Appendix 16

RETURN TO APPENDICES LIST

Critical Assets Due Diligence Review
(R2A Pty Ltd)

GLADSTONE AREA WATER BOARD

Critical Assets Due Diligence Review

February 2009

Risk & Reliability Associates
R2A Pty Ltd ACN 115 818 338 ABN 66 115 818 338

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On behalf of:
R2A Pty Ltd
ACN 115 818 338
ABN 66 115 818 338
Consulting Engineers
Level 1
55 Hardware Lane
Melbourne Australia 3000

Telephone: + 613 8631 3400
Facsimile: + 613 9670 6360
Email: risk@r2a.com.au
Internet: http://www.r2a.com.au

Authorised

	Distribution	Number	Comments
a.	Client	(1)	Mr Richard West
b.	R2A	(1)	Client File
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Gladstone Area Water Board
Critical Assets Due Diligence Review
February 2009

EXECUTIVE SUMMARY

In February 2009, the Gladstone Area Water Board (GAWB) commissioned R2A to undertake a critical infrastructure due diligence review to ensure that all sensible practicable precautions are in place to provide adequate water supplies to GAWB bulk customers.

The review identified critical infrastructure, key threat scenarios and the possible precautionary options. The judgement regarding the balance of the significance of the risk verses the effort required to achieve it and the subsequent implementation of further precautions is to be completed by others.

The review involved three tasks:

i. Functional boundary analysis to establish the risk context for the review. This examined the credible boundary threats to the critical success factors of GAWB defined as the requirements (quantity and availability) of supply to bulk water customers. This used established techniques from the military intelligence/security community.

ii. Zonal vulnerability assessment to identify the critical common mode and common cause failures within the GAWB asset base. This used established techniques from highly protected risk (HPR) underwriters.

iii. Raw water system availability modelling for each of the bulk water customers focussing on the possible operating configurations and the identified critical elements in the context of the high-level objectives of GAWB. This used standard reliability engineering tools.

The current network arrangements require water to be pumped from Awoonga Dam to Toolooa Reservoir nightly. The water is then distributed throughout the network the following day. Given this arrangement there is limited time available for preventive or corrective maintenance to the system without causing significant interruption to supply.

From a criticality viewpoint, there are a number of external threats and common mode failures that will interrupt supply for an extended period of time (see section 6.0) especially drought, dam break and the like. The provision of an alternate independent water supply such as the Gladstone - Fitzroy pipeline or a desalination plant will address all of these identified long term threat scenarios.

The provision of an 2 week + off-line storage facility and associated pumping station will address supply interruptions associated with failures of 14 days and less. This significantly reduces the network's current criticality for all lesser critical threats and improves the average availability of bulk water to GAWB customers by approximately 2 days per annum.

1.0 OBJECTIVE

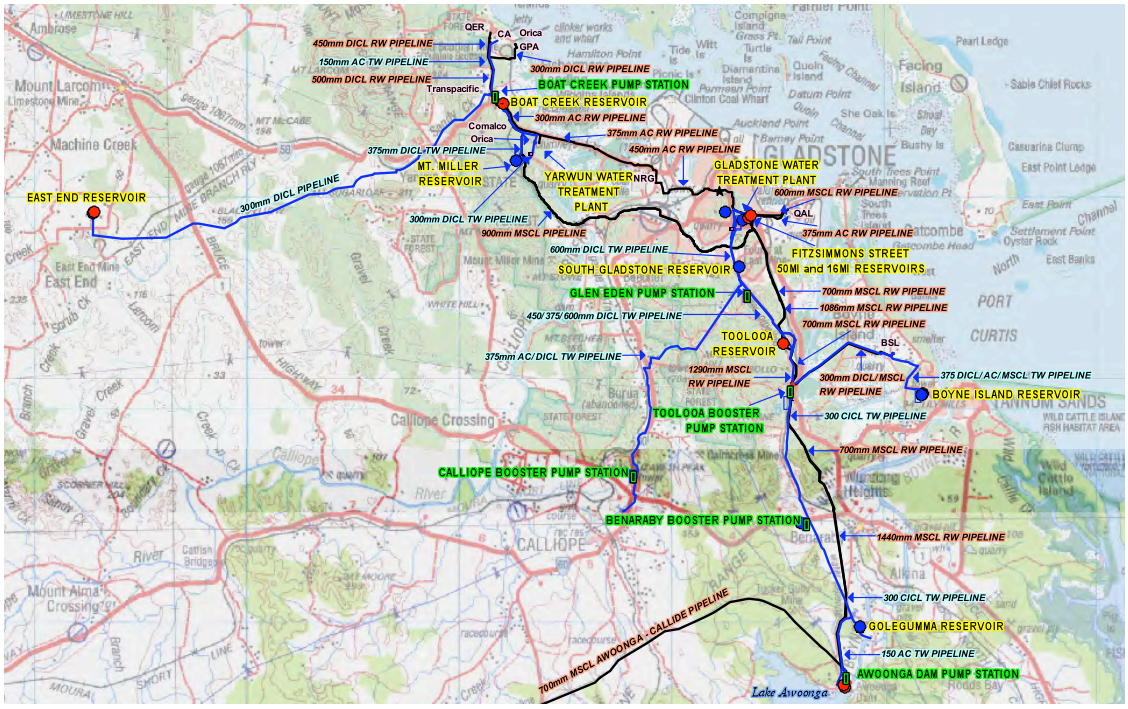
The objective of the review is to complete a due diligence study of Gladstone Area Water Board's critical infrastructure to confirm that all sensible practicable precautions are in place (based on the significance of the risk verses the effort required to reduce it) to provide adequate water supplies to GAWB bulk customers.

2.0 GLADSTONE AREA WATER BOARD

Gladstone Area Water Board (GAWB) is a Category 1 Water Authority under the Water Act 2000 and a registered service provider under the Water Supply (Safety & Reliability) Act 2008. GAWB owns and operates bulk treated (potable) and raw (non-potable) water storage and supply system throughout the Gladstone region of Central Queensland. Assets include:

- Awoonga Dam on the Boyne River and raw water pumping station
- Gladstone and Yarwun Water Treatment Plants
- Raw water reservoirs at Gladstone (Fitzsimmons Street – 50Ml and 16Ml) and Toolooa (50Ml)
- Treated water reservoirs at Boyne Island, East End, Golegumma, South Gladstone, Mt Miller, Gladstone Clearwater and Yarwun Clearwater
- Delivery pipelines (121km of raw water pipelines and 90km of treated water pipelines).

The following map outlines the GAWB network.

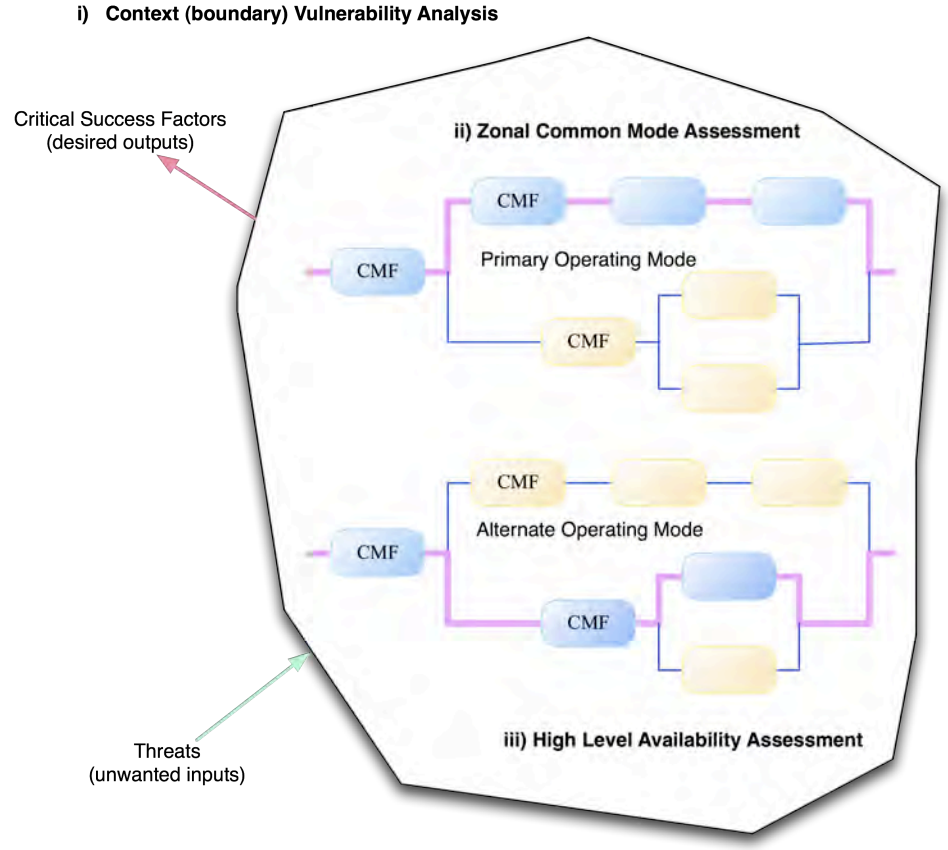


GAWB Water Systems and Services Network

3.0 METHOD

3.1 Enterprise Availability Profiling Process

The methodology adopted for the review is a risk based availability modelling technique that uses both top down and bottom up approaches as described in detail in Chapter 22 of the R2A text and is summarised below. The review involves three (3) tasks and is represented by the following diagram.



Context of the Three Assessments

i. Functional boundary analysis. This is a high-level context (boundary) vulnerability analysis establishing the risk context for the review. It examines the credible boundary threats to the critical success factors of GAWB. In this study, the critical success factors were defined as the requirements (quantity and availability) of the bulk water customers.

ii. Zonal vulnerability assessment. This process identifies the critical common mode and common cause failures such as issues associated with fires/explosions, pipe failures and such. This is usually done on a geographic and incident history basis.

iii. Raw water system availability modelling. The third task is a high-level availability analysis of the raw water system for each of the bulk water customers focussing on the possible operating configurations and the identified critical elements in the context of the high-level objectives of GAWB.

3.2 Tasks Completed

The majority of the review was complete on-site in Gladstone from Tuesday 3 February to Friday 6 February 2009. During that time the following tasks were completed.

3.2.1 Inception Meeting and Due Diligence Briefing (Tuesday 3 February 2009)

The review kicked off on Tuesday 3 February 2009with an inception meeting and due diligence briefing. The session was attended by:

Bernadette LeGrand	Commercial Manager / Corporate Counsel
James Stewart	Operations Manager
Peter Tame	Operational Assets and Dam Safety Supervisor
Richard West	Engineering Specialist

The objective of the session was to brief the group on the due diligence process for the review. This presentation is attached as Appendix A.

3.2.2 Inspection of Critical Assets (Tuesday 3 February 2009)

In order to provide an appreciation of the GAWB network, Peter Tame and Richard West accompanied Richard Robinson and Gaye Francis on a tour of critical infrastructure including the Awoonga Dam and pump station, the raw water reservoirs and water treatment plants. An overview of key customers and their location was also provided.

Representative photographs of GAWB critical infrastructure are attached in Appendix B.

3.2.3 Functional & Common Mode Assessment Workshop (Wednesday 4 February 2009)

A half-day workshop session was held on Wednesday 4 February 2009. The following GAWB personnel attended and participated in the session.

Luke Anderson	Student Civil Engineer
Brian Brown	Electrical and Mechanical Maintenance Services Supervisor
Geoff Howse	Senior Water Engineer
Bernadette LeGrand	Commercial Manager / Corporate Counsel
James Stewart	Operations Manager
Peter Tame	Operational Assets and Dam Safety Supervisor
Dean Tappin	O&M Services Manager
Richard West	Engineering Specialist

The session was facilitated and documented by Richard Robinson and Gaye Francis, R2A. As an introduction to the workshop, Richard Robinson provided the group with an overview of the Availability Profiling process. This presentation is attached as Appendix C.

3.2.4 Progress Briefing Session (Friday 6 February 2009)

At the conclusion of the initial week in Gladstone, Richard Robinson provided the following GAWB personnel with a progress on the workshop outcomes and the availability model to date:

Jim Grayson	Chief Executive Officer
Bernadette LeGrand	Commercial Manager / Corporate Counsel
James Stewart	Operations Manager
Peter Tame	Operational Assets and Dam Safety Supervisor
Dean Tappin	O&M Services Manager
Steve Vercoe	Operations Support Officer
Richard West	Engineering Specialist

3.2.5 Review Workshop

A review workshop was held on Wednesday 25 February 2009 at the GAWB offices, Gladstone. The objective of the session was to review the accuracy of the availability model and its implications on the provision of bulk water to GAWB customers. The following GAWB personnel attended and participated in the session:

Greg Clifford	Technical Officer, GIS
Rosemary Fredriksen	Project Administrator
Bernadette LeGrand	Commercial Manager / Corporate Counsel
Peter Tame	Operational Assets and Dam Safety Supervisor
Dean Tappin	O&M Services Manager
Steve Vercoe	Operations Support Officer
Richard West	Engineering Specialist

The session was facilitated and documented by Richard Robinson and Gaye Francis, R2A.

A summary of the review and the outcomes was also provided to James Stewart, Operations Manager and Jim Grayson, Chief Executive Officer.

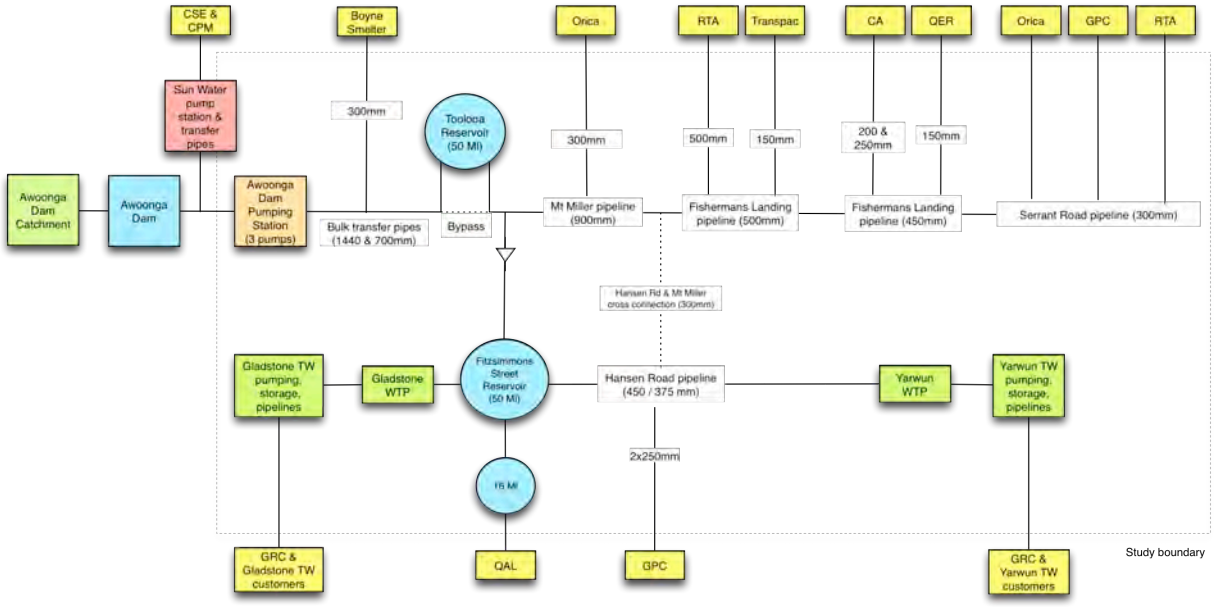
3.2.6 Review Sign-off

The group agreed that the availability model was a reasonable representation of the GAWB bulk water network in its current configuration and the estimates reflected GAWB's experience to date.

As a final check the group was asked if there were any other issues or good ideas that should be put on the table in relation to this review. No other suggestions were made.

4.0 BOUNDARY ANALYSIS

In order to determine the actual effective availability of the network in the context of all the credible risk issues for each of the critical customers identified, the following boundary analysis was completed. The context boundary was defined from the Awoonga pumping station to the meter of each critical customer as shown schematically in the diagram below.



Bulk Water Transfer Functional Schematic

Water is pumped nightly from Awoonga Dam to Toolooa Reservoir where the bulk water is then distributed across the network.

The following vulnerability assessment was then completed identifying the critical success factors and the external credible threats. The critical success factors were defined as the requirements of GAWB's bulk customers, namely;

- Boyne Smelter
- Cement Australia (CA)
- Gladstone Port Corporation (GPC)
- Orica
- Queensland Alumina Limited (QAL)
- Queensland Energy Resources (QER)
- Rio Tinto Aluminium (RTA)
- Transpacific (Transpac)
- Gladstone Regional Council (GRC)
- CSE and CPM Power Stations

Boundary credible threats are listed in the table over page. Vulnerabilities were then characterised by criticality. Note that these values do not address risk in that they do not consider likelihood. The intention was to test identified credible issues to determine how bad (or critical) they could be. The question of the likelihood of such issues occurring is only raised to test the value of suggested precautions.

		GAWB Delivery Critical Success Factors									
		Boyne Smelter	Cement Australia	Gladstone Port Corp.	Orica	QAL	QER	RTA	Transpacific	GRC	CSE & CPM
	Raw water (Ml pa)	650	230	580	1,120	10,775	10	3,700	25	-	-
	Treated water (Ml pa)	80	40	-	570	6	-	515	-	9,000	-
	Max service interruption interval										
Credible Threats											
1	Dam failure (earthquake, flood)	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
2	Bushfire (catchment)	x	x	x	x	x	x	x	x	x	x
3	Power failure (cyclone/storm, supply failure, switchyard failure)	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
4	Regulatory changes incl. reduced allocation	x	x	x	x	x	x	x	x	x	x
5	Inundation / flood (tailwater)	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
6	Industrial issues incl. contractors esp treated water	xxx	xxx	-	xxx	xxx	-	xxx	-	xxx	-
7	External comms failure eg backup comms, telephone, modems	x	x	x	x	x	x	x	x	x	x
8	Drought	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
9	Contamination	x	x	x	x	x	x	x	x	x	x
10	Sabotage / Terrorism	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
11	Sun Water infrastructure failure	xx	xx	xx	xx	xx	xx	xx	xx	xx	xxx

Boundary Vulnerability Assessment

xxx	Credible critical potential vulnerability that must be addressed
xx	Moderate potential vulnerability
x	Minor potential vulnerability
-	No vulnerability detected

For each credible issue which was identified as being capable of creating critical outcomes (xxx), a further analysis was undertaken to test for reasonable practicable precautions with the intention of ensuring that reasonable practicable precautions are in place based on the balance of the significance of the risk vs the effort required to reduce it. These are summarised below and the completed profiling sheets attached as Appendix D.

4.1 Dam failure

Dam failure was considered a critical threat to all bulk customers. The group identified a number of failure mechanisms including earthquake, flood, mechanical failure and structural failure. GAWB currently have a Dam Safety Management Program consistent with Australian National Committee on Large Dams (ANCOLD) and Queensland Dam Management Safety Guidelines which include annual inspections and independent third party audits every 5 years.

4.2 Power failure

The power to the Awoonga pumping station was considered critical for the delivery of water to bulk customers. Again a number of failure mechanisms were identified including cyclone/storm, ERGON supply failure and switchyard failure.

GAWB understand that the substation has two alternate feeds each capable of running the substation. This should be confirmed with ERGON. As an alternate power supply, a generator has been investigated and is understood not to be financially viable. This should be confirmed and documented.

It was subsequently confirmed by Welcon that there are two separate ERGON feeders to the substation.

4.3 Inundation / flood (tail water)

In the event of an extreme flood event, the tail water could rise and flood the pumping station or the switch rooms. It may also cause access difficulties to the dam. The workshop group was informed that the pumping station and switch rooms had been designed to be above the tailwater for a PMF event and were not expected to flood.

4.4 Industrial issues

Industrial issues including those associated with contractors was considered a credible critical issue. Operation of the two water treatment plants is currently contracted to the Gladstone Regional Council. In addition, long-term operation of the treatment plants relies on delivery of chemical supplies.

Existing controls include 2-3 weeks minimum supply of chemicals on-site, appropriately qualified operators on staff. Industrial relations issues are monitored.

No further controls were suggested.

4.5 Drought

Lack of water to supply customers is a credible critical threat. GAWB have a single water supply from the Awoonga Dam. Existing controls include the Contingent Supply Strategy and associated desal study, forward prediction drought modelling and a Drought Management Plan.

No further controls were noted for consideration.

4.6 Sabotage / terrorism

The threat of sabotage / terrorism was considered to be critical to all bulk water customers. A number of mechanisms including explosion at the dam or pumping station or disgruntled employee were noted as possible.

Existing controls included fencing, locked gates at the dam wall, Dam Supervisor on-site during office hours and live-in Rangers. Additional controls suggested for consideration include expansion of the exclusion zone on the water, installation of an electric fence and CCTV with appropriate Ranger response.

4.7 Sunwater infrastructure failure

Sunwater also have a pumping station at Awoonga and failure of this or other delivery infrastructure has the potential to impact GAWB customers resulting in loss of revenue. The particular vulnerability of concern is that there is no isolation valve between Sunwater's pipeline and GAWB's outlet works at the pumping station therefore having a potential to impact GAWB's infrastructure in the event of a failure.

Sunwater operate within the same regulatory environment as GAWB however it was suggested that consideration be given to installing an isolating valve to protect (other) GAWB customers.

5.0 BULK WATER TRANSFER SYSTEM AVAILABILITY MODELLING

The third task was to model the GAWB network in view of the high level critical success factors and external and common mode threats / issues. The following schematic represents the key elements for the delivery of bulk water to GAWB customers.

Availability estimates for the model were based on GAWB and general industry experience. The full model is attached as Appendix E.

5.1 External Threats

This describes incidents that can affect the whole GAWB water supply chain. These were identified during the context vulnerability assessment and include drought, dam failure and power supply failure. See section 4.0 for details.

5.2 Awoonga Pump Station Threats

The pump station at Awoonga has three pumps (duty, standby and backup) all capable of pumping the full bulk water requirement. However, a number of common mode failures were identified that take out all of the pumps at the same time. Key failure modes include:

- Wooden power pole failure
- Storm or cyclone resulting in power supply impact
- Grouped cable fire
- Fire / explosion in pumpwell, VFD building or HV switch room
- Pump well flood

It was also noted that there is a single point failure associated with the underground pipeline from the pump station to the bulk transfer pipes on the other side of the spillway.

5.3 Bulk Water Transfer

From the pump station the water can be transferred to the storage reservoirs either via the 1440mm underground or 700mm above ground pipeline. The two pipes run parallel along the road and three common mode failures were identified that could affect both pipes:

- Transfer SCADA failure
- Washaway (one pipe washes out the other)
- Malicious damage

5.4 Storage

Effectively bulk water is transferred to the two 50Ml storage reservoirs at Toolooa and Fitzsimmons St. before being distributed to the bulk water customers. Either of the reservoirs can feed all bulk water customers, therefore making the storage system redundant.

5.5 Distribution System

The distribution system delivers bulk water to customers from the two storage reservoirs and is made up of various length underground pipes. An average fault rate per kilometre per year based on GAWB experience of unplanned failures which was then used to estimate the failure rate for each delivery pipeline.

It was noted during the discussions that pipes are not usually expected to fail catastrophically and minor failures can usually be repaired without significant interruptions to water delivery.

5.6 Water Treatment

In addition to providing bulk raw water, GAWB is also responsible for the provision of some bulk treated water. GAWB have two water treatment plants, one at Gladstone and the other at Yarwun which are operated by the Gladstone Regional Council.

Two availability models were developed for the treated water, one each for Gladstone and Yarwun. Elements modelled included common mode failures to the water treatment plant, the treatment process, pumping, storage and customer delivery system.

5.7 Summary of Results

The following table summarises the modelling results for bulk customers in days unavailable for each of the high-level functional elements.

Customer	External threats	Awoonga PS	Bulk transfer	Storage	Bulk distribution	Raw water unavailability	Treated water unavailability
Boyne Smelter	4.65	1.0908	0.019	0.0127	0.0075	5.78	6.17
Cement Aust., Boat Creek	4.65	1.0908	0.019	0.0127	0.2205	6.02	6.77
Cement Aust., East End	4.65	1.0908	0.019	0.0127	0.2205	6.02	7.28
Gladstone Port Corp., Hansen Rd	4.65	1.0908	0.019	0.0127	0.0375	5.81	
Gladstone Port Corp., Serrant Rd	4.65	1.0908	0.019	0.0127	0.2206	6.03	
Gladstone Water Treatment Plant	4.65	1.0908	0.019	0.0127	0.0125	5.76	
Orica (Mt Miller)	4.65	1.0908	0.019	0.0127	0.2203	6.00	6.73
Orica, Serrant Rd	4.65	1.0908	0.019	0.0127	0.2206	6.03	
Queensland Aluminium	4.65	1.0908	0.019	0.0127	0.0025	5.77	6.17
Queensland Energy Resources	4.65	1.0908	0.019	0.0127	0.2205	6.02	
Rio Tinto Aust., Refinery	4.65	1.0908	0.019	0.0127	0.2204	6.01	6.73
Rio Tinto Aust., RMA	4.65	1.0908	0.019	0.0127	0.2206	6.03	6.85
Transpacific	4.65	1.0908	0.019	0.0127	0.2204	6.01	
Yarwun Water Treatment Plant	4.65	1.0908	0.019	0.0127	0.0375	5.81	

As can be seen in the table, the majority of the total days unavailable for bulk raw water is related to external threats and the common mode failures at the Awoonga pump station. Most of these items are characterised as unlikely but have significant downtime consequences. In turn the unavailability numbers for treated water is driven by the unavailability of bulk raw water to the treatment plants.

For example, based on the modelling Queensland Aluminium Limited, on average will not have raw water available 5.77 days per annum. 4.65 of these days are a result of the external threats identified and 1.09 days associated with the threats identified at Awoonga Dam.

6.0 PRECAUTIONARY REVIEW

From a criticality viewpoint, there are a number of external threats and common mode failures that will interrupt supply for an extended period of time. These are shown in the table below.

External threat / common mode failure	Criticality (days duration)
Sabotage / terrorism	1000
Dam failure	1000
Drought (single catchment)	36
Sunwater infrastructure failure	14
Inundation (tail water)	14
Fire / explosion in HV switch room	14
Pump well flood (broken pipe)	14
Fire / explosion in VFD building	14
Fire / explosion in pump well	14
Loss of surge tank	14
Corrosion / erosion of spillway pipe	14
Fire / explosion at Gladstone Water Treatment Plant	14
Sabotage / terrorism at Gladstone Water Treatment Plant	14
Fire / explosion at Yarwun Water Treatment Plant	14
Sabotage / terrorism at Yarwun Water Treatment Plant	14
Rail bridge failure (over Calliope River)	10
Power supply failure (grid loss)	7
Wash away of main transfer pipe to storage	7
Malicious damage of main transfer pipe	7
Group cable fire	5
Wooden pole failure at Awoonga	3
Storm or cyclone (power supply interruption)	3
Pole collapse into cutting	3
Lightning strike (control system)	3

During discussions with the GAWB stakeholders, a number of generic precautions emerged to address these concerns. These are discussed in turn below. They have been considered by their ability to address criticality (duration) of identified threat scenarios.

6.1 Alternate Independent Water Supply

GAWB's current single source of supply means that it is particularly vulnerable to any threats that can prevent the delivery of water for a long period of time (months and years).

Provision of an alternate independent water supply such as the Gladstone - Fitzroy pipeline project and desalination poject currently under consideration by GAWB will address all of the long term identified credible critical threats including drought, dam failure and terrorism, based on current demands.

6.2 Large Off-line Storage and Pump Station

Once full, a large off-line storage with a capacity of 2+ weeks supply and redundantly connected to the GAWB bulk supply network would address supply interruptions associated with failures of 14 days and less. This means that from a criticality viewpoint, the only external threats that remain critical to the network with the large storage in place are sabotage / terrorism, dam failure and drought.

Such a new large storage arrangement will slightly improve the average availability of the bulk water customers by approximately 2 days per annum (see table below). The full availability model for this option is attached as Appendix F.

Customer	External threats	Awoonga PS	Bulk transfer	Storage	Bulk distribution	Raw water unavailability	Treated water unavailability
Boyne Smelter	3.71	0	0	0.0127	0.0075	3.74	4.13
Cement Aust., Boat Creek	3.71	1.0908	0.019	0.0127	0.2205	3.98	4.74
Cement Aust., East End	3.71	1.0908	0.019	0.0127	0.2205	3.98	5.25
Gladstone Port Corp., Hansen Rd	3.71	1.0908	0.019	0.0127	0.0375	3.77	
Gladstone Port Corp., Serrant Rd	3.71	1.0908	0.019	0.0127	0.2206	3.99	
Gladstone Water Treatment Plant	3.71	1.0908	0.019	0.0127	0.0125	3.72	
Orica (Mt Miller)	3.71	1.0908	0.019	0.0127	0.2203	3.97	4.70
Orica, Serrant Rd	3.71	1.0908	0.019	0.0127	0.2206	4.00	
Queensland Aluminium	3.71	1.0908	0.019	0.0127	0.0025	3.74	4.13
Queensland Energy Resources	3.71	1.0908	0.019	0.0127	0.2205	3.98	
Rio Tinto Aust., Refinery	3.71	1.0908	0.019	0.0127	0.2204	3.98	4.70
Rio Tinto Aust., RMA	3.71	1.0908	0.019	0.0127	0.2206	3.99	4.74
Transpacific	3.71	1.0908	0.019	0.0127	0.2204	3.98	
Yarwun Water Treatment Plant	3.71	1.0908	0.019	0.0127	0.0375	3.77	

6.3 Improving Current Network Reliability

A number of precautions were suggested to address individual issues. These include:

- Discuss delivery requirements with bulk customers with a view to encouraging on-site storage.
- Confirm that there are two independent power supplies to the Ergon substation.
- Installing an underground power supply to the Awoonga pump station. This will address pumping common mode failures such as wooden pole failures, storm/cyclone impacting power, pole collapse into cutting. If this option is not implemented then replacement of the current wooden power poles at Awoonga with concrete poles should be considered.
- Installation of an isolation valve between GAWB and Sunwater infrastructure so that a failure of Sunwater's infrastructure at Awoonga pump station will not affect GAWB's delivery to customers.

Alternatively, a second pump station could be provided. However, it is important to note that these will not address the critical long duration threats like drought.

All of these solutions address a limited number of identified localised critical threats and are expected to have a minor effect on the overall criticality and availability of the network.

6.4 Good Practice Precautions

During the review a number of good practice precautions were identified for implementation. These have little or no effect on the criticality or the overall availability of the bulk water network. They are listed below for completeness.

- Desirably the bulk water supply system should have N-1 redundancy so that short duration preventative and corrective maintenance can be carried out without interruption to supply to any bulk water customer. This also relates to encouraging customer on-site storage.
- Burnt timber power poles should be repaired / replaced.
- Power supply systems should be inspected regularly.
- Cables within the Awoonga Pumping Station should be separated where possible.
- The 2000mm pipeline under the spillway should be inspected for condition assessment.
- A geotechnical inspection of the power poles on the top of the cut slope should be considered for geotech stability.