,648,294ML. Discharging 79,083ML/day at 2.17m over the spillway.
Raymond possible peak now at 12.2m discharging an est of 300,000ML/day
Craigmore at 6am 15.07 discharging 269,892ML/day.
Forecast is now for a flood level around 2008.

[redacted]

Robin

From: Boon, Robin
Sent: Monday, 27 December 2010 10:14 AM
[redacted];
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 2 - Flood Event

Good Morning.
Rainfall in the last 24hrs over the catchment varied from 20mm to 250mm.
Fairbairn Dam is at EL 206.1 or 1.87m above the spillway and rising 0.01m/hr
Raymond is rising 0.09m/hr.
Craigmore is rising 0.12m/hr.
The currant situation.
Fairbairn Dam at 7:40am EL 206.10 = 123% or1,597,733ML. Discharging 61,940ML/day at 1.87m over the spillway.
Raymond at 8:30am 9.15 discharging 143,544ML/day.
Craigmore at 7am 9.64 discharging 56,191ML/day.
Forecast of a 3.5m discharge would be reasonable but as usual no event is the same and more rain forecast for the next two days could change everything .

Robin

From: Boon, Robin
Sent: Sunday, 26 December 2010 8:33 AM
[redacted];
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good Morning.
Rainfall over the area again was low with only 10mm to 30mm being recorded over the catchment.
Fairbairn Dam is at EL 206.07 or 1.84m above the spillway and is still rising slowly at 0.003m/hr
Raymond is rising slowly.
Craigmore is falling at 0.06m/hr.
The currant situation.
Fairbairn Dam 6am is at EL 206.07 = 122% capacity or 1,592,722ML. discharging 60,417ML/day at 1.84m above the spillway.
Raymond at 3:45am 5.75 discharging 11,057ML/day.
Craigmore at 6am 9.49 discharging 52,300ML/day.
Fairbairn is now spilling more than is coming in through Craigmore so the EL should level out today. (depending on the weather)
Forecast for tomorrow is for falls up to 80mm.

Robin

From: Boon, Robin
Sent: Saturday, 25 December 2010 8:20 AM
[redacted]

[redacted]

[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good morning
Rainfall in the area overnight was only 2mm to 8mm in the catchment.
Fairbairn Dam is at 205.96 or 1.73m above the spillway and rising 0.001m/hr.
Raymond is still falling.
Craigmore is rising 0.01m/hr.
The currant situation.
Fairbairn Dam at 6am is at EL 205.96 = 121% capacity or 1,574,416ML.Discharging 55,081ML/day at 1.73m over the spillway.
Raymond at 6:45am 5.45 discharging 9,459ML/day.
Craigmore at 6am 10.256 discharging 74,379ML/day.
Forecast is still around 1.8m.

Robin

From: Boon, Robin
Sent: Friday, 24 December 2010 8:24 AM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good morning
Rainfall in the area overnight was minimal with only around 10mm falling in the catchment.
Fairbairn Dam is at EL 205.88 or 1.65m above the spillway and rising 0.004m/hr.
Raymond is falling again after peaking at only 13,700ML/day at 8pm last night.
Craigmore is still falling but only at 0.004m/hr.
The currant situation.
Fairbairn Dam at 6am 205.88 = 120% capacity or 1,561,170ML. Discharging 51,042ML/day at 1.65m over the spillway.
Raymond at 6:15am 6.1 discharging 13,111ML/day.
Craigmore at 6am 9.86 discharging 62.224ML/day.
Forecast is now around 1.8m.

Robin

From: Boon, Robin
Sent: Thursday, 23 December 2010 1:52 PM
[redacted]
Subject: FW: FW: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good Afternoon
Rainfall over Fairbairn Dam catchment for the last 24 hrs was 20mm to 60mm.
Fairbairn Dam is at EL 205.68 or 1.45m above the spillway and rising 0.018m/hr.
Raymond was falling but has stopped at 12,806ML/day and is starting to rise.
Craigmore is still falling at 0.02m/hr.
The currant situation.

[redacted]

Fairbairn Dam at 6am 205.68 = 117% capacity or 1,528,312ML. Discharging 41,998ML/day at 1.45m over the spillway.
Raymond at 6:45am 6.05 discharging 12,806ML/day.
Craigmore at 10.554 discharging 84,664ML/day.
Forecast peak is still around the 2m but could change because of rain last night.

Robin

From: Boon, Robin
Sent: Wednesday, 22 December 2010 2:11 PM
[redacted]
Subject: FW: RE: Fairbairn Dam EAP Stage 1 - Flood Event

Good Afternoon
The rainfall event last weekend triggered falls over Fairbairn Dam catchment that totalled between 30mm and 140mm over the three days.
Fairbairn Dam is at EL 205.27 or 1.04m above the spillway and rising 0.01m/hr.
Raymond peaked 6pm yesterday at 65,900ML/Day and is now falling 0.05m/hr
Craigmore peaked at 7am this morning at 97,367ML/Day and is now falling at 0.01m/hr.
The currant situation.
Fairbairn Dam 6am EL 205.27 = 112% capacity or 1,462,120ML. Discharging 25,690ML/day at 1.04m over the spillway.
Raymond 7am 7.7m discharging 50,132 ML/day.
Craigmore 6am 10.883m discharging 97,246ml/day.
Forecast peak spill level at Fairbairn Dam would be around 1.5 to 2.0m Thursday or Friday.
Weather forecast for the next week is for rain in varying amounts.

Robin

[redacted]

Schedule 4: Fairbairn Dam – Supplementary Number 2 – Attachment B

[redacted]

CENTRAL HIGHLANDS REGIONAL COUNCIL

MINUTES OF LOCAL DISASTER MANAGEMENT GROUP MEETING

MEETING HELD: **MONDAY 27 DECEMBER 2010**

PRESENT: Cr Peter Maguire, Cr Kerry Hayes (CHRC), Cr Paul Bell (CHRC), Geoff Kavanagh (C&R Consultancy), Carey Challacombe (Ergon Energy), Cr Peter Haylock (CHRC), Steve Harris (Ergon), Neil Farrell (SunWater), Simon Cuppel (Kestral), Luke Lankowski (CHRC), Logan McIntosh (QAS), Cr Patty Schwarz (CHRC), Stephen De Keyger (QAS), Wayne Spacie (QR), OC Terry McCullough (QPS), Lorelei Kinsey (EMD Hospital), Phil Brumley (CHRC), Andrew Bullock (CHRC).

MEETING COMMENCED: 12 noon

VENUE: CHRC Executive Meeting Room 1

MEETING CHAIRED BY: Mayor – Cr Peter Maguire

MINUTE TAKER: Phil Brumley

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
1.	Update	• The LDMG met earlier this morning and the decision was made to activate the LDMG. • Mayor updated everyone on weather situation and dam. • Mayor reminded the group that any information and discussions within the LDMG was to be kept confidential. • Staff and agencies will be stationed to work for 24 hours from now on. • Communications to the residents will be mainly through the Website which will be updated regularly. • Di Stanley will be doing Council's media role.	
2.	Rolleston	• Gail – wall of water heading to Rolleston. • Nissan Patrol has turned over. • Lionel Jackson (ESU) is going back to Rolleston and will warn the townspeople.	
3.	Springsure	• Water main break – have contacted Dan Pymble. • Water gone down. • Person to relocate.	
4.	Ergon	• Taking actions to be prepared, including ready for businesses. • Could lose Comet South customers. • Will need SES boat to get to disconnect power in Riverview Street.	
5.	Alerts & Evacuations	• Have alerted residents on Selma Road, Riverview Street and Waldby Court.	

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
		• Evacuation required at Mantuan Downs for 2 adults and 2 children. • Evacuation required for 2 backpackers in the Arcadia Valley. • 2 People in Waldby Court need to be assisted and put in a disability motel.	
6.	Resources	• Control centre 24 hours • Key people and agencies • Key agencies activated	
7.	Requests for Assistance	• Requests to QR for wagons • Request to Telstra • TMR to escort Ergon across if needed. • New protocols for calling Helicopters	
8.	Other	• Clarify who actions 000 calls. • Busses to be stationed on East side. • Qbuild for supplies.	

MEETING CLOSED: The Mayor closed the meeting at 12.55pm.

NEXT MEETING: **10.00am Tuesday 28th December 2010.**

VENUE: CHRC Emerald Executive Meeting Room 1.

[redacted]

CENTRAL HIGHLANDS REGIONAL COUNCIL

<u>MINUTES OF LOCAL DISASTER MANAGEMENT GROUP MEETING</u>

MEETING HELD: **TUESDAY 28 DECEMBER 2010**

PRESENT: Cr Peter Maguire, Les Crossman (DTMR), Cr Peter Haylock, Cr Paul Bell, Wayne Spacie (QR), Phil Brumley (CHRC), Cr Kerry Hayes, Carey Challacombe (Ergon Energy), Neil Farrell (SunWater), Steve Murray (QFRS), OC Terry McCullough (QPS), George Thomson (SES), Bill Wilkinson (CHRC), Steve Bullough (BMA), Jenny Nuss (CHRC), Lorelei Kinsey (EMD Hospital), Dan Pymble (CHRC), Geoff Kavanagh (C&R Consultancy), Mary-Anne Uren (CHRC), Di Stanley (CHRC Media Rep).

MEETING COMMENCED: 10.00am

VENUE: CHRC Executive Meeting Room 1

MEETING CHAIRED BY: Mayor – Cr Peter Maguire

MINUTE TAKER: Tracey Olsen

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
1.	Update	Cr Maguire updated everyone on BOM, Sunwater, DERM confirmed the current flooding is expected to be as high as 2008. 4.5 over spillway with the VL bridge reached on Wednesday afternoon. Peak will occur on Saturday with no more infill. Moderate to heavy falls are expected until Wed/Thurs.	
2.	Rolleston	3m higher than previous floods. Flood boat is not serviceable Springsure boat to go there – SES team from Emerald to relieve.	
3.	Emerald / Railway	VL Bridge to close Wednesday pm. Hospital supplies have been set up at the Ag College – 130 beds. Evacuation Centres set up at Ag College, town Hall, Borilla Street School, and Cotton Gin. QR Train track may close on Thurs at 4pm – discussions are currently taking place between CHRC and QR to seek suitable wagons for transporting people between North & South of Emerald Town. Diesel and Cattle wagons are all that is available in Emerald at the moment. Hope to have an update in the morning. Rail Bridge closed once hits the (15.75m) girders. Can only reopen once reached (15.34m) and inspected. Need to check if can get ramp etc on other side and also stairs from train in Comet and Bluff. QR Rep to look in to this.	All members.

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
		More support (2 people) needed from Rockhampton for QR. Co-ordinate flight with EMQ Rockhampton for essential services. Also need to check stairs at the airport in Emerald. If water levels are higher than 2008 will look at evacuating to the other side before bridge is closed. Flood levels will effect sewage, water etc.	
4.	Food supply	Cr Bell advised notices to shops in Emerald Centro, Toyworld etc given to evacuate staff/stock. Aware of supply issues with Road/Rail cut off. Cr Bell to co-ordinate supply of food.	
5.	Community Support Committee	Activated and ready to help community organise and co-ordinate set ups in Emerald.	
6.	Evacuations	Riverview St, Coles and Little Farm Road 1st to be evacuated – notices out to all there please. Riverview Street and Selma Rd evacuated or ready to go. Need to inform people where to store personal/household belongings – town Hall, PCYC, Emerald North.	
7.	Communications	SMS message alert set up and to be sent to people registered to Emerald addresses.	

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
		Website updated. Email out from the Mayor Map of town flood water set up in Reception area of CHRC	
8.	Sandbags	Lot of requests and enquires on the location and availability of sandbags. Sand and bags disappearing so a new system for distribution has been arranged with SES. Work through areas that will need sandbags on a priority location area – SES with the help of BMA and Kestrel mine works to distribute. Re-stocking sand regularly. Left overs from Selma Road.	
9.	Water/Sewage/Power	Ergon disconnections to Botanical Garden areas, The Links, Kalarah Court, Centro Emerald Market Plaza, Toyworld etc and other areas as water rises in specific locations. Sticker system to be put in place on mailboxes of homes with power cut and water in houses.	
10.	Fire/Ambulance	Team can help assess needs of residents – get Fire team from Rockhampton. Set up on South East Side.	
11.	Air Support	Assistance required – Fire can Assist. High increase in air traffic. Qantas Link – aircraft off line for maintenance. Charter Flights – 12 SES, 2 Rail, 4 Ambos stuck at Nebo – need to get back to Mackay.	

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
		Need to co-ordinate who needs flights and what charter flights are needed i.e. Rocky-Emerald-Mackay-Rocky etc	
12.	ABC Radio	Relocate to Emerald OPC.	
13.	Telstra	Looking at increasing use/coverage	
14.	Security	Extra Police are in Emerald and will be patrolling areas where houses/premises have been evacuated.	
15.	Pets	People with pets are welcome at the evacuation centre at the Ag College	

MEETING CLOSED: The Mayor closed the meeting at 10.55am.

NEXT MEETING: **10.00am Wednesday 29th December 2010.**

VENUE: CHRC Emerald Executive Meeting Room 1.

[redacted]

CENTRAL HIGHLANDS REGIONAL COUNCIL

MINUTES OF LOCAL DISASTER MANAGEMENT GROUP MEETING

MEETING HELD: **SUNDAY 2 JANUARY 2011**

PRESENT: Cr Peter Maguire, Bryan Ottone (CHRC), Glenn Scanlan (QAS), Matt Wallace (QFRS), Peter Day (CHRC), Andrew Bullock (CHRC), Neil Farrell (SunWater), Rex Cowan (DTMR), Dan Pymble (CHRC), Peter Dowling (BMA), Clinton Barnes (BMA), Mick Lucifora (BMA), Steve Harris (Ergon Energy), Monica Sidhu (CHRC), Jenny Nuss (CHRC), Judy McDonald (SES), Steve Murray (QFRS), Cr Kerry Hayes, Geoff Kavanagh (C&R Consultancy), Alex Jones (Rio Tinto), Emily D'Alterio (Rio Tinto), Dan Amos (Qld Police), Lyle Harman (CHRC), Phil Brumley (CHRC).

MEETING COMMENCED: 9.00am

VENUE: CHRC Executive Meeting Room 1

MEETING CHAIRED BY: Mayor – Cr Peter Maguire

MINUTE TAKER: Tracey Olsen

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
1.	Recovery	• LDMG is now moving into the Recovery Phase. • Dept of Communities staff are arriving later today. They will be	

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
		located at the PCYC and the Ag College. • Additional SES volunteers from NSW and Victoria, have now arrived to assist with the clean up and recovery process	
2.	Roads	• Access north of town to Capella is available. Light vehicles only via the Capricorn Highway, past BP onto Tyson Road and Wills Road to Gregory Highway. Vehicles up to 10 tonne can use Brief St, Baker, St, Capricorn Highway, then onto Tyson Road and Wills Road to Gregory Highway. Please exercise caution at all times. • Water will be off the Vince Lester Bridge by tomorrow morning. Main Roads will inspect the bridge and approaches at first light. Only single lane, one way traffic only will be available once a decision is made as to when the bridge is open– therefore long delays are likely, and patience and understanding will be required. • Access to the south side is possible using Selma Road to Long St. • Still no access north across the Gregory Highway at LN1 drain. There has been major damage and significant road base lost. It is likely when the road eventually reopens it will be single lane only.	
3.	Cleaning Up	• Recovery centre at the Art Gallery is out of cleaning products, Harvest Life Church very low. • People on the airport side should go to the airport and staff there will advise them as to where to collect cleaning products. • Disinfectant has not arrived yet. • More cleaning products are being flown in today. • Mines crews are working to help people clean out their homes.	

[redacted]

ITEM NO.	SUBJECT	DISCUSSION	ACTION IF REQUIRED BY WHOM & BY WHEN
		• When re entering your house, be aware that animals such as snakes, spiders etc. may have entered in order to escape the floodwaters. • Please be careful and remember risks and hazards when hosing out your house – eg avoid water entering in power points, protect your skin from exposure to flood waters etc.	
4.	Health	• Hospital is now back fully operational. Anakie St clinic no longer operating. • The clinic at the Ag College will remain operational until access across to the hospital is available.	
5.	Police	Police are maintaining patrols of inundated areas, including the industrial estates, to deter looting.	
6.	Shops	• Woolies will be open this afternoon between 3 and 5 pm. LIMITED STAFF AND SUPPLIES, so please be patient. Enter the shopping centre from Rock Building Society/ Kaesbie Gardens end.	
7.	Power	Ergon Energy are continuing to work in the area to restore power supply.	
8.	Accommodation	• The Habitat is currently being transported by Black Hawk helicopter to St Patrick's school where it will be set up today. This can provide emergency accommodation for up to 150 people. • Numbers at the evacuation centres remain steady.	

[redacted]

MEETING CLOSED:	The Mayor closed the meeting at 9:55am.
NEXT MEETING:	**9.00am Monday 3rd January 2011.**
VENUE:	CHRC Emerald Executive Meeting Room 1.

[redacted]

Schedule 5: Peter Faust

5.1 Peter Faust

The flood event at Peter Faust Dam commenced on 24th December 2010. The total inflow to the dam was 44% of the total storage volume of the dam. Flood levels along the Proserpine River were below minor during the event.

5.1.1 Overview

Peter Faust Dam is a 51 m high earth and rockfill dam with a concrete spillway and concrete lined spillway chute in the right abutment of the dam. The storage capacity is 491,400 ML. The dam is located on the Proserpine River (AMTD 57.7 km) approximately 25 km west of the township of Proserpine. The dam was designed and constructed by the Queensland Water Resources Commission and construction was completed in 1990.

Peter Faust Dam is the major headwork of the Proserpine River Water Supply Scheme. The purpose of the Dam is to supply water for irrigation of agricultural lands, to supply urban water to the Whitsunday Regional Council, as well as to provide flood mitigation along the Proserpine River.

Peter Faust Dam has a *fixed crest spillway* with no *spillway gates* i.e. the *spillway* is *uncontrolled*. Peter Faust Dam has two key features. Firstly the width of the *spillway* is relatively narrow. Secondly the crest of the dam is high relative to the *fixed crest* of the *spillway*. *Discharge* is a function of the *spillway* width. Peter Faust Dam is designed to provide greater flood attenuation by virtue of the smaller *spillway* width (38.9m)[1]. The dam has a relatively high crest to reduce the risk of *overtopping* and any consequent dam safety issue. The flood mitigation partition for Peter Faust exists above the *fixed crest* of the *spillway* as a temporary storage. The flood mitigation provided by Peter Faust is passive in that the operator has no discretionary control of the flows.

The Comprehensive Risk Assessment study for Peter Faust Dam concluded that failure of the dam is not likely at floods below the 1:1,000,000 AEP. During rarer events water could seep through the gravel layer over the top of the core. This risk can be eliminated by constructing a cut-off wall in this region. The probability of failure was found to be very low. However it has been recommended that the dam be upgraded by installing a zone of fine filter within a trench to extend into the top of the clay core. In addition the area at the toe of the embankment on either side of the spillway chute training walls would be protected from overtopping erosion by rock-filled wire mattresses. These upgrade works would enable the dam to pass the PMF, which is the acceptable flood capacity. A final decision on this upgrade project has not yet been made (refer to paragraph 6.2.3 of the statement).

	Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
4	Peter Faust	491,400	2	Proserpine River	57.7	Earth and Rockfill	4,350	1990	Water Supply & Flood Mitigation	Proserpine	Proserpine

[1] Contrast with other spillway widths – Burdekin 504m, Fairbairn 158.5m, Tinaroo 76.3m

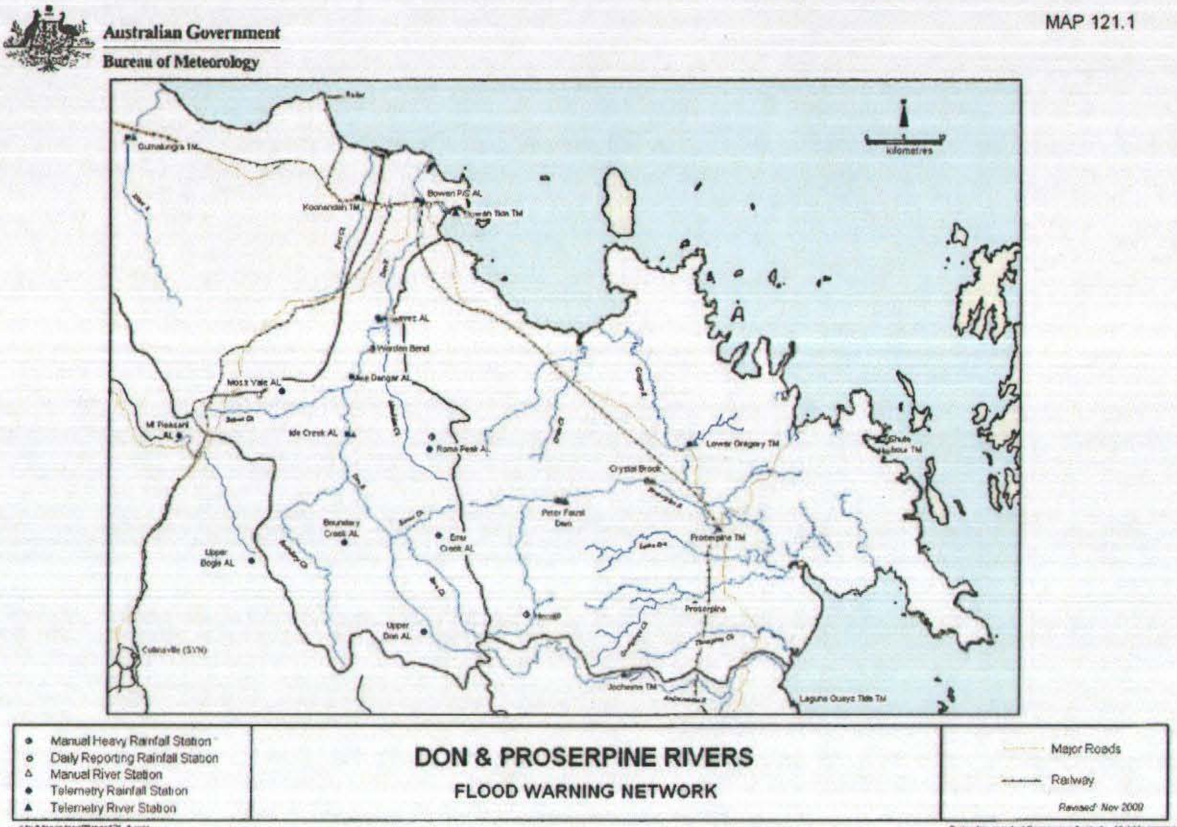


Figure 5-1 Proserpine River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- The Peter Faust Dam Operations and Maintenance Manual
- Peter Faust Dam: Standing Operating Procedures
- Emergency Action Plan: Peter Faust Dam
- Peter Faust Dam: Data Book Part 1-Text
- Peter Faust Dam: Data Book Part 2-Drawings
- Peter Faust Dam: Dam Safety Review (May 2001)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

5.1.1.1 Type

Peter Faust Dam is a 51 metre high, earth and rock-fill dam with a concrete spillway and concrete lined spillway chute in the right abutment of the dam

Table 5-1 Overview of Peter Faust Dam Details[2]

Peter Faust Dam

Latitude	–20.367 N
Longitude	148.380 E
Stream and AMTD	Proserpine River AMTD 57.7 km

Main Dam

Type	Earth and rock fill embankment, rock faced on both the upstream and downstream faces
Full Supply Level (FSL)	EL 85.6 m AHD
Storage capacity at FSL	491,400 ML
Storage area at FSL	4,325 ha
Crest length along axis	534 m
Dead Storage	970 ML
Minimum Operation Level	EL 53.1 m AHD
Height of Dam (from lowest general foundation level)	51 m
Dam Crest Level (DCL)	EL 94.3 m AHD
Available Flood Storage (above FSL)	358,260 ML

Spillway

Spillway type	Un-gated, reinforced concrete ogee crest spillway chute, flip bucket and plunge pool
Spillway crest level	EL 85.6 m AHD
Crest length	38.9 m
Spillway Design Capacity (PMF)	1,664 m^3/s

Outlet Works

Description	Inlet Tower, Diversion Conduit, Valve House and Outlet Structure
Conduit details	Single barrel 2,400 mm DIA RC/MSCL conduit; 200 m long
Outlet Branch Lines	Two 1,200 mm pipelines branching from the main conduit into the Valve House

[2] Peter Faust Dam O&M Manual p16

Guard valves	Two 1,200 mm DIA Butterfly Valves, one on each outlet pipe
Regulating valves	Two 750 mm DIA Cone Valves, one on each outlet pipe
Outlet Capacity	20 m^3/s through both Cone Valves

5.1.1.2 Purpose

The purpose of the Peter Faust Dam is to supply water for irrigation and for rural, urban, and industrial water supplies as well as provide passive flood mitigation downstream along the Proserpine River. In 2009-10 the scheme supplied 32,000ML to agricultural users, industry, and towns.

The operational objectives of Peter Faust Dam are as follows[3]:

1. The Peter Faust Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with
   - Peter Faust Dam Operations and Maintenance Manual
   - SunWater policies and approved practices,
   - The Proserpine River Water Supply Scheme's Interim Resource Operating Licence and/or Development Permit, and
   - Sound engineering and water management standards and practices
2. Water releases from Peter Faust Dam must be scheduled to comply with
   - Schedule 2 of the Proserpine River Water Supply Scheme Interim Resource Operations Licence (April 2003)
   - SunWater's Customer Charter
   - All applicable supply agreements and licences

5.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

5.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Peter Faust dam:

- The EAP was reviewed as part of an annual inspection in May 2010.
- The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.
- A supplementary notice for Issue 2 of the EAP was issued in October 2010 by the Principal Engineer - Dam Safety (refer section 6.1.2).
- Senior SunWater staff met with the Whitsunday LDMG on 20 December 2010 (prior to any discharge from the spillway in the current wet season) to discuss possible emergency scenarios and raise awareness of the EAP.

[3] Peter Faust O&M Manual p21

5.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The Peter Faust EAP was activated on 24 December 2010, due to flooding, and remained active beyond the end of February 2011. Downstream landholders were notified by phone on 24 December 2010 that the EAP had been activated and that the dam would spill resulting in river rises.

5.1.3 Outline of flood event 2010/2011

Figure 5-2 outlines the estimated inflows and recorded outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. There is no gauging station upstream of the dam to record the inflow to the storage. The inflow shown in Figure 5-2 is an estimate derived from the recorded storage behaviour. The estimated peak inflow of over $600m^3$ was attenuated to a peak discharge of $82m^3/s$. The peak discharge was recorded on 29th December 2010.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 215,000ML or 44% of the full storage volume of the dam.

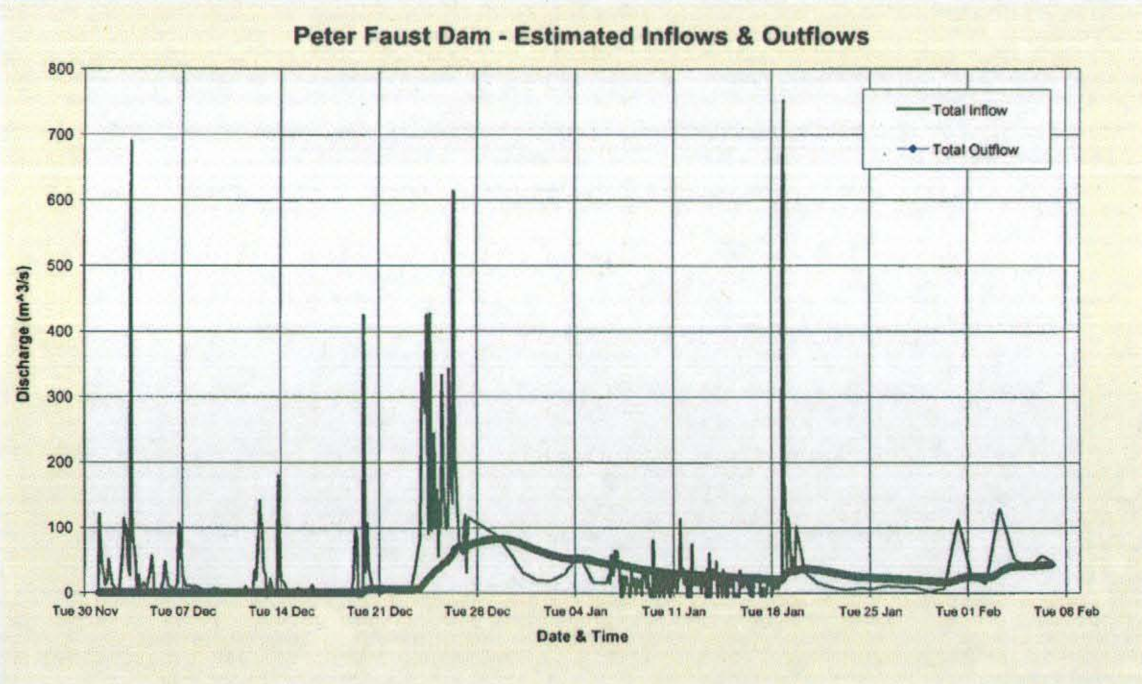


Figure 5-2 Peter Faust Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 5-3 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[4]. The event was reported as below minor floods.

---

[4] www.bom.gov.au

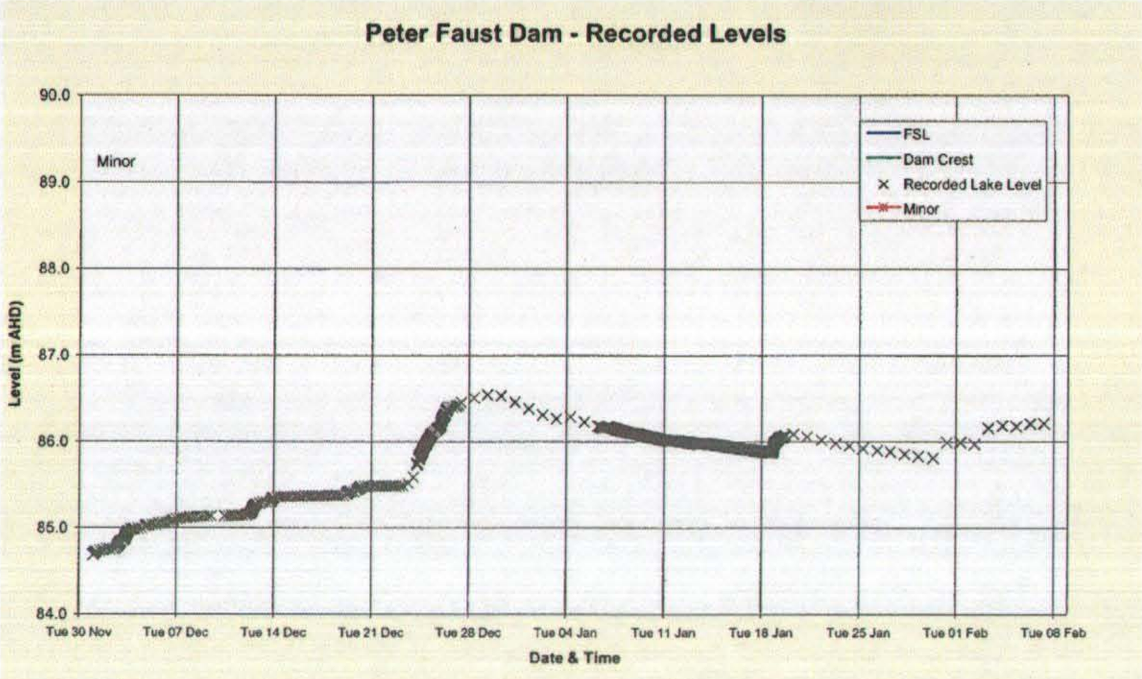


Figure 5-3 Peter Faust Dam Recorded Flood levels

5.1.3.1 Communities that were effected

The peak river height at Proserpine was below minor flood height (refer Figure 5-4). There was no significant flooding impact on communities along the Proserpine River (refer to Table 3-5 of the Statement).

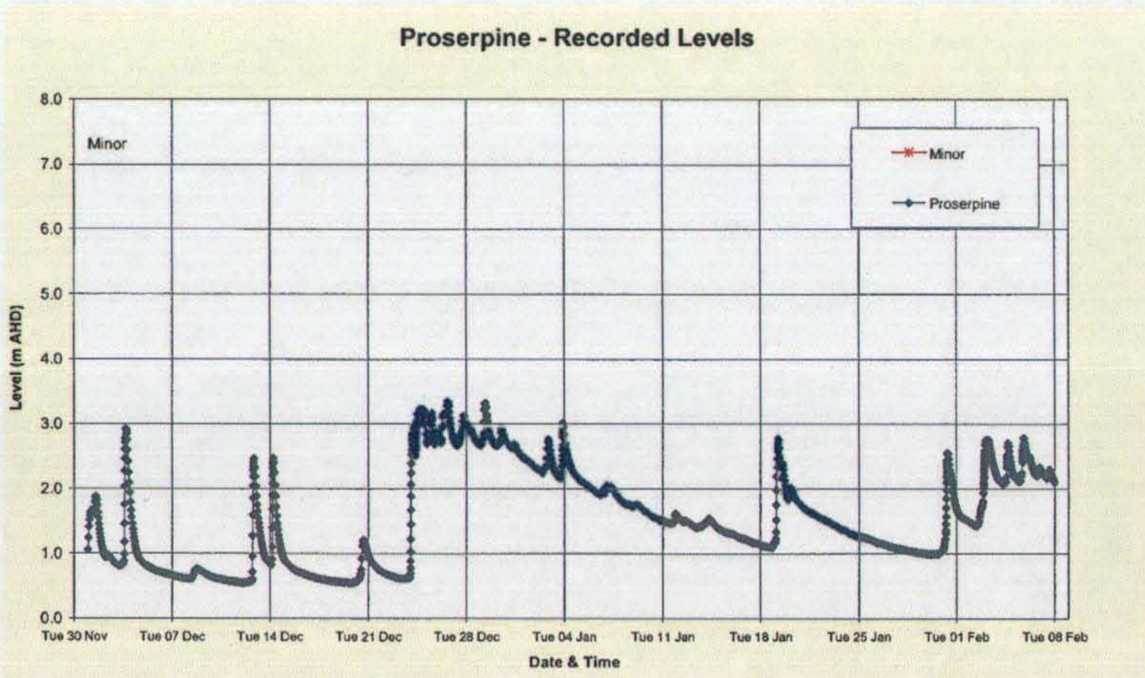


Figure 5-4 Proserpine River at Proserpine - Recorded levels

5.1.3.2 Damage to the dam and response to damage

There was some very minor damage to the spillway and access road. The damage does not impact on the integrity of the dam or its ability to safely pass and mitigate floodwater, and has been scheduled for repairs.

5.1.3.3 Gauging stations – effect on data collection

Figure 5-1 shows the location of gauging stations in the catchment. There are no inflow gauges that can be reliably used for Peter Faust. SunWater's FOC does not provide any predictive modelling for Peter Faust due to the lack of reliable data sources.

5.1.3.4 Community inquiries

SunWater received a small number inquiries from the general public seeking information on water levels, flows and recreation at Peter Faust Dam during the 2010-11 wet season.

Some community inquiries related to the number of fish that were washed over the spillway. The main concern was that the fish were the product of extensive fish stocking activity over a number of years. A fear was expressed that loss of the fish would have an adverse impact on tourism.

5.1.3.5 Media Coverage

In an article of 10 January 2011 published in the Whitsunday Times "Barra die over dam spillway", by Courtney Garnham. The article reports that the Fish Stocking Society had proposed netting due to fish kills during the flooding. The dam safety regulator sought and received assurance from SunWater that netting would not be installed unless approval was first obtained and risks had been appropriately managed.

Local media also reported that Peter Faust Dam spilled for the first time in its history and that SunWater had put on extra security at the dam which was prompted by additional visitors to the site. The local media reported comments from SunWater's Area Operations Manager.

Attached to this schedule are copies of Media Releases from SunWater in relation the Peter Faust Dam as follows:

- *Rainfall continues to keep Peter Faust dam at high levels* on 25 November 2010;
- *SunWater Dam safely passing flooding water* on 29 December 2010, stating that unprecedented continued rain across QLD has resulted in the overflowing of all SunWater's bulk storages across the state, and providing a summary of SunWater dam levels, including at Peter Faust Dam;
- *Water supplies guaranteed for Proserpine Valley* on 3 January 2011;
- *Dam spills for first time* on 5 January 2011;
- *Barra die over dam spillway* on 10 January 2011.

5.1.3.6 Post Event Review

SunWater undertook a review of the event. The review found that:

- The EAP and O&M Manual were adequate and provided an excellent guide during the event. Only minor amendments are required to reflect current reporting arrangements. The amendments to these documents are in progress;

- A good working relationship was established and maintained with the LDMG; and,
- SunWater had adequate staff resources to respond to the event however SunWater has identified that some improvement is needed to the logistics of re-supplying staff. This will be addressed in the planning for future events.

5.1.4 Previous flood events

The February event is ranked as the largest (and only) flood through the dam since it was constructed in 1990.

Table 5-2 Peter Faust Dam - Ranking of historic events

	FSL		85.6 m
Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Dec-10	86.545	0.945
2			
3			
4			
5			
6			
7			
8			
9			
10			
2010-11 Flood			
1	Dec-10	86.545	0.945

5.1.5 Flood mitigation opportunities

The design of Peter Faust Dam includes passive flood mitigation as set out above. The peak outflow from the dam during the 2010-11 wet season was 82 m^3/s. This was approximately 14% of the estimated peak inflow. No further flood mitigation scenarios have been investigated.

Schedule 6: Tinaroo Falls

6.1 Tinaroo Falls

The flood event at Tinaroo Falls Dam commenced on 25th December 2010. The total inflow to the dam was 0.9 times the total storage volume of the dam. Only minor flood levels were experienced along the Barron River downstream of the dam during the event

6.1.1 Overview

The Barron River Catchment covers an area of 2,100 km^2 in the Wet Tropics Region of North Queensland. The Barron River originates in the upland ranges of the Atherton Tablelands at Mt Hypipamee National Park, at an altitude of about 1,000 metres AHD. Twenty kilometres downstream, the Barron River drains into Tinaroo Falls Dam. Annual rainfall varies widely across the catchment. In the higher altitudes in the southeast and east of the catchment, annual rainfall exceeds 2,000mm. Going north from Yungaburra, the rainfall drops from 1,700mm to less than 1,000mm annually near Mareeba. The mean annual discharge of the Barron Catchment is 990,000 megalitres.[1]

Tinaroo Falls Dam is situated on the Barron River in Far North Queensland at AMTD 101.4 km. The purpose of the dam is to supply irrigation water to the Mareeba-Dimbulah Water Supply Scheme and water for urban development in the area. The dam was constructed in 1959 and is owned and operated by SunWater.

The Mareeba-Dimbulah Water Supply Scheme (MDWSS) is located approximately 40km South-West of Cairns. The scheme encompasses the towns of Atherton, Walkamin, Mareeba, Mutchilba and Dimbulah. The MDWSS is a gravity system which uses 176km of main channel, 189km of subsidiary channels and pipelines, and 276km of supplemented streams. It provides water for 43,600 ha of agricultural land and 2 hydro-power stations.

The recommendation of the Comprehensive Risk Assessment (Dec 2008) was that Tinaroo Falls Dam should be upgraded to the *Standard Based* AFC to enable the PMF to be safely passed. The upgrade of Tinaroo Falls Dam has reached practical completion, the upgrade involved:

- Installation of post tension anchors in the concrete monoliths of the main wall and *spillway*;
- Erosion protection slabs to the toe of the main wall;
- Passive anchors in the *spillway* apron slabs;
- A crest wave wall; and
- Raising of the saddle dam.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Tinaroo Falls	438,900	2	Barron River	101 4	Post tensioned Mass Concrete	3,500	1958	Water Supply	Atherton	Mareeba

Insert Summary of flood event impact on properties, road closed etc.

---

[1] http://www.barronriver.org.au/about_bricma/FeatBricma.html

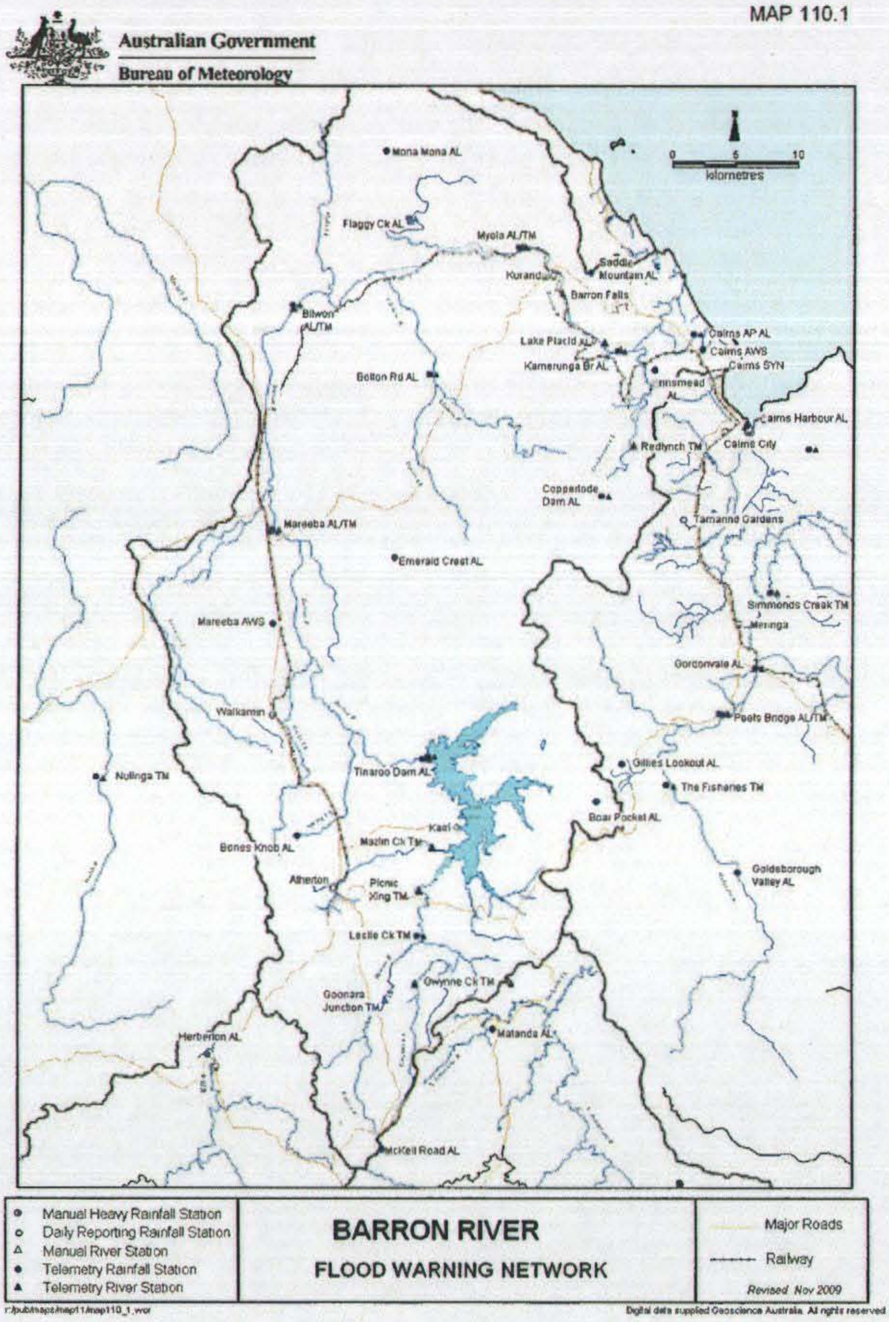


Figure 6-1 Barron River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- Tinaroo Falls Dam: Standing Operating Procedures
- Tinaroo Falls Dam: Operation & Maintenance Manual
- Tinaroo Falls Dam: Emergency Action Plan
- Tinaroo Falls Dam: Data Book Part 1-Text
- Tinaroo Falls Dam: Data Book Part 2-Drawings

- Tinaroo Falls Dam: Dam Safety Review (July 1999)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

6.1.1.1 Type

Tinaroo Falls Dam is a mass concrete gravity dam. The dam has been post tensioned (refer to section 6.2.3 of statement). The dam was originally constructed in 1959 with post tensioning installed in 2010.

Reservoir	
Catchment area	545 km^2
Storage capacity at FSL	438,920ML
Dead Storage	1300ML
Storage area at FSL	3318ha
Length of storage	15km
Length of shoreline	209km
Main Dam	
Type	Post tensioned mass concrete gravity dam
Full Supply Level (FSL)	EL 670.42m AHD
Deck Elevation	EL 674.10m AHD
Total crest length	550.0m
Minimum Foundation Level	EL 230.00m AHD
Height of wall	41.48m
Maximum width at base	35.4m
Quantity of concrete	223,000m^3
Spillway at Main Dam	
Type	Ungated, central ogee spillway
Crest Elevation	EL 670.42m AHD
Crest length	76.2m
Outlet works	
Irrigation outlets	1 x 1500mm DIA Radial Gate, 1 x 1300mm DIA Turbine Inlet Valve with Hydroelectric turbine installed

Barron River outlet	1 x 1300mm DIA Cone Valve
Main Dam Guard (Isolation) valves	3 x 1500mm DIA Butterfly Valve
Saddle Dam	
Type	Zoned earthfill with clay core

6.1.1.2 Purpose

The foreword of the Barron Basin Resource Operations Plan (ROP) notes that:

> *While the Water Resource Plan strives to achieve a sustainable balance between meeting human needs and those of the environment, the resource operations plan is concerned with the practical business of sharing and managing the water resources from day to day in a way that meets water resource plan objectives.*

The purpose of the Tinaroo Falls Dam Dam is to supply water for irrigation and for rural, urban, and industrial water supplies. In 2009-10 the scheme supplied 141,000ML to agricultural users, industry, and towns

The operational objectives[2] of the Tinaroo Falls Dam are as follows:

1. The Tinaroo Falls Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with
   - Tinaroo Falls Dam Operations and Maintenance Manual
   - SunWater policies and approved practices,
   - Barron Basin Resource Operations Plan, and
   - Sound engineering and water management standards and practices
2. Water releases from Tinaroo Falls Dam must be scheduled to comply with
   - Barron Resource Operations Licence (November 2000)
   - SunWater's Customer Charter
   - All applicable supply agreements and licences

6.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

6.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Tinaroo Falls dam:

- SunWater participated in exercise "Poseidon" in June 2010. The exercise was run by emergency services and included a flood scenario involving Tinaroo Falls Dam.
- The EAP was reviewed as part of an annual inspection in August 2010.
- Issue 3 of the EAP was distributed in August 2010.

[2] Tinaroo Falls Dam O&M Manual

- The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.
- Senior SunWater staff met with the Tablelands LDMG prior to any flood event (10 December 2010) to discuss possible scenarios and raise awareness of the EAP.
- The periodic (annual) inspection was undertaken in August 2010 by a SunWater's engineering inspection team. The dam was found to be in a satisfactory condition.

6.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The Tinaroo Falls EAP was activated on 25 December 2010 and remained active beyond the end of February 2011. Downstream landholders were notified on 26 December 2010 that the EAP had been activated and that the dam would spill resulting in river rises.

As the dam was upgraded during 2010, the 2010-11 event was treated as if it were a "first fill" for the dam. Additional surveillance was undertaken in accordance with ANCOLD guidelines.

6.1.3 Outline of flood event 2010/2011

Figure 6-2 outlines the recorded inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak discharge occurred in mid-January 2011.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 390,000 ML or 0.9 times the full storage volume of the dam. The peak inflow of 266 m^3/s was attenuated to a peak outflow of approximately 150 m^3/s.

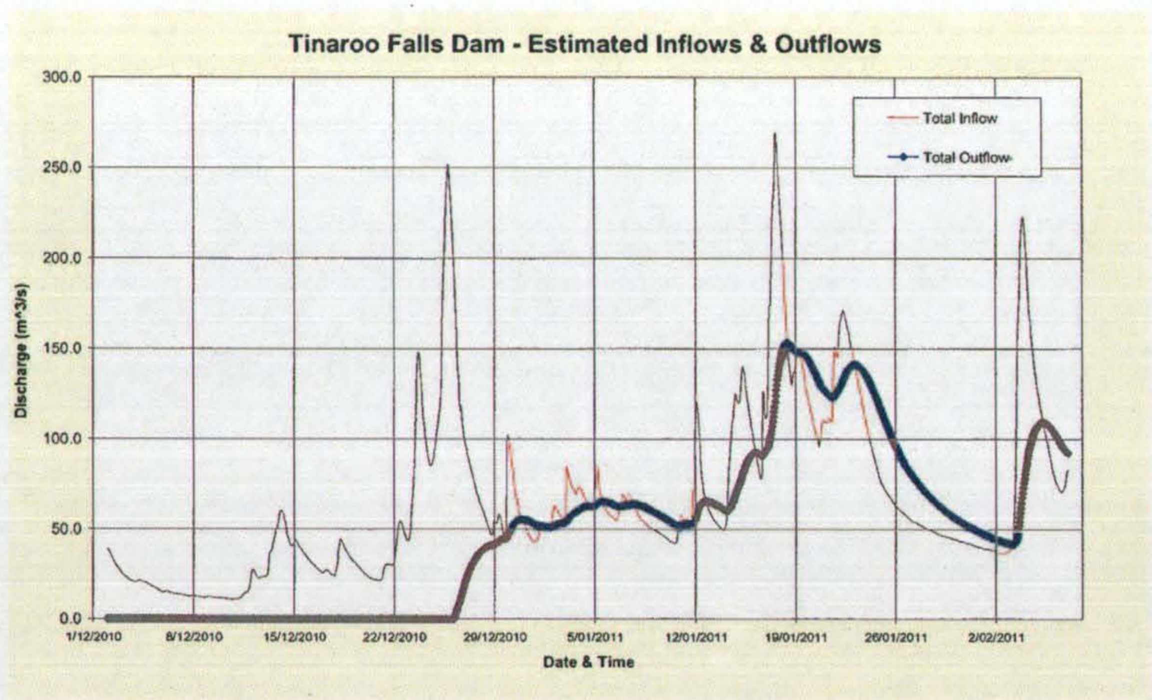


Figure 6-2 Tinaroo Falls Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 6-3 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[3]. The event was reported as below minor to minor flooding.

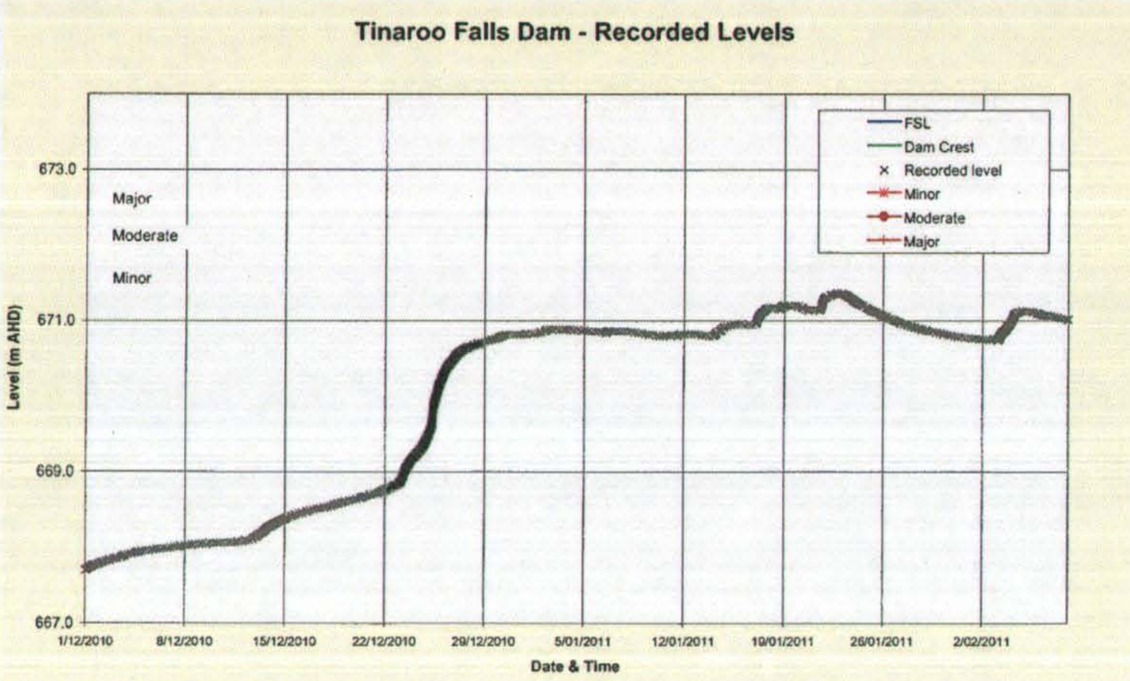


Figure 6-3 Tinaroo Falls Dam Recorded Flood Levels

6.1.3.1 Communities that were effected

The peak river height at Mareeba was at a minor flood height (refer Figure 6-4). There was no significant flooding impact on communities along the Barron River (refer to Table 3-5 of Statement).

[3] www.bom.gov.au

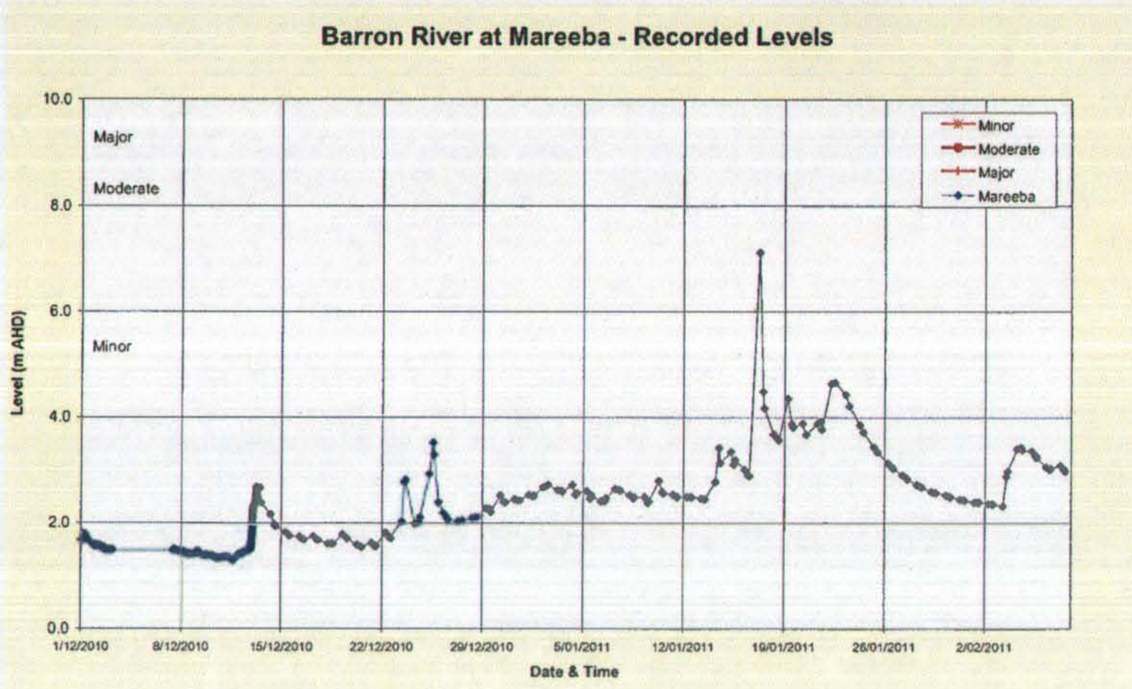


Figure 6-4 Barron River at Mareeba - Recorded Levels

6.1.3.2 Damage and response to damage

There was no damage to Tinaroo Falls Dam from the 2010-11 flooding.

6.1.3.3 Gauging stations – effect on data collection

Figure 6-1 shows the location of gauging stations in the catchment. The key stations remained available through the BOM web page for most of the period. This data was used for predictive flood modelling (refer section 6.1.2.1 of statement).

6.1.3.4 Community inquiries

SunWater received a number of inquiries from the general public seeking information on water levels, flows and releases at Tinaroo Falls Dam. There were about four inquiries regarding lowering the water level for flood mitigation or the upgrade project. These concerns culminated in a public meeting on the subject (refer below)

There were also a small number of inquiries regarding recreation and road access issues.

SunWater staff worked closely with the LDMG and attended briefings as required.

SunWater attended a public meeting on 25th January 2011. The meeting was called by the community to address concerns over the potential for flooding in the district. The local community had raised concerns of the impact of an event similar to that experienced in February 2000. The community was concerned that a repeat of the February 2000 event on an already full storage would result in major flooding. The meeting was convened by the local authority. SunWater presented the findings from modelling of the February 2000 flood event (refer section 6.1.5).

6.1.3.5 Media Coverage

In an article of 21 January 2011 published in the Cairns News reported a view that, if SunWater released its water between April and August last year, the pre-release would alleviate the flooding. SunWater responded that downstream releases are mandated only for environmental purposes and allocation users.

The media reports referred to concerns of residents in communities impacted by the flood event which occurred along the Barron River in 2000.

On 28 January 2011 an article was published in the Tablelands Advertiser, by Norman Beck. This article reported on issues raised by locals including:

- that locals wanted to know whether Tinaroo levels could be lowered to provide a buffer and SunWater had responded that it was unable to make a difference as it did not have large capacity flood gates;
- that locals thought the area needed more flow monitoring stations so information was available about rising creek and river levels; and
- frequent flooding of One Mile Crossing.

A number of articles reported on the public meeting which SunWater attended on 25 January 2011.

During cyclone Yasi there were media reports that there was a "crack" in Tinaroo Falls dam. This was a false report. SunWater advised media outlets and the LDMG that the report was false and that the dam was performing satisfactorily.

Attached to this schedule are copies of articles from the local newspapers as follows:

- *Tinaroo Dam sets record* printed in the Atherton Tablelander on 18 January 2011;
- *Mareeba district residents fear repeat of terrifying 2000 floods* printed in the Cairns News on 21 January 2011;
- *Calm urged over 'bursting dam' fear* printed in the Cairns Post on 25 January 2011;
- *Tinaroo won't stop floods* printed in the Cairns Post on 26 January 2011; and
- *Weather eye advice for Bilwon* printed in the Atherton Tablelander on 28 January 2011.

6.1.3.6 Post Event Review

SunWater undertook a review of the event. The review found that:

- The additional inspections due to the "first fill" nature of the event may have created some of the public concerns that were expressed in the media and the public meeting. Providing additional information to the public may have allayed this perception;
- The new EAP was found to be an improvement by staff; and,
- A good working relationship was established and maintained with the LDMG.

6.1.4 Previous flood events

The February event is ranked as the tenth largest flood through the dam since it was constructed.

Table 6-1 Tinaroo Falls Dam - Rank of historic events

Flood Rank	Date	Peak Height EL (FSL 670.42 m)	Above Crest
1	Feb-99	672.74	2.32
2	Mar-77	672.70	2.28
3	Mar-74	672.37	1.95
4	Feb-00	672.30	1.87
5	Mar-08	671.95	1.53
6	Mar-72	671.42	1.00
7	Feb-01	671.41	0.99
8	Feb-91	671.40	0.98
9	Jan-79	671.39	0.97
10	Jan-11	671.37	0.95
2010-11 Flood			
10	Jan-11	671.37	0.95

6.1.5 Flood mitigation opportunities/ upgrade or communities potentially affected

The maximum release rate from the dam is limited to 38m^3/s. At this rate it would take a number of months to significantly lower the storage notwithstanding any regulatory restrictions on such a release.

SunWater's predictive flood model for Tinaroo Falls Dam has been used to evaluate how the dam might operate to mitigate flood events. There is no flood mitigation storage in Tinaroo Falls dam. The only air space would be if the dam was below the full supply level prior to an event. As noted in section 6.1.3 above, the 2010-11 flood event only resulted in below minor to minor flood levels. The magnitude of this event was not sufficient to gauge the flood mitigation opportunities. The local community had raised concerns of the impact of an event similar to that experienced in February 2000. The community was concerned that a repeat of the February 2000 event on an already full storage would result in major flooding. The February 2000 event had resulted in major flooding in the Biboohra area, however most of the flows in the river during that event had entered the system down stream of the dam. The February 2000 event was selected for modelling purposes.

In January 2000 Tinaroo Falls Dam was at about 88% of FSL. It is noted from Figure 6-5 that, if the dam had been at 100% prior to the February 2000 event, there would have been virtually no difference to the flood peak.

A number of scenarios were run to determine how low the storage level would have to be at the start of the February 2000 event to make a noticeable difference to the peak height of the flood at the dam. It is noted in Figure 6-5 that the dam would have had to be drawn down to approximately 68% in order to lower the flood peak by 300mm, however this would not have been practical for the reasons set out above. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Tinaroo Falls Dam without significant loss of water supply to the local community.

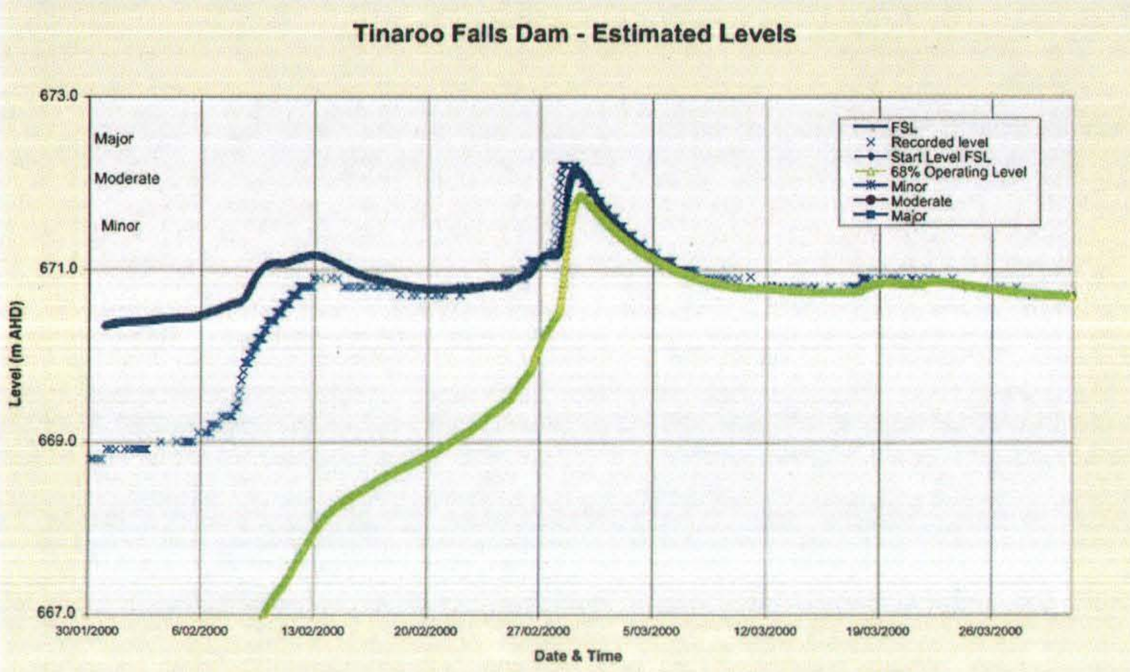


Figure 6-5 Tinaroo Falls Dam Simulated Behaviour - February 2000 Event

Schedule 7: Paradise Dam

7.1 Paradise Dam

The flood event at Paradise Dam commenced on 7th December 2010. The total inflow to the dam was 25 times of the total storage volume of the dam. At the peak of the flood levels major flood levels were experienced downstream in Bundaberg.

7.1.1 Overview

The Burnett River system has a total catchment area in excess of 33,000 km2. The catchment is situated in the north of the Southeast Queensland region. It is bound to the north by the catchments of the Fitzroy River, to the northeast by the Kolan River, to the west and southwest by the Dawson and Condamine Rivers, and to the south by the Brisbane River and the coastal Mary River.

The major tributaries of the Burnett River are Three Moon Creek in the north of the catchment, the Nogo River in the northwest, the Auburn River in the southwest, the Boyne and Stuart Rivers in the south, Barker and Barambah Creeks in the southeast, and the Perry River in the east of the catchment.

Paradise Dam is a 40 m high roller compacted concrete (RCC) dam with a 315m long spillway. The right abutment monoliths are approximately 400m long and act as a secondary spillway. The dam is situated approximately 100 km by road west of Bundaberg on the Burnett River at AMTD 131.4 km. The storage capacity at FSL is 300,000 ML. The dam was designed and constructed by the Burnett River Alliance and construction was completed in 2005. The dam is owned Burnett Water Pty Ltd (a subsidiary of SunWater) and operated by SunWater.

The purpose of the dam is to supply irrigation water for agricultural purposes in the Bundaberg Water Supply Scheme as well as water for urban and industrial development in the region. A mini hydro-electric station is attached to the outlet works of the dam. The Bundaberg Water Supply Scheme surrounds the town of Bundaberg. It supplies water to 55,600 ha of farmland within an area bound by the towns of Childers and Gin Gin to the west and the South Pacific Ocean to the east. The scheme also supplies urban and industrial customers. The scheme is subdivided into two river systems – Kolan and Burnett River.

The Comprehensive Risk Assessment for Paradise Dam concludes that the dam can safely pass the risk based AFC. The AFC is the PMP event with an AEP of 1 in 30,000 years. Some erosion vulnerabilities were noted for events with an AEP in excess of 1 in 10,000 years. These vulnerabilities do not pose any life safety risks and an upgrade is not recommended.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town
Paradise	300,000	2	Burnett River	131.4	RCC	2,951	2005	Water Supply	Biggenden

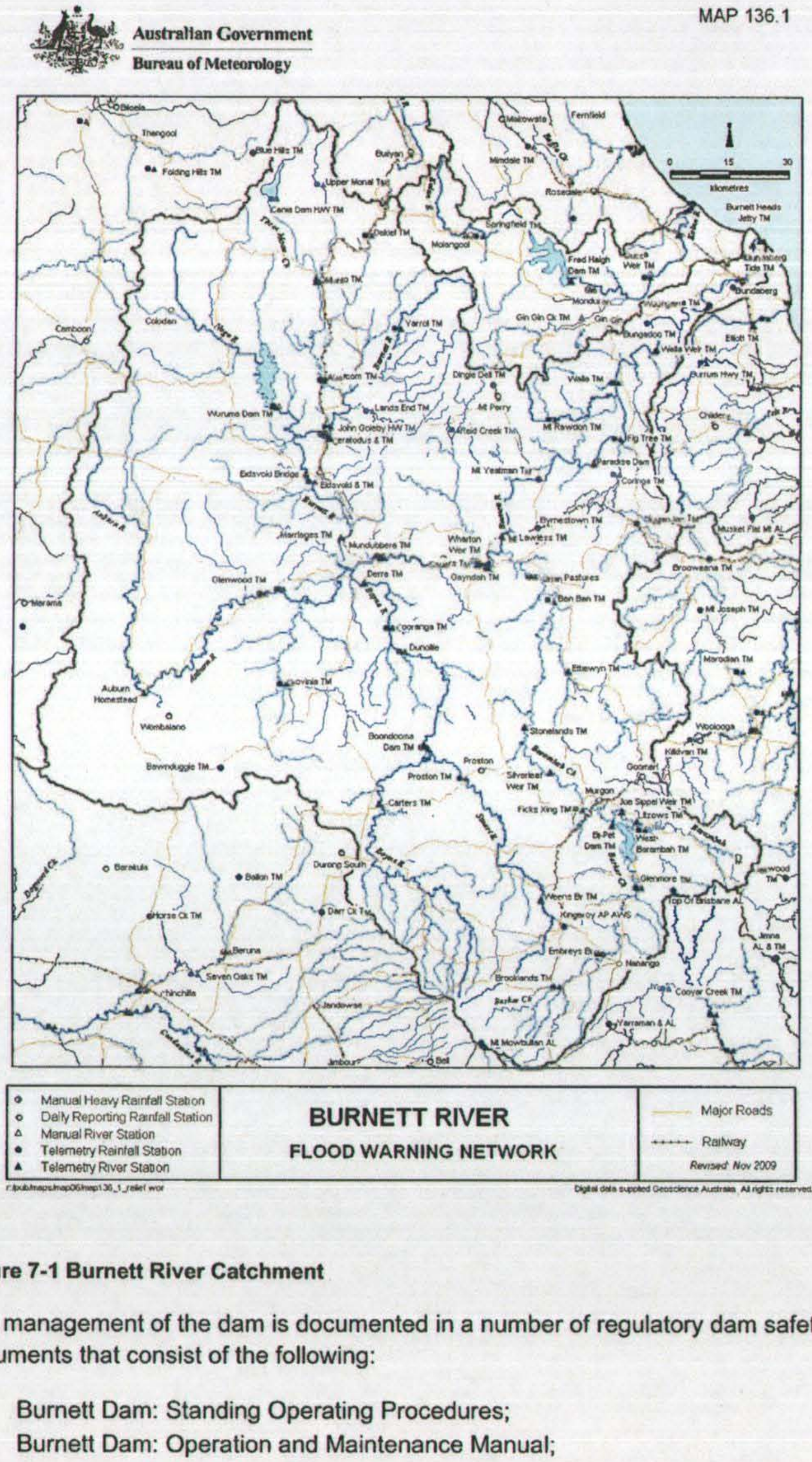


Figure 7-1 Burnett River Catchment

The management of the dam is documented in a number of regulatory dam safety documents that consist of the following:

- Burnett Dam: Standing Operating Procedures;
- Burnett Dam: Operation and Maintenance Manual;
- Emergency Action Plan: Burnett Dam;

- Burnett Dam: Data Book; and
- Burnett Dam Design report.

In an emergency situation the procedures in the Emergency Action Plan take precedence over the manual.

7.1.1.1 Type

Burnett River Dam is a 50m high mass concrete gravity structure constructed of roller compacted concrete (RCC) and associated structures on the Burnett River in central Queensland. The dam creates a 45 km long narrow reservoir with a surface area of 2,951ha and a storage volume of 300,000 ML.

The dam has a central primary spillway with a crest length of 315m and full supply level of EL 67.6m. The secondary spillway is located on the right abutment and has a crest length of 480m and an overtopping level of EL 78.0. The left abutment has a crest length of 110m and a crest level of EL 83.0. The spillways are uncontrolled. The dam is fitted with an environmental outlet that has a capacity of up to 270m3/s. This outlet is used for release of very small floods to minimise fish deaths from skimming flows over the spillway.

Table 7-1 Overview of Paradise Dam Details

DAM NAME	Burnett Dam
STREAM	Burnett River
RESERVOIR NAME	Burnett Dam
LATITUDE / LONGITUDE	25°21'15" S / 151°55'0" E
DAM TYPE	Roller compacted concrete gravity dam
HEIGHT	50m
CREST LEVEL	EL 67.6m (Primary Spillway) EL 78.0m (Secondary Spillway) EL 83.0m (Non-Overflow Section at left abutment)
FULL SUPLY LEVEL (FSL)	EL 67.6m
CAPACITY AF FSL	300,000 ML
SUBMERGED AREA AT FSL	3,000 ha
DESIGN FLOOD LEVEL (DFL)	EL 87.7m (PMP DF)
NORMAL MINIMUM OPERATING LEVEL (NMOL)	EL 46.0
MINIMUM ACTIVE STORAGE LEVEL	EL 42.0

(MASL)	
VOLUME OF DAM	400,000 m^3 (roller compacted concrete)
RESERVOIR STORAGE CAPACITY	300,000 ML
TYPE OF SPILLWAY	Primary: Free overflow ogee crest Secondary: Free overflow broad crest
SPILLWAY CREST LEVEL	Primary: EL 67.6m Secondary: 78.0m
SPILLWAY CAPACITY	95,000 m^3/s at DFL
TYPE OF OUTLET WORKS	Irrigation: Intake tower with fine screens and shutter system, 5.2m x 5.1m conduit controlled by 2 x vertical discharge valves (or future mini-hydro station). Environmental: Intake tower with coarse screen through 5.0m x 5.1m conduit controlled by 3m x 4.8m fixed wheel regulating gate and guard gate.
CATCHMENT AREA	33,000 km^2
PERIOD OF CONSTRUCTION	2003-2005
PERIOD OF INITIAL FILLING	October 2005 – 2010

7.1.1.2 Purpose

The foreword of the Burnett Basin Resource Operations Plan (ROP) notes that:

> *The WRP and the ROP are complementary parts of a water planning process that will ensure that the basin's rivers are sustainably managed. The WRP strives to strike a balance between human needs and those of the environment. The resource operations plan is concerned with the practical business of sharing and managing the basin's water resources from day to day in a way that meets the water resource plan objectives.*[1]

Paradise Dam was constructed to support the existing Bundaberg Water Supply Scheme (BWSS). The BWSS was initially established in the early 1970s to provide supplementary irrigation water to the local sugar cane industry, replace the existing groundwater extraction practices, and provide supplies for towns and industry.

---

[1] Burnett Basin Resource Operations Plan, Forward

In 2009-10 the Bundaberg water scheme supplied 111,000ML to agricultural users, industry and towns.

The operational objectives of the Paradise Dam are as follows:

1. The Paradise Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
   - Burnett Dam Operations and Maintenance Manual;
   - SunWater policies and approved practices;
   - Burnett Basin Resource Operations Plan; and
   - Sound engineering and water management standards and practices.
2. Water releases from Paradise Dam must be scheduled to comply with:
   - The Burnett Resource Operations Licence;
   - SunWater's Customer Charter, and
   - All applicable supply agreements and licences.

7.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

7.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Paradise dam:

- The EAP was reviewed as part of a comprehensive inspection in November 2010.
- The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer - Dam Safety.
- Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers prior to the wet season.
- The comprehensive (5-yearly) inspection was undertaken in November 2010 by a multidisciplinary engineering inspection team. The dam was found to be in a satisfactory condition.

Emergency preparations prior to the wet season included:

- Testing and servicing of the standby diesel generator and standby lighting;
- Filling of all fuel stores;
- Testing of communication equipment;
- Testing of portable equipment and instruments;
- Checking of operations of gauging stations; and,
- Contingency planning for site access.

7.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The EAP was first activated due to flooding on 7th December 2010 and ceased on 9th December. The EAP was reactivated due to flooding on 12th December 2010 and remained active to after the end of February 2011. Downstream landholders were notified on 6th and

7th December 2010 that the EAP had been activated and that the dam would spill resulting in river rises.

7.1.3 Outline of flood event 2010/2011

Figure 7-2 outlines the recorded inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak occurred at the end of December 2010.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 7,480,000ML or 25 times the full storage volume of the dam.

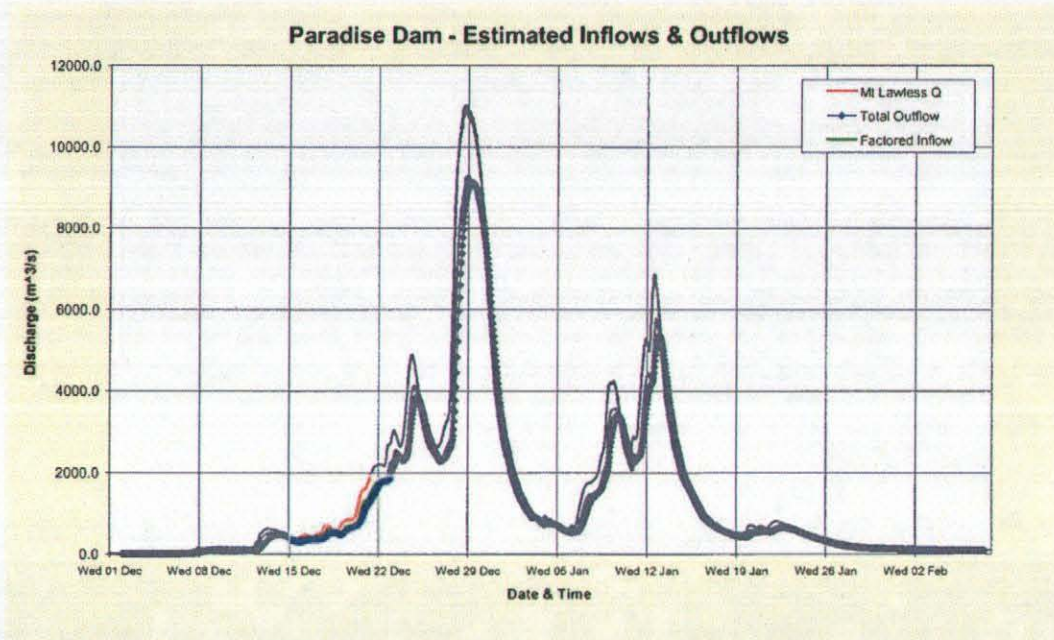


Figure 7-2 Paradise Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 7-3 plots the recorded and estimated storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The storage automatic level recorder failed during the flood event. Manual readings and estimated data has been added to complete the records. The plot also shows the flood classification levels2. Both the December and January events were reported as major floods.

---

[2] www.bom.gov.au

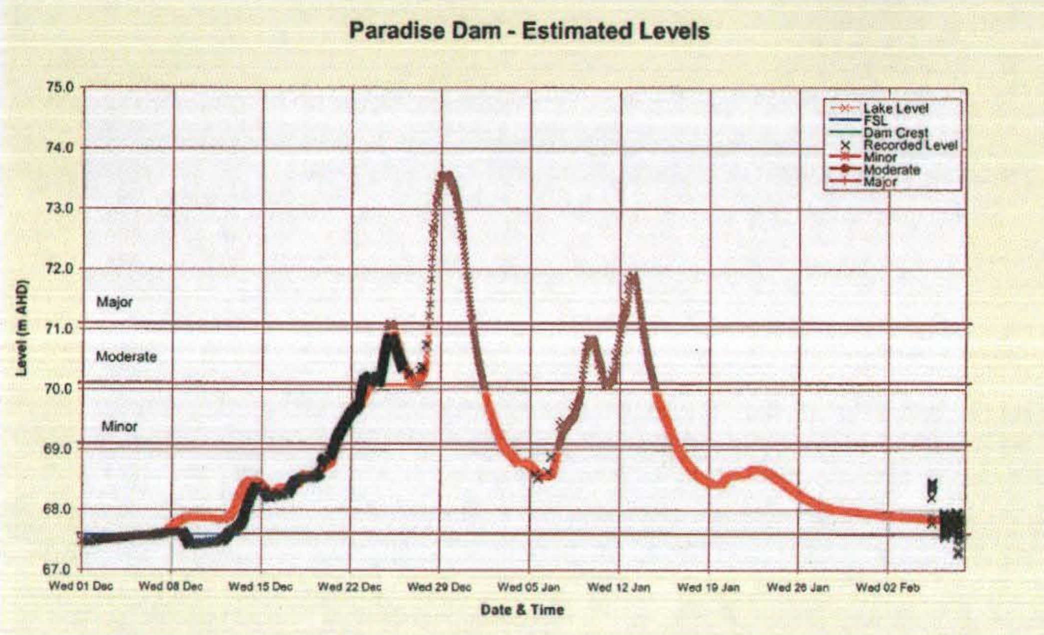


Figure 7-3 Paradise Dam Flood Levels

7.1.3.1 Communities that were affected

The peak of the flood event caused major flooding in the city of Bundaberg and surrounding areas. Figure 7-4 provides a plot of river heights in SunWater's Ben Andersen Barrage. Ben Andersen is slightly upstream of the city of Bundaberg. Ben Andersen Barrage is fitted with crest shutter gates. The shutters were in the fully down (open) position during the flood. The shutters were raised on the tail of the flood to create the barrage storage pool in accordance with the scheme operating rules in the ROP. Hence the step up in levels at the beginning of February.

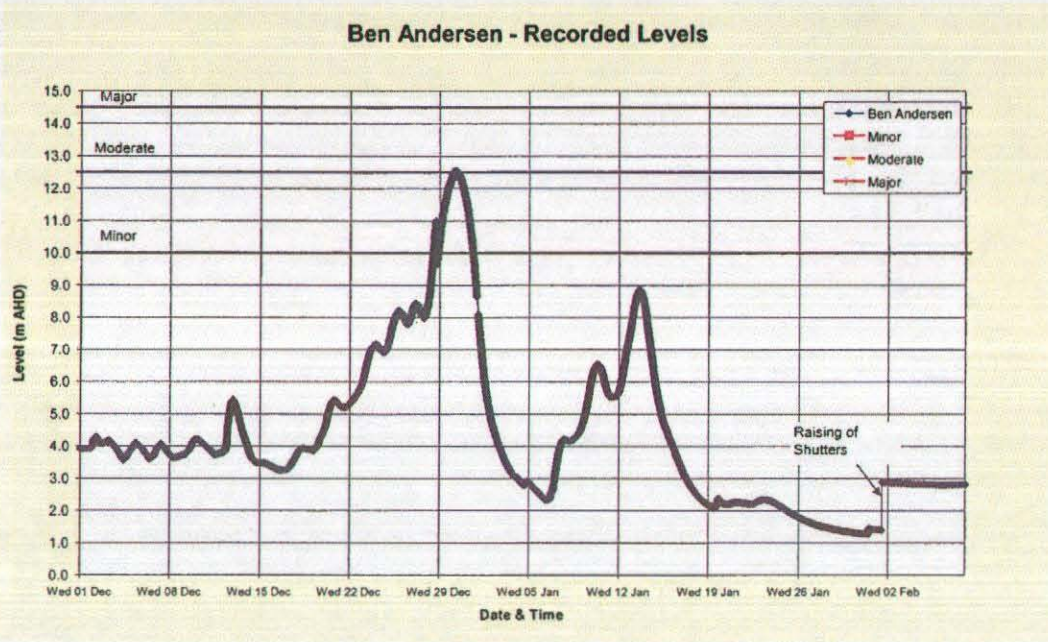


Figure 7-4 Burnett River at Ben Andersen Barrage - Recorded Levels

7.1.3.2 Damage and response to damage

Paradise Dam suffered severe flood damage to the appurtenant works. A full inspection by engineers has found that the main dam structure is undamaged and performed well from a dam safety perspective.

The damage to appurtenant works include:

- Inundation of the valve house and consequential damage to mechanical, electrical and control systems. The outlet valves and fishways are not operational as a result;
- Innundation and failure of the automatic storage recorder;
- Loss of the access road to the valve house;
- Inundation of the hydro-electric station and damage to the generator and control systems; and
- Erosion to the bed and banks of the river down stream of the dam.

During the event operators relied on manual storage level readings. These were provided to BoM, LDMG and SunWater's FOC for emergency planning and management purposes.

A program of works is being developed and implemented to return the dam to a fully operational status as quickly as possible. It is expected to take several months to complete the program however the dam remains in a safe condition.

7.1.3.3 Gauging stations – effect on data collection

Figure 7-1 shows the location of gauging stations in the catchment. The key inflow station, Mt Lawless, remained available through the BOM web page for most of the period. This data was used for predictive flood modelling (refer to statement section 7.1.2.2). The automatic storage level recorder for Paradise Dam failed on about the 26th December. After the failure of the storage level recorder, predictive flood modelling was reliant on manual readings being provided by the operator. The replacement recorder will address and overcome the cause of the failure of the original instrument.

7.1.3.4 Community Inquiries

During the last week of December 2010 there were persistent media reports and inquiries from the public that there was a "crack" in Paradise Dam, or that the dam had failed. These were false reports. SunWater advised media outlets and the LDMG on several occasions that the report was false and that the dam was performing satisfactorily.

SunWater received a number of inquiries from the general public seeking information on water levels, flows and releases at Paradise Dam.

There was also a small number of inquiries regarding recreation and road access issues.

SunWater staff worked closely with the LDMG and attended briefings as required.

7.1.3.5 Media Coverage

Attached to this Schedule are a number of articles published which referred to Paradise Dam, these included:

- *Widespread rain means flood comes from all corners,* Clint Heathorn, published in the News Mail on 28 December 2010;
- *Dirty floodwater enters Gayndah supply,* published in the Fraser Coast chronicle on 28 December 2010;
- *Hoax calls anger police,* published in the News Mail on 31 December 2010;
- *What could have been...Advancements made since 1942 have alleviated damage in 2010,* Doug Gillet, published in the News Mail on 4 January 2011;
- *Any Further rainfall could spell disaster,* Nat Bromhead, published in the Fraser Coast Chronicle on 5 January 2011;
- *Water roars at Paradise,* Central & North Burnett Times published on 6 January 2011.

Refer to section 7.1.3.4.

7.1.3.6 Post Event Review

SunWater undertook a review of the event across the Central Region. The review found that:

- The EAP was generally adequate, however some updating is required to reflect current reporting arrangements. The amendments to these documents are in progress;
- Some difficulties were experienced with continuity of communication networks. NextG communications in addition to land lines at some dams is being investigated;
- Site facilities for staff were found to be inadequate where staff were on duty and isolated for prolonged periods. Planning is underway to improve facilities for the next event; and
- The EEC role (refer to statement table 6.2) across the Bundaberg service centre was found to be too demanding for one person. The role will be split into different sub areas for future events.

7.1.4 Previous flood events

The February event is ranked as the largest flood through the dam since it was constructed.

Table 7-2 Paradise Dam Historic Floods

		FSL	67.6 m
Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Dec-10	73.56	5.96
2	Jan-11	71.83	4.23
3	Mar-10	69.43	1.83
4			
5			
6			
7			
8			
9			
10			
2010-11 Flood			
1	Dec-10	73.56	5.96

7.1.5 Flood mitigation opportunities/ upgrade or communities potentially affected

The Burnett Basin ROP specifies rules for the operation of Paradise Dam, including how releases are to be determined.

SunWater's predictive flood model for Paradise Dam has been used to evaluate how the dam might operate to mitigate flood events. There is no flood mitigation storage in Paradise dam. The only air space would be if the dam was below the full supply level prior to an event. The maximum benefit would be if the dam was empty at the beginning of the wet season. Figure 7-5 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December, however this would not be practical for the reason of compliance set out above. If compared with Figure 7-3 it is noted that there is no difference in the height of the peak outflow from about the 20th December 2010 onwards. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Paradise Dam without a significant loss of water supply to the local community.

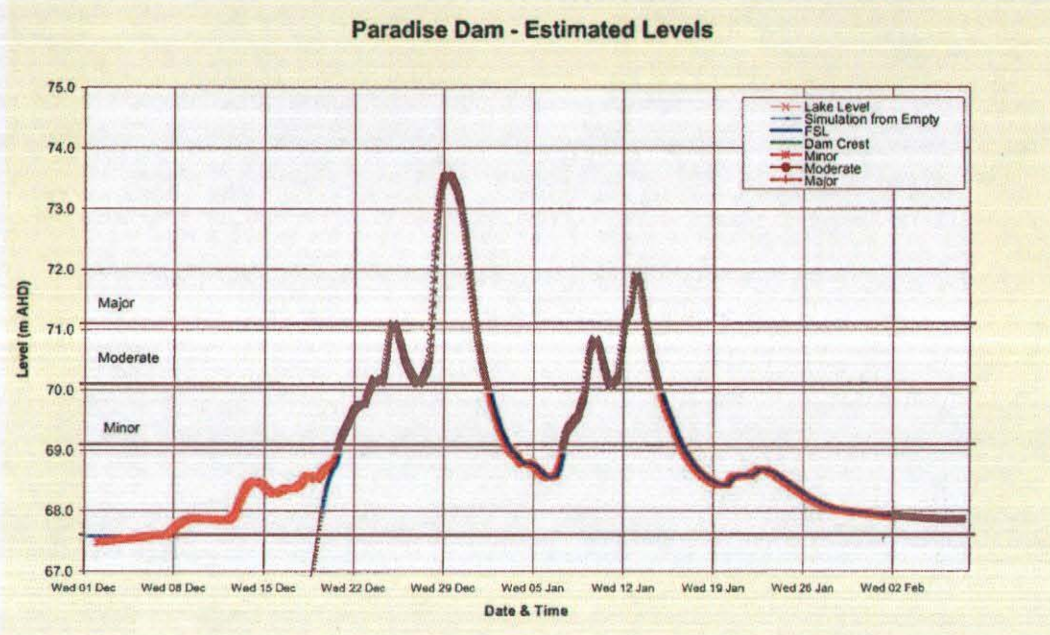


Figure 7-5 Paradise Dam Simulated Behaviour if Empty on 1 December

Schedule 8: Boondooma

8.1 Boondooma

The flood event at Boondooma Dam commenced on 5th December 2010. The total inflow to the dam was 5.3 times of the total storage volume of the dam. Communities along the Burnett River experienced major flooding during the peak of the event.

8.1.1 Overview

The Burnett River system has a total catchment area in excess of 33,000 km^2. The catchment is situated in the north of the Southeast Queensland region. It is bound to the north by the catchments of the Fitzroy River, to the northeast by the Kolan River, to the west and southwest by the Dawson and Condamine Rivers, and to the south by the Brisbane River and the coastal Mary River.

The major tributaries of the Burnett River are Three Moon Creek in the north of the catchment, the Nogo River in the northwest, the Auburn River in the southwest, the Boyne and Stuart Rivers in the south, Barker and Barambah Creeks in the southeast, and the Perry River in the east of the catchment.

The Boyne River and Tarong Water Supply Scheme is one of several water supply schemes contained within the Burnett Basin Catchment. It is centred on the Boyne River and extends from the upstream extent of Lake Boondooma to the river's confluence with the Burnett River over an AMTD-length of 110.5 km.

The scheme was established in the early 1980s with the construction of Boondooma Dam. Its primary purpose was to supply cooling water for the 1400 MW coal fired Tarong Power Station being constructed next to the Tarong coalfield at the same time. Its secondary purpose was to supply landholders along Lake Boondooma and along the Boyne River downstream of Boondooma Dam.

Boondooma Dam is owned and operated by SunWater. The dam is situated on the Boyne River at AMTD 86.7 km, approximately 22 kms by road west of Proston

The Dam Crest Flood (DCF) has a 1: 60,000 AEP.

The comprehensive risk assessment concludes that as the current level of risk associated with Boondooma dam is tolerable and ALARP, the existing dam achieves 100% of Acceptable Flood Capacity as determined by the Risk Assessment approach. In addition it is concluded that any upgrade to reduce the level of risk further from this position is unjustified as the costs of upgrade would be grossly disproportionate to the benefits gained.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Boondooma	204,200	2	Boyne River	86.7	Concrete faced rockfill	1,815	1982	Water Supply	Proston	Mundubera

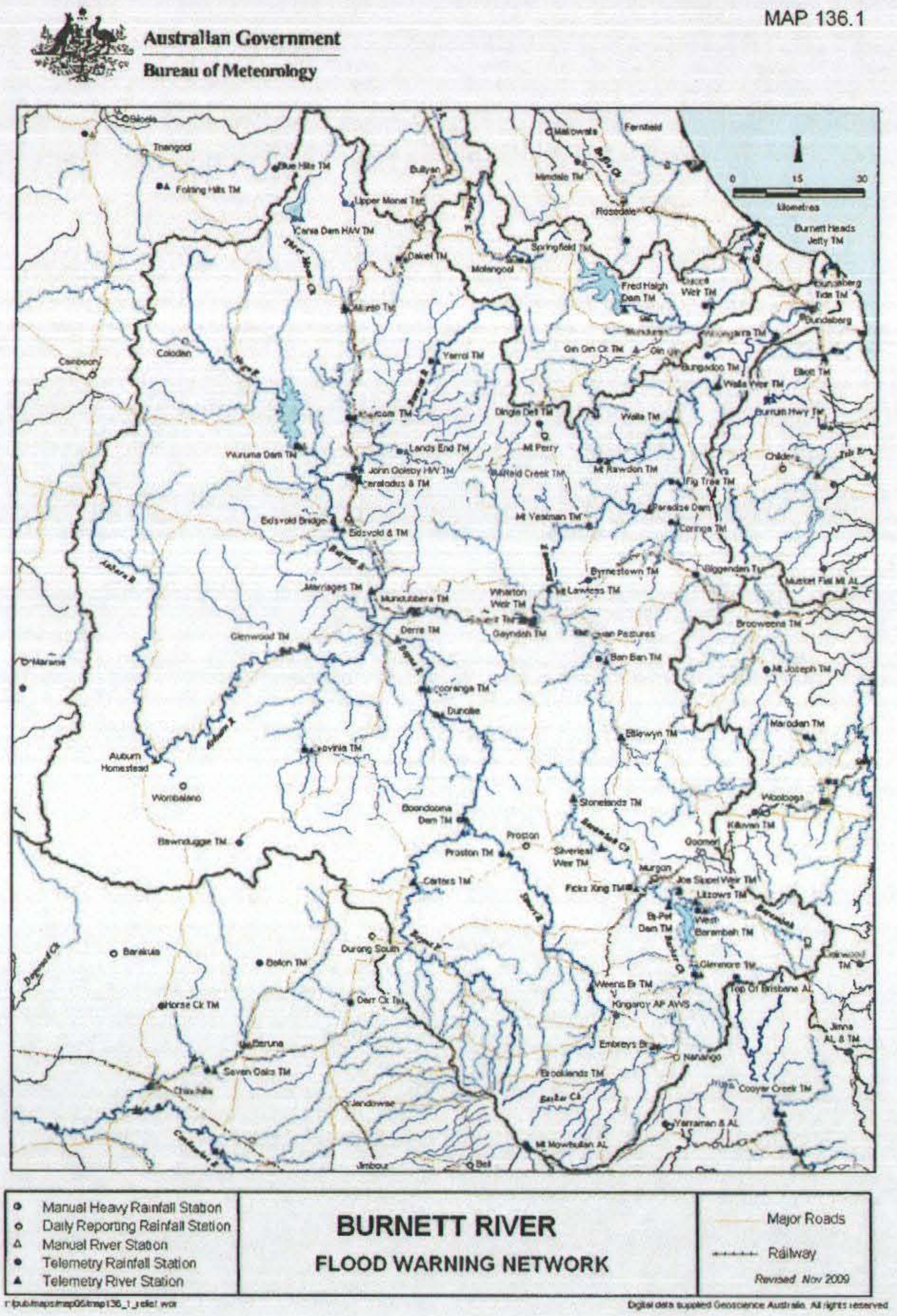


Figure 8-1 Burnett River Catchment

The management of the dam is documented in a number of regulatory dam safety documentation including:

- Boondooma Dam: Standing Operating Procedures
- Boondooma Dam: Operation & Maintenance Manual
- Emergency Action Plan: Boondooma Dam
- Boondooma Dam: Data Book Part 1 - Text
- Boondooma Dam: Data Book Part 2 – Drawings

- Boondooma Dam: Dam Safety Review (June 2000)

In an emergency the procedures in the Emergency Action Plan take precedence over this manual.

8.1.1.1 Type

Boondooma Dam is a 63 m high concrete-faced rockfill dam with an unlined uncontrolled spillway chute excavated through the left abutment of the dam. The dam consists of a main embankment over the Boyne River and a smaller subsidiary left embankment over Sandy Creek in the left abutment. Both embankments are of concrete faced rockfill. The storage capacity is 204,200 ML. The dam is located on the Boyne River (AMTD 86.7 km) which is a tributary of Burnett River, approximately 22 km by road from Proston. The dam was designed and constructed by the Queensland Water Resources Commission and construction was completed in 1983.

Table 8-1 Boondooma Dam Details

Overview	
Dam Name	Boondooma Dam
Nearest Town	Proston
Stream and AMTD	Boyne River (86.7km)
Catchment Area	4200 km^2
Average rainfall	800 mm annually
Construction Period	1979-1983
Main Dam	
Type	Concrete faced rock fill
Full Supply Level (FSL)	280.4 m AHD
Storage capacity at (FSL)	204,200 ML
Reservoir surface area at FSL.	1,815 ha
Dam Crest Level (DCL)	295.5 m AHD
Maximum height of the dam	63 m from stream bed
Crest length	570 m
Spillway	

Spillway location	Left Abutment
Spillway type	Uncontrolled Ogee-type crest
Spillway crest level	280.4 m AHD
Spillway width	115 m
Spillway capacity for DCF	13,385 m^3/sec

Dam Embankment

Type	Concrete faced rock fill
Crest Elevation	315.60 m AHD
Total Length	550 m
Total Crest Width	8 m
Maximum Height above foundation	44 m

Outlet Works

River outlet works – pipe size	2159 mm
River outlet works - Control	2 x 1200 mm guard valves
	2 x 750 mm cone valves
Tarong Pipeline outlet – pipe size	1085 mm
Tarong Pipeline outlet - Control	1200 mm guard valves
Tarong Pipeline pump duty	1.57 m^3/sec against 155 metres

8.1.1.2 Purpose

The foreword of the Burnett Basin Resource Operations Plan (ROP) notes that:

> *The WRP and the ROP are complementary parts of a water planning process that will ensure that the basin's rivers are sustainably managed. The WRP strives to strike a balance between human needs and those of the environment. The resource operations plan is concerned with the practical business of sharing and managing the basin's water resources from day to day in a way that meets the water resource plan objectives.*[1]

[1] Burnett Basin Resource Operations Plan, Forward

The principal purpose of the dam is to supply water to the Tarong Power Station via three separate pumping stations. In addition to supplying the Tarong Power Station, the dam also supplements supplies to Boyne River irrigators.

During 2009-10, the scheme supplies 16,800ML to agricultural users, and the Tarong Power Station.

The operation of Boondooma Dam must meet the following criteria:

1. Boondooma Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
   - Boondooma Dam Operations and Maintenance Manual;
   - SunWater policies and approved practices;
   - The Burnett Resource Operating Plan and/or Development Permit;
   - Good engineering and water management standards and practices.
2. Water releases from Boondooma Dam must be scheduled to comply with:
   - Burnett Resource Operations Plan;
   - SunWater's Customer Charter; and
   - All applicable supply agreements and licences.

8.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

8.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Boondooma dam:

- The EAP was reviewed as part of annual inspection in April 2010.
- The notification and emergency communication list (EAP section 3) was revised and reissued in November 2010.
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety.
- Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers prior to the wet season.
- Senior SunWater staff met with the South Burnett LDMG prior to any event (9^{th} December 2010) to discuss possible scenarios and raise awareness of the EAP.

8.1.2.2 Emergency Actions

The EAP was first activated on 5th December 2010 and remained active until after the end of February 2011. The Boondooma Dam EAP does not require downstream landholders to be notified of an event.

8.1.3 Outline of flood event 2010/2011

Figure 8-2 outlines the recorded inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. There were four distinct flood peaks over the 2010-11 wet season. The highest peak occurred on 11 January 2011.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 1,080,000ML or 5.3 times the full storage volume of the dam. The peak inflow of about 2,000 m^3/s was attenuated to a peak outflow of approximately 1,600 m^3/s.

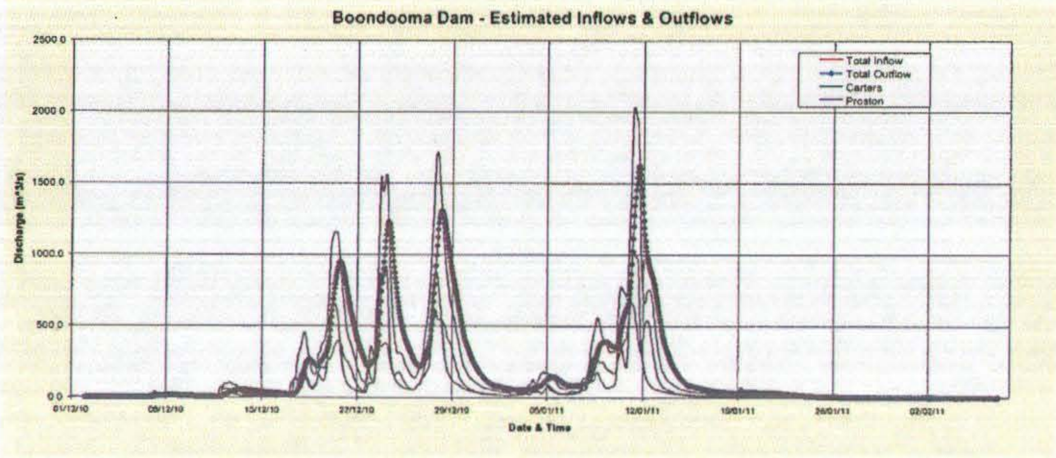


Figure 8-2 Boondooma Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 8-3 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[2]. Three of the events were reported as major floods.

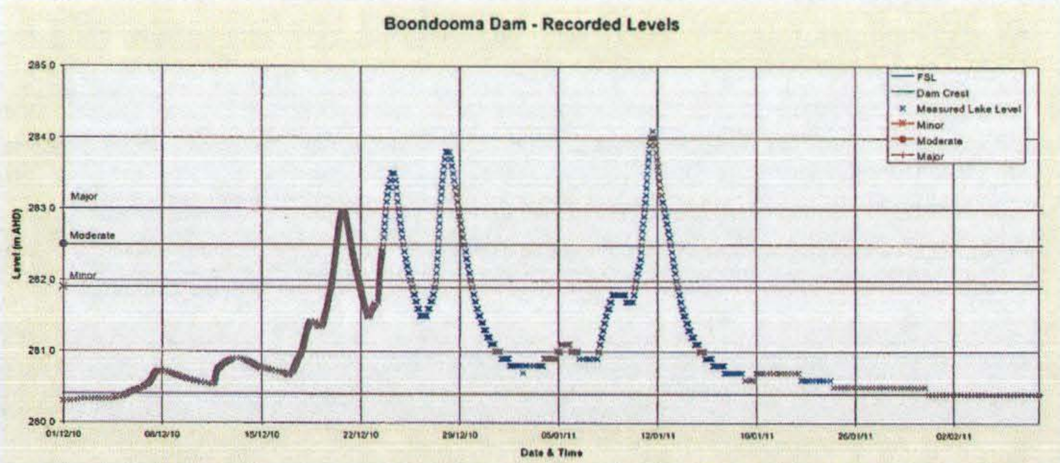


Figure 8-3 Boondooma Dam Recorded Flood levels

---

2 www.bom.gov.au

8.1.3.1 Communities that were affected

The town of Mundubbera was significantly impacted by flooding. The flood flows from the Boyne catchment were just one of the contributing streams to the flood event in Mundubbera.

8.1.3.2 Damage and response to damage

Boondooma Dam suffered significant flood damage to the rock face on the spillway exit chute. A full inspection by engineers has found that main dam structure is undamaged and performed well from a dam safety perspective. Planning is underway to repair the erosion in the spillway chute.

8.1.3.3 Gauging stations – effect on data collection

Figure 7.1 shows the location of gauging stations in the catchment. The key stations remained available through the BOM web page for most of the event.

8.1.3.4 Community Inquiries

SunWater received a small number of inquiries regarding water levels and flows in the Boyne River. Those inquiries were answered by SunWater staff on an ongoing basis during the event.

8.1.3.5 Media Coverage

We have not identified any specific references to Boondoomba Dam in media reports.

8.1.3.6 Post Event Review

SunWater undertook a review of the event across the Central Region. The review found that:

- The EAP was generally adequate, however some updating is required to reflect current reporting arrangements. The amendments to these documents are in progress;
- Some difficulties were experienced with continuity of telecommunication networks. NextG telecommunications in addition to land lines at some dams is being investigated;
- Site facilities for staff were found to be inadequate where staff were on duty and isolated for prolonged periods. Planning is underway to improve facilities for the next event; and,
- The EEC role (refer to statement table 6.2) across the Bundaberg service centre was found to be too demanding for one person. The role will be split into different sub areas for future events.

8.1.4 Previous flood events

The February event is ranked as the largest flood through the dam since it was constructed in 1982.

Table 8-2 Boondooma Dam - Ranking of historic flood events

Flood Rank	Date	Peak Height EL	Peak Height Above Crest
	FSL	280.4 m	
1	Jan-11	284.10	3.70
2	Jul-84	281.67	1.27
3	Oct-10	281.43	1.03
4	May-83	281.36	0.96
5	Jan-96	281.21	0.81
6	May-83	281.17	0.77
7	Jun-83	281.14	0.74
8	May-98	280.98	0.58
9	Dec-83	280.78	0.38
10	Feb-99	280.78	0.38
2010-11 Flood			
1	Jan-11	284.10	3.70

8.1.5 Flood mitigation opportunities/ upgrade or communities potentially affected

The maximum release rate from the dam is limited to $15m^3/s$[3]. At this rate it would take several months to significantly lower the storage notwithstanding any regulatory restrictions on such a release. The Burnett Basin ROP specifies rules for the operation of Boondooma Dam, including how releases are to be determined.

SunWater's predictive flood model for Boondooma Dam has been used to evaluate how the dam might operate to mitigate flood events. There is no flood mitigation storage in Boondooma dam. The only air space would be if the dam was below the full supply level prior to an event. The maximum benefit would be if the dam was empty at the beginning of the wet season. Figure 8-4 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December, however this would not be practical for the reasons set out above in respect to release rates and compliance obligations. If compared with Figure 8-2 it is noted that there is no difference in lake level height from about the 23rd December 2010 onwards. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Boondooma Dam without a significant loss of water supply to the local community.

[3] SunWater Drawing 59216

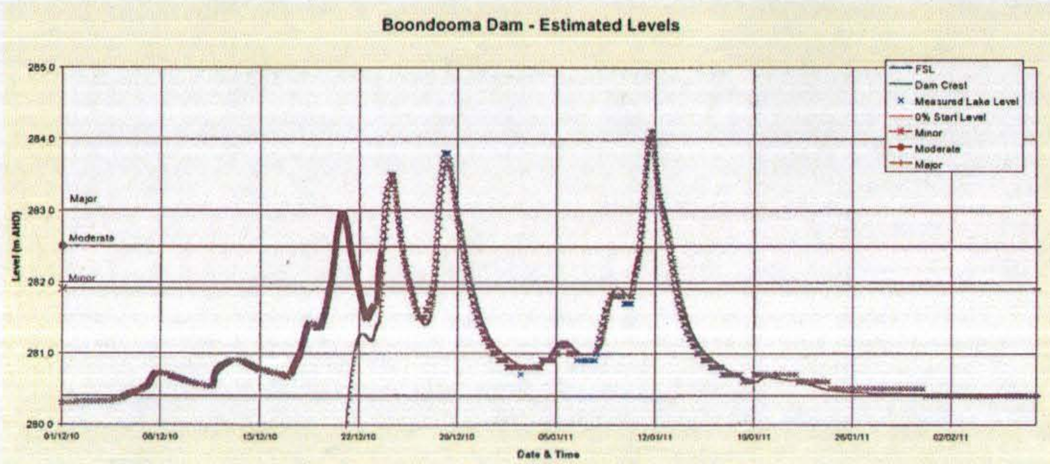


Figure 8-4 Boondooma Dam Simulated Behaviour if empty on 1 December 2010

10 Schedule 10: Schedules of SunWater Dams

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

10.1 Callide and Kroombit Dams

Callide and Kroombit Dams are both in the headwaters of the Callide Valley upstream of the town of Biloela. The dams are managed as part of the one water supply scheme. The two dams will be dealt with in the one schedule.

The flood event at Callide Dam commenced on 2nd January 2011. The total inflow into to the dam, was approximately 0.9 times of the total storage volume of the dam. Some communities along the Callide Valley experienced major flooding during the 2010-11 wet season. However flows through Callide Dam were insignificant relative to the capacity of Callide Creek.

The flood event at Kroombit Dam commenced on 20th December 2010. The total inflow to the dam was approximately 7.2 times of the total storage volume of the dam

10.1.1 Overview

Callide and Kroombit dams are located in the Callide Valley catchment.

Callide dam has a catchment area of 516 km^2. Kroombit dam has a catchment area of 328 km^2. The Callide Valley Water Supply System has a total catchment area in excess of 3,100 km^2. The catchment is situated in the Central Queensland region. It is bound to the north by the catchments of the Fitzroy River, to the west by the Dawson River, and to the south by the Burnett River.

The major creeks in the Callide Valley Region are the Callide, Kroombit and Kariboe Creeks.

The Callide Valley Water Supply Scheme is one of the 5 Water Supply Schemes in the Fitzroy Basin. The others being the Dawson Valley, Nogoa Mackenzie, Lower Fitzroy River and Fitzroy barrage. The Callide Valley Water Supply Scheme is owned and operated by SunWater.

The Callide Valley Water Supply Scheme is centred on the Callide and Kroombit Creeks. The purpose of the scheme is to provide water for the Callide Power Stations, downstream irrigation and town water supplies. Callide Dam is the major headworks of the Callide Valley Water Supply Scheme. Kroombit Dam is the second largest headworks of the Callide Valley Water Supply Scheme

Callide dam is situated on the Callide Creek at AMTD 81.0 km upstream from its junction with the Don River and is approximately 5 km by road east of the town of Biloela.

[redacted]

Kroombit Dam is situated on the Kroombit Creek at AMTD 68.8 km upstream from its junction with the Callide Creek and is approximately 30 km by road south-east of the town of Biloela

A recent comprehensive risk assessment of Callide Dam (October 2010) has concluded that the current level of risk associated with the dam is tolerable and ALARP.

A recent comprehensive risk assessment of Kroombit Dam (November 2009) has concluded that the current level of risk associated with the dam is acceptable without any upgrade.

The existing dams achieves 100% of the acceptable flood capacity as determined by the risk assessment approach. A final decision not to undertake any further upgrade of the dams has not yet been made (refer to section 6.2.3 of the statement). SunWater finalised its comprehensive risk assessment (CRA) program across its portfolio in 2010. The SunWater Board will consider the recommendations of each CRA and finalise the dam safety upgrade program during 2011.

A copy of the comprehensive risk assessment for Callide and Kroombit Dams can be provided on request.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Callide	136,300	2	Callide Ck	80.1	Earthfill & mass concrete with Radial gates	1,240	1965-1988	Water Supply	Biloela	Biloela
Kroombit	14,600	2	Kroombit Ck	68.8	Earth and Rockfill with RCC	289	1992	Water Supply	Biloela	Biloela

[redacted]

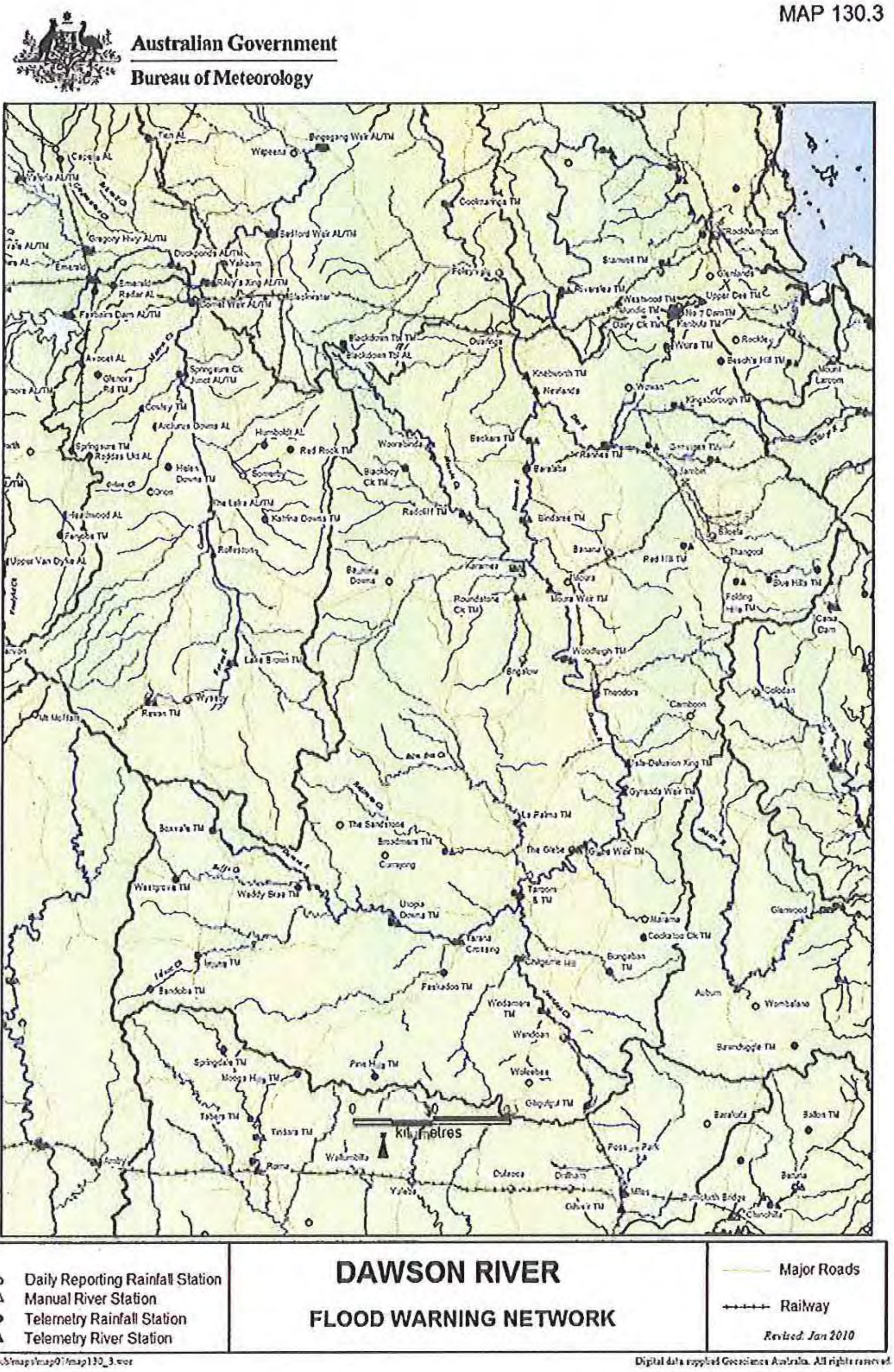


Figure 10-1 Dawson River catchment including the Callide Valley WSS

[redacted]

10.1.2 Callide Dam

The management of the dam is recorded in a number of regulatory dam safety documents including:

- The Callide Dam Operations and Maintenance Manual;
- Callide Dam: Standing Operating Procedures;
- Emergency Action Plan: Callide Dam;
- Callide Dam: Data Book Part 1 – Text;
- Callide Dam: Data Book Part 2 – Drawings; and,
- Callide Dam: Dam Safety Review (March 1999).

In an emergency situation the procedures in the Emergency Action Plan take precedence.

10.1.2.1 Type

Construction of the rock and earthfill dam with central spillway was completed in early 1969. The spillway is of concrete ogee crest construction with automatically operated, radial gates. The spillway gates were installed in 1988. The storage capacity at Full Supply Level (FSL) is 136,300 ML..

The dam has a total length of 2,008 m and a maximum height of 37.24 m above the original creek bed level.

Table 10-1 Callide Dam Details

Overview		
Dam Name	Callide Dam	
Storage Name	Lake Callide	
Location	Latitude	24° 25' 38" S
	Longitude	150° 64' 00" E
Regional Council	Banana Shire	
Nearest Town with Road Access	Biloela	
Stream and AMTD	Callide Creek AMTD 80.1 km	
Catchment area	516 km^2	
Average rainfall	683.3 mm	
Main Dam		
Type	Rock and Earthfill	
Full Supply Level (FSL)	216.10 m AHD	
Storage capacity at FSL	136,300 ML	
Storage area at FSL	1,240 ha	
Dam Crest Level (DCL)	219.24 m AHD	
Maximum height of the dam	37.24 m above foundation	
Crest length along axis (main embankment)	2008 m (including spillway)	

[redacted]

Spillway	
Spillway type	Automatically operated, Radial Gate controlled reinforced concrete ogee crest
Spillway crest level	207.57 m AHD
Crest length	79.25 m
Outlet Works	
Description	• Concrete Intake Tower • 2/1220 mm diameter concrete lined MS pipes, within a reinforced concrete outlet conduit • Concrete Valve House
Outlet Control	• Callide A Outlet – 2 x 400mm Gate Valves • Callide Creek Outlet 1 x 600mm Cone Valve & 1 x 300mm Cone Valve • Kroombit & Kariboe Creek Outlet 1 x 914mm Butterfly Valve • 2 x 1200mm butterfly Valves to isolate Callide B and Biloela water supply pipes. • Callide B & C Outlets 2x 850mm pipes • Biloela Shire Council O/T 2 x 450 Gate Valves

10.1.2.2 Purpose

The Introduction to the Fitzroy Basin Resource Operations Plan (ROP) notes that:

> *"The strategies specified in the WRP are designed to meet environmental flow objectives and water allocation security objectives ..... The Resource Operations Plan (ROP) has been developed to ensure that these objectives are satisfied. The management arrangements in the ROP for supplemented water supply schemes and associated infrastructure, and those for unsupplemented water are dealt with in Chapter 4 and Chapter 5 respectively.*
>
> *The assessment program will check for compliance with the management arrangements in the ROP and, over the long term, will assist in determining how effectively the strategies in the WRP are achieving the WRP outcomes."*

The dam was designed and constructed by the Irrigation and Water Supply Commission, primarily for the purpose of supplying water to the Callide power stations, Biloela town, downstream irrigators and to recharge the aquifer. The dam, supplements natural flows in

[redacted]

the Callide Creek and diverts water through a diversion channel to Kroombit and Kariboe Creeks.

The major regular inflow to the dam is via a pipeline from the Awoonga Dam near Gladstone. The purpose of this pipeline is to provide additional supplies to the Callide power stations over and above the yield of Callide Dam.

The operational objectives[1] of the Callide Dam are as follows:

1. The Callide Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
   - Callide Dam Operations and Maintenance Manual;
   - SunWater policies and approved practices;
   - Fitzroy Basin Resource Operations Plan; and
   - Sound engineering and water management standards and practices.
2. Water releases from Callide Dam must be scheduled to comply with:
   - Callide Valley Water Supply Scheme Interim Resource Operations Licence (April 2010);
   - SunWater's Customer Charter; and
   - All applicable supply agreements and licences.

10.1.3 Kroombit Dam

The management of the dam is recorded in a number of regulatory dam safety documents including:

- The Kroombit Dam Operations and Maintenance Manual;
- Kroombit Dam: Standing Operating Procedures;
- Emergency Action Plan: Kroombit Dam;
- Kroombit Dam: Data Book Part 1 – Text;
- Kroombit Dam: Data Book Part 2 – Drawings; and,
- Kroombit Dam: Dam Safety Review (March 1999).

In an emergency situation the procedures in the Emergency Action Plan take precedence.

10.1.3.1 Type

Construction of the rock and earthfill dam with central spillway was completed in 1992. The spillway is of RCC ogee crest construction. The storage capacity at Full Supply Level (FSL) 14,600 ML.

The dam has a total length of 910 m and a maximum height of 18.6 m above the original bed level.

[1] Callide Dam O&M Manual

[redacted]

Table 10-2 Kroombit Dam Details

Overview	
Dam Name	Kroombit Dam
Storage Name	Kroombit
Location	Latitude 24.4166S Longitude 150.774E
Regional Council	Banana Shire
Nearest Town with Road Access	Biloela
Stream and AMTD	Kroombit Creek AMTD 68.8 km
Catchment area	328 km^2
Average rainfall	683.3 mm
Main Dam	
Type	Rock and Earthfill
Full Supply Level (FSL)	265.8 m AHD
Storage capacity at FSL	14,600 ML
Storage area at FSL	289 ha
Dam Crest Level (DCL)	270.70 m AHD
Maximum height of the dam	18.6 m above foundation
Crest length along axis (main embankment)	910 m (including spillway)
Spillway	
Spillway type	The spillway is of concrete ogee crest construction.
Spillway crest level	265.8 m AHD
Crest length	250 m
Outlet Works	
Description of inlet	Vertical stack of precast concrete units with grooves for trash screens, selective withdrawal baulks and a dome type bulkhead gate.
Description of main outlet	Ø1200 mm RC pressure pipe with a 600 mm butterfly guard valve leading to a 450 mm cone dispersion valve.

10.1.3.2 Purpose

The Introduction to the Fitzroy Basin Resource Operations Plan (ROP) notes that [redacted]

"The strategies specified in the WRP are designed to meet environmental flow objectives and water allocation security objectives ..... The Resource Operations Plan (ROP) has been developed to ensure that these objectives are satisfied. The management arrangements in the ROP for supplemented water supply schemes and associated infrastructure, and those for unsupplemented water are dealt with in Chapter 4 and Chapter 5 respectively.

The assessment program will check for compliance with the management arrangements in the ROP and, over the long term, will assist in determining how effectively the strategies in the WRP are achieving the WRP outcomes."

The dam was designed and constructed by the Water Resources Commission, primarily for the purpose of recharging the groundwater and for downstream irrigation.

The operational objectives[2] of the Kroombit Dam are as follows:

3. The Kroombit Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
    - Kroombit Dam Operations and Maintenance Manual;
    - SunWater policies and approved practices;
    - Fitzroy Basin Resource Operations Plan; and
    - Sound engineering and water management standards and practices.
4. Water releases from Kroombit Dam must be scheduled to comply with:
    - Callide Valley Water Supply Scheme Interim Resource Operations Licence (April 2010);
    - SunWater's Customer Charter; and
    - All applicable supply agreements and licences.

10.1.4 Implementation of System Operations Plans for 2010-11 Wet Season

10.1.4.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Callide and Kroombit dams:

- The Callide Dam EAP was reviewed as part of the comprehensive inspection in April 2010. The inspection team was led by Peter Richardson (RPEQ). Other members of the team were Mal Halwala (Principal Engineer Dam Safety), Ross Mewett (Asset Engineer Headworks), Chris Kuenne (Senior Mechanical Engineer), Brendan Trebilco (Senior Engineer) and Michael Purser (Graduate Engineer). The inspection team was assisted by a number of local operations and maintenance staff. The inspection team confirmed that the current version of the EAP was available at the Biloela office where the dam operations staff are based. As part of the inspection the team conducted a full scenario EAP exercise. The scenario was based on a 1 in 100 AEP flood. The aim of the exercise was to check the accuracy and relevance of the

[2] Callide Dam O&M Manual

[redacted]

EAP and train staff. The findings of the review were documented in the *Callide Dam Five Yearly Comprehensive Dam Safety Inspection Report April 2010* (Appendix F). The team concluded that the instructions were understood. However it was noted that changes were required to the EAP to reflect the changes to SunWater's business structure in 2010. These changes were addressed in the supplementary notice issued by the Principal Engineer Dam Safety (PEDS) described below. Other minor improvements were also identified. These improvements are in progress and will be published in the next release of the EAP before the next wet season;

- The Kroombit Dam EAP was reviewed as part of the comprehensive inspection in April 2010. The inspection team was the same team who conducted the Callide Dam inspection described above. The findings of the review were documented in the *Kroombit Dam Five Yearly Comprehensive Dam Safety Inspection Report April 2010* (Page 14). The team noted that the current version of the EAP was available at the Biloela office where the dam operations staff are based. The team concluded through inquiry that the instructions were understood based on the successful operations of the dam during a recent spill event. However it was noted that changes were required to the EAP to reflect the changes to SunWater's business structure in 2010. These changes were addressed in the supplementary notice issued by the Principal Engineer Dam Safety (PEDS) described below;
- The notification and emergency communication list (EAP section 3) for both Callide and Kroombit Dams were revised and reissued on 14th December 2010. The notification and emergency communication was issued as a controlled document to the distribution list (Section 1, page 2 of 3 of the EAP). A transmittal advice was issued with each controlled copy. The transmittal advice included instructions for updating the EAP;
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety (Mal Halwala). The notice was principally designed to address changes to the roles and responsibilities that occurred as part of an internal reorganisation within SunWater. The notice was based on the Tinaroo Falls Dam EAP that had been updated to Issue 3 and was to be used as the template for Issue 3 for all SunWater dams. The supplementary notice was issued by email on 29 October 2010 to all of the Area Operations Managers and Service Managers who all fulfil the role of EEC for the dams in their respective areas; and,
- Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers on 29th November 2010 prior to the wet season. The training was conducted by Daryl Conway (Service Manager). The training consisted of the presentation of a set of slides outlining roles and responsibilities. The training was attended by all except two operations staff in the service centre. The two staff who were absent were provided the information the following week.

10.1.4.2 Emergency Preparedness/Actions

The O&M Manuals notes that the actual maintenance schedules and work instructions are obtained from SunWater's SAP system. This means that work orders for maintenance, document revisions and other activities such as emergency preparations are automatically generated by the SAP system on a monthly basis This creates a controlled document trail that requires actioning and closing out. A work order is issued for each scheduled or corrective maintenance item (refer Figure 10-2 for sample work order header). The work orders are issued to the appropriate supervisor. Scheduled maintenance items would include such items as:

- Monthly Dam Safety Inspection-Callide Dam
- 12 M Electrical Condition Monitoring Callide Dam
- 12 M Mechanical Condition Monitoring Callide Dam
- 12M Dam Safety Inspection-Callide Dam
- 6M-Flood Ops Preparation - Callide Dam

A detailed work instruction is issued with each work order. Each work instruction includes a detailed check list of tasks to be performed to complete the work order Refer Figure 10-3 for sample extract from a completed work instruction.

Once the work on an order and in an instruction has been competed it is signed off as complete, dated and verified by the supervisor (refer Figure 10-4)

SunWater

PM01-Preventive - Day to Day Work Order 5108628

Printed By: MORRISA On: 27.09.2010 Page: 1 Original

Job Description: *CVA-1M-Ops Tests-Radial Gates-CDAM*
Work Instruction: *CVA00002*
(SPILLWAY)

Functional Location:	*CVA-CDAM-SPWY-GATE*	*SPILLWAY GATES*	
Equipment:			
Location:		*at:*	
General Location			
Planner:	*320 Biloela Planner*	*Main work center:*	*3200OP Operations - OMS Biloela*
Priority:	*5 Priority 5 < 1 month*	*Status :*	*REL NMAT PRC SETC*

Notifications:
10126271 CVA-1M-Ops Tests-Radial Gates-CDAM *CVA-CDAM-SPWY-GATE*

Figure 10-2 Sample Work Order Header

	Move to Radial Gates 1 & 2	✓
15.	**Remove cover and Open valves on gates 1 & 2 (minimum 4 turns)**	✓
16.	**Open Control Box** • Press switch (Green Button)	✓
17.	**Wait for gates to open fully** • Listen for any abnormal mechanical noise ie. worn bearings • Listen for water running in and around the valve • Visually inspect seals, for debris, damage and/or rocks • Listen for the generator (NB. Beacon should be flashing whilst ever generator is on)	✓
18.	**Press Stop Button – before counter weight bearing support rests in cradle (approximately 8.5 – 9.0m on gauge board)**	✓
19.	**Switch Valves Off (anti-clockwise) – replace cover**	✓

Figure 10-3 Sample of Work Instruction for Work Order 5108628

[redacted]

COMPLETION INFORMATION

Please complete the attached work instructions and record all non-conformances, issues
and any additional information at the end of these instructions in the additional comments section.

Job Completed By : [redacted] __________
Date: 14-10-10

Supervisor Verification: __________
Date: 21- 12 -10

Data Entry Completed : __________
Date: __________

ENTERED

Figure 10-4 Sample Work Order Completion

Emergency preparations prior to the wet season included:

- Monthly Functional testing of spillway gates as evidenced by dam log and work order record eg 5108628;
- Monthly testing and servicing of the standby generator sets as evidenced by work orders eg 5108628;
- Filling of all fuel stores as evidenced by work orders eg 5108628;
- Weekly dam surveillance as evidenced by dam log books;
- Regular condition monitoring of electrical systems as evidenced by work orders 5107344 and 5107347; and
- Testing of portable equipment.

10.1.5 Overview of EAP – Callide Dam

Section 5 of the Callide Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the dam will be continuously manned and the emergency controlled from the Service Centre. The EAP identifies the roles for the dam duty officer (DDO) and emergency event coordinator (EEC), however, in all cases the EAP identifies that the O&M Manual and SOPs are to be followed. Within section 5 of the EAP, actions for a number of stage or alert levels are defined. The alert levels are defined by certain storage levels and catchment conditions.

The first alert level is noted as *flood operations stage 1* where the reservoir reaches EL215.60m (0.5m below FSL), and reservoir is rising and there is heavy rain in the catchment and major inflows expected. This stage is largely preparatory. At this level there is communication between the DDO, EEC and standby officers. The DDO works through a checklist that is designed to ensure that the automatic spillway gate system will function correctly.

[redacted]

The next alert level in the EAP is *flood operations stage 2*. This stage is triggered when the water level in the dam is at 216.10m (FSL) and rising. The dam begins to spill at 216.259m. Only the centre pair of gates open at this stage. The main focus at this stage is to monitor spillway gate operation and dam surveillance. At this stage the EEC provides notification to the counter disaster executive, police and the District Disaster Coordinator (refer Figure 10-5).

The next alert level in the EAP is *flood operations stage 3*. This stage was not triggered during the recent event. This stage is triggered when the water level in the dam is at 216.26m and rising. Gate pairs 1 and 3 open at this stage. The main focus at this stage is to monitor spillway gate operation and dam surveillance. At this stage the EEC provides further notification to the counter disaster executive, police, the District Disaster Coordinator and downstream landholders.

Counter Disaster Groups					
TITLE/NAME	**Phone Business**	**Phone Mobile**	**Phone A/H**	**Fax**	**Controlled Copy Holder Addresses**
Counter Disaster Executive Officer (Banana Shire, Biloela) (Ray Geraghty) 6	[redacted]	[redacted]	[redacted]	[redacted]	PO Box 412 Biloela Q4715
Counter Disaster Room	[redacted]	[redacted]	[redacted]	[redacted]	
Technical Officer Works (Banana Shire, Biloela) (Jim Watson)	[redacted]	[redacted]	[redacted]	[redacted]	
Director of Engineering Services (Banana Shire, Biloela) (Colin Head)	[redacted]	[redacted]	[redacted]	[redacted]	
Plumbing Inspector (Banana Shire, Biloela) (Ken Johnson)	[redacted]	[redacted]	[redacted]	[redacted]	
Chemical Hazards Local Fire Service	000	112	000	-	

Figure 10-5: Callide Dam Counter Disaster Notification list

10.1.6 Overview of EAP – Kroombit Dam

Section 5 of the Kroombit Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the dam will be continuously manned and the emergency controlled from the Service Centre. The EAP identifies the roles for the dam duty officer (DDO) and emergency event coordinator (EEC), however, in all cases the EAP identifies that the O&M Manual and SOPs are to be followed. Within section 5 of the EAP, actions for a number of stage or alert levels are defined. The alert levels are defined by certain storage levels and catchment conditions.

[redacted]

The first alert level is noted as *flood operations preparedness* where the reservoir reaches EL264.80m (1m below FSL), and reservoir is rising and there is heavy rain in the catchment with a major inflow expected. This stage is largely preparatory. At this level there is communication between the DDO, EEC and standby officers. There are no external notifications at this stage.

The next alert level in the EAP is *flood operations stage 1*. This stage is triggered when the water level in the dam is approaching 265.8m (FSL) and rising and spillway discharge is imminent. The main focus at this stage is to monitor the event. At this stage the EEC provides notification to the counter disaster executive, and police (refer Figure 10-5).

The next alert level in the EAP is *flood operations stage 2*. This stage is triggered when a spillway discharge is occurring. The main focus at this stage is to monitor the event and dam surveillance. At this stage the EEC provides further notification to the counter disaster executive, and police.

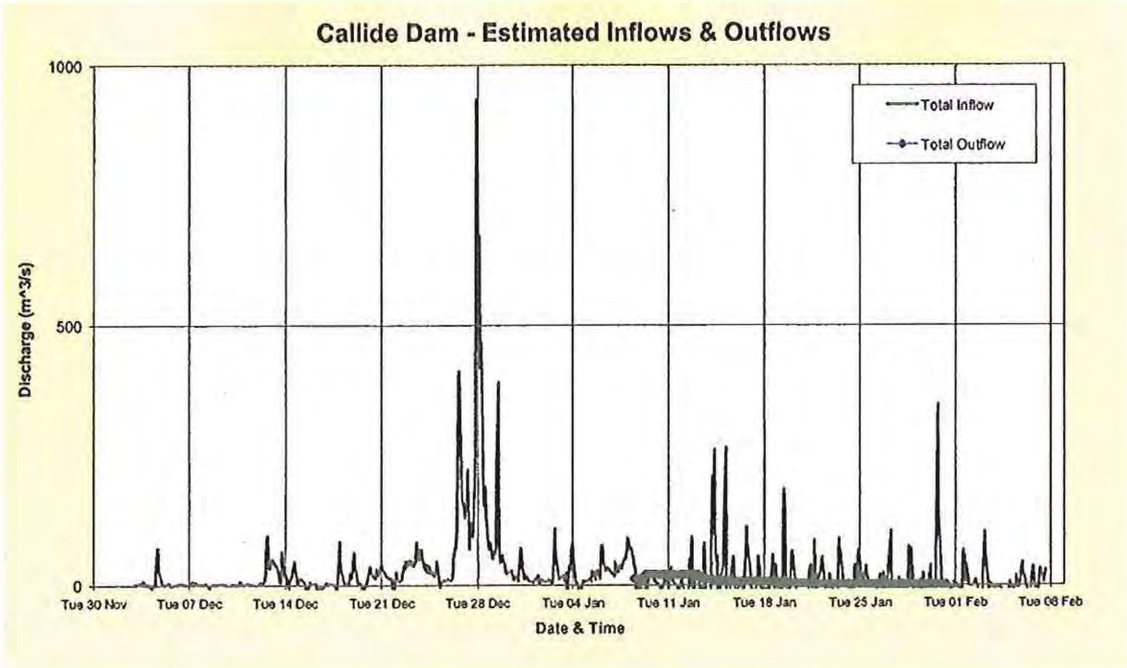
The next alert level in the EAP is *flood operations stage 3*. This stage was not triggered during the recent event. This stage is triggered when the water level in the dam is approaching 270.7m (dam crest level) and overtopping of the dam is imminent.

10.1.7 Outline of flood event 2010/2011 – Callide Dam

The EAP was first activated in accordance with SOP 40 on 2nd January 2011 in preparation of an event with the dam close to FSL and significant rain occurring in the catchment. The automatic gates opened and began a spill event on the 8th January 2011. The EAP remained in effect until the end of the spill event on 31st January (refer Table 10-3).

Figure 10-6 outlines the estimated inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The inflow shown in Figure 10-6 is an estimate derived from the recorded storage behaviour.

[redacted]



[3]

Figure 10-6 Callide Dam Inflow and Outflow (Dec 2010 - Feb 2011)

The spillway discharge event at Callide Dam was very minor. The peak discharge was only about 20 m^3/s. This compares to a bank full flow (no flooding outside of the watercourse) capacity of Callide Creek of about 210 m^3/s. The duration of the discharge was from 8 January to 31st January.

The peak inflow was estimated at over 900m^3/s. The peak inflow was attenuated to a peak discharge of 20. The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 120,000ML or 0.9 times the full storage volume of the dam.

Table 10-3: Callide Dam EAP Status

Date	EAP Stage
02-Jan-11	Activated
06-Jan-11	
06-Jan-11	Stage 1
08-Jan-11	
08-Jan-11	Stage 2
31-Jan-11	

The LDMG and Biloela Police were notified on the 2nd January by Daryl Conway (Service Manager) that the EAP had been activated. This notification is logged in the emergency event report. The LDMG was notified again on the 7th January just prior to the commencement of any discharge. Daryl Conway and the LDMG representative (Maureen

[3] Inflow derivation model over estimates inflows in late January to early February indication further calibration is required.

[redacted]

Clancy) discussed the minor nature of the event and no further update was requested. The District Disaster Coordinator in Gladstone was not notified due to the minor nature of the event.

The EAP notes that local school bus operators should be notified for spillway discharges greater than 500ML/d. A decision was made not to provide this notification as the event was occurring during school holidays.

Table 10-4: Callide Dam Duty Roster

Date	Operator	Dam Duty Operator
24/12/2010	Daryl Conway	Ron Boal
25/12/2010	Daryl Conway	John Barber
26/12/2010	Daryl Conway	Justin Hooper
27/12/2010	Daryl Conway	Justin Hooper
28/12/2010	Daryl Conway	Justin Hooper / Ron Boal
29/12/2010	Daryl Conway	Justin Hooper / Ron Boal
30/12/2010	Daryl Conway	Justin Hooper / Ron Boal
31/12/2010	Daryl Conway	Justin Hooper / Ron Boal
1/01/2011	Daryl Conway	Justin Hooper / Ron Boal
2/01/2011	Daryl Conway	Justin Hooper / Ron Boal
3/01/2011	Daryl Conway	Justin Hooper / Ron Boal
4/01/2011	Daryl Conway	Justin Hooper
5/01/2011	Daryl Conway	John Barber
6/01/2011	Daryl Conway	Justin Hooper
7/01/2011	Daryl Conway	Justin Hooper / John Barber
8/01/2011	Daryl Conway	John Barber / Chris Eade / Justin Hooper
9/01/2011	Daryl Conway	John Barber / Chris Eade / Justin Hooper
10/01/2011	Daryl Conway	John Barber / Chris Eade / Justin Hooper
11/01/2011	Daryl Conway	Ron Boal
12/01/2011	Daryl Conway	Justin Hooper
13/01/2011	Daryl Conway	Justin Hooper
14/01/2011	Daryl Conway	Chris Eade
15/01/2011	Daryl Conway	Justin Hooper
16/01/2011	Daryl Conway	Justin Hooper
17/01/2011	Daryl Conway	John Barber
18/01/2011	Daryl Conway	John Barber
19/01/2011	Daryl Conway	John Barber
20/01/2011	Daryl Conway	John Barber
21/01/2011	Daryl Conway	John Barber
22/01/2011	Daryl Conway	John Barber
23/01/2011	Daryl Conway	John Barber

Figure 10-7 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive.

[redacted]

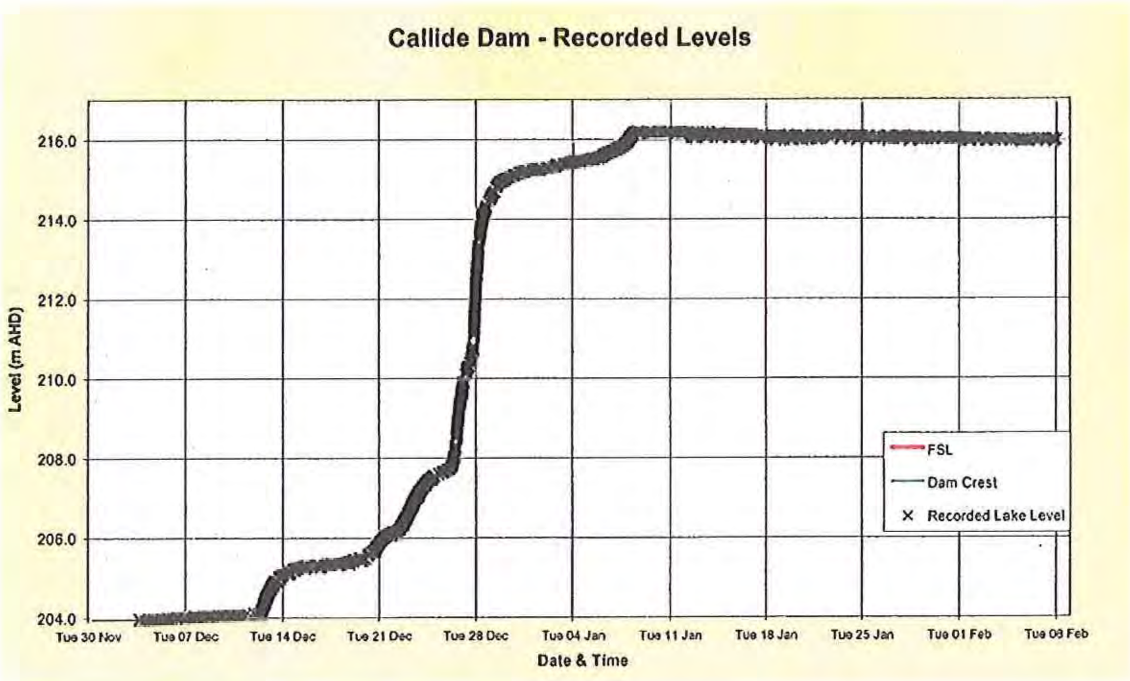


Figure 10-7 Callide Dam Recorded Flood Levels

10.1.8 Outline of flood event 2010/2011 – Kroombit Dam

The EAP was first activated in accordance with SOP 40 on 20th December 2010 in preparation of an event with the dam close to FSL and significant rain occurring in the catchment. The spill event began on the 21st December 2010. The EAP remained in effect until the end of the initial spill event on 21st January (refer Table 10-5). A second minor spill occurred on the 8th and 9th February 2011.

Figure 10-6 outlines the estimated inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The inflow shown in Figure 10-6 is an estimate derived from the recorded storage behaviour.

The peak inflow was estimated at over 390m^3/s. The peak inflow was attenuated to a peak discharge of 380m^3/s, which was recorded on the 8th January 2011. The total inflow into the dam over the period 10 December 2010 to 7 February 2011 was 95,000ML or 7.2 times the full storage volume of the dam.

[redacted]

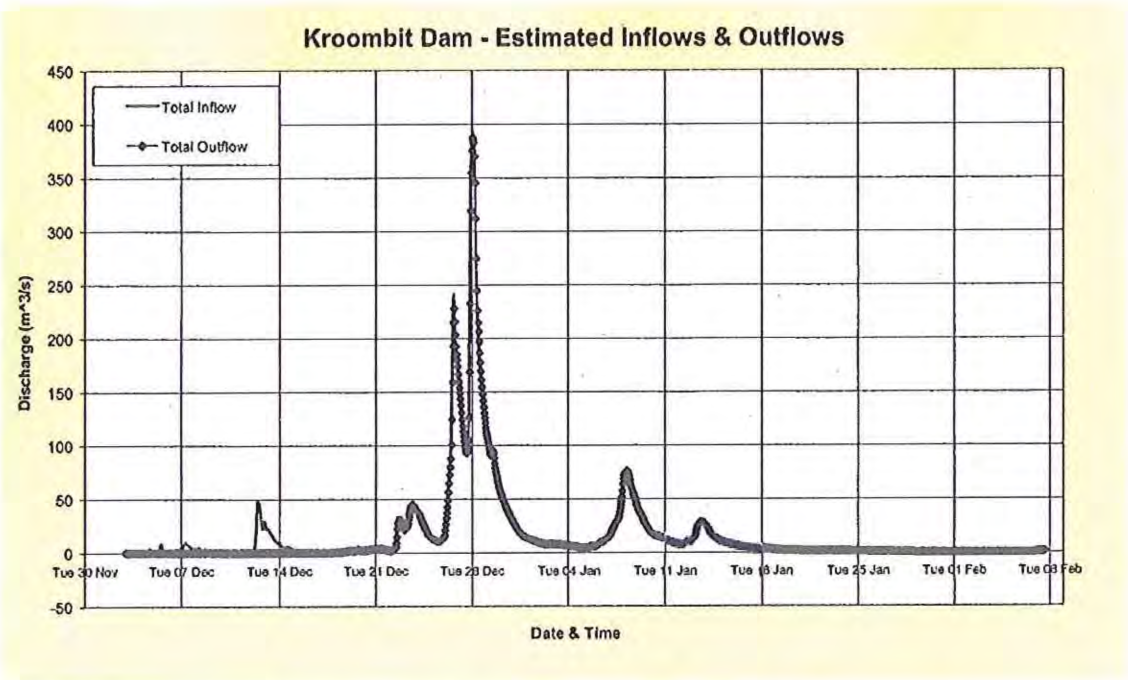


Figure 10-8 Kroombit Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Table 10-5: Kroombit Dam EAP Status

Date	EAP Stage
20-Dec-10 20-Dec-10	Preparedness
21-Dec-10 21-Jan-11	Stage 2
22-Jan-11 07-Feb-11	Inactive
08-Feb-11 09-Feb-11	Stage 2

The downstream landholders were notified on 15th December 2010 of a potential spill event. The notifications were made by the DDO (Mr John Barber) and are recorded in the emergency event report. On the 19th December the DDO (Mr John Barber) contacted the Kroombit Tops tourist park and advised that their road access was likely to be cut[4]. The DDO (Mr John Barber) notified the Banana Shire Council of likely road closures on 21st December 2010. The EEC (Mr Daryl Conway) notified the Banana Shire Council (Colin Head) and Biloela Police at 1330 on 22nd December 2010. Prior to the afternoon of the 22nd December the spill had been a trickle over the spillway. The flow began to increase at about 1300 on 22nd December.

Kroombit Dam was not continuously manned as stipulated in the EAP. During the flood event the access roads were impassable. It was assessed that the nature of the event

---

[4] The road access to Kroombit Tops Tourist Park is a low level crossing immediately downstream of the dam

[redacted]

(small relative to the design flood) and the type of dam (uncontrolled spillway) did not warrant flying staff into site. Staff were rostered on duty (refer Table 10-6) to monitor the event through the dam remotely. The next version of the Kroombit Dam EAP will exclude the requirement for continuous staffing of Kroombit Dam during minor spill events.

[redacted]

Table 10-6: Kroombit Dam Duty Roster

Date	Emergency Event Operator	Dam Duty Operator
15/12/2010		
16/12/2010		
17/12/2010		
18/12/2010		
19/12/2010		
20/12/2010	Daryl Conway	John Barber
21/12/2010	Daryl Conway	John Barber
22/12/2010	Daryl Conway	John Barber
23/12/2010	Daryl Conway	John Barber
24/12/2010	Daryl Conway	John Barber
25/12/2010	Daryl Conway	John Barber
26/12/2010	Daryl Conway	Justin Hooper
27/12/2010	Daryl Conway	Justin Hooper
28/12/2010	Daryl Conway	Justin Hooper / Ron Boal
29/12/2010	Daryl Conway	Justin Hooper / Ron Boal
30/12/2010	Daryl Conway	Justin Hooper / Ron Boal
31/12/2010	Daryl Conway	Justin Hooper / Ron Boal
1/01/2011	Daryl Conway	Justin Hooper / Ron Boal
2/01/2011	Daryl Conway	Justin Hooper / Ron Boal
3/01/2011	Daryl Conway	Justin Hooper / Ron Boal
4/01/2011	Daryl Conway	Justin Hooper
5/01/2011	Daryl Conway	Justin Hooper
6/01/2011	Daryl Conway	Justin Hooper
7/01/2011	Daryl Conway	Justin Hooper
8/01/2011	Daryl Conway	John Barber / Chris Eade / Justin Hooper
9/01/2011	Daryl Conway	John Barber / Chris Eade / Justin Hooper
10/01/2011	Daryl Conway	John Barber / Chris Eade / Justin Hooper
11/01/2011	Daryl Conway	John Barber
12/01/2011	Daryl Conway	John Barber
13/01/2011	Daryl Conway	John Barber
14/01/2011	Daryl Conway	John Barber
15/01/2011	Daryl Conway	John Barber
16/01/2011	Daryl Conway	John Barber
17/01/2011	Daryl Conway	John Barber
18/01/2011	Daryl Conway	John Barber
19/01/2011	Daryl Conway	John Barber
20/01/2011	Daryl Conway	John Barber
21/01/2011	Daryl Conway	John Barber
22/01/2011	Daryl Conway	John Barber
23/01/2011	Daryl Conway	John Barber

Figure 10-7 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive.

[redacted]

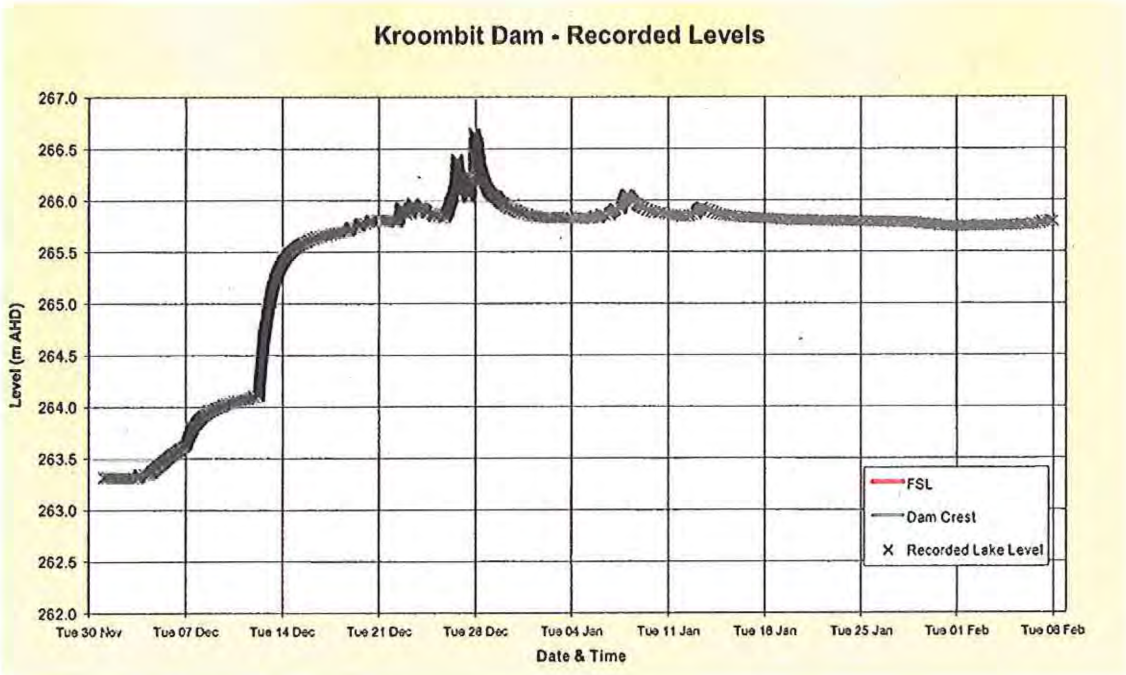


Figure 10-9 Kroombit Dam Recorded Flood Levels

10.1.9 Communities that were affected

Some communities along the Callide Valley experienced major flooding during the 2010-11 wet season. However flows through Callide Dam were insignificant relative to the capacity of Callide Creek and the flows from Kroombit Dam contributed only a relatively small proportion of flows in the valley. The total discharge from Kroombit dam was approximately 95,000ML. The total estimated flow in the Callide Valley at Goovigen was 400,000ML (refer Figure 10-10)

The rain event created some water management issues for the Callide power stations. Local runoff raised the storage levels in the sites ash dam. On January 11th 2011, DERM gave CS Energy permission to release water from its ash dam into Callide Creek whilst Callide dam was discharging.

[redacted]

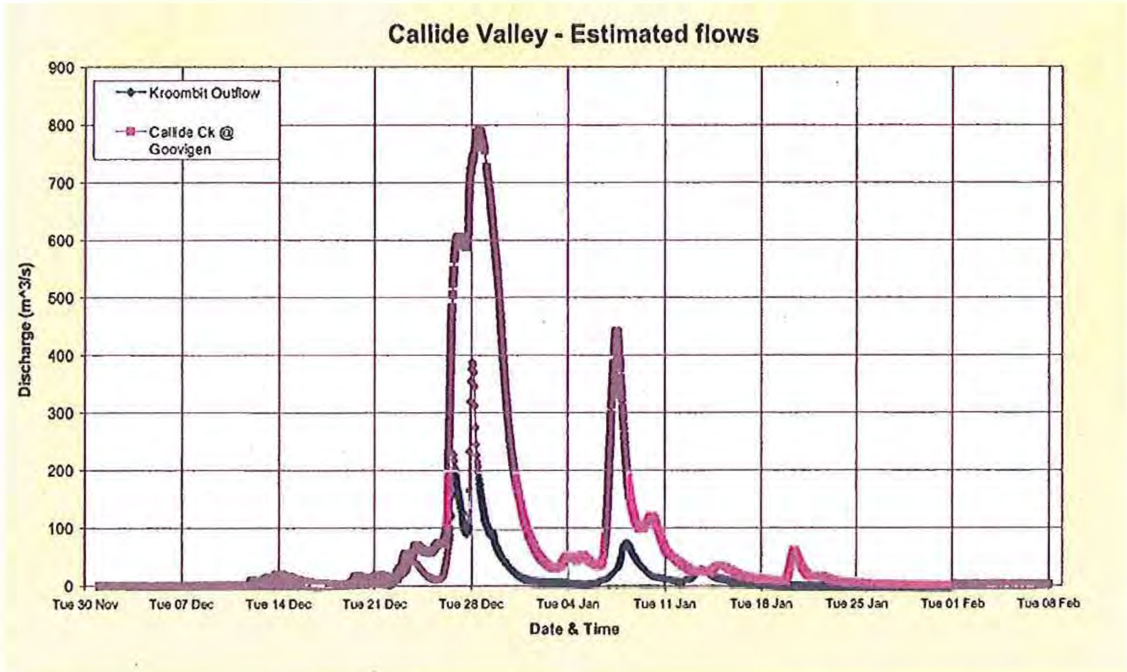


Figure 10-10: Relative size of flood event at Kroombit Dam and Callide Valley Flows[5]

10.1.10 Damage and response to damage

There was negligable flood damage to Callide and Kroombit dams.

10.1.11 Gauging stations – effect on data collection

Figure 10-1 shows the location of gauging stations in the catchment. There were no issues reported with the stations at Callide and Kroombit Dams.

Callide Dam is in a relatively small catchment. Consequentially gate opening decisions are reactions to observed changes in storage rather than routing from inflow stations.

10.1.12 Community inquiries

SunWater received a small number of inquiries regarding water levels and flows in the Callide Creek.

10.1.13 Media Coverage

- An article dated 12 January 2011 *'Dam makes history as water spills'* in the Rockhampton Morning Bulletin reported that the Callide dam had made its first water release since it was built in 1965.
- An article of 10 January 2011, published in the Biloela Central Telegraph also reported the gates being opened, *saying that it was the last of SunWater's dams to fill.*
- The Gladstone Observer also reported the overflow at Callide Dam.

---

[5] Goovigen flows © The State of Queensland (Department of Environment and Resource Management) 2011

[redacted]

- There were no significant news reports concerning the flooding at Kroombit Dam.

10.1.14 Post Event Review

SunWater undertook a review of the event across the Central Region. The review found that:

- The EAP was generally adequate, however some updating is required to reflect current reporting arrangements and the scenario of both Callide and Kroombit EAPs being activated simultaneously. The review and amendment of these documents is in progress;
- The Callide O&M manual needs to include greater details on the spillway discharge rates. A review of the O&M manual has been scheduled for the current financial year.

10.1.15 Local Disaster Management SunWater Relationship

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[6] The Operational Planning Guidelines for Local Disaster Management Groups[7] identifies the role of the LDMG during an event as coordination of support to response agencies, reconnaissance and impact assessment, and provision of public information.

The Callide and Kroombit Dam EAPs are consistent with the State Emergency Management framework described above and in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dams and keeping the LDMG informed. The construct of the EAP is based on the premise that the LDMG will use the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

During this recent event the dams performed to expectations. The stream flows were not extreme in a dam safety sense. If circumstances had been more extreme or serious operational problems had been experienced, SunWater staff would have given primacy to protection of life and safety of the dam. The focus of SunWater staff should not be diverted from this priority. It is for this reason that SunWater supports the Queensland Government District Disaster Management framework. In the frame work SunWater provides the necessary communications to LDMG who take the lead in provision of information to the public. SunWater focuses on operating and managing the safety of the dams.

---

6 http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

7 http://www.disaster.qld.gov.au/publications/pdf/Operational%20Planning%20Guidelines%20for%20Local%20Disaster%20Management%20Groups.pdf

[redacted]

The model described above was not as mature for the Biloela area as it could be with respect to the relationship with SunWater. The relationship functioned on an "as-needs" enquiry basis. The LDMG had not included SunWater in formal operational meetings of the group.

SunWater regional staff (Service Managers) have been instructed to make contact with LDMGs in their areas with the aim of improving communications and requesting that SunWater is invited to participate in LDMG meetings during future flood events.

Daryl Conway (Service Manager) was invited to a meeting with the Biloela LDMG on the 28th March 2011. The outcome of the meeting was that SunWater will be invited to be listed as an advisory party to the LDMG. SunWater will accept this invitation.

10.1.16 Previous flood events – Callide Dam

The January event is ranked as the largest and only flood through the dam since the spillway gates were installed in 1988.

Table 10-7 Callide Dam - Ranking of Historic Flood Events

Dam: **Callide**

FSL 216.1

Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Jan-11	216.23	0.13
2			
3			
4			
5			
6			
7			
8			
9			
10			
2010-11 Flood			
1	Jan-11	216.23	0.13

10.1.17 Previous flood events – Kroombit Dam

The December 2010 event is ranked as the largest flood through the dam since it was constructed in 1992.

[redacted]

		FSL	265.8 m
Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Dec-10	266.66	0.86
2	Feb-03	265.92	0.12
3	Mar-10	265.85	0.05
4	Mar-04	265.80	0.00
5	Jan-96	265.81	0.00
6			
7			
8			
9			
10			
2010-11 Flood			
1	Dec-10	266.66	0.86

10.1.18 Flood mitigation opportunities/ upgrade or communities potentially affected

The Callide Valley Water Supply Scheme Interim Resource Operating Licence specifies rules for the operation of Callide and Kroombit dams, including how releases are to be determined.

There is no flood mitigation storage in Callide or Kroombit dam. The only air space would be if the dams were below the full supply level prior to an event.

Callide Dam has been at very low levels for several years. On 1 December 2010 the dam was only storing approximately 25% of its capacity. The discharge from Callide Dam during this event was very small and did not contribute to any downstream flooding.

As Callide Dam has spillway gates, it is conceivable that the dam could be operated in an active flood mitigation mode. Time constraints have not permitted any evaluation of possible scenarios. However, this would require changes to the regulatory rules. Moreover, it is unlikely that any flood mitigation benefit could be derived from the current configuration of Callide Dam without a significant loss of water supply to the local community.

The Fitzroy Basin ROP and Callide valley IROL specifies rules for the operation of Kroombit Dam, including how releases are to be determined.

Notwithstanding that any alternative operating arrangements are not possible under the current regulatory rules. SunWater developed a flood model for Kroombit Dam to evaluate how the dam might operate to mitigate flood events.

Figure 10-11 shows the scenario of the actual inflows from 1 December 2010 if Kroombit dam had been empty as at 1 December 2010; however this would not be practical for the reason of compliance set out above. It is noted that the peak discharge under this scenario would have been similar to the actual event. There is no dedicated allowance for flood mitigation storage in Kroombit Dam. The storage volume of Kroombit Dam is relatively small at just 14,600ML. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Kroombit Dam.

[redacted]

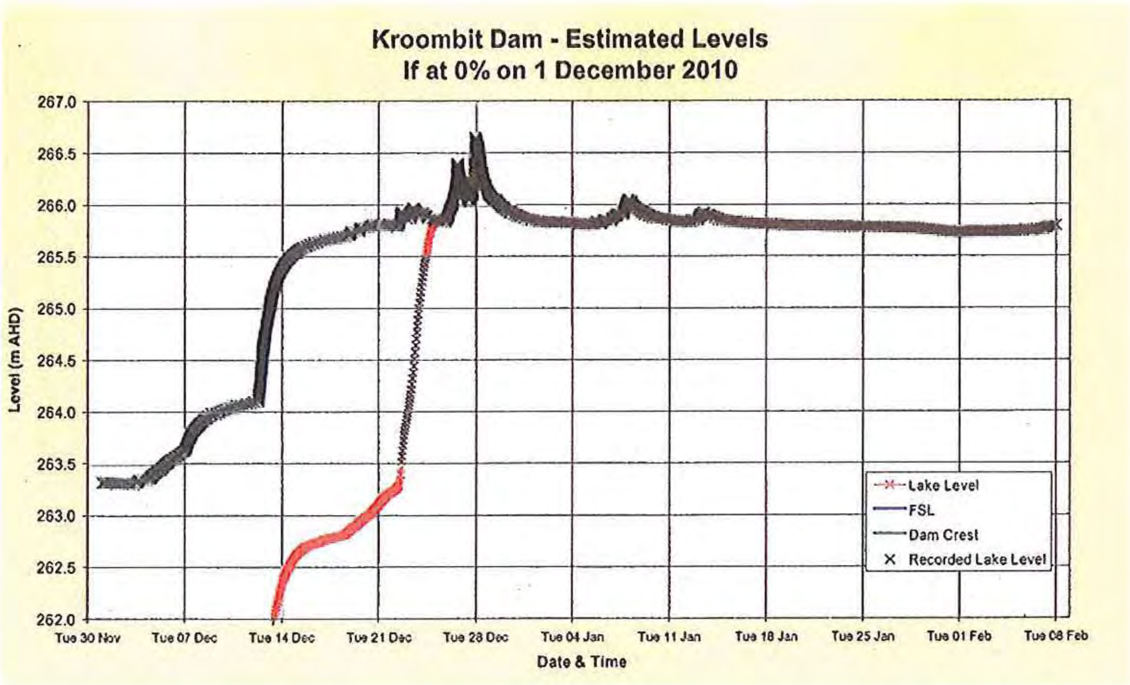


Figure 10-11 Kroombit Dam Simulated Behaviour if Empty on 1 December 2010

[redacted]

Schedule 15: Leslie Dam

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

15.1 Leslie

The flood event at Leslie Dam commenced on 3 January 2011 and concluded on 17 January 2011 (flood event). The total wet season inflow to the dam from 1 December 2010 to 7 February 2011 was 1.3 times the total storage volume of the dam. Communities along the Condamine and Balonne Rivers experienced major flooding during the peak of the flood event. Discharges from Leslie Dam were a relatively small contributor to the total flood volumes.

15.1.1 Overview

The 2.75 million hectare Condamine catchment (refer Figure 15-1) is located at the headwaters of the Murray–Darling Basin in Southern Queensland. Extending from Queen Mary Falls near Killarney in the Border Ranges through to Chinchilla on the north western edge of the Darling Downs, the Condamine River is approximately 500kms long and is a tributary of the Darling River. The catchment includes the cities of Warwick, Toowoomba and Dalby.

The Upper Condamine Water Supply Scheme is one of the 4 SunWater Water Supply Schemes in the Condamine Balonne catchment. The others are Chinchilla Weir, Maranoa Weir and St George. The scheme is owned and operated by SunWater.

The Upper Condamine Water Supply Scheme is centred on the upper reaches of the Condamine River, Condamine North Branch and Sandy Creek. The purpose of the scheme is to provide water for irrigation, industry and town water supplies. Leslie Dam is the major headworks of the Upper Condamine Water Supply Scheme.

Leslie Dam is situated on the Sandy Creek at AMTD 8.5 km upstream from its junction with the Condamine River and is approximately 13 km by road west of Warwick.

A comprehensive risk assessment of Leslie Dam (Jan 2010) has concluded that the dam needs to be upgraded to meet modern engineering standards. Although the dam can safely pass very rare events (up to about 1 in 50,000 year AEP), it has been recommended that an upgrade of the dam be implemented by strengthening of abutment monoliths with passive anchors, and the construction of protective slabs at the toe of the non-spillway monoliths on each side of the spillway,. A final decision on this upgrade project has not yet been made (refer to paragraph 6.2.3 of the statement). SunWater finalised its comprehensive risk assessment (CRA) program

[redacted]

across its portfolio in 2010. The SunWater Board will consider the recommendations of each CRA and finalise the dam safety upgrade program during 2011.

A copy of the comprehensive risk assessment for Leslie Dam can be provided on request.

[redacted]

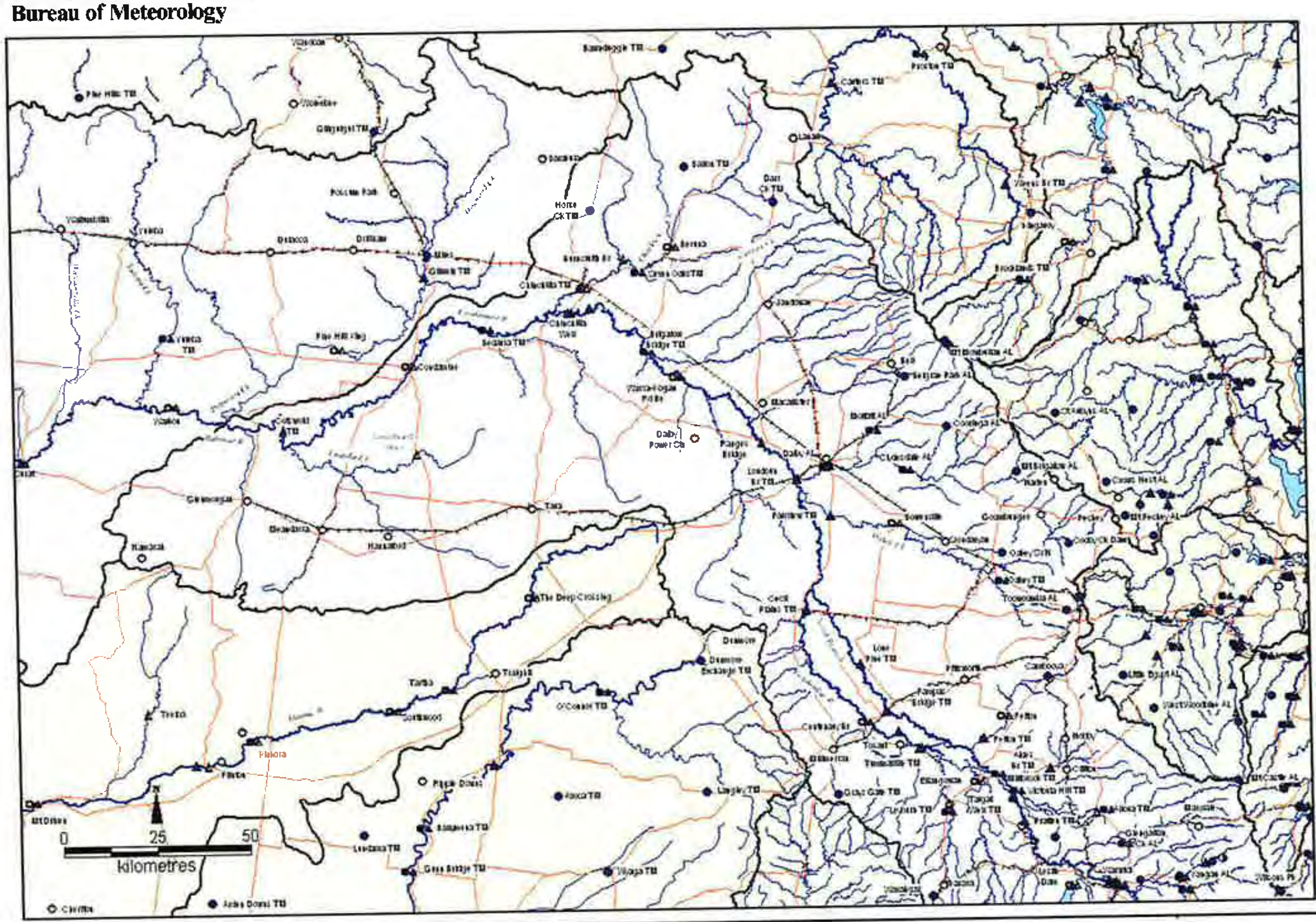


Figure 15-1 Condamine River Catchment

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town
Leslie	106,200	2	Sandy Ck	8.5	Mass concrete with Radial gates	1,288	1965-86	Water Supply	Warwick

The management of the dam is documented in a number of regulatory dam safety documents including:

- The Leslie Dam Operations and Maintenance Manual
- Leslie Dam: Standing Operating Procedures
- Emergency Action Plan: Leslie Dam
- Leslie Dam: Data Book Part 1 – Text
- Leslie Dam: Data Book Part 2 – Drawings
- Leslie Dam: Dam Safety Review (June 1999)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

15.1.1.1 Type

Leslie Dam is a mass concrete gravity dam with central spillway. Leslie Dam was constructed in two stages. Stage-1 was completed in October 1965; giving the dam a storage capacity of 47,119 ML. Stage-2 was completed in 1985. Stage-2 involved the raising of the wall and the installation of seven spillway gates increasing the storage to 106,200 ML at Full Supply Level (EL 472.41 m AHD). The reservoir inundates 1,288 ha at FSL. The catchment area is 603 km^2.

The dam has a total length of 399 m and a maximum height of 31.1 m above the original creek bed level. A zoned earthfill saddle dam is constructed on the right bank of the main dam. The 366 m long saddle dam has a maximum height of 5.5 m with a crest elevation 2.37 m above the crest of the main dam.

Table 15-1 Leslie Dam Details

Type of Dam (Main Dam)	Mass Concrete Gravity Dam
Wall Length	399 m
Maximum height above river bed	31.10 m approximately
Dam crest level	473.63 m LD (Leslie Datum)
Spillway crest level	466.31 m LD
Full Supply Level (FSL)	472.58 m LD
Spillway type	Gated Ogee crest and roller bucket
Spillway width (incl. Piers)	109.118 m

[redacted]

Spillway width (excl. piers)	92.052 m
Spillway gates	7 only, 12.74 m wide by 6.64 m high, hydraulic operated radial gates.
Spillway discharge at DCF	3920 m^3/s
River outlet works	2 x 760 mm diameter cone valves
River outlet works capacity	430 ML/d per outlet
Southern Downs Council Outlet works	6 x 685 mm diameter gate valves
Saddle Dam	Zoned earthfill with riprap along storage side. Max height 5.5m, length 366m. Crest level 476.00 m LD
Reservoir surface area at FSL.	1288 ha
Storage capacity at FSL	106200 ML
Commandable storage capacity	104070 ML
Catchment	603 km^2
Average annual rainfall	710 mm

15.1.1.2 Purpose

The Condamine and Balonne Resource Operations Plan (ROP) notes that the plan addresses the Water Resource (Condamine and Balonne) Plan 2004 outcomes by:

- specifying processes, rules and limits that are consistent with the environmental flow objectives and water allocation security objectives in the Water Resource (Condamine and Balonne) Plan 2004; and
- providing monitoring and reporting arrangements to assist in the ongoing assessment of whether water allocation and management arrangements in the plan area will contribute to the achievement of the Water Resource (Condamine and Balonne) Plan 2004 outcomes.

Leslie Dam was designed and constructed by the Irrigation and Water Supply Commission, primarily for the purpose of maintaining a regulated flow in the Condamine River and North Branch and to improve the water supply to irrigators and the towns of Warwick and Cecil Plains.

In 2009-10 the Upper Condamine Water Supply Scheme supplied 17,300ML to agricultural users, industry and towns.

The operational objectives[1] of the Leslie Dam are as follows:

1. The Leslie Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
    - Leslie Dam Operations and Maintenance Manual,
    - SunWater policies and approved practices,
    - Condamine and Balonne Resource Operations Plan, and
    - Sound engineering and water management standards and practices.
2. Water releases from Leslie Dam must be scheduled to comply with
    - Upper Condamine Resource Operations Licence,
    - SunWater's Customer Charter,
    - All applicable supply agreements and licences.

15.1.1.3 Spillway Gate Operations

Leslie Dam has seven hydraulically operated radial gates on the spillway. They are progressively and sequentially opened to pass flood waters and close in reverse order towards the end of an event. Each gate has two identical hydraulic power packs. One power pack is used as a duty the other standby. The spillway gates operate off mains power with four possible backup power sources.

There is a programmable logic controller (PLC) installed to operate the gates in an automatic mode. If the PLC or sensors are not available then the gates can be operated in a manual mode.

Spillway gates are installed on Leslie Dam to maximise the available storage volume whilst minimising upstream flood levels. In the case of Leslie Dam the FSL is located near the top of the gates. When the spillway gates at Leslie Dam are in the closed position there is a 540mm freeboard between the top of the gates and FSL. The gates are operated in a manner whereby the outflow is balanced with the inflow to maintain the storage level within a narrow band close to the FSL. This arrangement is typical of SunWater's gated storages. This means that the discharge from the dam is approximately equal to the inflow.

Whether operating in automatic or manual mode, the O&M Manual in section 2.6.9.1 defines the gate opening sequence as a function of storage level. The first gate opening commences when the storage level is 0.1meters above FSL. Each 0.01meter rise in storage triggers the next gate opening step.

---

[1] Leslie Dam O&M Manual

When the spillway gates at Leslie Dam are in the closed position there is a 540mm freeboard between the top of the gates and FSL. There is approximately 7,000ML of storage in this freeboard zone. The freeboard provides a small margin of error that might provide some time to rectify a fault in the event of a gate malfunction and prevent gate overtopping from wave action. At an inflow of $800m^3/s$ the storage would rise 540mm in just 2.4 hours if the gates failed to open. Overtopping of the gates could result in damage to the gates and pose a dam safety risk. There is no flood mitigation storage available above FSL.

15.1.2 Implementation of System Operations Plans for 2010-2011 Wet Season

15.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Leslie Dam:

- The EAP was reviewed as part of a periodic (annual) inspection on 13 April 2010. The inspection team was led by John Richardson (RPEQ). Other members of the team were Leonard Wiliem (Asset Engineer), Dave Thomas (Senior Technical Officer), and Phil Mann (Storage Supervisor). The inspection team confirmed that the current version of the EAP was available at the dam. The team considered whether or not the instructions were adequate and, through inquiry, confirmed that the instructions were understood by the dam staff. The findings of the review were documented in the Leslie Dam Annual Inspection Report 13 April 2010 (page 9). The team concluded that the instructions were adequate and understood. However it was noted that changes were required to the EAP to reflect the changes to SunWater's business structure in 2010. These changes were addressed in the supplementary notice issued by the Principal Engineer Dam Safety (PEDS) described below.

- The notification and emergency communication list (EAP section 3) was revised and reissued on 26 November 2010. The notification and emergency communication was issued as a controlled document to the distribution list (Section 1, page 2 of 3 of the EAP). A transmittal advice was issued with each controlled copy. The transmittal advice included instructions for updating the EAP.

- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety (Mal Halwala). The notice was principally designed to address changes to the roles and responsibilities that occurred as part of an internal reorganisation within SunWater. The notice was based on the Tinaroo Falls Dam EAP that had been updated to Issue 3 and was to be used as the template for Issue 3 for all SunWater dams. The supplementary notice was issued by email on 29 October 2010 to all of the Area Operations Managers and Service Managers who all fulfil the role of EEC for the dams in their respective areas.

- One of the nominated EECs for the Toowoomba service area, Mr Ron Newman met with the Warwick DDMG (known as the Warwick Disaster District Management Group) on 1st December 2010 (prior to any discharge from the spillway in the current wet season) to discuss possible emergency scenarios and raise awareness of the EAP. The meeting was held at the Warwick Police Station. There was a set agenda and minutes for the meeting that can be made available if required.

- Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers in June 2010 prior to the wet season. There are no records available for this training.

15.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The O&M Manual outlines the required maintenance plans for Leslie Dam. The live maintenance schedules and work instructions are obtained from SunWater's SAP system. This means that work orders for maintenance, document revisions and other activities such as emergency preparations are automatically generated by the SAP system on a monthly basis This creates a controlled document trail that requires actioning and closing out. A work order is issued for each scheduled or corrective maintenance item (refer Figure 15-2 for sample work order header). The work orders are issued to the appropriate supervisor. Scheduled maintenance items would include such items as:

- 1M-Condition Monitoring – Leslie Dam[2]
- 1M-Dam Surveillance – Leslie Dam
- 1M-Component Servicing – Valves – Leslie Dam
- 2M-Component Servicing – Leslie Dam
- 3M-Condition Monitoring – Spillway Gates – Leslie Dam
- 3M Condition Monitoring – Leslie Dam

A detailed work instruction is issued with each work order. Each work instruction includes a detailed check list of tasks to be performed to complete the work order Refer Figure 15-3 for sample extract from completed work instruction.

Once the work on an order and in an instruction has been competed it is signed off as complete, dated and verified by the supervisor (refer Figure 15-4).

---

[2] 1M denotes a monthly frequency, 2M every 2 months, 3M quarterly etc

SunWater

PM01-Preventive - Day to Day Work Order 5108694

Printed By: NEWMANR On: 22.09.2010 Page: 1 Original

Job Description: ***UCO-3M-CONDITION MONITORING-LESLIE DAM***
Work Instruction: ***UCO00003***

Functional Location:	*UCO-LES*	*LESLIE DAM*	
Equipment:			
Location:		*at:*	
General Location	*SANDY CK.NEAREST TOWN WARWICK*		
Planner:	*310 Toowoomba Planner*	*Main work center:*	*3100 WS Toowoomba*
Priority:	*5 Priority 5 < 1 month*	*Status :*	*REL NMAT PRC SETC*

Notifications:
10126334 UCO-3M-CONDITION MONITORING-LESLIE DAM *UCO-LES*

Figure 15-2 Sample Work Order Header

			NECESSARY (REFER TO O&M MANUAL).		
4	OPERATION S COMPLEX	STANDBY DIESEL	CHECK BATTERIES, BATTERY CHARGES 1 & 2, INDICATOR LIGHTS & GAUGES. CHECK ENGINE FOR OIL, WATER, FUEL LEVELS AND CHECK FOR LEAKS ETC. RUN ENGINE TILL IT REACHES OPERATING TEMPERATURE CHANGE OIL, OIL FILTER, & FUEL FILTER WHEN NECESSARY (REFER TO O&M MANUAL).		22/11/10
5	OPERATION S COMPLEX	PORTABLE DIESEL	CHECK BATTERIES, INDICATOR LIGHTS & GAUGES. CHECK ENGINE FOR OIL, WATER, FUEL, LEVELS AND CHECK FOR LEAKS ETC. RUN ENGINE TILL IT REACHES OPERATING TEMPERATURE CHANGE OIL, OIL FILTER, & FUEL FILTER WHEN NECESSARY (REFER TO O&M MANUAL).		06.12.10
6	OPERATION S COMPLEX	U.P.S.	CHECK OPERATION. VISUAL CHECK ON BATTERIES. WORMALD MONTHLY SERVICE.		

Figure 15-3 Sample of Work Instruction for Work Order 5101612

COMPLETION INFORMATION

Please complete the attached work instructions and record all non-conformances, issues
and any additional information at the end of these instructions in the additiona
comments section.

Job Completed By : [redacted] Date: 30.12.2010

Supervisor Verification: [redacted] Date: 21-2-11

Figure 15-4 Sample Work Order Completion

Emergency preparations prior to the wet season included:

- Functional test of spillway gates on the 1st and 2nd December as evidenced by entry in dam log
- Testing and servicing of the standby diesel generator on the 6th and 7th December as evidenced by entry in dam log;
- Filling of all fuel stores as evidenced by work order 5110290;
- Testing of communication equipment;
- Testing of portable equipment and instruments; and

[redacted]

- Checking of operations of gauging stations.

Section 5 of the Leslie Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the dam will be continuously manned and the emergency controlled from the regional office. The EAP identifies the roles for the dam duty officer (DDO) and emergency event coordinator (EEC), however, in all cases the EAP identifies that the O&M Manual and SOPs are to be followed. Within section 5 of the EAP actions for a number of stage or alert levels are defined. The alert levels are defined by certain storage levels and catchment conditions.

The first alert level is noted as *normal flood operations* where the reservoir reaches EL471.91m (0.5m below FSL), approaching FSL and raining heavily. This level is largely a preparatory stage with communication between the DDO, EEC and standby officers. Gate controls are set to automatic and backup systems are checked.

The next alert level is noted in the EAP as flood operations stage 1. The EAP defines Stage 1 flood operations to commence when the reservoir reaches EL 472.41m (FSL). This level is transitionary if the storage is rising.

The next alert level in the EAP is flood operations stage 2. This stage is triggered at FSL (472.41m) and the storage is rising. The DDOs main focus at this stage of the EAP at the dam is the operation of the spillway gate in accordance with the O&M Manual. At this stage the EEC provides notification to the DDMG, police and downstream irrigators and landholders.

The Leslie Dam EAP is consistent with the State Emergency Management framework described in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the DDMG informed. The construct of the EAP is based on the DDMG using the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

The EAP was first activated as defined in SOP 40 for Leslie Dam on 3rd January 2011 and remained in effect until 17th January.

15.1.3 Outline of flood event 2010/2011

Leslie Dam reached EL 471.91 on 3rd January 2011, however the dam log notes that rainfall of less than 10mm was recorded at the dam on both 3rd and 4th January. The DDO noted a fault with the water level sensor. I (Robert Keogh, Manager Asset Management) was contacted by the EEC at 8:15am on the 3rd and advised of the fault. I gave a verbal instruction to ensure that the dam was manned and to operate the gates in manual mode (as per WP 25-04 of the O&M Manual) until the fault could be rectified. Geoff Timms, SCADA control engineer was despatched from Brisbane on 4th January to attempt a repair. The sensor could not be repaired on site so operations continued in manual mode. The dam log notes that 24 hour staffing commenced on 4th January.

[redacted]

The EAP defines Stage 1 flood operations to commence when the reservoir reaches EL 472.41m (FSL). The dam log notes that this level was reached at 21:08 on 5th January 2011. The data log from the storage level recorder indicates that the storage was rising at about 8cm per hour. This immediately triggered stage 2 of EAP flood operations (at FSL and rising). Stage 2 of the EAP requires that the DDMG, Warwick Police and downstream irrigators and landholders be notified. The communication with parties other than DDMG is by agreement to ensure rapid response at the commencement of an event. The event log records that the EEC made these notifications at 8pm, about 1 hour before reaching stage 2. Leslie Dam remained at stage 2 for the remainder of the event.

The flood event at Leslie dam had three distinct inflow peaks recorded on the 6th, 9th and 11th January 2011. SunWater provided updates to the contacts identified in the EAP on numerous occasions during the event. These communications are logged in the Leslie Dam Flood Event Report and in the communication logs and diaries of various members of staff.

At 16:40 on the 6th January, after the first peak had passed there was a discussion between Peter Collett, SunWater's Area Operations Manager and Mr Ron Bellingham, Mayor of the Southern Downs Regional Council (SDRC). The impact of releases from Leslie Dam on the Sandy Creek bridge on the Cunningham Highway was discussed. DDMG has lead accountability for communication with media, community and other agencies. However SunWater did communicate directly with the Main Roads Department during the remainder of the event in addition to the listed EAP contacts at the request of the Mayor.

On the 7th January an article appeared in the Warwick Daily News that indicated that the Mayor of the SDRC had requested that SunWater reduce the release rate from the dam to reduce the impact on the Cunningham Highway and that SunWater had agreed. This is not correct. Later the same day the dam safety regulator, Mr Peter Allen emailed the article to myself and sought clarification on how decisions had been taken to operate the gates. The dam safety regulator was assured that operations were in accordance with the O&M Manual and EAP.

Figure 15-5 outlines the estimated inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. There is no gauging station upstream of the dam to record the inflow to the storage. The Leslie Dam catchment is small and there is a rapid response time for flows from the catchment. Spillway gates are operated on actual storage level not projected inflows. The inflow shown in Figure 15-5 is an estimate derived from the recorded storage behaviour (further information about these calculations can be provided upon request). The peak inflow was estimated at over 800m^3/s. Figure 15-6 details the discharge from the dam in more detail during the flood event. The full record of gate operations is contained in the *Leslie Dam Flood Event Report*.

Spillway gates are installed on Leslie Dam to maximise the available storage volume whilst minimising upstream flood levels. In the case of Leslie Dam the FSL is located near the top of the gates. When the spillway gates at Leslie Dam are in the closed position there is a 540mm freeboard between the top of

[redacted]

the gates and FSL. The gates are operated in a manner whereby the outflow is balanced with the inflow to maintain the storage level within a narrow band close to the FSL.

This arrangement is typical of SunWater's gated storages. This means that the discharge from the dam is approximately equal to the inflow. There is very little attenuation of flood peaks for dams with this mode of gate operation as demonstrated in Figure 15-5.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 139,000ML or 1.3 times the full storage volume of the dam.

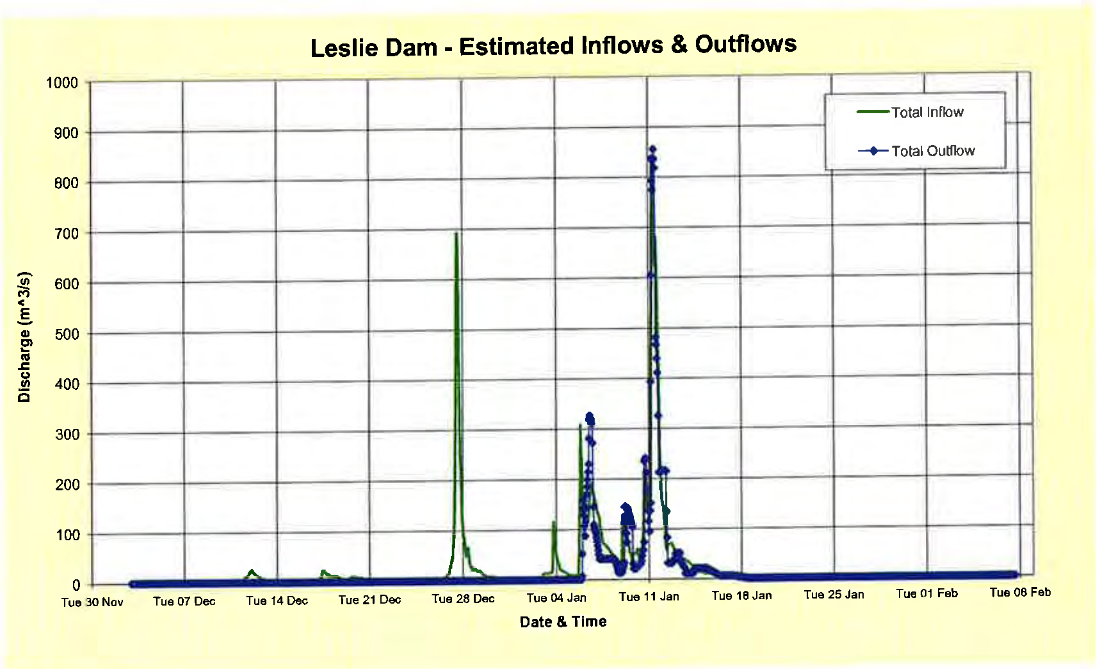


Figure 15-5 Leslie Dam Inflow and Outflow (Dec 2010 - Feb 2011)

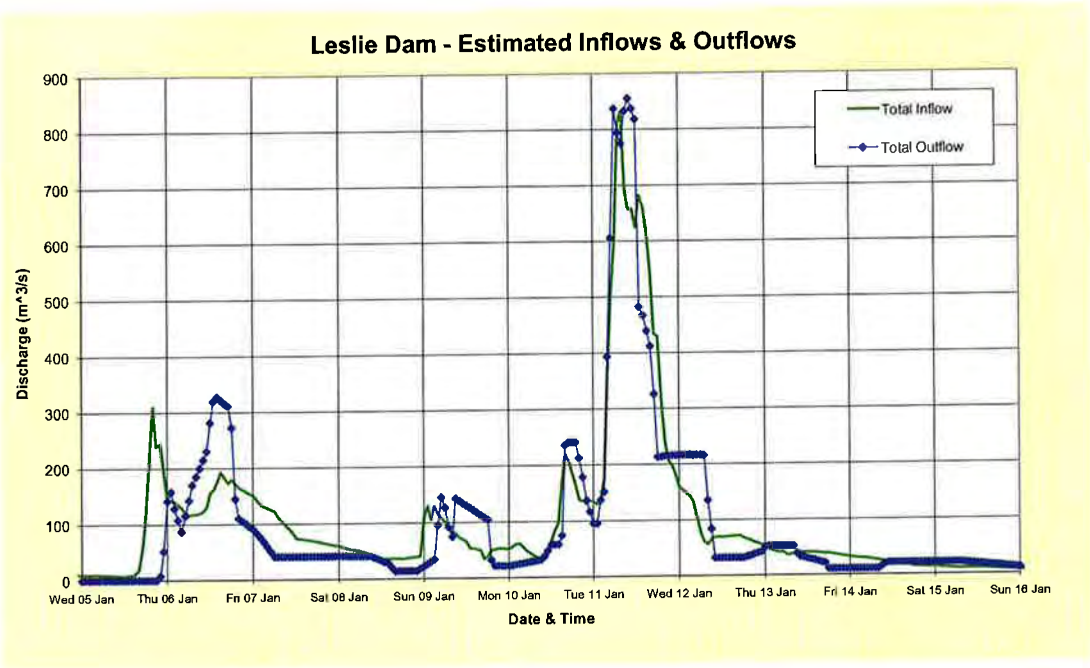


Figure 15-6 Leslie Dam Inflow and Outflow during Flood Event

Figure 15-7 plots the recorded tailwater level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[3]. The January event was reported as a major flood.

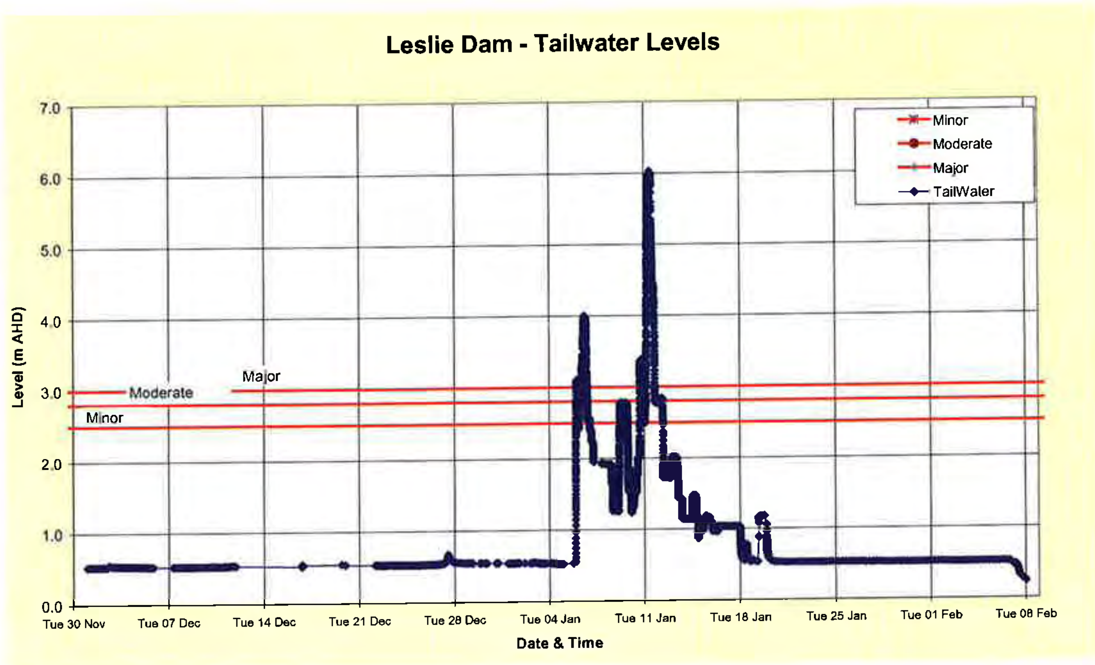


Figure 15-7 Leslie Dam Recorded Tailwater Flood Levels

---

[3] www.bom.gov.au

[redacted]

15.1.3.1 Communities that were affected

A number of communities along the Condamine River were severely affected by flooding during December 2010 to January 2011[4]. The flood flows from the Leslie Dam catchment were a minor contributor to the flood event along the Condamine River (refer Figure 15-8).

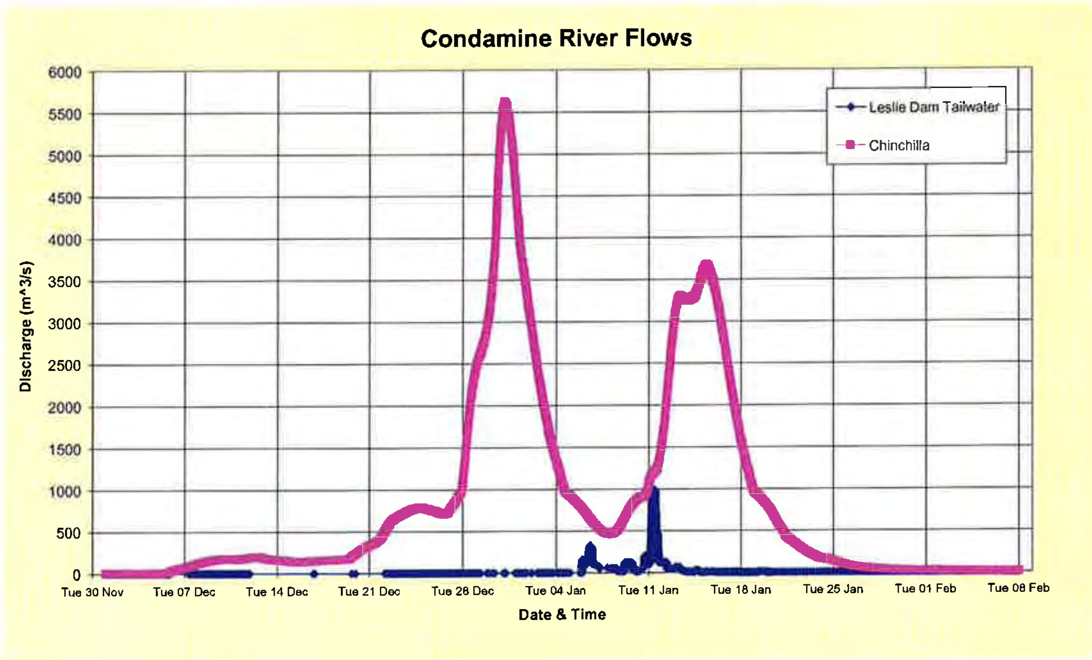


Figure 15-8 Relative size of Flood Event at Leslie Dam to Condamine River Flows

A significant local issue was the closure of the Sandy Creek Bridge on the Cunningham Highway. The flood waters from Sandy Creek rose above the level of the road on a number of occasions during the event. SunWater does not have any knowledge of the exact times of the closure of the highway nor depth of inundation. The flood waters in Sandy creek came from both the discharge from Leslie Dam and significant flows from an unnamed tributary to Sandy Creek down stream of the dam. The DDMG was notified that discharges from the dam would occur prior to the discharges occurring. The DDMG was first notified of a potential discharge at 8pm on the 5th January 2011. This notification was two and a half hours before the first discharge from the dam.

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[5] The Leslie Dam EAP notification and emergency

[4] As per BoM flood classifications

[5] http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

[redacted]

communication list (section 3 of the EAP) includes the District Disaster Coordinator Warwick, Counter Disaster Executive Officer Southern Downs Regional Council and the Mayor of the Southern Downs Regional Council. The Leslie Dam EAP has been developed based on the premise that SunWater's role in a emergency scenario at Leslie Dam is to manage activities at the dam and to provide regular notification and update to the above DDMG contacts. The DDMG will then use this information to plan and coordinate whole-of-government responses. This would include Police and Department of Main Roads (MRD) for road closures. The Leslie Dam EAP does not contemplate direct contact between SunWater and MRD during an emergency.

SunWater formally notified or updated disaster management contacts on the following occasions via phone:

- 27/12/10 @ 1430 District Disaster Mgmt Group (DDMG)
- 05/01/11 @ 2000 called EAP communications [6]
- 06/01/11 @ 1730 called EAP communications list with an update
- 06/01/11 @ 2030 DDMG
- 07/01/11 @ 0900 EAP communications list with an update
- 09/01/11 @ 0535 DDMG
- 09/01/11 @ 06:00 Southern Downs RC (SDRC)
- 09/01/11 @ 0830 SDRC
- 09/01/11 @1435 SDRC & DDMG
- 09/01/11 @ 1450 DDMG
- 09/01/11 @ 1810 State Disaster Co-ordination Centre (SDCC)
- 10/01/11 @ 1538 SDRC & DDMG
- 11/01/11 @ 08:35 DDMG
- 11/01/11 @ 0945 SDRC
- 11/01/11 @ 1600 EAP communications list with an update
- 12/01/11 @ 0930 EAP communications list with an update

In addition to the formal EAP communications, Peter Collett SunWater's Area Operations Manager had a number of discussions with the Southern Downs Regional Council (SDRC).

At 16:40 on the 6th January, after the first peak had passed there was a discussion between Peter Collett, SunWater's Area Operations Manager and Mr Ron Bellingham, Mayor of the Southern Downs Regional Council (SDRC). The impact of releases from Leslie Dam on the Sandy Creek bridge on the Cunningham Highway

---

[6] EAP communications list refers to the full list of parties to be notified in section 3 of the EAP

was discussed. SunWater maintains that the DDMG has lead accountability for communication with media, community and other agencies. However SunWater did communicate directly with the Main Roads Department (MRD) during the remainder of the event in addition to the listed EAP contacts at the request of the Mayor. The communication (via phone) with the MRD included the following:

- 09/01/11 @ 1440 Main Roads Department (MRD)
- 09/01/11 @ 1450 MRD
- 10/01/11 @ 1535 MRD
- 10/01/11 @ 1805 MRD
- 10/01/11 @ 1935 MRD
- 11/01/11 @ 0242 MRD
- 11/01/11 @ 0355 MRD
- 11/01/11 @ 0835 MRD
- 12/01/11 @ 0930 MRD
- 12/01/11 @ 0931 MRD

It is noted that SunWater usually has two staff on duty at Leslie Dam during any shift when the EAP is activated. The EEC in Toowoomba has responsibilities for a number of other dams in the service area. Leslie Dam performed to expectations during this event notwithstanding the need to operate in manual mode. If staff had had to deal with other emergency scenarios such as some gate operating failure or damage then their primary focus would be the safety of the dam. The DDMG has the direct coordinating role under the State Disaster Management Framework. The risk of SunWater site operational staff taking on additional communication roles is that dam safety issues may take precedence and the additional communications may not occur. SunWater's EEC has the responsibility to manage the relationship with the DDMG. The DDMG should therefore continue to take the lead role in coordinating and communicating with other agencies.

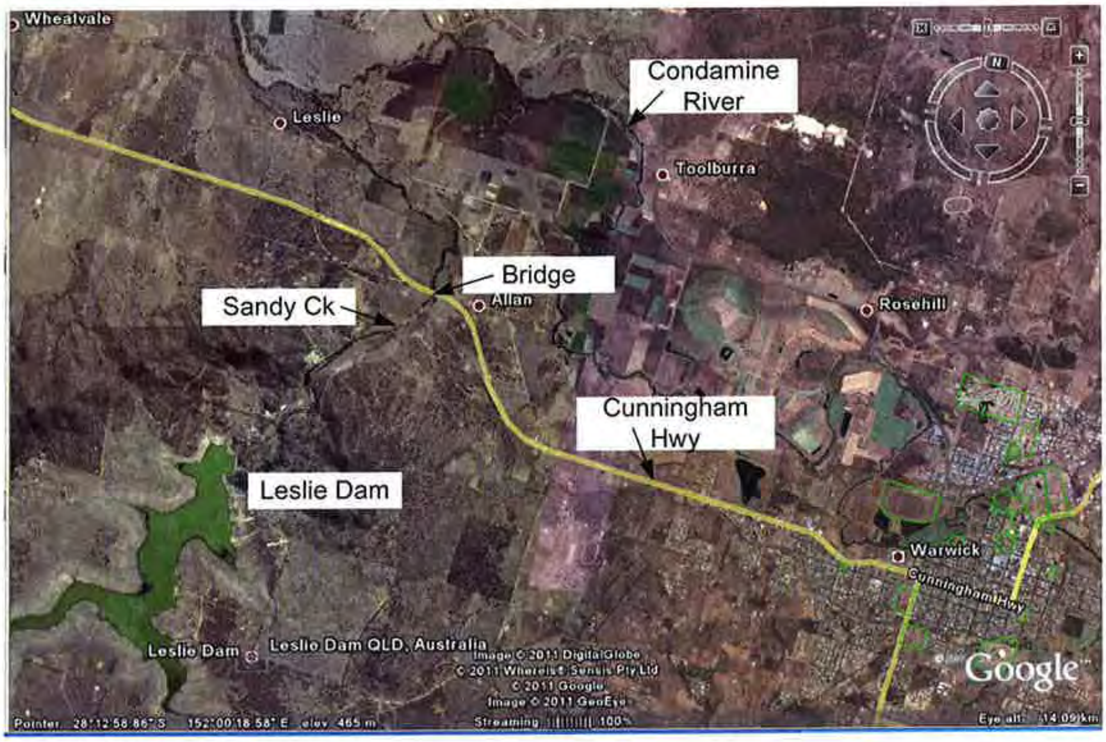


Figure 15-9 Locality Map - Leslie Dam and Surrounds

It is noted that the SDRC in its submission to the Commission dated 10 March 2011 identified that significant outflows from the dam may result in flood waters in Warwick not receding as quickly as it might otherwise. As noted elsewhere in this submission, Leslie dam does not have any flood storage and that when the storage reaches FSL the gates must be operated to pass the inflow to the dam as it occurs. There is no capacity to change the timing or magnitude of releases from Leslie Dam. SunWater does not have any knowledge of backwater[7] effects in the Condamine River during the recent flood event. The backwater effect would have been similar to that experienced had the dam not been in existence given that the dam is operated to pass inflows.

SunWater has undertaken a dam break analysis for Leslie Dam in 2005. The analysis considered a PMP failure flood, dam crest no failure flood and sunny day failure flood. In the former two extreme rainfall events the inundation maps indicate low lying areas of Warwick would be inundated. These inundation maps are included in the Leslie Dam EAP however they are not representative of the recent event. The maps in the EAP are based on much larger extreme rainfall events.

15.1.3.2 Damage and response to damage

Flood damage to Leslie dam was limited to some erosion downstream of the spillway and damage to fences and signs. The main dam structure is undamaged and performed well from a dam safety perspective. Planning is underway to repair the erosion damage.

---

7 Backwater is effect of a downstream condition to pond water or locally raise water levels

15.1.3.3 Gauging stations – effect on data collection

Figure 15-1 shows the location of gauging stations in the catchment.

The dam does not have an inflow gauge to aid in predicting storage rises. Consequentially gate opening decisions are made according to observed changes in storage levels. Installation of a suitable inflow gauge may provide some limited advance warning of gate openings. However a suitable site must first be identified. SunWater has commenced investigations as to possible sites for an inflow gauge.

15.1.3.4 Community inquiries

The January 2011 flood event at Leslie Dam was the first event for many years. There was significant local interest, and in some cases concern about flood releases from the dam. SunWater call centre received approximately 12 inquiries regarding water levels, gate operations, flooding and flows at Leslie Dam (refer section 2.1.1 of my statement re provisions for 24/7 emergency contact with SunWater through the call centre).

15.1.3.5 Media Coverage

On 28 December 2010, the Toowoomba Chronicle reported on evacuations in Warwick and stated that Leslie had reached 100% capacity last night and was expected to overflow.

On 30 December 2010 the Warwick Daily News reported that Leslie Dam was one of nearly a dozen major water storages in Queensland needing a safety upgrade and that SunWater did not intend on releasing water from it. On that date in the same publication, an article by Eloise Handley, *Dam strong as ever: SunWater,* referred to New extreme rainfall projections for Queensland announced by BOM have led to an increase in the standards applied to dam safety and referring to scheduled upgrade of Leslie Dam programmed for 2035. This article also refers to a paper of Peter Allen which referred to an incident in the 1980s which occurred at Leslie in which heavy mist caused sensor to open gate prematurely. The article stated that this incident "caused a lot of rethinking on level sensors and the way the automatic operating system was employed."

> *Note:-The Leslie Dam EAP and O&M Manual reflect the learnings from this event. The spillway gate control system remains in manual mode until the EAP is activated. The O&M Manual (WP 25-02) require verification that the water levels are being measured correctly. These procedures are designed to ensure that premature releases are not made from the dam. It was during these verification procedures that the water level sensor fault was identified during this event and a decision taken to operate in manual mode.*

On 31 December 2010 the Warwick Daily News editorial reported on rumours that there were cracks in Leslie Dam. This was a false report. SunWater advised media outlets that the report was false and that the dam was performing satisfactorily.

On 4 January 2011, the Warwick Daily News reported that the Leslie dam levels continued to rise and referred to a statement from a SunWater Spokesman about the operation of the gates being determined by the inflows.

[redacted]

On 7 January 2011 the Warwick Daily News' Jeremy Sollars and Cassandra Garvey reported that Mayor Billingham had pleaded with Leslie Dam owner, SunWater, to ease back on its release from the dam after the highway west of Warwick was hit by a torrent of water. Mayor Billingham is quoted as saying, "I guess part of the issue may be that it's been 22 years since Leslie Dam was last full and perhaps there is no one around who remembers how that was managed,".

> *In response to this report the dam safety regulator sought and received assurances from SunWater that the dam was being operated in accordance with the approved O&M Manual.*

On 8 January 2011 the Warwick Daily News reported that water would be released from Leslie dam for a few more days, depending on rainfall however that the volume of water would be released following intervention from the Mayor.

On 13 January 2011, in an article published in the Warwick Daily News, *How the flooding disaster unfolded,* reported on water releases from Leslie dam throughout the flood event.

On 19 January 2011 Jeremy Sollars from the Daily News reported that the feeling amongst some people in the community was that the release of water from Leslie was well timed in relation to the flows in Condamine, however some people say the releases could have started a week earlier when the dam was at a moderate volume.

> *Note:- early release of water would have been in breach of the Resource operating Licence and would not have had a material flood mitigating benefit (refer 15.1.6).*

On 31 January 2011 Eloise Handley from the Warwick Daily News reported that scheduled upgrades to Leslie Dam had not been brought forward and that Leslie Dam may not be strong enough to contain a maximum flood.

On 15 February 2011 Jenna Cairney and Jeremy Sollars from the Warwick Daily News stated that SunWater had no plans to release any water as was the plan at Wivenhoe Dam and that Mayor Billingham had said that if there was another extreme forecast received, that he would like to see some water released from the Leslie as a cushion.

> *Note:- early release of water would have been in breach of the Resource operating Licence and would not have had a material flood mitigating benefit (refer 15.1.6).*

On 1 March 2011 Jenna Cairney reported that it was difficult warning people out at Leslie Dam which was an issue because the flood rose quickly, although Mayor Billingham doubted that a siren would be considered. Mayor Billingham stated in its post-flood debrief council was discussing with Emergency Management Queensland (EMQ) about signing up to the Early Warning Network, which sends SMS and email alerts in disasters..

[redacted]

15.1.3.6 Post Event Review

SunWater undertook a review of the flood event for Leslie Dam. This review took the form of a memo from the Area Operations Manager. The review found that:

- The EAP was generally adequate; however some updating is required to reflect current reporting arrangements within SunWater. The amendments to these documents are in progress. Issue 3 of the Leslie Dam EAP will be released before the next wet season;
- A review of the gate opening sequence specified in the O&M Manual could provide operators with more information on discharge rates for each gate opening step. A review of the O&M Manual is in progress.
- Some difficulties were experienced with continuity of telecommunication networks. The potential introduction of NextG telecommunications in addition to land lines is being investigated
- Site facilities for staff require some improvement where staff were on duty and isolated for prolonged periods. For example there was only a small fridge available which was too small for staff provisions. Facilities will be improved before the next event; and,
- An upstream gauging station to give an early indication of inflow would provide some limited ability to predict gate operations and discharge. This would facilitate improved communication with the DDMG. Investigations are in progress to evaluate possible sites for a gauging station; and,
- Expanding SunWater's use of an SMS messaging service to include notification of nominated landholders in the EAP could streamline communication of an EAP event. This option is under investigation and if feasible will be implemented before the end of 2011.

15.1.4 Local Disaster Management-SunWater Relationship

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[8] The Operational Planning Guidelines for Local Disaster Management Groups[9] identifies the role of the LDMG during an event as coordination of support to response agencies, reconnaissance and impact assessment, and provision of public information.

---

8 http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

9 http://www.disaster.qld.gov.au/publications/pdf/Operational%20Planning%20Guidelines%20for%20Local%20Disaster%20Management%20Groups.pdf

[redacted]

The Leslie Dam EAP is consistent with the State Emergency Management framework described above and in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the DDMG informed. The construct of the EAP is based on the premise that the DDMG will use the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment

During this recent event the dam performed to expectations. The stream flows, although significant, were not extreme in a dam safety sense. If circumstances had been more extreme or serious operational problems had been experienced, SunWater staff would have given primacy to protection of life and safety of the dam. The focus of SunWater staff should not be diverted from this priority. It is for this reason that SunWater supports the Queensland Government District Disaster Management framework. In the frame work SunWater provides the necessary communications to LDMG and/or DDMG who take the lead in provision of information to the public and media. SunWater focuses on operating and managing the safety of the dam.

The model described above was not as mature for the Southern Downs Region as it could be with respect to the relationship with SunWater. The relationship functioned on an "as-needs" enquiry basis. The DDMG had not included SunWater in formal operational meetings of the group. The information provided to the DDMG did not appear to be disseminated to appropriate parties in all cases. SunWater found it necessary to communicate to individual agencies, in particular MRD rather than that information being managed by DDMG.

The Queensland disaster management framework is premised on the DDMG/LDMG as responsible for providing "one voice" to the community and coordinating actions and resources. The risk of mixed messages is evidenced in the above media coverage with multiple organisations presenting sometimes conflicting views.

On 9th February Barry Jeppesen, General Manager Infrastructure Management SunWater and Peter Collett met with the CEO of SDRC (Rod Ferguson). The purpose of the meeting at SunWater's request was to discuss opportunities for improving the relationship with SunWater and the Local/District Disaster Management Groups with respect to SunWater's dam operations in emergency events i.e. floods. It was SunWater's position that the current ADHOC phone enquiry based relationship was not as effective as the relationship should be.

The CEO of SDRC agreed with SunWater's proposal that in future events SunWater should have a direct involvement in the DDMG operational meetings. The CEO of SDRC agreed with SunWater's position that it was the DDMG's role to provide a consistent and factual voice to the community and media. The CEO also recognized SunWater's position that provision of flood information to the L/DDMG was the role of the BOM.

The meeting closed with SunWater accepting two offers from the Council;

[redacted]

- Firstly that we would be formally invite to and directly involved in the DDMG debrief when it was held.

- Secondly, that Council would benefit from SunWater attending a Council Meeting to explain the physical and operational characteristics of Leslie Dam. Council would organize and contact us to organize a suitable date.

A record of the meeting described above can be made available on request.

15.1.5 Previous flood events

The February event is ranked as the largest flood through the dam since the spillway gates were added in 1986.

Table 15-2 Leslie Dam - Ranking of Historic Flood Events

FSL 472.41 m

Flood Rank	Date	Peak Height	
		EL	Above Crest
1	Jan-11	472.70	0.29
2	Sep-88	472.61	0.20
3	May-90	472.54	0.13
4			
5			
6			
7			
8			
9			
10			
2010-11 Flood			
1	Jan-11	472.70	0.29

15.1.6 Flood mitigation opportunities

The Condamine and Balone ROP specifies rules for the operation of Leslie Dam, including how releases are to be determined. Notwithstanding that any alternative operating arrangements are not possible under the current regulatory rules, SunWater developed a flood model for Leslie Dam to evaluate whether the dam could be operated to mitigate flood events.

There is no flood mitigation storage in Leslie dam. The only air space would be if the dam was below the full supply level prior to an event. Leslie Dam has been at very low levels for several years. On 1 December 2010 the dam was only storing approximately 58% of its capacity. Figure 15-10 shows the scenario of the actual inflows from 1 December 2010 if the dam had been full as at 1 December. If compared with Figure 15-7 it is noted that the peak spillway discharge for the hypothetical case is similar to the actual recorded peak. The main difference would have been that there would have also been an earlier discharge from Leslie Dam in late December. The size of the January floods would have been similar to those actually experienced.

Figure 15-11 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December 2010; however this would not be practical for the reason of compliance set out above. It is noted that the peak discharge under this scenario would only have been slightly lower (approximately 10%) than the actual event.

As Leslie Dam has spillway gates, it is conceivable that the dam could be operated in an active flood mitigation mode, subject to changes to the regulatory rules. The effect on downstream flooding would be a function of the operating rules adopted. Time constraints have not permitted a full evaluation of possible scenarios. Figure 15-12 shows the outcome for the scenario of the actual inflows from 1 December 2010 if the FSL were reduced to the fixed crest level of the spillway and the gates used to provide temporary flood storage. If compared to Figure 15-5 the January peak discharge would be reduced from approximately 800m^3/s to approximately 550m^3/s. However such a change to the operating rules would:

- Have created an additional discharge in December 2010 of over 300m^3/s;
- Have only localised benefits. Figure 15-8 demonstrates the small contribution of Leslie Dam to the flood event further downstream in the Condamine River;
- Reduce water supplies to the community resulting in negative impacts on the local economy; and,
- Require a change to the WRP and ROP.

It is unlikely that any flood mitigation benefit could be derived from the current configuration of Leslie Dam without a significant loss of water supply to the local community.

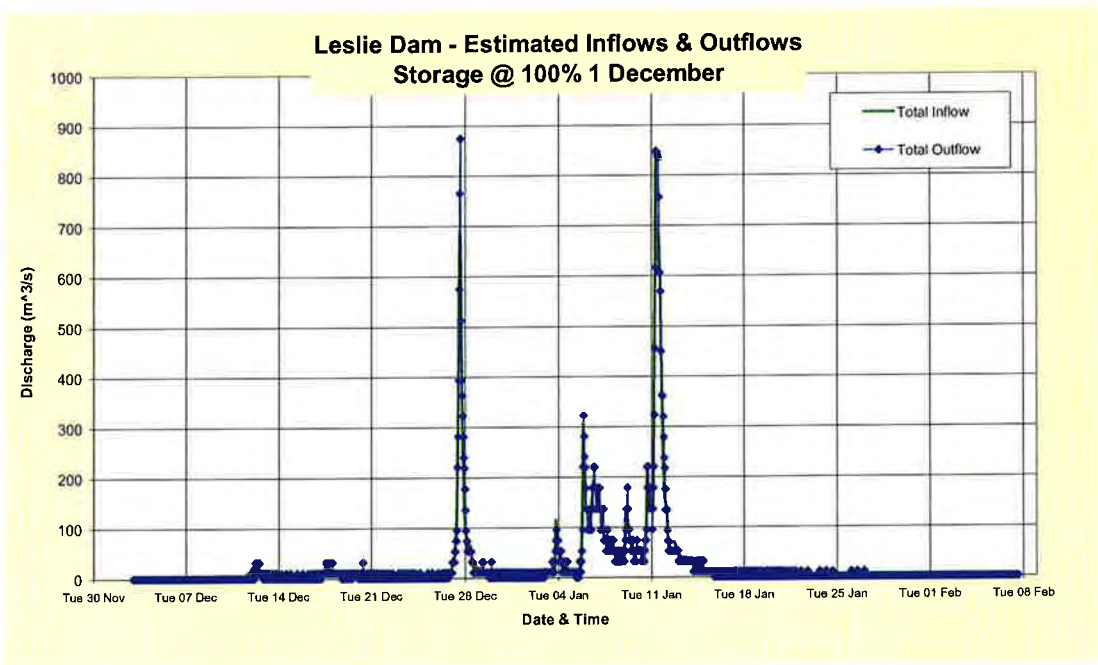


Figure 15-10 Leslie Dam Simulated Behaviour if Full on 1 December 2010

[redacted]

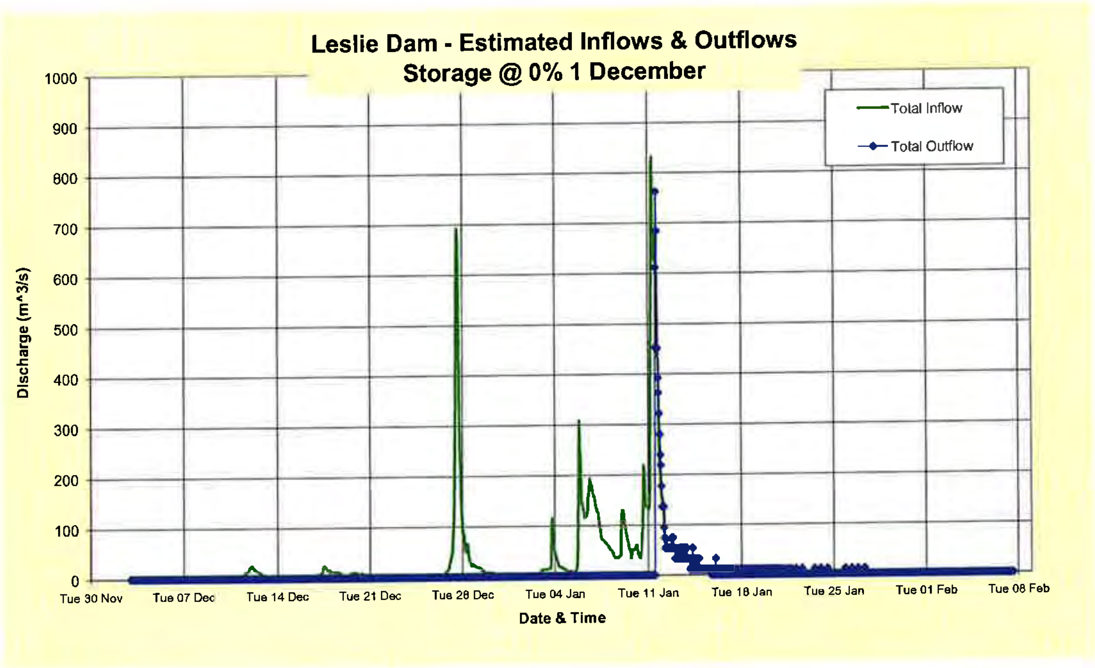


Figure 15-11 Leslie Dam Simulated Behaviour if empty on 1 December 2010

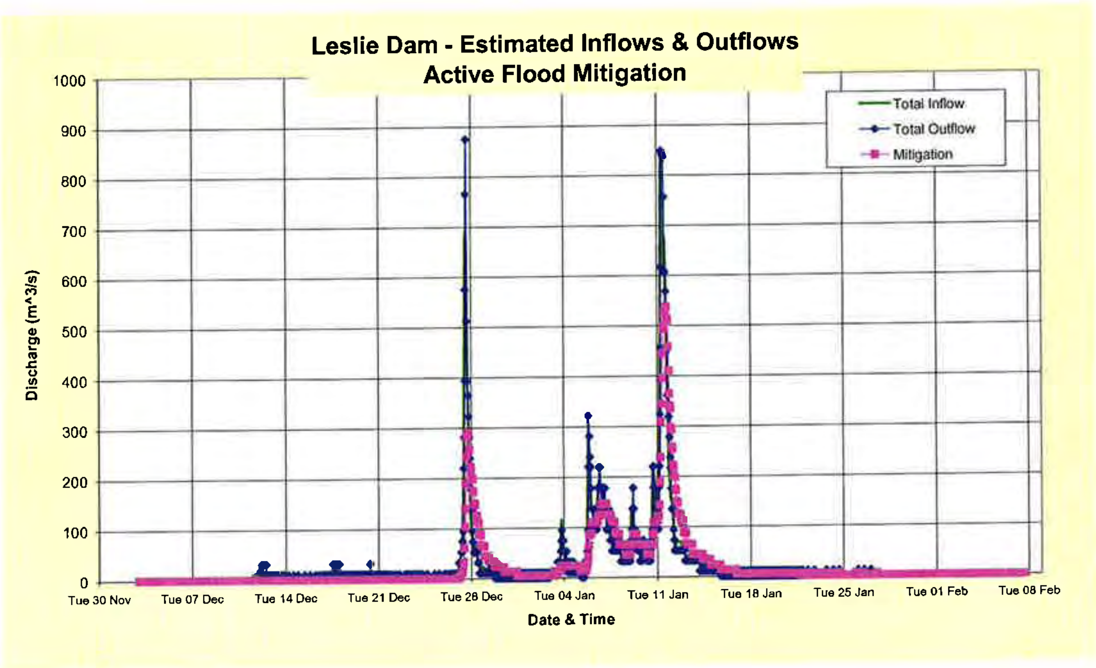


Figure 15-12 Leslie Dam Simulated Behaviour with Active Flood Mitigation

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.

Sworn and Declared at Brisbane	)	
this 28th day of April 2011 in the	)	[redacted]
presence of:	)	
		Signature of the declarant

[redacted]

ASHLEY WREN

~~Justice of the Peace~~/ Solicitor/

~~Commissioner for Declarations~~

Schedule 16: Beardmore Dam

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

16.1 Beardmore

The flood event at Beardmore Dam commenced on 17th September 2010 and concluded 3rd February 2011. The total wet season inflow to the dam from 1 December 2010 to 7 February 2011 was 82 times the total storage volume of the dam. Communities along the Condamine and Balonne Rivers experienced major flooding during the peak of the flood event.

16.1.1 Overview

The Condamine-Balonne river system is one of the major tributaries of the Murray-Darling river system and is one of the most important river systems in Queensland in terms of agriculture. The headwaters of the Condamine-Balonne River rise in the Border Ranges upstream of Killarney and flows for approximately 1200 kilometres through Queensland before entering New South Wales.[1] The catchment at St George is 7.53 million hectares. The catchment includes the towns of St George, Warwick, Toowoomba, Roma and Dalby.

The St George Water Supply Scheme is one of the 4 SunWater Water Supply Schemes in the Condamine Balonne catchment. The others are Chinchilla Weir, Maranoa Weir and Upper Condamine. The scheme is owned and operated by SunWater.

The St George Water Supply Scheme is centred on the town of St George. Water can be released from Beardmore Dam to either the Jack Taylor Weir or to the Thuraggi Diversion Channel. The purpose of the scheme is to provide water for irrigation, industry and town water supplies. Beardmore Dam is the major headworks of the St George Water Supply Scheme.

Beardmore Dam is situated on the Balonne River at AMTD 251.4 km and is approximately 21 km by road north of St George.

---

1 http://www.bom.gov.au/hydro/flood/qld/brochures/condamine_balonne/condamine_balonne_downstream_of_cotswold.shtml

[redacted]

A comprehensive risk assessment of Beardmore Dam (June 2009) has concluded that in view of the fact that the dam is drowned out [2]for any event above the Dam Crest Flood (DCF), with tailwater being only slightly below the headwater, the existing dam satisfies a risk assessment AFC, and an upgrade to meet a higher flood capacity is not required. A final decision on this recommendation has not yet been made (refer to paragraph 6.2.3 of the statement). SunWater finalised its comprehensive risk assessment (CRA) program across its portfolio in 2010. The SunWater Board will consider the recommendations of each CRA and finalise the dam safety upgrade program during 2011.

A copy of the comprehensive risk assessment for Beardmore Dam can be provided on request.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
EJ Beardmore	81,700	2	Balonne River	251.4	Earthfill & mass concrete with vertical lift gates	2,850	1972	Water Supply	St George	St George

[2] Drown out is a term that refers to the circumstance where there is little difference in the headwater and tailwater elevation and there is limited energy released in the event of a failure.

[redacted]

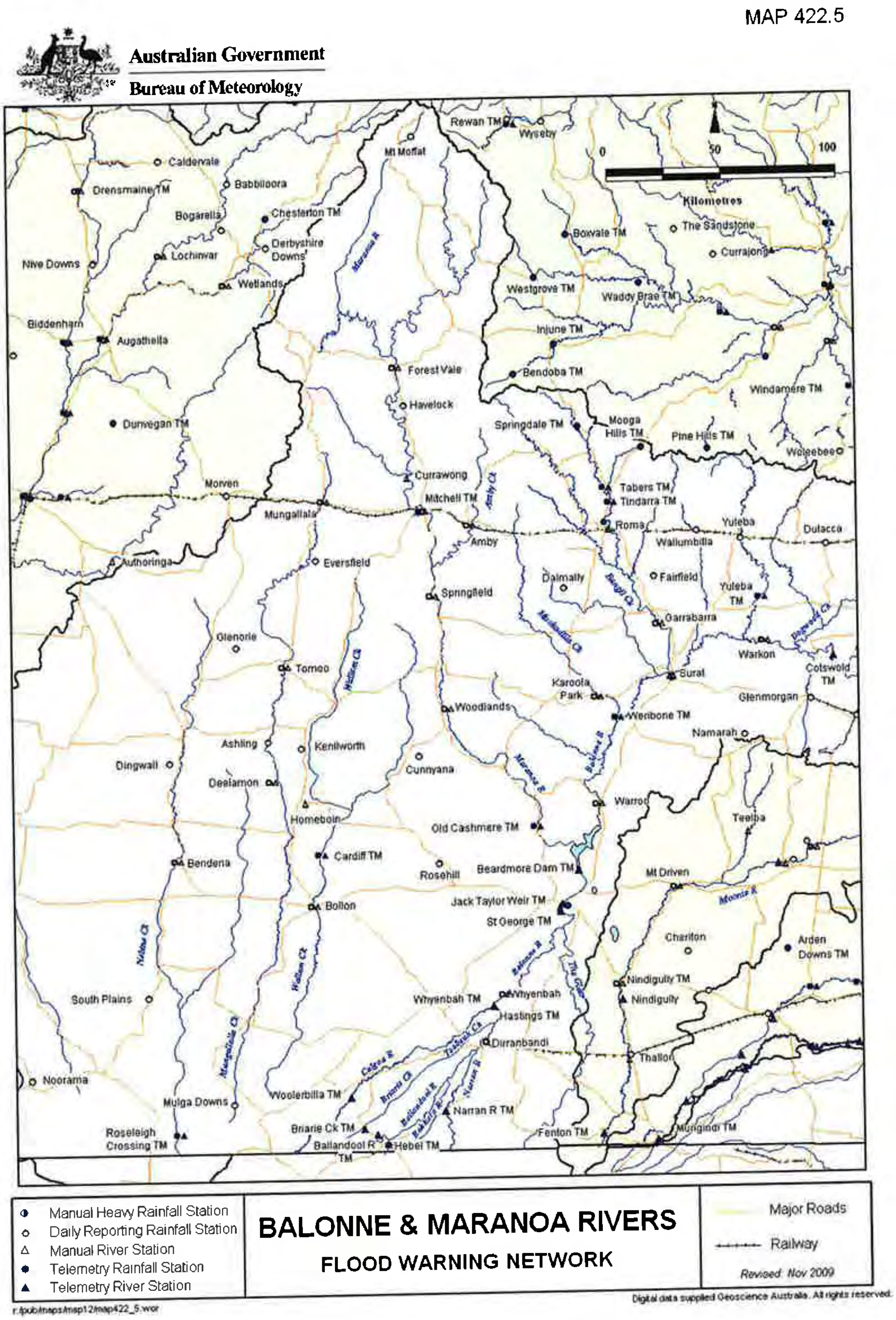


Figure 16-1 Balonne River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- The Beardmore Dam Operations and Maintenance Manual
- Beardmore Dam: Standing Operating Procedures

[redacted]

- Emergency Action Plan: Beardmore Dam
- Beardmore Dam: Data Book Part 1 – Text
- Beardmore Dam: Data Book Part 2 – Drawings
- Beardmore Dam: Dam Safety Review (May 2000)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

16.1.1.1 Type

Beardmore Dam is a 17 m high earth and rock fill dam with an ogee crest spillway controlled by twelve manually operated fixed wheel gates. The storage capacity is 81,800 ML at FSL. The catchment area is 75,032 km^2. The construction of the dam was completed in 1972.

Table 16-1 Beardmore Dam Details

Type of Dam	Earth and rockfill embankment
Length along crest	2571 m
Maximum height above river bed	15.2 m approximately
Dam crest level	210.17 m AHD
Spillway crest level	201.02 m AHD
Full Supply Level (FSL)	207.12 AHD
Spillway type	Gated Ogee crest and roller bucket
Spillway width (incl. piers)	180.8 m
Spillway width (excl. piers)	157.2 m
Spillway gates	12 only, 13.1 m wide, manually controlled vertical fixed-wheel gates
Spillway discharge at DCF	660.960 ML/d
River outlet works	1200 x 1200 mm Armco 50-10 gate
River outlet works capacity	1100 ML/d
Irrigation outlet works	2 only 1500 x 1500 gates
Irrigation channel max. safe flow	1350 ML/d
Reservoir surface area at FSL.	2850 ha

[redacted]

Storage capacity at FSL	81,800 ML (79200 ML useable)
Catchment area	75 032 km^2
Average Annual Rainfall	483 mm
Period of construction	1968 – 1972

16.1.1.2 Purpose

The Condamine and Balonne Resource Operations Plan (ROP) notes that the plan addresses the Water Resource (Condamine and Balonne) Plan 2004 outcomes by:

- specifying processes, rules and limits that are consistent with the environmental flow objectives and water allocation security objectives in the Water Resource (Condamine and Balonne) Plan 2004; and
- providing monitoring and reporting arrangements to assist in the ongoing assessment of whether water allocation and management arrangements in the plan area will contribute to the achievement of the Water Resource (Condamine and Balonne) Plan 2004 outcomes.

Beardmore Dam was built in 1972 and is owned and operated by SunWater. It supplies water for the St George Irrigation Area and the town of St George.

In 2009-10 the St George Water Supply Scheme supplied 76,700ML to agricultural users, industry and towns.

The operational objectives of the Beardmore Dam under the Beardmore Operations and Maintenance Manual are as follows:

1. The Beardmore Dam and all its associated structures, facilities, and spaces shall be operated and monitored in accordance with:
    - Beardmore Dam Operations and Maintenance Manual
    - SunWater policies and approved practices,
    - Condamine and Balonne Resource Operations Plan, and
    - Sound engineering and water management standards and practices
2. Water releases from Beardmore Dam must be scheduled to comply with:
    - St George Resource Operations Licence
    - SunWater's Customer Charter
    - All applicable supply agreements and licences

16.1.1.3 Spillway Gate Operations

Beardmore Dam has twelve electrically operated fixed wheel vertical lift gates on the spillway. They are progressively and sequentially opened to pass flood waters and

[redacted]

close in reverse order towards the end of an event. Each gate has an electrically operated hoist. The primary power source for the hoists is mains power. There is a standby generator housed downstream of the main wall on the left abutment. A portable generator can also be located on the main wall adjacent to the gate superstructure

Spillway gates are installed on Beardmore Dam for the purposes of maximising the available storage volume whilst minimising upstream flood levels. Beardmore Dam FSL is located near the top of the gates

The O&M Manual in section 2.7.3 notes that the objective is to keep the storage level at FSL and flows as natural as possible. Such objectives requires the balancing of inflow with outflow once FSL is reached. To achieve this the storage level is monitored and gate openings adjusted to maintain a near constant level.

When the spillway gates at Beardmore Dam are in the closed position there is a 460mm freeboard between the top of the gates and FSL. There is approximately 14,500ML of storage in this freeboard zone. The freeboard provides a small margin of error that might provide some time to rectify a fault in the event of a gate malfunction and prevent gate overtopping from wave action. At an inflow of 3,300m^3/s the storage would rise 460mm in just 1.2 hours if the gates failed to open. Overtopping of the gates could result in damage to the gates and pose a dam safety risk. There is no flood mitigation storage available above FSL.

16.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

16.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Beardmore Dam:

- The EAP was reviewed as part of periodic (annual) inspection on 18th August 2010. The inspection was also a special inspection following the flood of record that occurred in March 2010. The inspection team was led by Peter Richardson (RPEQ). Other members of the team were Michael Costa (Senior Engineer Headworks), Mal Halwala (Principal Engineer Dam Safety), and Bill Taylor (Storage Supervisor). The inspection team confirmed that the current version of the EAP was available at the dam. The team considered whether or not the instructions were adequate and, through inquiry, confirmed that the instructions were understood by the dam staff. The findings of the review were documented in the *Beardmore Dam Special Inspection Report 18 August 2010* (page 6). The team concluded that the instructions were understood. However it was noted that changes were required to the EAP to reflect the changes to SunWater's business structure in 2010. These changes were addressed in the supplementary notice issued by the Principal Engineer Dam Safety (PEDS) described below. The report also noted that the lessons learnt from the March 2010 flood including alternative access, mains and stand-by power needed to be incorporated. These improvements

[redacted]

are to be included in Issue 3 of the EAP that will be published shortly. An additional standby generator was sourced from the Balonne Council during the recent event to address the power supply issue. An new, permanent and flood immune stand-by generator is at an advanced stage of planning and will be commissioned in 2011;

- The notification and emergency communication list (EAP section 3) was revised and reissued on 14 December 2010. The notification and emergency communication was issued as a controlled document to the distribution list (Section 1, page 2 of 3 of the EAP). A transmittal advice was issued with each controlled copy. The transmittal advice included instructions for updating the EAP;
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety (Mal Halwala). The notice was principally designed to address changes to the roles and responsibilities that occurred as part of an internal reorganisation within SunWater. The notice was based on the Tinaroo Falls Dam EAP that had been updated to Issue 3 and was to be used as the template for Issue 3 for all SunWater dams. The supplementary notice was issued by email on 29 October 2010 to all of the Area Operations Managers and Service Managers who all fulfil the role of EEC for the dams in their respective areas.
- In March 2010 the largest flood since Beardmore Dam was constructed in 1972 passed through the dam. As a precaution SunWater mobilised a number of senior staff to St George, during this event, including the then Area Operations Manager Steve Goudie and Service Manager Toowoomba Graham Hargreaves. These staff, along with St George based supervisor William Bennett established a working relationship with the St George LDMG and attended the LDMG meetings during that flood event.
- The LDMG was aware of emergency scenarios and the EAP from the previous March 2010 flood event discussed above.
- Additional EAP training for staff responsible for Beardmore Dam prior to the 2010-11 wet season was not deemed necessary given the experience of St George staff from the March 2010 flood event and the verification of staff knowledge during the August 2010 inspection.

16.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The O&M Manual notes that the actual maintenance schedules and work instructions are obtained from SunWater's SAP system. This means that work orders for maintenance, document revisions and other activities such as emergency preparations are automatically generated by the SAP system on a monthly basis This creates a controlled document trail that requires actioning and closing out. A work order is issued for each scheduled or corrective maintenance item (refer Figure 16-2 for sample work order header). The work orders are issued to the appropriate supervisor. Scheduled maintenance items would include such items as:

[redacted]

- 1M-Component Servicing –discharge valves-headworks
- 1M-Component Servicing Generator
- 1M-Component Servicing Beardmore Dam
- 3M-Component Servicing Beardmore Dam
- 6M- Component Servicing Beardmore Dam[3]

A detailed work instruction is issued with each work order. Each work instruction includes a detailed check list of tasks to be performed to complete the work order Refer Figure 16-3 for sample extract from completed work instruction.

Once the work on an order and in an instruction has been competed it is signed off as complete, dated and verified by the supervisor (refer Figure 16-4)

SunWater

PM01-Preventive - Day to Day Work Order 5101612

Printed By: NEWMANR On: 21.12.2009 Page: 1 Original

Job Description: ***SGA-3M-COMPONENT SERVICE-BEARDMORE DAM***
Work Instruction: ***SGA00012***

Functional Location:	***SGA-BMD***	***EJ BEARDMORE DAM***	
Equipment:			
Location:		***at:***	
General Location	***BALONNE RIVER NEAREST TOWN ST GEORGE***		
Planner:	***310 Toowoomba Planner***	***Main work center:***	***3300 OMS Goondiwindi***
Priority:	***5 Priority 5 < 1 month***	***Status :***	***REL NMAT PRC***

Notifications:
10119654 SGA-3M-COMPONENT SERVICE-BEARDMORE DAM ***SGA-BMD***

Figure 16-2 Sample Work Order Header

[3] 1M denotes a frequency of monthly, 3M quarterly etc

[redacted]

SYSTEM	FACILITY	DESCRIPTION					
BMD	SPWY	Beardmore Dam Spillway					
ITEM	Carry out the following services to Gate Hoisting Equipment						
	UNIT			SG01	SG02	SG03	SG0
	COMPONENT			HMEC	HMEC	HMEC	HME
33.		Remove any rubbish from downstream side of gates		✓	✓	✓	✓
34.		Carry out repairs to any lifting apparatus not securely attached to gates and hoist drums		✓	✓	✓	✓
		Hoist Drum Gearbox Limit Switches					
35.		Carry out general housekeeping (such as wasp nests etc around periphery of the cam and plungers of limit switches)		✓	✓	✓	✓
		General Lifting Mechanism					
36.		Raise and lower each gate utilizing bulkhead gate at least 6" to check operation and circulate lubricants		X	✓	✓	✓

Figure 16-3 Sample of Work Instruction for Work Order 5101612

COMPLETION INFORMATION

Please complete the attached work instructions and record all non-conformances, issues and any further information at the end of these instructions in the additional comments section.

Job Completed By : [redacted] Date: 01-02-10.

Supervisor Verification: [redacted] Date: 3-2-10

Data Entry Completed : [redacted] Date: 3-2-10

Ron Newman

Technical Planner

Toowoomba

Figure 16-4 Sample Work Order Completion

Emergency preparations prior to the wet season as required under the O&M Manual and from lessons learnt from March 2010 flood included:

- Testing and servicing of the standby diesel generator as evidenced by work order 5110297 and Beardmore Dam log book on 22-9-2010;
- Function testing of spillway gates as evidenced by work order 5101612, the *Beardmore Dam Special Inspection Report 18 August 2010* (page 19 and photos 42 & 48) and Beardmore Dam log book on 9-11-2010
- Servicing of spillway gate gearboxes and motors as evidenced by Beardmore Dam log book on 25-10-2010
- Filling of all fuel stores;
- Installing an additional temporary standby diesel generator which was located above maximum flood level as evidenced by Beardmore Dam log book on 4-1-2011;
- Testing of communication equipment;

[redacted]

- Testing of portable equipment and instruments; and
- Checking of operations of gauging stations.

Section 5 of the Beardmore Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the dam will be continuously manned and the emergency controlled from the St George Service Centre. The EAP identifies the roles for the dam duty officer (DDO) and emergency event coordinator (EEC), however, in all cases the EAP identifies that the O&M Manual and SOPs are to be followed. Within section 5 of the EAP actions for a number of stage or alert levels are defined. The alert levels are defined by certain storage levels and catchment conditions.

The first alert level is noted as *flood operations stage 1* where the reservoir reaches EL207.12m (FSL), and gates are opened to maintain FSL. This stage includes discharge up to 20,000ML/d. At this level there is communication between the DDO, EEC and standby officers. The EEC notifies the LDMG contacts listed in the EAP and the first two groups of landholders.

The next alert level in the EAP is *flood operations stage 2*. This stage is triggered at discharges exceeding 20,000ML/d up to 60,000ML/d. The gates are operated to maintain FSL. The main focus at this stage is to operate the gates at Jack Taylor weir to pass the discharge from Beardmore dam. At 60,000ML/d all gates at Jack Taylor weir should be fully open. At this stage the EEC provides further notification to the LDMG and downstream landholders and local radio stations. The communication with parties other than LDMG is by agreement to ensure rapid response to an event.

The next alert level in the EAP is *flood operations stage 3*. This stage is triggered at discharges exceeding 60,000ML/d up to 165,000ML/d. At this stage the gates at Jack Taylor weir must already be fully open. The dam gates are operated to maintain FSL. The approaches to the Andrew Nixon bridge are inundated at about 160,000ML/d. At this stage the EEC provides further notification to the LDMG about potential inundation of the Andrew Nixon Bridge. Irrigator groups 3 to 5 as listed in the EAP are added to the EEC notifications.

The next alert level in the EAP is *flood operations stage 4*. This stage is triggered at discharges exceeding 165,000ML/d up to about 330,000ML/d when the gates at Beardmore Dam are fully open. The gates are operated to maintain FSL. At this stage the EEC provides notification to the contact list as requested. Once the flow at the dam has peaked the EEC will notify the LDMG.

There is a further *flood operations stage 5* that was not reached during this event.

The Beardmore Dam EAP is consistent with the State Emergency Management framework described in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the LDMG using the information on an event gathered from SunWater and others to assess,

[redacted]

determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

The EAP was first activated as defined in SOP 40 for Beardmore Dam on 16th September 2010 and concluded on 3rd February 2011.

16.1.3 Outline of flood event 2010/2011 and EAP Actions

Figure 16-8 outlines the estimated inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak inflow was estimated at over 3,300m^3/s.

Water spilled from the spillway gates (a spillway discharge event) on an almost continuous basis from 16th September 2010 through to the 3rd February 2011. There were two significant periods where Beardmore Dam reached stage 4 of the EAP with peaks on 8th January 2011, and 23rd January 2011. The peak discharge from the dam for these events is estimated at 3,300m^3/s, and 2,400m^3/s respectively. These appear as the two large peaks in Figure 16-8.[4] Refer to Table 16-2 for details of how the flood event progressed at Beardmore Dam.

Beardmore dam was manned on a continuous basis as detailed in staffing rosters provided.

	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY
	29/12/2010	30/12/2010	31/12/2010	1/01/2011	2/01/2011	3/01/2011	4/01/2011
Nev Johnston	8am-4pm	8am-4pm	4pm-12midni	4pm-12midn	4pm-12midnig	RDO	RDO
Douglas Talbot	8am-4pm	8am-4pm	4pm-12midni	RDO	RDO	4pm-12midn	4pm-12midnight
Billy Kadel	RDO	RDO	12midnight-8	12midnight-8	12midnight-8a	12midnight-8	12midnight-8am
Gordon Roberts	8am-4pm	8am-4pm	12midnight-8	12midnight-8	12midnight-8a	RDO	RDO
William Taylor	8am-4pm	SL	8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm
Donald Bennett	8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm	RDO	RDO
William Bennett	RDO	RDO	8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm
Ashley McDonald	8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm
Karan Quartermaine				RL	RL	RL	RL
Warren Trost	RL	RL	RL	RL	RL	RL	RL
Pat Fitzgerald						4pm-midnigh	4pm-midnight
New Water Officer (Phillip Ruge)							
WH1			12midnight-8	12midnight-8	12midnight-8a	12midnight-8	12midnight-8am
WH2			4pm-12midni	4pm-12midn	4pm-12midnig	4pm-12midn	4pm-12midnight
WH3			8am-4pm	8am-4pm	8am-4pm	8am-4pm	8am-4pm

Figure 16-5 Sample Staffing Roster for Beardmore Dam

[4] These flows are derived from the SunWater flood model for Beardmore Dam and differ from the event report that used the published discharge tables that are now known to be incorrect at high flows.

[redacted]

Table 16-2 Beardmore Dam EAP Status

Date	EAP Stage	Comment
16-Sep-10 16-Oct-10	Stage 1	
17-Oct-10 22-Oct-10	Stage 2	
23-Oct-10 10-Nov-10	Stage 1	
11-Nov-10 15-Nov-10	<500ML/d	
16-Nov-10 04-Dec-10	Stage 1	
05-Dec-10 22-Dec-10	Stage 2	
23-Dec-10 01-Jan-11	Stage 3	
02-Jan-11 15-Jan-11	Stage 4	Event report shows Stage 5 from 7 January to 11 January however all gates were never fully open
16-Jan-11 18-Jan-11	Stage 3	
19-Jan-11 27-Jan-11	Stage 4	
28-Jan-11 31-Jan-11	Stage 3	
01-Feb-11 02-Feb-11	Stage 2	
03-Feb-11	Stage 1	

SunWater provided updates to the contacts identified in the EAP on numerous occasions during the event. These communications are logged in the EECs Record of communication and in the communication logs and diaries of various members of staff. SunWater formally notified or updated disaster management contacts and landholders on the following occasions via phone:

- 15/09/10 EAP communications list[5]
- 29/12/10 EAP communications list with an update
- 01/01/11 @ 1700 Irrigators
- 06/01/11 @ 1800 EAP communications list with an update
- 07/01/11 @ 0900 EAP communications list with an update
- 09/01/11 @ 0830 EAP communications list with an update
- 11/01/11 @ 1600 EAP communications list with an update
- 12/01/11 @ 0930 EAP communications list with an update

William Bennett (Supervisor at St George) and Karen Quartermaine (Service Manager) in their role as EEC attended the LDMG meetings and provided dam status

[5] EAP Communications list refers to the full list of parties to be notified in section 3 of the EAP

[redacted]

updates. These meetings were held on a daily basis during the significant phase of the event described above. SunWater's attendance is detailed in Figure 16-6.

Local Disaster Management Group Meetings				
Date	Commenced	Concluded	Attendee	Apology
30.12.10	1:00pm	??		
31.12.10	1:00pm	??	Bill Bennett (SunWater)	
01.01.11	1:00pm	1:55pm	Bill Bennett (SunWater)	
02.01.11	1:04pm	2:14pm	Bill Bennett (SunWater)	
03.01.11	1:04pm	1:45pm	Bill Bennett (SunWater)	
04.01.11	1:06pm	1:34pm	Bill Bennett (SunWater)	
05.01.11	1:02pm	1:19pm		Bill Bennett (SunWater)
06.01.11	1:02pm	1:30pm	Bill Bennett (SunWater)	
07.01.11	1:06pm	1:06pm	Bill Bennett (SunWater)	
08.01.11	1:04pm	1:20pm	Bill Bennett (SunWater)	
09.01.11	1:00pm	1:20pm	Bill Bennett (SunWater)	
10.01.11	1:00pm	1:19pm	Bill Bennett (SunWater)	
11.01.11	1:00pm	1:47pm		Bill Bennett (SunWater)
12.01.11	1:01pm	1:32pm	Ms Karen Quartermaine (SunWater)	
13.01.11	1:01pm	1:20pm	Ms Karen Quartermaine (SunWater)	
14.01.11	1:05pm	1:20pm		
15.01.11	1:02pm	1:21pm		
16.01.11	1:01pm	1:16pm		
17.01.11	1:00pm	1:15pm		
18.01.11	1:05pm	1:23pm	Karen Quartermaine attended	
19.01.11	1:03pm	1:23pm	BoM meetings at	
20.01.11	1:03pm	1:30pm	11am	
21.01.11	1:03pm	1:27pm		
24.01.11	1:02pm	1:15pm		
27.01.11	1:05pm	1:27pm		
31.01.11 Final	1:04pm	1:23pm		
24.02.11 Debrief	3:12pm	5:00pm	Bill Bennett (SunWater)	

Figure 16-6 St George LDMG Meetings

The SunWater FOC provided regular updates to the EEC and dam DDO during the major stream rises during the flood event. Reports issued from 5th January were also provided to the BoM Flood Warning Centre. Generally updates were provided on a daily basis. FOC *Rainfall and Flood Status* reports were issued on the following days:

- 24 December 2010
- 25 December
- 26 December
- 27 December
- 28 December
- 31 December
- 1 January 2011
- 2 January – Included BoM model results

[redacted]

- 3 January – Included BoM model results
- 4 January
- 5 January
- 6 January
- 7 January
- 8 January
- 9 January
- 10 January
- 18 January

The *Rainfall and Flood Status* provided the EEC and DDO with a forward look at likely changes in inflow and gate adjustments over the next 24 hours. A prediction of the ultimate peak of the flood was not offered until the report of 2nd January. The predicted peak at that time was 250,000ML/d (2,900m^3/s). This prediction was based largely on BoM model that was available to the FOC through the registered user site. In the report of the 4th January this prediction was increased to 3,600 to 4,000m^3/s, again based on the BoM model. It wasn't until the report of the 6th January that the SunWater model made a prediction of the peak at 3,220m^3/s

On the 3rd January I became aware of some concerns within BoM that there was some data that indicated a potential peak that was potentially much higher than the publicly available forecasts. A discussion with Peter Baddiley from BoM on the 3rd January revealed that DERM hydrographers had measured a peak flow of 3,600 m^3/s at Cotswold. Further discussions with Peter Baddiley from BoM on the 5th January revealed that DERM hydrographers had measured a peak flow of 4,500 m^3/s at Surat. BoM was concerned that if that flow was to occur in St George then the consequences would be more severe than the March 2010 event. From the 3rd January to 10th January the SunWater FOC and BoM (Peter Baddiley and Jim Stuart) collaborated daily and increased the level of information sharing. The intent being to maximise the certainty of the flood prediction provided by BoM for the magnitude of the flood in St George.

The collaboration included sharing of information such as the tailwater levels at Beardmore Dam, development and extension to rating tables, impact of the Barrackdale choke and general discussions to fine tune the models of both organisations.

On the evening of 4th January 2011 I became aware of a very high level of concern within State government regarding disastrous flood levels predicted for St George. The information came to me from a phone call from Geoff White A/CEO of SunWater. Geoff White advised that Debbie Best of DERM had come from the SDMG where the BoM had advised of a predicted 4,500 m^3/s flow at St George. I advised Geoff White that this was not consistent with my discussions with BoM to that time and it was likely that Debbie Best was probably only quoting the very upper range of the uncertainty band of the model predictions. I expressed my view that the peak was

[redacted]

likely to be approximately 3,500 m^3/s which would be slightly lower than the March 2010 event. However I undertook to collaborate further with BoM the following morning. After the *Rainfall and Flood Status* report was issued for the 5th January Geoff White confirmed with Debbie Best that both SunWater and BoM were predicting a flood peak at or below the March 2010 peak.

The Tailwater level at Beardmore dam peaked at 206.76m in March 2010. The peak tailwater level in January 2011 was 206.25m. The corresponding flows from the BoM rating table for the Beardmore tailwater being 3,800 m^3/s and 3,450 m^3/s respectively.

The Commission has requested information regarding the effect on the operation on the dam of the Barrackdale Choke. The choke is a natural narrowing in the Balone river between Werribone and Beardmore Dam (refer Figure 16-7 Aerial Photo of the Barrackdale Choke). The choke does not tend to have an effect on low to moderate flows. Typically the travel time of flows from Werribone to Beardmore Dam is about 48 hours for normal flood levels. The SunWater FOC Beardmore Dam Flood Model calibration from this last event suggests that the choke impacts on flows over about 2,700 m^3/s to 3,000 m^3/s. The choke acts as a large retention basin. The choke certainly increases the travel time from Werribone to Beardmore Dam during large flows. The choke may have delayed the peak by as much as three days during the January 2011 event. It is not certain that the choke reduced the size of the peak to any great extent. The effect that the choke had on the operation of Beardmore Dam was to increase the uncertainty of the flood model predictions. The SunWater model prior to the event did not consider the impact of the choke. However the ongoing calibration of the model during the event resulted in reasonable outcomes in terms of accuracy for the operations of the dam. Ultimately the operation of the gates is not reliant on model predictions. The operators can operate simply from the storage level guage.

The Commission has also requested information regarding the effect on the operation on the dam of water allocation holders taking water from the dam or catchment system. The taking of water during this flood event did not have any impact on the operation of Beardmore dam. The estimated total volume of the flood event was around 6,700,000ML. The total annual water allocations within the St George Water Supply scheme are only about 85,000ML. The waterharvesting extractions are managed by DERM. SunWater does not have direct knowledge of the extraction of water harvesting entitlements during the event.

[redacted]

Figure 16-7 Aerial Photo of the Barrackdale Choke

The Commission has requested an account of communication with property owners upstream of Beardmore Dam. No upstream landholders are listed within section 3 of the EAP and therefore none were contacted as part of the EAP operations. However, SunWater did receive a number of inquiries. These are listed as follows:

- An inquiry from an upstream landholder Mr Rodney Neil on Friday 7th January. Mr Neil indicated that the Werribone gauge was being reported as falling whereas he was observing rises on his property. This was passed onto the BoM Flood Warning Centre as it had a more immediate impact on their modelling work. Peter Baddiley advised later the same day that it had been a false alarm.

- An unknown upstream landholder contacted Peter Collett (Area Operations Manager) on 7th January to complain that SunWater was causing the flood. It is noted that the operations at Beardmore Dam were maintaing a relatively constant storage level in the dam.

- On 18th January Geoff White A/CEO of SunWater received representations from Mr Howard Hobbs MP that landholders upsteam of Beardmore Dam were worried about the impact of closing the (spillway) gates at Beardmore. SunWater had been progressively closing the spillway gates at Beardmore Dam from about 10th January through to the 17th January. This was in accordance with the O&M Manual. A similar representation came via Minister Robertson's office the same day on behalf of Mr Lloyd Hearth. Peter Collett (Area Operations Manager) called Mr Hearth later the same day to explain that Beardmore dam was passing all inflows as they occurred and could not be impacting on flooding above the Barrackdale Choke.

[redacted]

Spillway gates are installed on Beardmore Dam for the purposes of maximising the available storage volume whilst minimising upstream flood levels. Beardmore Dam FSL is located near the top of the gates. When the spillway gates at Beardmore Dam are in the closed position there is a 460mm[6] freeboard between the top of the gates and FSL. The gates are operated in a manner whereby the outflow is balanced with the inflow to maintain the storage level within a narrow band close to the FSL.

This manner of operating the gates is typical of SunWater's gated storages. This means that the discharge from the dam is approximately equal to the inflow. There is very little attenuation of flood peaks for dams with this mode of gate operation as demonstrated in Figure 16-8.

Generally Beardmore Dam operated to expectations with very few issues recorded. The few issues outlined below did not pose any risk to the safe operation of the dam:

- The mains power was cut for several days during the event from the 5th January. The back-up generator was used to operate the spillway gates;
- On the 29th December 2010 the spillway gates had to be closed for a short period of time to allow for the safe removal of the buoy line. This caused the storage level to rise to about 0.2m above FSL for a short period. The buoys had to be removed to ensure that they did not come lose and foul the gate operations.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 6,678,000ML or 82 times the full storage volume of the dam.

[6] SunWater Drawing 24278

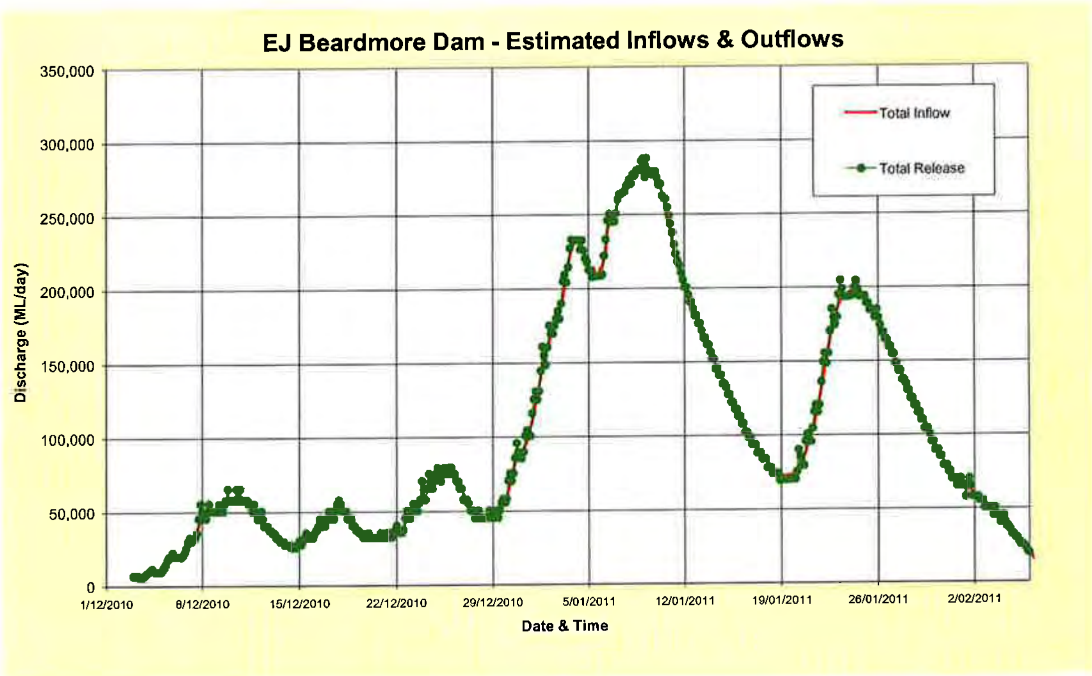


Figure 16-8 Beardmore Dam Inflow and Outflow (Dec 2010 - Feb 2011)

16.1.3.1 Communities that were affected

A number of communities along the Balonne River were severely affected by flooding during December 2010 to January 2011 period. The town of St George experienced major flood levels during the event (refer Figure 16-9).

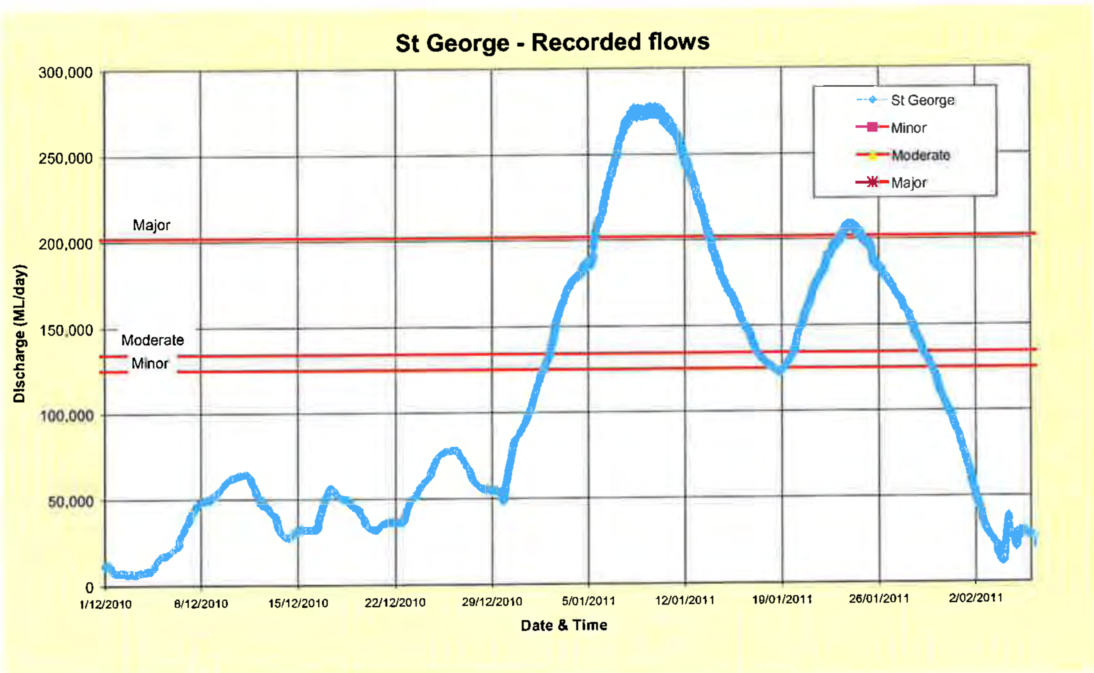


Figure 16-9 St George Recorded Flood Flows

16.1.3.2 Damage and response to damage

Beardmore dam suffered some erosion of the rock face on the right embankment during the flood event. A full inspection of the dam has not yet been possible due to continuing flows. The main dam structure is undamaged and performed well from a dam safety perspective. Planning is underway to repair the erosion damage. Repairs will be completed before the next wet season.

16.1.3.3 Gauging stations – affect on data collection

Figure 16-1 shows the location of gauging stations in the catchment.

The dam is located at the confluence of the Balonne and Mitchell rivers. The predictive flood model, which provided the EEC and DDO with a forward look at likely changes in inflow and gate adjustments over the next 24 hours for the dam relies on data collected from a number of gauging stations. It should be noted that most of these stations are managed by DERM or other organisations.

During the event a number of issues were noted with the gauging station network. These issues included:

- The recorded height at the Werribone gauging station exceeded the published rating curve. The curve had to be extended to estimate flows in the flood model. If stream gauging information is available for higher flows from this event the rating table will need to be extended by DERM and the flood model updated;
- The Cotswold station on the Balonne River (upstream of Werribone) did not report flows from the 2nd to 6th of January. This delayed the prediction of the peak inflow at the dam. The peak could not be predicted until the Werribone gauge peaked Refer to the discussion in section 16.1.3 above regarding collaboration between SunWater's FOC and BoM;
- A natural restriction in the Balonne River, known locally as the Barrackdale choke changed the flow relationship between Werribone gauging station and Beardmore Dam at high flow rates. This impacted on the accuracy of the flood modelling. If information could be obtained on the storage-height relationship and flow-height relationship then both the BoM and SunWater flood models could be improved. Refer to the discussion in section 16.1.3 above regarding the Barrackdale Choke;
- The automatic storage level recorder at the dam was affected by local drawdown conditions at high spillway discharge rates. This did not impact on the dam operations but caused some confusion for those who were accessing the data remotely for flood modelling such as the Bureau of Meteorology. The operators made their decisions using the more reliable manual gauge boards. BoM were made aware of the issue and data was provided to BoM daily from the 3rd January to 10th January; and,
- The tailwater levels at Beardmore Dam are not available remotely. If the data were available it could improve the accuracy of BoM's flood modelling.

[redacted]

SunWater's FOC staff were in regular contact with BoM staff to share data and modelling predictions.

- For the period 1 December 2010 to 7 February 2011 SunWater's FOC used the Beardmore Dam flood model to estimate the total volume passing the major gauging stations and the dam. The following flow volumes were noted:
    - Cotswold 5,200,000 ML
    - Werribone 5,900,000 ML
    - Beardmore Dam 6,700,000 ML
    - St George 7,300,000 ML.

  The volumes passing each of these gauges should be similar to each other for this event. This discrepancy indicates a number of errors, probably in rating tables. DERM and/or BoM may consider a review of this event with a view to improving the overall accuracy.

16.1.3.4 Community inquiries

There was significant local interest, and in some cases concern about flood releases from the dam. SunWater received approximately 12 inquiries regarding water levels, gate operations, flooding and flows at Beardmore Dam (refer section 2.1.1 of my statement re provisions for 24/7 emergency contact with SunWater through the call centre).

16.1.3.5 Media Coverage

On 3 January 2011 ABC Online reported that Beardmore had a dam surveillance and monitoring program underway which included monitoring the dam sensors and river gauges.

16.1.3.6 Post Event Review

SunWater undertook a review of the event for Beardmore Dam. The findings are included in the Beardmore Dam Emergency Event Report. The review found that:

- The EAP was generally adequate, however some updating is required to reflect current reporting arrangements within SunWater. The amendments to these documents are in progress;
- Some difficulties were experienced with continuity of telecommunication networks. The potential introduction of NextG telecommunications, in addition to land lines, is being investigated for email and internet access for implementation before the next wet season;
- Site facilities for staff were found to be inadequate where staff were on duty and isolated for prolonged periods. Planning is underway to move facilities to higher ground for the next event;
- Expanding SunWater's use of an SMS messaging service to include notification of nominated landholders in the EAP could streamline communication of an EAP event. This option is under investigation and if feasible will be implemented before the end of 2011;

[redacted]

- Extend the spillway gate discharge table within the O&M Manual to include all floods and recalibrate against recent events. The review and update to the O&M Manual is in progress and will be completed before the next wet season; and,
- The standby generator is inundated at high tailwater levels. Planning is underway to relocate the standby generator above tailwater levels and will be completed before the next wet season.

16.1.4 Local Disaster Management – SunWater Relationship

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[7] The Operational Planning Guidelines for Local Disaster Management Groups[8] identifies the role of the LDMG during an event as coordination of support to response agencies, reconnaissance and impact assessment, and provision of public information.

The Beardmore Dam EAP is consistent with the State Emergency Management framework described above and in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the premise that the LDMG will use the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment

During this recent event the dam performed to expectations. The stream flows, although significant, were not extreme in a dam safety sense. If circumstances had been more extreme or serious operational problems had been experienced, SunWater staff would have given primacy to protection of life and safety of the dam. The focus of SunWater staff should not be diverted from this priority. It is for this reason that SunWater supports the Queensland Government District Disaster Management framework. In the frame work is that SunWater provides the necessary communications to LDMG who take the lead in provision of information to the public. SunWater focuses on operating and managing the safety of the dam.

The model described above worked well for Beardmore dam both in the March 2010 event and recent events. The LDMG invited SunWater to attend each meeting of the group and accepted reports from each agency. The LDMG then coordinated

---

7

http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

8

http://www.disaster.qld.gov.au/publications/pdf/Operational%20Planning%20Guidelines%20for%20Local%20Disaster%20Management%20Groups.pdf

[redacted]

responses and took a lead, through the Mayor, to provide consistent accurate and relevant information to the public and media.

16.1.5 Previous flood events

The January event is ranked as the second largest flood through the dam since the dam was constructed in 1972. The largest flood event occurred in March 2010.

16.1.6 Flood mitigation opportunities

The Condamine and Balone ROP specifies rules for the operation of Beardmore Dam, including how releases are to be determined. Any alternative operating arrangements are not possible under the current regulatory rules.

There is no flood mitigation storage in Beardmore dam. The only air space would be if the dam was below the full supply level prior to an event.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 6,678,000ML or 82 times the full storage volume of the dam. Even if Beardmore Dam had been emptied prior to 1 December, which would not be practical for the reasons set out above in respect to compliance obligations, the dam would have refilled by the 7th December 2010, and would have had no mitigating effect on further inflow events. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Beardmore Dam without a significant loss of water supply to the local community.

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.

Sworn and Declared at Brisbane)

this 28th day of April 2011 in the) [redacted]

presence of:)

Signature of the declarant

[redacted]..

ASHLEY UREN

~~Justice of the Peace~~/ Solicitor/

~~Commissioner for Declarations~~

Schedule 17: Coolmunda Dam

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

17.1 Coolmunda

The first flood event at Coolmunda Dam during the recent wet season commenced on 13th September 2010. This event concluded 4th October 2010. A second event ran from 16th October to 21st October and a third event from 25th October to 28th October. The final and largest event commenced 19th November 2010 and concluded 16th January 2011. The total wet season inflow to the dam between 1 December 2010 and 7th February 2011 was 1.9 times the total storage volume of the dam. The town of Inglewood experienced moderate flooding on three occasions.

17.1.1 Overview

The Macintyre Brook catchment covers an area of approximately 4,193 km^2. The Macintyre Brook catchment is a sub-catchment of the Border Rivers region of Queensland and New South Wales and lies within the northern region of the Murray-Darling Basin

The Macintyre Brook Water Supply Scheme (MBWSS) is located in South East Queensland, with the nearest town being Inglewood. Its main features are Coolmunda Dam and Greenup, Inglewood, Whetstone and Ben Dor Weirs. The scheme was designed to supply surface water for irrigation, industry and towns.

The State of Queensland, represented by DERM is holder of the Resource Operations Licence for the Border Rivers Water Supply Scheme, which is immediately downstream of the MBWSS. DERM own an allocation of 6400ML which is a bulk supply from the MBWSS for the Border Rivers Water Supply Scheme.

Coolmunda Dam forms the headworks of the Macintyre Brook Water Supply Scheme. It is located at AMTD 77.8km on the Macintyre Brook, approximately 14 km East of Inglewood halfway between Warwick and Goondiwindi in South East Queensland. It has a catchment area of 1,746km^2.

A comprehensive risk assessment of Coolmunda Dam (November 2009) has concluded that the dam needs to be upgraded to meet modern engineering standards. Although the dam can safely pass rare events (up to about 1 in 7,000 year AEP), it has been recommended that an upgrade of the dam be implemented by:

- The addition of filters to the short homogeneous section at the right hand end of the embankment;

[redacted]

- The addition of filters over the top of the core over the main embankment;
- The addition of filters at the interface with the spillway walls and the fuse-plug separation wall; and,
- The extension of the crest control wall of the fuse-plug auxiliary spillway to the left abutment.

A copy of the Comprehensive Risk Assessment for Coolmunda Dam can be provided upon request.

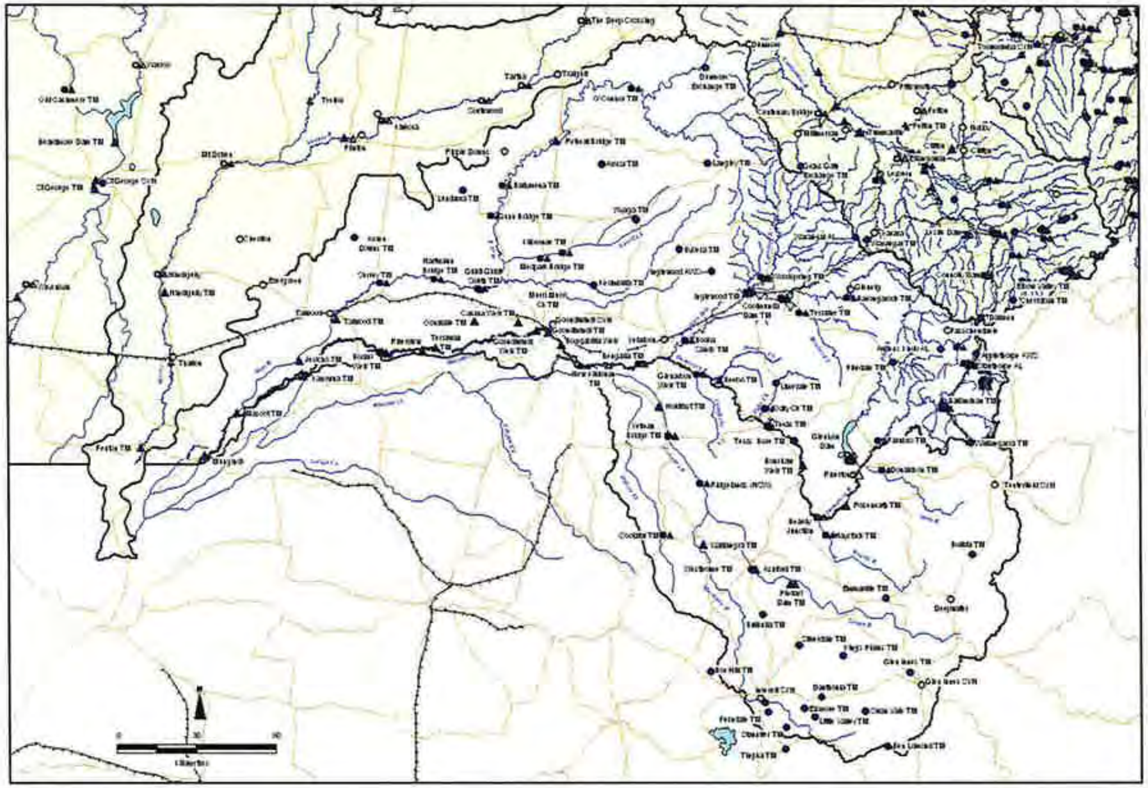
A final decision on this upgrade project has not yet been made (refer to paragraph 6.2.3 of the statement). SunWater finalised its comprehensive risk assessment (CRA) program across its portfolio in 2010. The SunWater Board will consider the recommendations of each CRA and finalise the dam safety upgrade program during 2011.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Coolmunda	69,000	2	Macintyre Brook	78	Earthfill & mass concrete with Radial gates	1,645	1968	Water Supply	Inglewood	Inglewood

[redacted]

Australian Government

Bureau of Meteorology



- ◑ Manual Heavy Rainfall Station
- ○ Daily Reporting Rainfall Station
- △ Manual River Station
- ● Telemetry Rainfall Station
- ▲ Telemetry River Station

MACINTYRE & WEIR RIVERS

FLOOD WARNING NETWORK

Major Roads

Railway

Revised: Dec 2009

Figure 17-1 Macintyre River Catchment

The management of the dam is documented in a number of regulatory dam safety documents including:

- The Coolmunda Dam Operations and Maintenance Manual
- Coolmunda Dam: Standing Operating Procedures
- Emergency Action Plan: Coolmunda Dam
- Coolmunda Dam: Data Book Part 1 – Text
- Coolmunda Dam: Data Book Part 2 – Drawings
- Coolmunda Dam: Dam Safety Review (June 2000)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

17.1.1.1 Type

Coolmunda Dam is an 18 m high central core zoned-earth and rockfill dam, owned and operated by SunWater. The dam is located in the Goondiwindi Regional Council area, approximately 13 km east of Inglewood. The Coolmunda Dam main dam wall is 2,286 m long across the crest. The dam spillway is a Radial gate controlled ogee crest with 7 radial gates (12.8m wide x 9.6m high).

Table 17-1 Coolmunda Dam Details

Type of dam	Zoned earth and rock fill
Length across crest	2286 m
Height above foundation	18 m
Dam crest level	316.66 m AHD
Full Supply Level FSL	314.07 m AHD
Lowest drawdown	311.15 m AHD
Spillway type	Ogee type concrete with 7 automatic, counter-balanced, radial gates
Spillway crest length	89.6 m
Full Spillway width	107 m
Max design discharge	6 850 m^3/s (through gates only)
Max discharge with fuse plug in place	9210 m3/s (EL 316.66 m AHD) overtopped, but with fuse plug in place

[redacted]

Fuse Plug EL	315.45
Storage capacity/area at FSL	69,061 ML
Catchment area	1746 km^2
Outlet Works description	1/915 mm diameter steel pipe with 915 dia guard valve and 762 diameter cone dispersion valveand1/305mm diameter bypass pipe with gated guard valve and cone dispersion valve
Average annual rainfall	610 mm
Period of construction	1963-1968

17.1.1.2 Purpose

The foreword of the Border Rivers Resource Operations Plan (ROP) notes that:

> *The implementation phase of the water resource planning process will bring water users an unprecedented level of confidence and flexibility…*
>
> *This resource operations plan provides for operating rules and management arrangements for supplemented water in the Macintyre Brook Water Supply Scheme and the Border Rivers Water Supply Scheme*

The main purpose of the dam is to store and to supply water for downstream irrigators, industry and the town of Inglewood down to Ben Dor Weir and to provide bulk water supply to Dumaresq River

In 2009-10 the Macintyre Brook Water Supply Scheme supplied 13,300ML to agricultural users, industry and towns

The operation of the Coolmunda Dam must meet the following criteria[1]:

1. The Coolmunda Dam and all associated structures, facilities, and included land area are operated, monitored, and maintained in accordance with the approved dam safety documents, generally accepted engineering and water management practices, SunWater policies and standards, and all applicable legislated requirements.
2. Water releases from Coolmunda Dam must be scheduled to comply with the Resource Operating License (ROL) for the Macintyre Brook Water Supply Scheme, SunWater's Customer Charter and Customer Supply Agreements.

[1] Coolmunda Dam O&M Manual

[redacted]

17.1.1.3 Spillway Gate Operations

Coolmunda Dam has seven counterweighted radial gates on the spillway. The gates open and close automatically with the rise and fall of upstream water levels. They are progressively and sequentially opened to pass flood waters and close in reverse order towards the end of an event. Each gate has two opposing and balanced counterweights. One counterweight is trying to open the gate whilst the other trying to close the gate. When the storage level rises water enters a chamber around the closing counterweight. The buoyancy reduces the closing force allowing the gate to open.

There are a number of backup systems to ensure that the gates open. If the gates fail to operate automatically through the primary pipe and weir system there is a secondary weir system to force automatic operation. There is also a float connected to the top of each gate to force the gate open if water rises to that level. If the gates do not open automatically then the gates can be operated in a manual mode by pumping water into the float chambers.

Spillway gates are installed on Coolmunda Dam to maximise the available storage volume whilst minimising upstream flood levels. At Coolmunda Dam the FSL is located near the top of the gates. The gates are operated in a manner whereby the outflow is balanced with the inflow to maintain the storage level within a narrow band close to the FSL. This arrangement is typical of SunWater's gated storages. This means that the discharge from the dam is approximately equal to the inflow.

Whether operating in automatic or manual mode, the O&M Manual in section 2.5.2 defines the gate opening sequence as a function of storage level. The first gate opening commences when the storage level is 0.1meters above FSL. Each 0.06 meter rise in storage triggers the next gate opening, up to step 11. Thereafter each gate step is triggered by a rise of 0.03 metres.

The O&M Manual notes that gate openings are designed to satisfy three requirements. Firstly the storage level must not be allowed to rise above 315.14 (0.3m below fuse plug) if preventable: Secondly the rate of outflow is not to exceed the rate of inflow: Finally flow over the spillway should be symmetrical about the centreline of the spillway. To achieve this gates are opened symmetrically from the centre gate.

When the spillway gates at Coolmunda Dam are in the closed position there is a 600mm freeboard between the top of the gates and FSL. There is approximately 13,000ML of storage in this freeboard zone. The freeboard provides a small margin of error that might provide some time to rectify a fault in the event of a gate malfunction and prevent gate overtopping from wave action. At an inflow of 700m^3/s the storage would rise 600mm in just 5.3 hours if the gates failed to open. Overtopping of the gates could result in damage to the gates and pose a dam safety risk. There is no flood mitigation storage available above FSL.

[redacted]

17.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

17.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Coolmunda Dam:

- **The EAP was reviewed as part of a comprehensive inspection on 22nd to 26th November 2010.** The inspection team was led by Peter Richardson (Chief Design Engineer)(RPEQ). Other members of the team were Mal Halwala Principal Engineer Dam Safety)(RPEQ), Chris Kuenne (Senior Mechanical Engineer), and Ross Mewett (Asset Engineer). The following operations and maintenance staff were involved in the inspection: John Eaton (Technical Officer), Nev Cole (Storage Supervisor), Doug Rabbitt (Operator/Maintainer), and Nev Johnston (Electrician). The inspection team confirmed that the current version of the EAP was available at the dam. The team conducted an emergency exercise to test the operators knowledge and understanding of the EAP. The team considered whether or not the instructions were adequate and, through the exercise, confirmed that the instructions were understood by the dam staff. The findings of the review were documented in the Draft *Coolmunda Dam Five Yearly Comprehensive Dam Safety Inspection Report 22-26 November 2010* (page 12)[2]. The team concluded that, with the exception of the environment group in Brisbane, the instructions were adequate and understood. The environment group does not have a role in flood scenarios. The environment group awareness is being rectified with training. It was noted that changes were required to the EAP to reflect the changes to SunWater's business structure in 2010. These changes were addressed in the supplementary notice issued by the Principal Engineer Dam Safety (PEDS) described below;
- The notification and emergency communication list (EAP section 3) was revised and reissued on 14 December 2010. The notification and emergency communication list was issued as a controlled document to the distribution list (Section 1, page 2 of 3 of the EAP). A transmittal advice was issued with each controlled copy. The transmittal advice included instructions for updating the EAP;
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety (Mal Halwala). The notice was principally designed to address changes to the roles and responsibilities that occurred as part of an internal reorganisation within SunWater. The notice was based on the Tinaroo Falls Dam EAP that had been updated to Issue 3 and was to be used as the template for Issue 3 for all SunWater dams. The supplementary

[2] At the time of writing this statement the report was undergoing final review and had not been finalised.

[redacted]

notice was issued by email on 29 October 2010 to all of the Area Operations Managers and Service Managers who all fulfil the role of EEC for the dams in their respective areas;

- Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers in June 2010 prior to the wet season. No records are available for this training; and,
- The comprehensive (5-yearly) inspection was undertaken on 22nd to 26th November 2010 by a multidisciplinary engineering inspection team. The dam was found to be in a satisfactory condition. The inspection team was led by Peter Richardson (Chief Design Engineer)(RPEQ). Other members of the team were Mal Halwala Principal Engineer Dam Safety)(RPEQ), Chris Kuenne (Senior Mechanical Engineer), and Ross Mewett (Asset Engineer). The following operations and maintenance staff were involved in the inspection: John Eaton (Technical Officer, Nev Cole (Storage Supervisor), Doug Rabbitt (Operator/Maintainer, and Nev Johnston (Electrician). The findings of the inspection are documented in the Draft *Coolmunda Dam Five Yearly Comprehensive Dam Safety Inspection Report 22-26 November 2010* (page 12)[3].

17.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The O&M Manual outlines the required maintenance plans for Coolmunda Dam. The live maintenance schedules and work instructions are obtained from SunWater's SAP system. This means that work orders for maintenance, document revisions and other activities such as emergency preparations are automatically generated by the SAP system on a monthly basis This creates a controlled document trail that requires actioning and closing out. A work order is issued for each scheduled or corrective maintenance item (refer Figure 17-2 for sample work order header). The work orders are issued to the appropriate supervisor. Scheduled maintenance items would include such items as:

- 12m Condition Monitoring Radial Gates[4]
- 12m Condition Monitoring Gantry Crane
- 12m safety Equipment External Servicing Coolmunda Dam
- 3m Safety Equipment Inspection
- 1m Dam Surveillance & Routine tasks
- 3 m Condition Monitoring Outlet Works Coolmunda Dam

---

[3] At the time of writing this statement the report was undergoing final review and had not been finalised.

[4] 1M denotes a monthly frequency, 2M every 2 months, 3M quarterly etc [redacted]

 [redacted]

A detailed work instruction is issued with each work order. Each work instruction includes a detailed check list of tasks to be performed to complete the work order Refer Figure 17-3 for sample extract from completed work instruction.

Once the work on an order and in an instruction has been competed it is signed off as complete, dated and verified by the supervisor (refer Figure 17-4)

SunWater

PM01-Preventive - Day to Day Work Order 5103438

Printed By: NEWMANR On: 23.03.2010 Page: 1 Original

Job Description: ***MAB-12M-Cond Mon-Radial Gate 1-Coolmunda***
Work Instruction:
(SPILLWAY)

Functional Location:	*MAB-COOL-SPWY-GT01*	*REGULATING GATE 01*	
Equipment:			
Location:		*at:*	
General Location	*1ST ON LEFT LOOKING D/S*		
Planner:	*310 Toowoomba Planner*	*Main work center:*	*3100 WS Toowoomba*
Priority:	*5 Priority 5 < 1 month*	*Status :*	*REL CSER MSCP NMAT PRC SETC*

Notifications:
10121403 MAB-12M-Cond Mon-Radial Gate 1-Coolmunda *MAB-COOL-SPWY-GT01*

Figure 17-2 Sample Work Order Header

SYSTEM		FACILITY	DESCRIPTION	INSERT (✓ or ✖)	DATE
COOL		SPWY	Coolmunda Dam – Radial Gate 3		
ITEM	COMPONENT	Applies to each Radial Gate when scheduled			
1.	RADIAL GATES	INSPECT CONDITION OF STEELWORK AND JOINTS FOR DETERIORATION, LOOSE CONNECTIONS, DAMAGE, ETC.		14/4	✓
2.	RADIAL GATES	INSPECT CONDITION OF PAINTWORK, INCLUDING UPSTREAM SKINPLATE, FOR DETERIORATION OR DAMAGE.		"	✓
3.	GATE CONTROL AND COUNTERWEIGHT SYSTEMS	WHILE INSPECTING THE UPSTREAM SKINPLATE - CHECK UNIFORMITY OF GATE MOVEMENT; CHECK HOIST ROPES, PULLEYS AND VARIABLE COUNTERWEIGHTS FOR FREEDOM OF MOVEMENT.		"	✓
4.	GATE CONTROL AND COUNTERWEIGHT SYSTEMS	INSPECT CONDITION OF WIRE ROPES AND FITTINGS FOR DETRIORATION OR DAMAGE. GREASE IF REQUIRED.		"	✓
5.	GATE CONTROL AND COUNTERWEIGHT SYSTEMS	INSPECT CONDITION OF MOVABLE CONTROL WEIRS FOR DETERIORATION OR DAMAGE. CHECK FOR FREEDOM OF MOVEMENT.		"	✓

Figure 17-3 Sample of Work Instruction for Work Order 5101612

[redacted]

COMPLETION INFORMATION

Please complete the attached work instructions and record all non-conformances, issues
and any additional information at the end of these instructions in the additiona comments section.

Job Completed By : [redacted] Date: 15-4-10

Supervisor Verification: Date: 4-5-10

Data Entry Completed : Date:

Ron Newman
Technical Planner
Toowoomba

Figure 17-4 Sample Work Order Completion

Emergency preparations prior to the wet season as required under the O&M Manual included:

- Functional testing of spillway gates and emergency pump as evidenced by workorders 5103438, 5103969, 5105176, 5107046, 5107049, 5107948, and 5108733;
- Testing and servicing of the standby diesel generator;
- Filling of all fuel stores;
- Testing of communication equipment;
- Testing of portable equipment and instruments; and
- Checking of operations of gauging stations.

Section 5 of the Coolmunda Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the dam will be continuously manned and the emergency controlled from the regional office. The EAP identifies the roles for the dam duty officer (DDO) and emergency event coordinator (EEC), however, in all cases the EAP identifies that the O&M Manual and SOPs are to be followed. Within section 5 of the EAP actions for a number of stage or alert levels are defined. The alert levels are defined by certain storage levels.

The first alert level is noted as *normal flood operations* where the reservoir reaches EL314.00m (0.07m below FSL), approaching FSL. This level is largely a preparatory stage with communication between the DDO, EEC and standby officers. Backup systems are checked.

The next alert level is noted in the EAP as flood operations stage 1. The EAP defines Stage 1 flood operations to commence when the reservoir reaches EL 314.07m (FSL) up to 314.17m. This level is transitionary if the storage is rising and marks the beginning of gate operations. At this stage the EEC provides notification to the LDMG and downstream irrigators. The communication with parties other than LDMG is by agreement to ensure rapid response at the commencement of an event

[redacted]

The next alert level in the EAP is flood operations stage 2. This stage is triggered at 314.17m. The DDOs main focus at this stage at the dam is the operation of the spillway gate in accordance with the O&M Manual, and dam surveillance.

The Coolmunda Dam EAP is consistent with the State Emergency Management framework described in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the LDMG using the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

The first flood event at Coolmunda Dam during the recent wet season commenced on 13th September 2010. This event concluded 4th October 2010. A second event ran from 16th October to 21st October and a third event from 25th October to 28th October. The final and largest event commenced 21st November 2010 and concluded 16th January 2011. This statement will deal largely with the latter and largest event from 21st November 2010 to 16th January 2011. During this period there were a number of distinct peak inflows and discharges as evidenced by Figure 17-5.

17.1.3 Outline of flood event 2010/2011

Figure 17-5 outlines the estimated inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The peak inflow was estimated at over 700m^3/s.

Water spilled from the spillway gates (a spillway discharge event) on several occasions from November through to January. Many of the events were only small events (less than 100m^3/s) and short duration. These small events would have been largely contained within the banks of Macintyre Brook with little or no impact. There were three significant events with peaks on 28th December 2010, 6th January 2011, and 11th January. The peak discharge from the dam for these events is estimated at 300m^3/s, 600m^3/s, and 675m^3/s respectively. These appear as the three large peaks in Figure 17-5.

SunWater provided updates to the contacts identified in the EAP on numerous occasions during the event. These communications are logged in the Coolmunda Dam Flood Event Report and in the communication logs and diaries of various members of staff. SunWater formally notified or updated disaster management contacts via phone on the following occasions:

- 27/12/10 @ 1430 DDMG
- 27/12/10 @ 2130 downstream landholders
- 03/01/11 @ 1730 EAP communications list with an update[5]

---

[5] EAP communications list refers to the full list of parties to be notified in section 3 of the EAP

[redacted]

- 06/01/11 @ 2130 Inglewood Police
- 06/01/11 @ 2230 Inglewood Police
- 06/01/11 @ 2330 Inglewood Police
- 07/01/11 @ 0900 EAP communications list with an update
- 11/01/11 @ 0939 DDMG
- 11/01/11 @ 1600 EAP communications list with an update
- 12/01/11 0930 EAP communications list with an update

I note that the Commission has requested an account of communications with the State Emergency Service (SES) in respect to Coolmunda Dam. The Coolmunda Dam EAP notification and emergency communication list (section 3 of the EAP) includes the SES local controller at Goondiwindi. The EAP communications log confirms that the SES local controller was contacted and updated as per the list above where it is noted that the EAP communications list had been contacted or updated.

Spillway gates are installed on Coolmunda Dam to maximise the available storage volume whilst minimising upstream flood levels. At Coolmunda Dam the FSL is located near the top of the gates. When the spillway gates at Coolmunda Dam are in the closed position there is a 600mm freeboard between the top of the gates and FSL. The gates are operated in a manner whereby the outflow is balanced with the inflow to maintain the storage level within a narrow band close to the FSL. This arrangement is typical of SunWater's gated storages. This means that the discharge from the dam is approximately equal to the inflow. There is very little attenuation of flood peaks for dams with this mode of gate operation as demonstrated in Figure 17-5.

The spillway gates on Coolmunda Dam are designed to operate in an automatic mode utilising a float system. However, during this event the dam was staffed on a 24 hour basis as stipulated in the EAP. On 11th January 2011 Staff noted some debris was blocking the intake to the gate operating system which meant that the automatic gate opening system was not operating correctly In response to this risk and in accordance with the O&M Manual staff suspended the automatic operations. The gates were operated in accordance with the O&M manual in a manual mode. This is noted in both the dam log and record of communication in the Coolmunda Dam Flood Event Report for both 11th and 12th January. Section 17.1.1.3 above outlines the manual operation of the spillway gates.

Although there was no threat to the safe performance of the dam, investigations are underway to improve the system to prevent a repeat of the problem in future events. These investigations are being conducted by engineering staff and entail a review of the system design. It is anticipated that these investigations will be completed during 2011.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 130,000ML or 1.9 times the full storage volume of the dam.

[redacted]

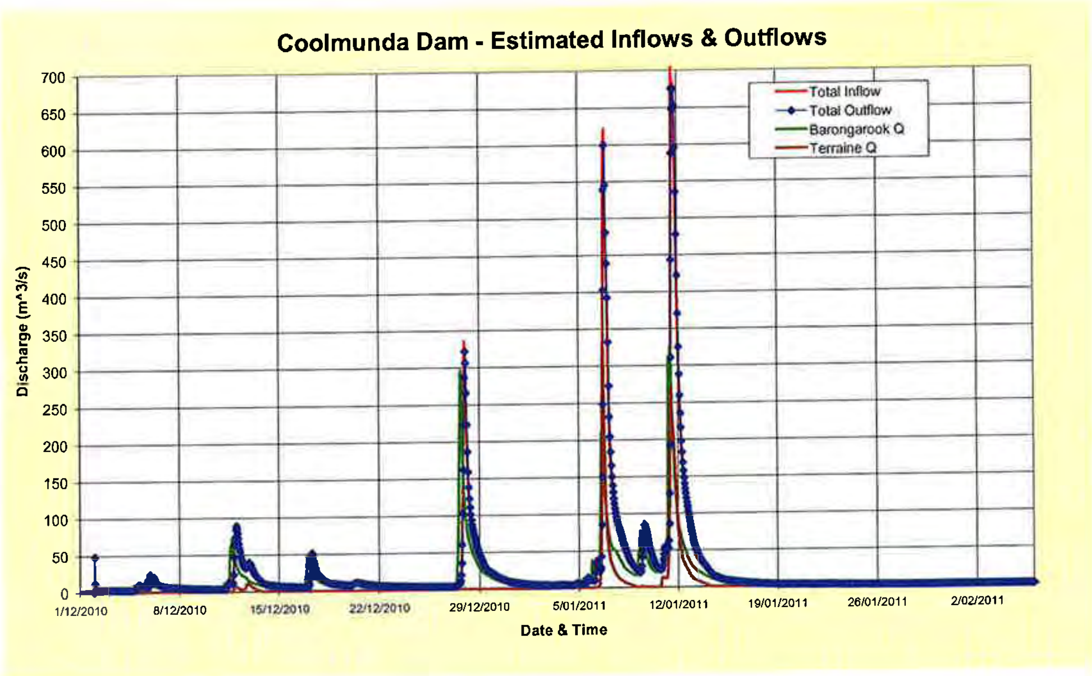


Figure 17-5 Coolmunda Dam Inflow and Outflow (Dec 2010 - Feb 2011)

Figure 17-6 plots the recorded tailwater level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[6]. The January event was reported as a major flood.

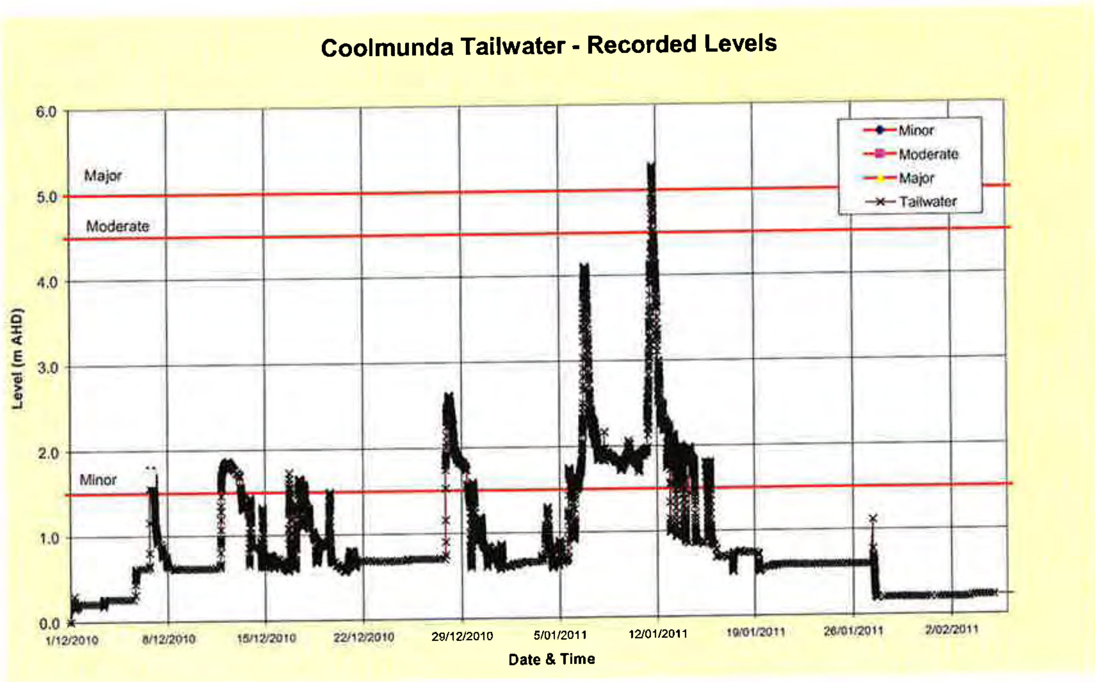


Figure 17-6 Coolmunda Dam Recorded Tailwater Flood Levels

[6] www.bom.gov.au

[redacted]

17.1.3.1 Communities that were effected

The town of Inglewood was affected by flooding during December 2010 to January 2011. The flood flows at Inglewood reached moderate flood levels on three occasions (refer Figure 17-7). It is noted that the flows at Inglewood were significantly larger than the flows at Coolmunda Dam (refer Figure 17-8). The total flow at Inglewood over the period 1 December 2010 to 7 February 2011 was 320,000ML or 2.5 times the estimated inflow into Coolmunda Dam. This indicates that significant inflows were generated from those parts of the catchment not controlled by Coolmunda dam.

The Coolmunda Dam log notes that on the 2nd January 2011 there was a boating accident on the lake behind Coolmunda Dam. Police notified SunWater staff that a boat had sunk 100m from the boat ramp. This did not impact on gate operations.

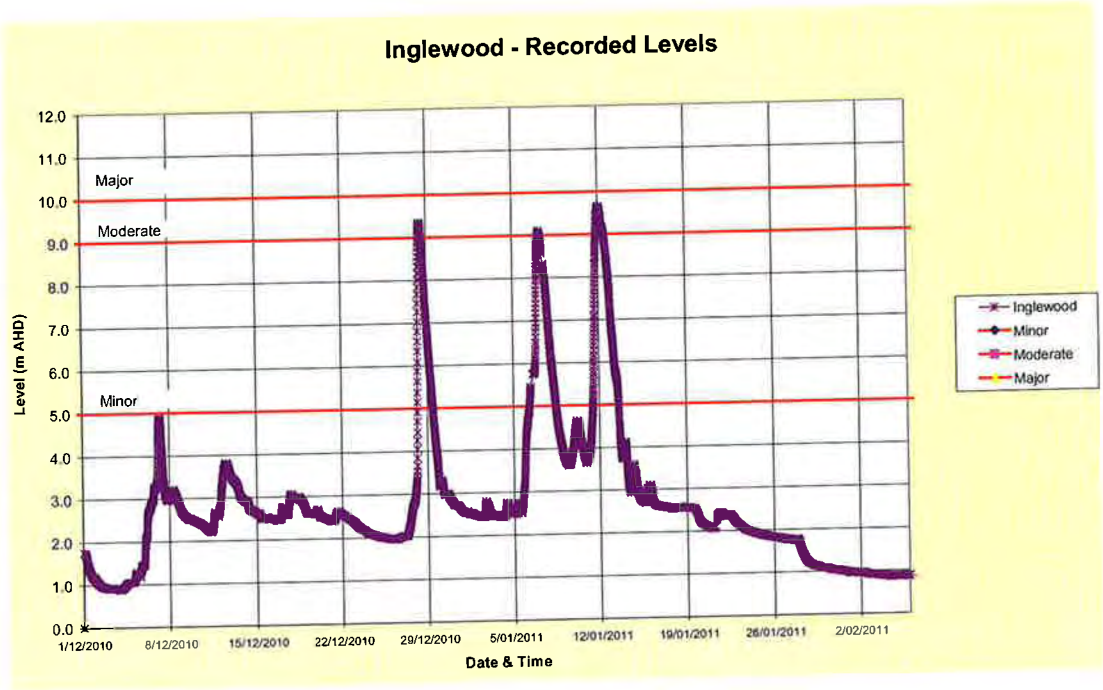


Figure 17-7 Recorded River Heights at Inglewood 1 Dec 2010 to 7 Feb 2011

[redacted]

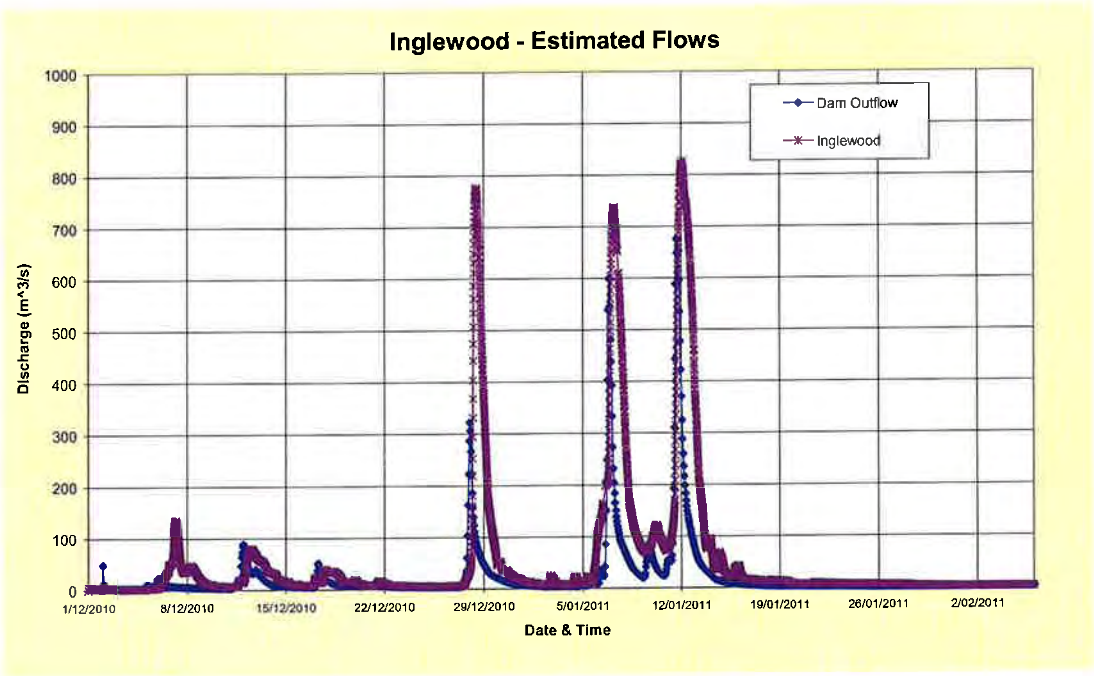


Figure 17-8 Relative size of Flood Event at Coolmunda Dam to River Flows at Inglewood

17.1.3.2 Damage and response to damage

There was no significant flood damage to Coolmunda dam. The main dam structure is undamaged and performed well from a dam safety perspective.

17.1.3.3 Gauging stations – effect on data collection

Figure 17-1 shows the location of gauging stations in the catchment. The key stations remained available through the BoM web page for most of the event. The Barongarook station failed from about 18 January to 1 February, however this did not impact on operations.

17.1.3.4 Community inquiries

SunWater received a small number of inquiries regarding water levels and flows in the Macintyre Brook. Those inquiries were answered by SunWater staff on an ongoing basis during the event Dam (refer section 2.1.1 of my statement re provisions for 24/7 emergency contact with SunWater through the call centre).

17.1.3.5 Media Coverage

There were no specific reports about Coolmunda Dam.

17.1.3.6 Post Event Review

SunWater undertook a review of the event for Coolmunda Dam. This review took the form of a memo from the Area Operations Manager. The review found that:

[redacted]

- The EAP was generally adequate, however some updating is required to reflect current SunWater internal reporting arrangements. The amendments to these documents are in progress;
- A review of the gate opening sequence specified in the O&M Manual is required to clarify some instructions on initial gate openings for small events. A review of the O&M Manual is in progress and will be completed before the next wet season.
- The review of the design of the intake arrangement into the float operating system to avoid debris blockages will be scheduled for completion before the next wet season.
- Expanding SunWater's use of an SMS messaging service to include notification of nominated landholders in the EAP could streamline communication of an EAP event. This option is under investigation and if feasible will be implemented before the end of 2011.

17.1.4 Local Disaster Management SunWater Relationship

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[7] The Operational Planning Guidelines for Local Disaster Management Groups[8] identifies the role of the LDMG during an event as coordination of support to response agencies, reconnaissance and impact assessment, and provision of public information.

The Coolmunda Dam EAP is consistent with the State Emergency Management framework described above and in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the premise that the LDMG will use the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment

During this recent event the dam performed to expectations. The stream flows, although significant, were not extreme in a dam safety sense. If circumstances had been more extreme or serious operational problems had been experienced, SunWater staff would have given primacy to protection of life and safety of the dam. The focus of SunWater staff should not be diverted from this priority. It is for this

---

7

http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

8

http://www.disaster.qld.gov.au/publications/pdf/Operational%20Planning%20Guidelines%20for%20Local%20Disaster%20Management%20Groups.pdf

[redacted]

reason that SunWater supports the Queensland Government District Disaster Management framework. In the frame work SunWater provides the necessary communications to LDMG who take the lead in provision of information to the public. SunWater focuses on operating and managing the safety of the dam.

The model described above was not as mature for the Coolmunda Dam as it could be with respect to the relationship with SunWater. The relationship functioned on an "as-needs" enquiry basis. The LDMG had not included SunWater in formal operational meetings of the group.

SunWater regional staff (Service Managers) have been instructed to make contact with LDMGs in their areas with the aim of improving communications and requesting that SunWater is invited to participate in LDMG meetings during future flood events.

17.1.5 Previous flood events

The February event is ranked as the sixth largest flood through the dam since it was constructed in 1968.

Table 17-2 Coolmunda Dam - Ranking of Historic Flood Events

		FSL	314.07 m
Flood Rank	**Date**	**Peak Height**	
		EL	**Above Crest**
1	Feb-76	314.92	0.85
2	Feb-71	314.55	0.48
3	Apr-88	314.51	0.44
4	Jul-84	314.36	0.29
5	May-83	314.46	0.39
6	Jan-11	314.36	0.29
7	Sep-78	314.32	0.25
8	Mar-75	314.31	0.24
9	Mar-82	314.30	0.23
10	Feb-84	314.25	0.18
2010-11 Flood			
6	Jan-11	314.36	0.29

17.1.6 Flood mitigation opportunities

The Border Rivers ROP specifies rules for the operation of Coolmunda Dam, including how releases are to be determined. Any alternative operating arrangements are not possible under the current regulatory rules. SunWater used the flood model for Coolmunda Dam to evaluate how the dam might operate to mitigate flood events.

There is no flood mitigation storage in Coolmunda dam. The only air space would be if the dam was below the full supply level prior to an event.

Figure 17-9 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December 2010; however this would not be practical for the reason of compliance set out above. It is noted that the peak discharge under this scenario would have been similar to the actual event, although the number of peaks would have been reduced.

As Coolmunda Dam has spillway gates, it is conceivable that the dam could be operated in an active flood mitigation mode. Time constraints have not permitted any evaluation of possible scenarios. However, this would require changes to the regulatory rules. Moreover, it is unlikely that any flood mitigation benefit could be derived from the current configuration of Coolmunda Dam without a significant loss of water supply to the local community.

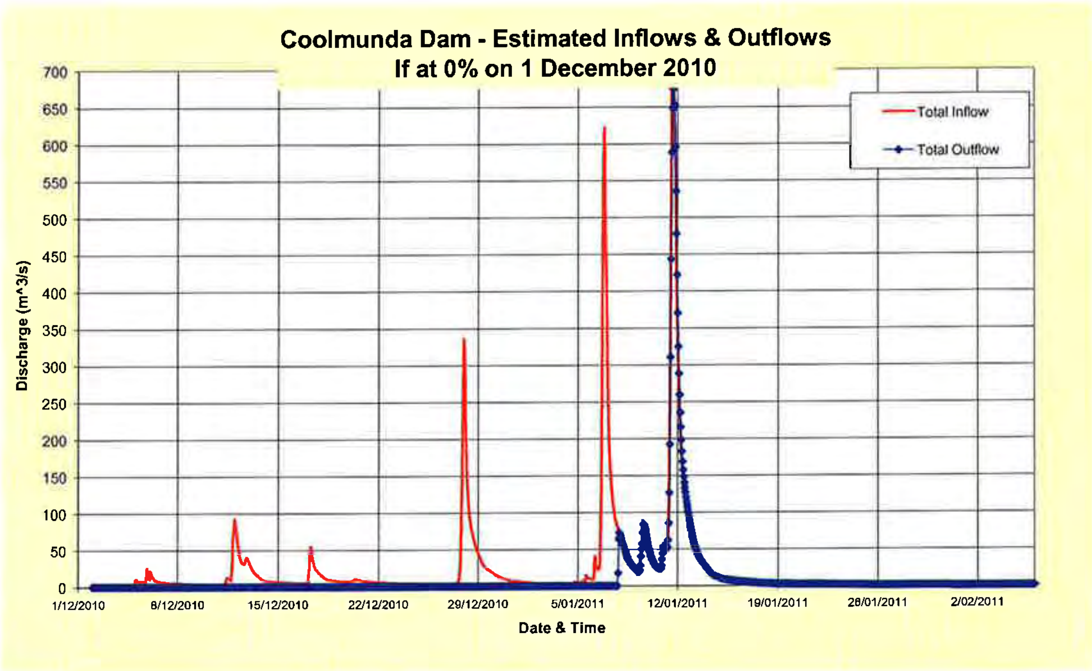


Figure 17-9 Coolmunda Dam Simulated Behaviour if empty on 1 December 2010

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.

Sworn and Declared at Brisbane	)	
this 28th day of April 2011 in the	)	[redacted]
presence of:	)	
		Signature of the declarant

[redacted]..

ASHLEY UREN

~~Justice of the Peace~~/ Solicitor/

~~Commissioner for Declarations.~~

Schedule 21: Glenlyon Dam

QUEENSLAND TO WIT

I, **ROBERT GERARD KEOGH**, of c/- SunWater Limited **(SunWater)**, Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare as follows:

21.1 Glenlyon

The flood event at Glenlyon Dam commenced on 17th December 2010 and concluded 31st January 2011. The total wet season inflow to the dam from 1 December 2010 to 7 February 2011 was approximately 1.7 times of the total storage volume of Glenlyon Dam. Downstream communities of Texas and Goondiwindi experienced major flooding. Discharges from Glenlyon Dam were a relatively small contributor to total flood volumes at Goondiwindi.

21.1.1 Overview

Glenlyon Dam is located in the Eastern Border Rivers catchment. The dam has a catchment area of 1295 km^2. The Eastern Border Rivers area having a total catchment area in excess of 34,250 km^2. The catchment is situated on the NSW/QLD Border region. It is bound to the north by the catchments of the Macintyre Brook/Dumaresq, to the west by the Barwon River, and to the south by the Severn River in NSW.

Other major rivers in the Region are the Severn and the Mole.

The Dumaresq River Water Supply System is one of the 2 in the Border Rivers area, the other being centred on the Pindari Dam. Glenlyon Dam is owned by the Dumaresq-Barwon Border Rivers Commission (BRC) and operated by SunWater under a facility contract.

The purpose of the scheme is to provide water for downstream irrigation and town water supplies. Glenlyon Dam is the major headworks of the Dumaresq River Water Supply System.

The dam is situated on Pike Creek at AMTD 6.6 km upstream from its junction with the Dumaresq River and is approximately 140 km by road Southwest of the town of Stanthorpe.

The BRC has not engaged SunWater to undertake a comprehensive risk assessment at this time.

Dam	Storage Volume (ML)	Failure Impact Rating	Stream	Stream Distance (km)	Type	Surface Area at FSL (Ha)	Date Completed	Purpose	Nearest town	Significant down stream Communities
Glenlyon	254,310	2	Pike Ck	6.4	Earth and Rockfill	1,800	1976	Water Supply	Stanthorpe	Goondiwindi

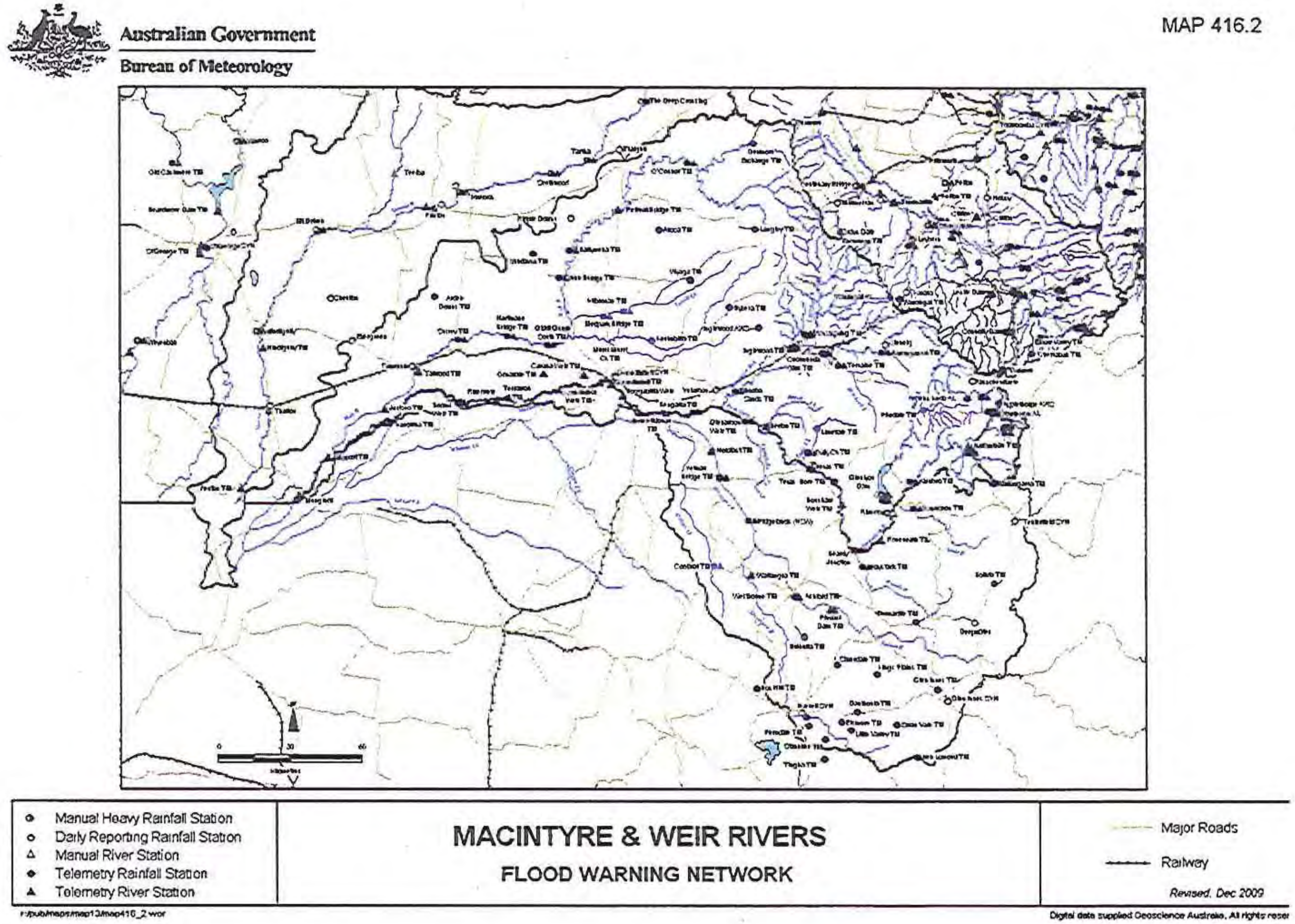


Figure 21-1 Border Rivers catchment

[redacted]

The management of the dam is recorded in a number of regulatory dam safety documents including:

- The Glenlyon Dam Operations and Maintenance Manual
- Glenlyon Dam: Standing Operating Procedures
- Emergency Action Plan: Glenlyon Dam
- Glenlyon Dam: Data Book Part 1 – Text
- Glenlyon Dam: Data Book Part 2 – Drawings
- Glenlyon Dam: Dam Safety Review (August 1999)

In an emergency situation the procedures in the Emergency Action Plan take precedence.

A Failure Impact Assessment was carried out by SunWater in January 2003 and a Dambreak Analysis in May 2007.

21.1.1.1 Type

Construction of the central core rock and earthfill dam with uncontrolled spillway was completed in early 1976. The spillway is of concrete ogee crest construction. The storage capacity at Full Supply Level (FSL), is 254,310 ML.

The dam has a total length of 445m and a maximum height of 62 m above the foundations.

Table 21-1 GlenlyonDam Details

Overview		
Dam Name	Glenlyon Dam	
Storage Name	Pike Creek Reservoir	
Location	Latitude	28°.9698 S
	Longitude	151° 465 E
Regional Council	Southern Downs Regional Council	
Nearest Town with Road Access	Stanthorpe	
Stream and AMTD	Pike Creek AMTD 6.6 km	
Catchment area	1,295 km^2	
Average rainfall	683.3 mm	
Main Dam		
Type	Central Core Rock and Earthfill	
Full Supply Level (FSL)	EL 411.73 m AHD	
Storage capacity at FSL	254,310 ML	
Storage area at FSL	1,800 ha	
Dam Crest Level (DCL)	EL 423.62 m AHD	
Maximum height of the dam	62 m above foundation	

Crest length along axis (main embankment)	445 m (including spillway)
Spillway	
Spillway type	Reinforced Concrete Ogee Crest
Spillway crest level	EL 411.73 m AHD
Crest length	69.5 m
Outlet Works	
Outlet capacity (Max)	2,500 ML/Day
Type:	Inlet tower (wet), 3,660 mm ID concrete tunnel
Control:	Hydraulically operated 60" FCDV with 84" BFV isolator and 24" FCDVs with 24" Sluice valve D/S Drop inlet bulkhead gate in tower U/S

21.1.1.2 Purpose

The foreword of the Border Rivers Resource Operations Plan (ROP) notes that:

> *The implementation phase of the water resource planning process will bring water users an unprecedented level of confidence and flexibility...*
>
> *This resource operations plan provides for operating rules and management arrangements for supplemented water in the Macintyre Brook Water Supply Scheme and the Border Rivers Water Supply Scheme*

The dam was designed and constructed by the NSW Water Conservation and Irrigation Commission in association with the Queensland Irrigation and Water Supply Commission, primarily for the purpose of supplying water to the downstream irrigators along Pike Creek/Dumaresq River.

21.1.2 Implementation of System Operations Plans for 2010-11 Wet Season

21.1.2.1 Pre-wet season EAP reviews/training

SunWater routinely reviews and updates emergency procedures and ensures staff are adequately trained in these procedures. Prior to the 2010-11 wet season the following preparations were made for Glenlyon dam:

- The EAP was reviewed as part of a periodic (annual) inspection on 22nd September 2010. The inspection team was led by Keith Ehm (Senior Engineer Headworks)(RPEQ). Other members of the team were Dave Thomas (Senior Technical Officer), John Eaton (Technical Officer), Brendan Swan (Storage Supervisor) and Neville Johnstone (Electrician). The inspection team confirmed that the current version of the EAP was available at the dam. The team

[redacted]

considered whether or not the instructions were adequate and, through inquiry, confirmed that the instructions were understood by the dam staff. The findings of the review were documented in the Glenlyon Dam Annual Inspection Report 21 September 2010 (page 8). The team concluded that the instructions were adequate and understood. However some changes to the contact list were recommended;

- The notification and emergency communication list (EAP section 3) was updated in October 2010. The notification and emergency communication list was not reissued to the full distribution list (Section 2, page 1 of 1 of the EAP) prior to the wet season. However, the updated contact information was available and used by the DDO and EEC during the recent event;
- A supplementary notice for the EAP was issued in October 2010 by the Principal Engineer Dam Safety (Mal Halwala). The notice was principally designed to address changes to the roles and responsibilities that occurred as part of an internal reorganisation within SunWater. The notice was based on the Tinaroo Falls Dam EAP that had been updated to Issue 3 and was to be used as the template for Issue 3 for all SunWater dams. The supplementary notice was issued by email on 29 October 2010 to all of the Area Operations Managers and Service Managers who all fulfil the role of EEC for the dams in their respective areas. The Storage Supervisor at Glenlyon Dam in the Glenlyon Dam Emergency Event Report confirms that this notice was available and used during the event; and
- Refresher training on EAP roles and responsibilities was provided to operators and dam duty officers in June 2010 prior to the wet season. No records are available for this training.

21.1.2.2 Emergency Preparedness/Actions/Redundancy/ back up systems

The O&M Manual outlines the required maintenance plans for Glenlyon Dam. The live maintenance schedules and work instructions are obtained from SunWater's SAP system. This means that work orders for maintenance, document revisions and other activities such as emergency preparations are automatically generated by the SAP system on a monthly basis This creates a controlled document trail that requires actioning and closing out. A work order is issued for each scheduled or corrective maintenance item (refer Figure 21-2 for sample work order header). The work orders are issued to the appropriate supervisor. Scheduled maintenance items would include such items as:

- BRC-12M-EMERGENCY ACTION PLANNING-GLENLY[1]
- BRC-6M-Comp Serv Outlet Works-Glenlyon
- BRC-1M-Dam Surv & Routine Tasks-Glenlyon

---

[1] 1M denotes a monthly frequency, 2M every 2 months, 3M quarterly etc

- BRC-1M-COND MONIT-SEPTIC SYSTEM-GLENLYON
- BRC-1M-OPS-MONITORING-TWS-GLENLYON
- BRC-1M-SITE SAFETY INSPECTION-GLENLYON

A detailed work instruction is issued with each work order. Each work instruction includes a detailed check list of tasks to be performed to complete the work order. Refer Figure 21-3 for sample extract from completed work instruction.

Once the work on an order and in an instruction has been competed it is signed off as complete, dated and verified by the supervisor (refer Figure 21-4).

SunWater

PM01-Preventive - Day to Day Work Order 5108745

Printed By: NEWMANR On: 23.09.2010 Page: 1 Original

Job Description: *12M Dam Safety Insp - Glenlyon*
Work Instruction:

Functional Location:	*BRC-GLEN*	*GLENLYON DAM*	
Equipment:			
Location:		*at:*	
General Location	*PIKE CREEK; NEAREST TOWN STANTHORPE*		
Planner:	*310 Toowoomba Planner*	*Main work center:*	*3100 WS Toowoomba*
Priority:	*3 Priority 3 < 1 week*	*Status :*	*REL MSCP NMAT PRC SETC*

Notifications:
10126373 12M Dam Safety Insp - Glenlyon *BRC-GLEN*
12M Dam Safety Insp - Glenlyon

Figure 21-2 Sample Work Order Header

			NECESSARY (REFER TO O&M MANUAL).		
4	OPERATION S COMPLEX	STANDBY DIESEL	CHECK BATTERIES, BATTERY CHARGES 1 & 2, INDICATOR LIGHTS & GAUGES. CHECK ENGINE FOR OIL, WATER, FUEL LEVELS AND CHECK FOR LEAKS ETC. RUN ENGINE TILL IT REACHES OPERATING TEMPERATURE CHANGE OIL, OIL FILTER, & FUEL FILTER WHEN NECESSARY (REFER TO O&M MANUAL).		22/11/10
5	OPERATION S COMPLEX	PORTABLE DIESEL	CHECK BATTERIES, INDICATOR LIGHTS & GAUGES. CHECK ENGINE FOR OIL, WATER, FUEL, LEVELS AND CHECK FOR LEAKS ETC. RUN ENGINE TILL IT REACHES OPERATING TEMPERATURE CHANGE OIL, OIL FILTER, & FUEL FILTER WHEN NECESSARY (REFER TO O&M MANUAL).		06.12.10
6	OPERATION S COMPLEX	U.P.S	CHECK OPERATION VISUAL CHECK ON BATTERIES. WORMALD MONTHLY SERVICE.		

Figure 21-3 Sample of Work Instruction

[redacted]

COMPLETION INFORMATION

Please complete the attached work instructions and record all non-conformances, issues
and any additional information at the end of these instructions in the additiona comments section.

Job Completed By : NEV. MICK - JOHN [redacted] Date: SEPT 10

Supervisor Verification: 18/10/10 [redacted] Date: 18/10/10.

Data Entry Completed : ______________________ Date: ____________

Figure 21-4 Sample Work Order Completion

21.1.2.3 Emergency Actions

The EAP was first activated on 17th December 2010 and remained in effect until the end of the spill event 31st January 2011.

Section 4 of the Glenlyon Dam EAP describes emergency identification, evaluation and actions for a number of emergency scenarios. Scenario 1: Flood Operations was relevant for this event. During flood events the EAP stipulates that the storage operator and standby officers will be available for the duration of the emergency event. There is no requirement for staff to be on duty on a 24 hour basis. Within section 4 of the EAP actions for a number of stage or alert levels are defined. The stages are defined by certain storage levels.

The first stage is denoted as *Stage 1* where the spillway is discharging at a depth of less than 3 metres. Actions at this level include preparations with communication between the DDO, EEC and standby officers. The Storage operator is required to notify District Disaster Coordinator, SES, Police and affected persons (residents closest to Glenlyon Dam). The Storage Operator monitors the performance of the dam and catchment conditions.

The next stage is noted in the EAP as *Stage 2* where the depth over the spillway is between 3 and 6 metres. There are 2 further stages that are not described here as the dam did not go beyond *Stage 1* in this event.

The Glenlyon Dam EAP is consistent with the State Emergency Management framework described in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping disaster management informed. The construct of the EAP is based on the DDMG using the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment.

The flood event at Glenlyon Dam commenced on 18th December 2010 and concluded 31st January 2011.

21.1.3 Outline of flood event 2010/2011

Figure 21-5 outlines the estimated inflows and outflows from the dam for the period 1 December 2010 to 7 February 2011 inclusive. The inflow shown in Figure 21-5 is an estimate derived from the recorded storage behaviour. The peak inflow was estimated at over 550m^3/s. The storage peaked early on the 12 January 2011. The estimated peak inflow of 550m^3/s was attenuated to a peak outflow of 350 m^3/s.

SunWater provided updates to the contacts identified in the EAP on numerous occasions during the event. These communications are logged in the Glenlyon Dam Flood Event Report and in the communication logs and diaries of various members of staff. The main contact events are summarised as follows:

- On the morning of 17th December downstream landholders were provided with a pre spill warning;
- Morning of 18th December downstream landholders were advised dam was spilling;
- Morning of 18th December District Disaster Coordinator, SES, LDMG Goondiwindi and Police were advised that dam had started overflowing;
- 22nd December Police at Texas were provided with an update;
- 28th December Police at Texas were provided with an update;
- Early on 11th January District Disaster Coordinator, SES, LDMG Goondiwindi and Police advised that the river was in flood; and,
- Morning of 12th January an update was provided to the SES in Texas.

The total inflow into the dam over the period 1 December 2010 to 7 February 2011 was 425,000ML or approximately 1.7 times the full storage volume of the dam.

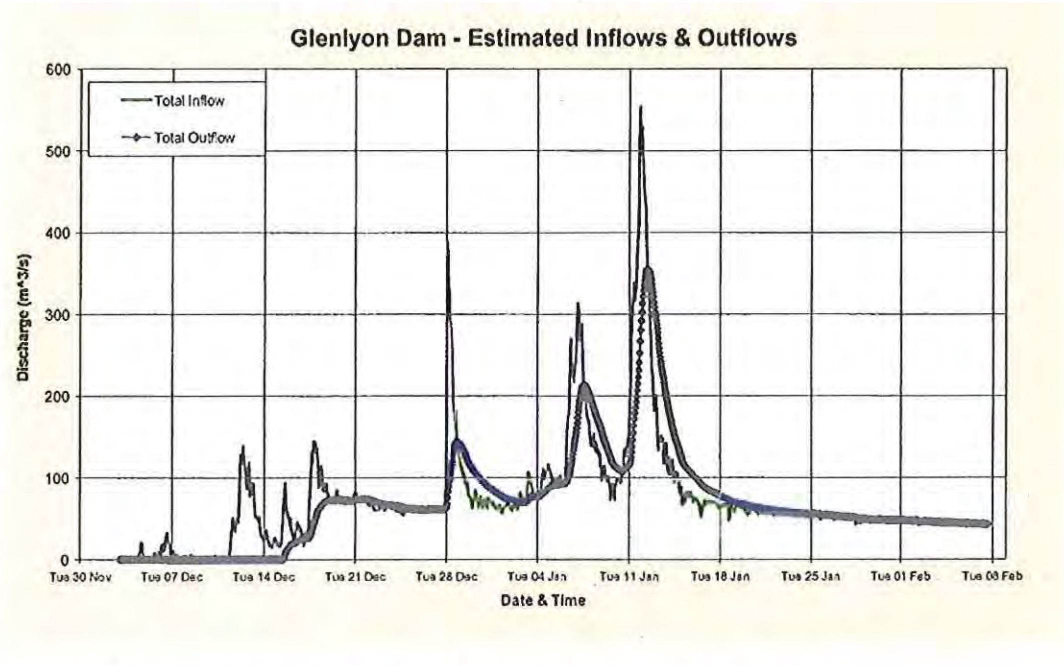


Figure 21-5 Glenlyon Dam Inflow and Outflow (Dec 2010 - Feb 2011)

[redacted]

Figure 21-6 plots the recorded storage level of the dam for the period 1 December 2010 to 7 February 2011 inclusive. The plot also shows the flood classification levels[2]. The December/January event was reported as a minor flood.

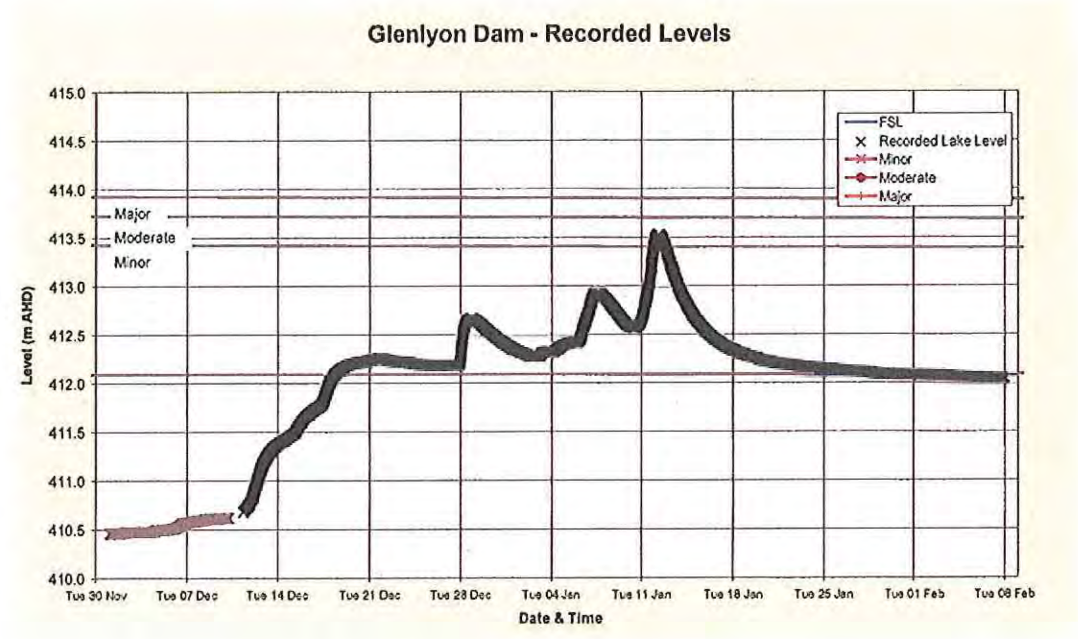


Figure 21-6 Glenlyon Dam Recorded Flood Levels

21.1.3.1 Communities that were affected

Communities along the Dumaresq River system were affected by flooding during the event. Figure 21-10 shows the recorded river heights at Goondiwindi. The river reached major[3] flood levels.

I note that the Commission has requested an account of warnings given to residents about the effect of releases from Glenlyon Dam on Texas. The communications are recorded in the record of communication in the Glenlyon Dam Flood Event Report. The communications with District Disaster Coordinator, SES, LDMG Goondiwindi and Police are replicated in *Table 21-2 Disaster Management Communications - Initial phase of event* and *Table 21-3 Disaster Management Communications - Peak of event.*

---

[2] www.bom.gov.au

[3] www.bom.gov.au

[redacted]

Table 21-2 Disaster Management Communications - Initial phase of event

Date	Time PHONE MOBILE	Contact Person	Message	Call Made By
18/12/10	[redacted]	Disaster District Coordinator Warwick QLD Sergeant Bushman	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES Local Controller Goondiwindi Graham Debrit	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES LDSM Goondiwindi Craig	Message Left - Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES LDSG Goondiwindi – Inglewood & Texas	No Answer	B Swan
18/12/10		SES Moree Steve Martin	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES Tenterfield Karan	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES Inverell Charlie Moir	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES Warwick John Newley	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES Stanthorpe Max Hunter	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		SES Inglewood Eric McGlason	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		Police Texas Andrew McNamara	Glenlyon Dam Spillway overflowing.	B Swan
18/12/10		Police Goondiwindi Sergeant Bushman	Sergeant Bushman Would contact Goondiwindi and notify them that - Glenlyon Dam Spillway was overflowing.	B Swan
18/12/10		Police Ashford – Inverell Did not catch name of Officer.	Glenlyon Dam Spillway overflowing.	B Swan
22/12/10		Police Texas Andrew	Checking overflow, height & conditions	Call into B Swan
28/12/10		Police Texas Greg Moore	Confirm storage overflow Approx 2000ML in 24HR Report	B Swan

Table 21-3 Disaster Management Communications - Peak of event

Date	Time PHONE MOBILE	Contact Person	Message	Call Made By
11/01/11	01:00	SES Texas Yogi	Brendon - confirm storage overflow going down stream.	SES Texas
11/01/11	[redacted]	Police Texas Greg More	Confirm storage overflow going down stream.	B Swan
11/01/11	[redacted]	SES Texas Yogi	Confirm storage overflow going down stream.	B Swan
11/01/11	[redacted]	Police DDC Warwick Greg Morrow	Confirm storage overflow going down stream, and storage Level.	B Swan
11/01/11	[redacted]	SES Moree Steve Martin	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	[redacted]	SES Tenterfield Graham	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	[redacted]	SES Inverell Charlie Moir	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	[redacted]	SES Warwick David	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	[redacted]	SES Stanthorpe Max Hunter	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	[redacted]	SES Inglewood No Name	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	[redacted]	SES Goondiwindi David Praw	Confirm storage overflow and that the river was in flood.	B Swan
11/01/11	08:00	LDM Goondiwindi Rick Kearney	Asked Brendon about River Flow And Height Down stream told to contact Peter Billsbrough in Goondiwindi	LDM Goondiwindi
12/01/11	09:00	SES Texas Yogi	Brendon - Confirm storage overflow and approx volume.	SES Texas

It is noted that Glenlyon Dam is located on Pike Creek whereas the town of Texas is located on the Dumaresq River. The total catchment at Texas is 7,880km^2. The catchment at Glenlyon Dam is 1,295km^2 which is 16% of the catchment at Texas (refer Figure 21-7). Figure 21-8 compares the flows in the Dumaresq River up stream of the confluence with Pike Creek with the discharges from Glenlyon Dam. A significant proportion of the flood volume passing Texas did not pass through Glenlyon Dam. Figure 21-9 shows that the size of the flood passing Glenlyon Dam was a relatively small proportion of the total flood volume passing Goondiwindi.

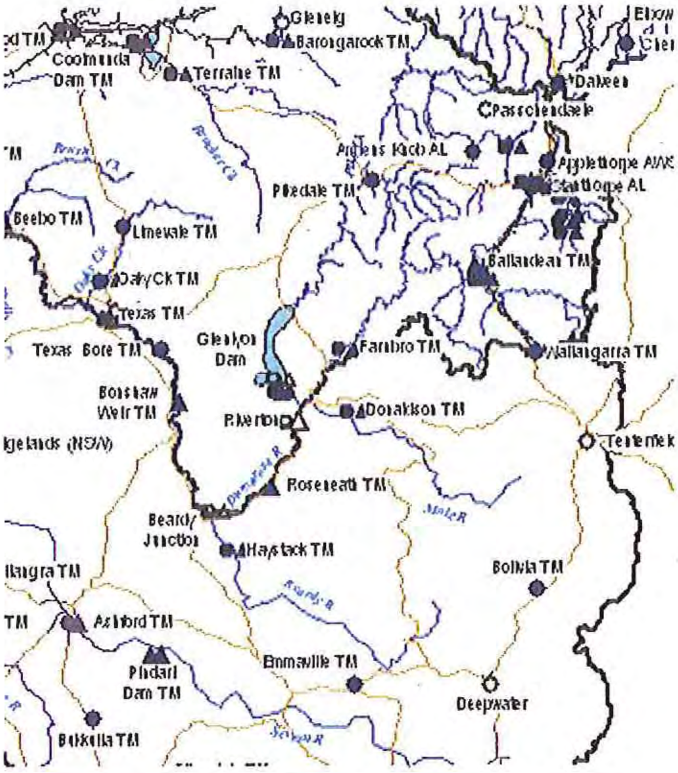


Figure 21-7 Catchment Map – Texas & Glenlyon Dam

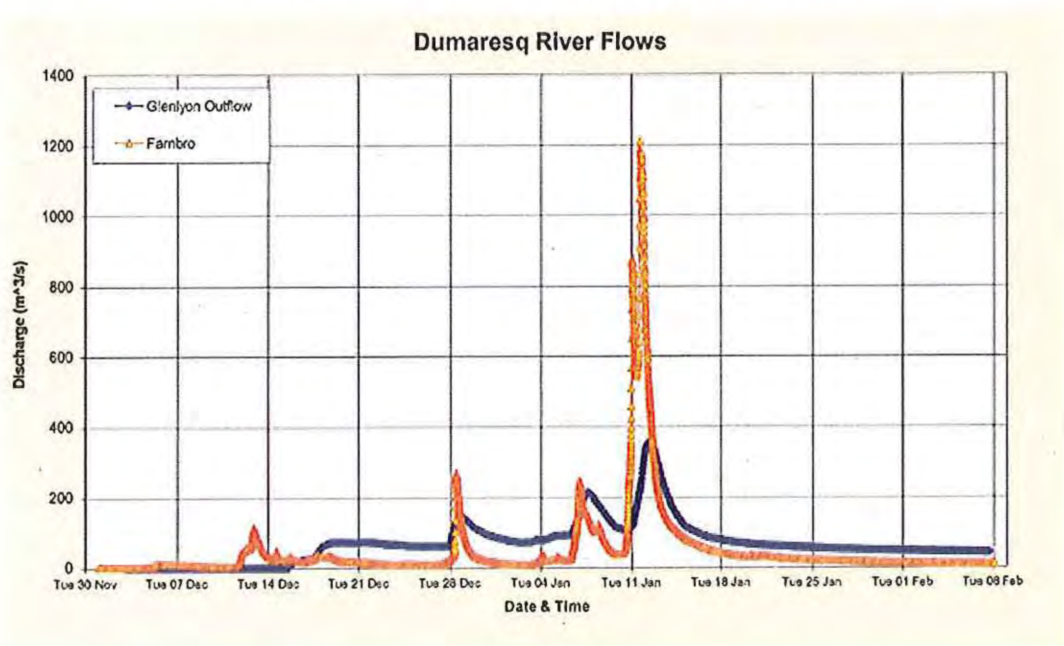


Figure 21-8: River Flows in the Upper Dumaresq River

[redacted]

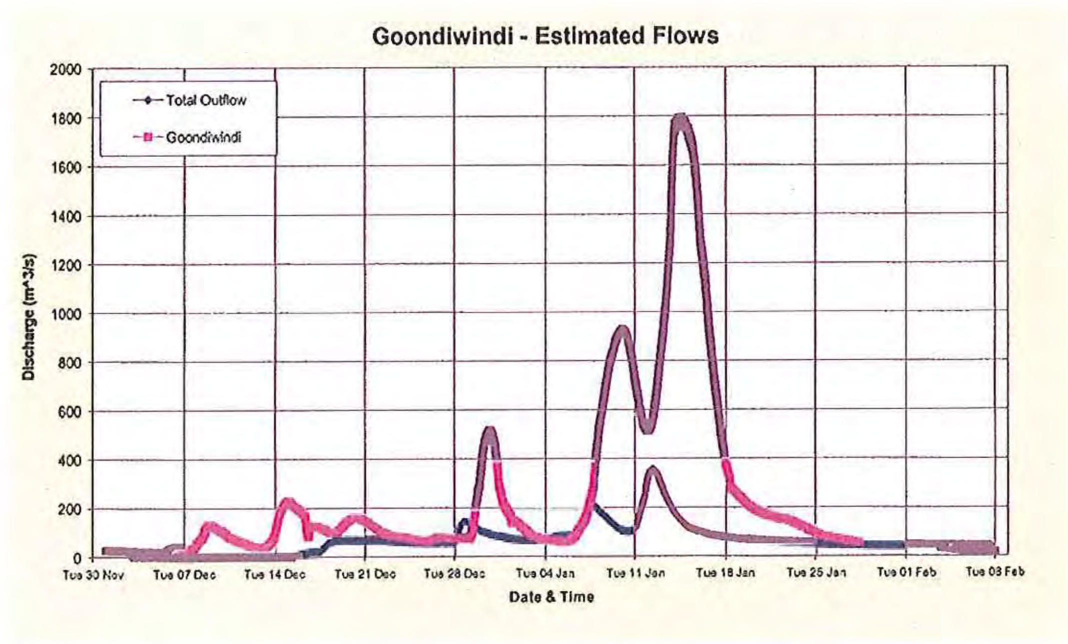


Figure 21-9: Relative size of flood at Glenlyon Dam and Goondiwindi

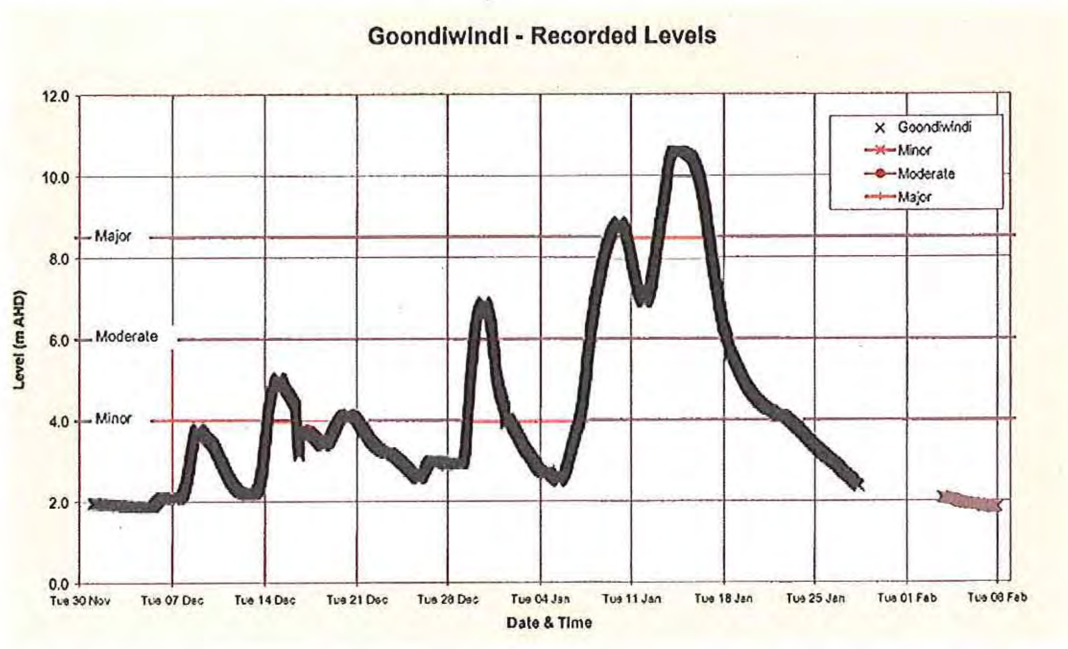


Figure 21-10: Recorded Flood Heights at Goondiwindi

21.1.3.2 Damage and response to damage

There was negligible flood damage to Glenlyon dam.

21.1.3.3 Gauging stations – effect on data collection

Figure 21-1 shows the location of gauging stations in the catchment. Phone line damage during the peak flood severed communication with the gauging stations. This did not have a direct impact on the operations of Glenlyon Dam. Operators were able to read the manual gauge boards for the headwater and tailwater gauges.

21.1.3.4 Community inquiries

SunWater received a small number of inquiries regarding water levels and flows from Glenlyon Dam (refer section 2.1.1 of my statement re provisions for 24/7 emergency contact with SunWater through the call centre).

21.1.3.5 Media Coverage

There were no specific reports about Glenlyon Dam.

21.1.3.6 Post Event Review

SunWater undertook a review of the event for the dams in southern Queensland. This review took the form of a memo from the Area Operations Manager. The review found that:

- The EAP was generally adequate, however some updating is required to reflect current SunWater internal reporting arrangements. The most current notification list needs to be issued to all on the distribution list. The amendments to the documents are in progress;
- Expanding SunWater's use of an SMS messaging service to include notification of nominated landholders in the EAP could streamline communication of an EAP event. This option is under investigation and if feasible will be implemented before the end of 2011.

The Glenlyon Dam Annual Inspection Report 21 September 2010 (page 8) notes that there are multiple SES contacts listed in the EAP and that a single SES contact would be an improvement. This will be considered as part of the review and reissue of the EAP described above.

21.1.4 Local Disaster Management SunWater Relationship

The Queensland Government District Disaster Management guidelines note that District Disaster Management Groups (DDMG) in the Queensland disaster management arrangements are established to provide a whole-of-government planning and coordination capability to support local governments in disaster management.[4] The Operational Planning Guidelines for Local Disaster Management Groups[5] identifies the role of the LDMG during an event as coordination of support to response agencies, reconnaissance and impact assessment, and provision of public information.

4

http://www.disaster.qld.gov.au/publications/pdf/District%20Disaster%20Management%20Guidelines.pdf

5

http://www.disaster.qld.gov.au/publications/pdf/Operational%20Planning%20Guidelines%20for%20Local%20Disaster%20Management%20Groups.pdf

[redacted]

The Glenlyon Dam EAP is consistent with the State Emergency Management framework described above and in section 7 of my statement. It is premised on SunWater operating and managing an emergency event at the dam and keeping the LDMG informed. The construct of the EAP is based on the premise that the LDMG will use the information on an event gathered from SunWater and others to assess, determine and coordinate the actions of various agencies. SunWater does not attempt to manage activities of other agencies elsewhere in the catchment

During this recent event the dam performed to expectations. The stream flows, although significant, were not extreme in a dam safety sense. If circumstances had been more extreme or serious operational problems had been experienced, SunWater staff would have given primacy to protection of life and safety of the dam. The focus of SunWater staff should not be diverted from this priority. It is for this reason that SunWater supports the Queensland Government District Disaster Management framework. In the frame work SunWater provides the necessary communications to LDMG who take the lead in provision of information to the public, media and other agencies. SunWater focuses on operating and managing the safety of the dam.

The model described above was not as mature for the Glenlyon Dam as it could be with respect to the relationship with SunWater. The relationship functioned on an "as-needs" enquiry basis. The LDMG had not included SunWater in the formal operational meetings of the LDMG. The need to contact an extensive list of individual SES controllers and disaster management staff could be streamlined.

SunWater regional staff (Service Managers) have been instructed to make contact with LDMGs in their areas with the aim of improving communications and requesting that SunWater is invited to participate in LDMG meetings during future flood events.

21.1.5 Previous flood events

The January event is ranked as the largest flood through the dam since it was constructed in 1976, marginally greater than the flood of July 1984.

FSL 412.09 m

Flood Rank	Date	Peak Height EL	Peak Height Above Crest
1	Jan-11	413.54	1.45
2	Jul-84	413.51	1.42
3	Feb-84	412.63	0.54
4	Apr-84	412.62	0.53
5	Aug-98	412.58	0.49
6	Nov-99	412.48	0.39
7	Apr-88	412.44	0.35
8	Sep-88	412.39	0.30
9	Oct-96	412.30	0.21
10	Oct-83	412.29	0.20
2010-11 Flood			
1	Jan-11	413.54	1.45

Figure 21-11 Glenlyon Dam - Ranking of Historic Flood Events

21.1.6 Flood mitigation opportunities/ upgrade or communities potentially affected

The Border Rivers ROP specifies rules for the operation of Glenlyon Dam, including how releases are to be determined. Any alternative operating arrangements are not possible under the current regulatory rules. SunWater developed and used the flood model for Glenlyon Dam to evaluate how the dam might operate to mitigate flood events.

There is no flood mitigation storage in Glenlyon dam. The only air space would be if the dam was below the full supply level prior to an event.

Figure 21-12 shows the scenario of the actual inflows from 1 December 2010 if the dam had been empty as at 1 December 2010; however this would not be practical for the reason of compliance set out above. It is noted that the peak height under this scenario would have been approximately 0.3m below the actual event. It is unlikely that any flood mitigation benefit could be derived from the current configuration of Glenlyon Dam without a significant loss of water supply to the local community.

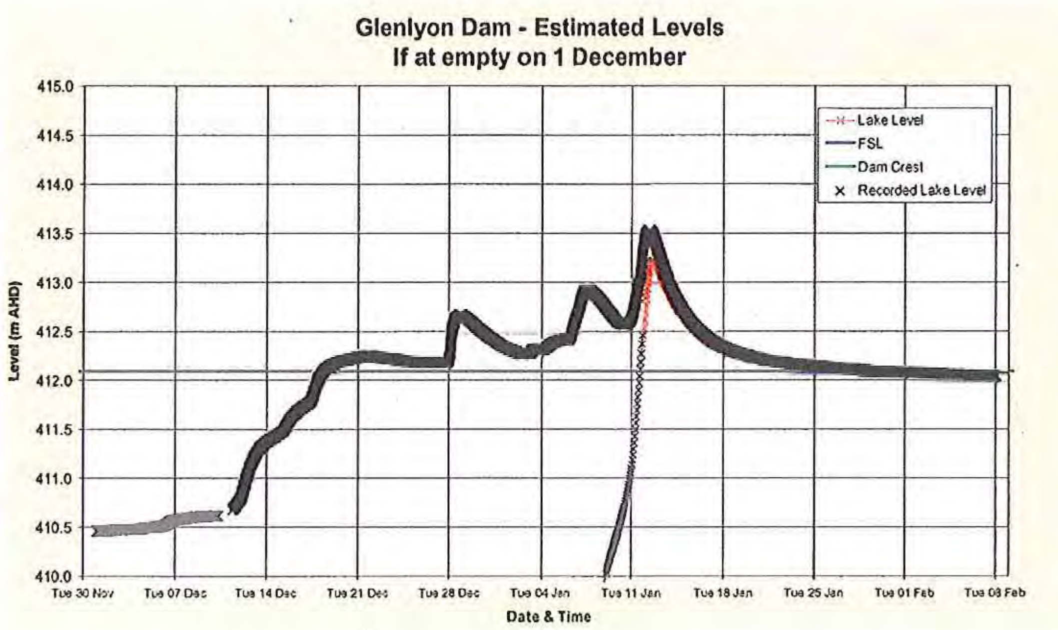


Figure 21-12 Glenlyon Dam Simulated Behaviour if Empty on 1 January 2011

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867*.

Sworn and Declared at Brisbane)

this 29th day of April 2011 in the)

presence of:)

[redacted]

Signature of the declarant

[redacted]..........

ASHLEY WREN

~~Justice of the Peace~~/ Solicitor/

~~Commissioner for Declarations~~