Appendix 6

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Final Report: Northern Area Water Supply Strategy
(MWH Australia Pty Ltd)

Gladstone Area Water Board

Gladstone Area Water Board

Final Report:

Northern Area Water Supply Strategy

July 2005

MWH

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Quality Assurance Statement	
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Gladstone Area Water Board

Northern Area Water Supply Strategy

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1. Introduction

MWH Australia was commissioned by Gladstone Area Water Board (GAWB) to review the treated and raw water supply systems of the Northern Area of GAWB's bulk delivery network and to develop a strategy for the future development of these systems based on anticipated demands.

The following report outlines the recommended strategy and the corresponding capital works associated.

1.1 Objectives of Study

The objective of this study is to determine the optimal infrastructure and program of works required and also assisting GAWB in their assessment of current and future system performance. It is anticipated that existing system performance will show certain deficiencies within the system that may be improved with system augmentations and additional storage.

Specific objectives that are of note are as follows:

- Assessment of demands for the region with particular attention the peaking;
- The need for mains augmentation and/or new infrastructure to service existing and future demand requirements
- Assessment for additional storage in the regional for servicing of base daily demands and also security of supply;
- Maximising the use of assets by a combination of flow control and balancing of storage;
- The need for and location of any flow or pressure control valves in the system;

1.2 Scope of Works

The scope of works for this project were to cover the following activities:

- System operation to be discussed and agreed with GAWB to determine existing system requirements and impending changes that may need to be to reviewed.
- Review network models and liaise with GAWB on functionality, assumptions and boundary conditions to gain understanding of model operation and its limitations and suitability for the study.
- Review system SCADA and other monitoring data for quality, continuity and suitability for model verification and undertaking of demand peaking assessment.
- Review current GAWB demand projection data and also customer meter data, where available, for suitability in assessment of planning demands and probable peaking factor requirements.
- Assess existing flow data to derive the optimum peak day profile to be used within the model.
- Develop existing and future models to reflect revised demand projections and flow patterns.
- Discuss with GAWB how system performance could be improved for future demand scenarios.

- Verify both existing raw and treated water system models and assess performance of both systems.
- Assess operational and capital system improvement options to both raw and treated water systems.
- Generation of Northern Area treated and raw water supply strategies.

2. System Overview

GAWB's operational area comprises the Local Government Area authorities of the City of Gladstone and the Shire of Calliope. One of the main statutory functions of GAWB is to conserve, store and supply treated and raw water in bulk to local authorities and major consumers within its operational area.

The existing GAWB Northern Area treated and raw water supply systems and serviced customers is presented in **Figure 1** (Appendix A).

2.1 Awoonga to Gladstone Raw Water System

The Awoonga Dam to Gladstone raw water system is the primary delivery system for the entire Gladstone / Calliope region. The system comprises pumped raw water supply from Awoonga Dam PS which has a peak two pump delivery capacity of some 3600L/s pumped through two bulk supply mains of 1440 / 1290mm and 700mm diameter rising mains to Toolooa 50 ML Reservoir balancing storage. Supply then gravitates via 1086mm and 700mm trunk mains to the 900mm Mt Miller pipeline offtake and thence to Gladstone 50 ML and 16 ML raw water reservoirs. One pump operation currently has a peak capacity of around 2,800 L/s.

The hydraulic grade line for this system is governed by the operation of Toolooa Reservoir from which all water is balanced and directed through without by-pass before it is distributed to the Mt Miller pipeline and Gladstone reservoirs. A 700mm diameter by-pass has been provided at Toolooa Reservoir in the event that the reservoir is required to be taken out of service for cleaning and/or maintenance. In this case pump delivery would be made directly to Gladstone Reservoirs.

The overall capacity of this system is some 150 to 200 ML/d with unrestricted two pump operation at Awoonga PS operating via Toolooa reservoir replenishment requirements. Energy management protocols for the Awoonga Dam pumps restrict operation to certain times of the day to avoid large electricity tariffs that are incurred during peak times. The delivery capacity of the system under current energy management (i.e. off-peak times of 9pm to 6am) with two pumps operating is around 100 ML/d. With one pump operation (as with the current scenario) the delivery capacity reduces to around 80 ML/d.

Flow control valves (FCVs) currently installed on the inlet to Gladstone 50 ML reservoir are automatically operated via level in the receiving reservoir which subsequently dictate the flow demanded from Toolooa reservoir. It is understood that in conjunction the removal of a reflux valve at Gladstone reservoir these FCVs will be reprogrammed to close on a low-level alarm in Toolooa reservoir allowing backfeeding from Gladstone reservoirs to the Mt Miller pipeline. GAWB currently proposes this action as a security of supply and optimising measure to better distribute and utilise available storage.

2.2 Yarwun and Fishermans Landing Raw Water System

The Yarwun and Fishermans Landing raw water system is sourced from the 900mm diameter Mt Miller pipeline which receives its supply from the 1086mm diameter Toolooa to Gladstone trunk main prior to its delivery to Gladstone reservoirs. This system is highly dependent on the operation of the Awoonga to Gladstone system

and its capacity varies according to whether Gladstone reservoirs are filling, what level they are filling from and whether the inlet supply is being regulated.

This system currently services raw water customers in the Yarwun and Fishermans Landing area via 500mm and 450mm mains and is at present separated from the Hansons Rd main raw water supply through a cross-connection and isolation valve at the railway bridge between Reid and Boat Creek Roads, Yarwun. Customer demand peaking in this system is currently known to have significant bearing on its performance and supply to the extremities of the Fishermans Landing area is known to be extremely variable.

2.3 Hansons Rd to Yarwun Raw Water System

The Hansons Rd to Yarwun system forms part of the original raw water supply to the Fishermans Landing area which now currently supplies raw water supply to the Yarwun WTP and remains isolated from the Yarwun / Fishermans Landing system (or Mt Miller pipeline). The system consists of 450-375-300mm diameter supply mains sourced from the higher 50 ML Gladstone raw water reservoir (or alternatively the lower 16 ML Fitsimmons St reservoir at a lower supply capacity). This supply is directed to the Yarwun WTP via a 300mm diameter inlet after which this water is treated to form the basis of treated water supply to the Yarwun / Mt Miller treated water system.

2.4 Yarwun and Mt Miller Treated Water System

The Yarwun / Mt Miller treated water system sources it supply from the Yarwun WTP from which treated water is pumped from the clear water tank directly to Mt Miller reservoir (TWL = 83.6m AHD and capacity = 6.4 ML). The Mt Miller reservoir provides the supply head and storage necessary to service the Yarwun and Fishermans Landing areas which is achieved through a 375-300mm mains to the local Yarwun area and a 150mm main servicing the Fishermans Landing area. Boat Creek PS can further boost this head to enable periodic supply via a high level 300mm diameter main to East End reservoir and Mt Larcom township. At present the East End main is pumped on a automatic basis when East End Reservoir requires replenishment (usually once weekly) or when the CAR RMA site serviced off this main requests water for replenishment of its storage which is currently a manual operation.

3. Demand Forecasts

In order to assess existing and future system performance, it was necessary to review existing and future demand requirements for both the raw and treated water systems. The following sections detail the methodology in which flow data was assessed, demand patterns determined and annual demand forecasts employed for future assessments.

3.1 Existing Demand

To assess the existing base demands currently being applied on the treated and raw water supply systems, it was necessary to review existing documented demand data and any flow logged data for the purpose of developing base demands which could be applied to the network model. In this regard GAWB has undertaken a recent extensive monitoring program of key customer usage and their daily patterns of usage which was important to understanding how the system was currently utilized. This data was individually reviewed to determine a peak day profile that could be utilised within the model. Section 3.4 explains the methodology used in the generation of these profiles.

3.2 Annual Demand Forecasts

Annual demand forecasts for all bulk users within the system have been developed by several external sources including those internal to GAWB. Subsequent discussions with GAWB allowed this information to be further broken down and reviewed against expected future growth. It is understood that GAWB have been in discussions with customers and industry to determine their future growth, and to also review their requirement for treated and/or raw water supply to service their usage needs.

Table 3.1 details how the existing and future demands have been attributed within the model. It is understood that the demand data was derived by analysis of GAWB historic data and reviewed against several augmentation reports undertaken for GAWB for future planning by other consultants.

Flow data provided by GAWB from customer flow monitoring formed the basis for determination of demand patterns for use within the model. All demands detailed in **Table 3.1** have an associated pattern, allowing a 24 hour profile to be generated within the model for subsequent 24 hour peak and 7 day continuous storage analysis. These patterns have been discussed with GAWB and adjusted to cater for certain excessive peaks and/or anomalies that have been reflected in the data, i.e., Fire System Testing, which does not normally occur on a daily basis within the system and therefore alleviating unnecessary 'spiking' from the data.

The flow data was reviewed to determine an optimum day that would allow an appropriate pattern to be generated. A normalised profile was generated for each demand user based on the total flow for the day. The total flow for the day was then utilised in the existing system scenario as the demand for that customer. This profile was then employed on all future demand projection scenarios.

Table 3-1: Daily Demands Applied to Model Scenarios

Confidential customer information

Figure 3.1 – Projected Daily Model Demands

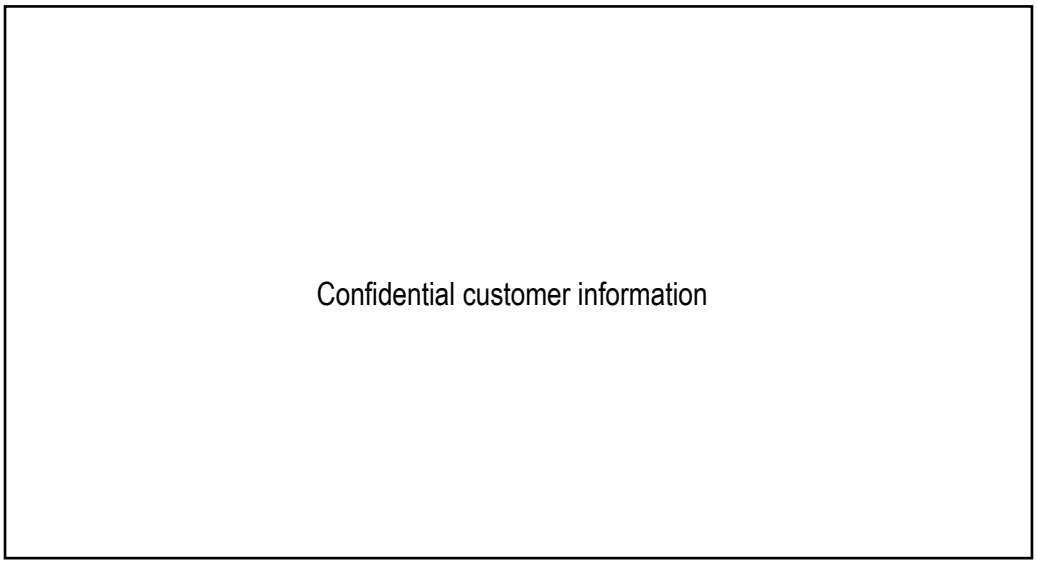
Confidential customer information

3.3 Adopted Demand Patterns and Peaking Factors

The following section details the methodology and processes used in the determination and calculation of the adopted demand patterns and the use of peaking factors within the model.

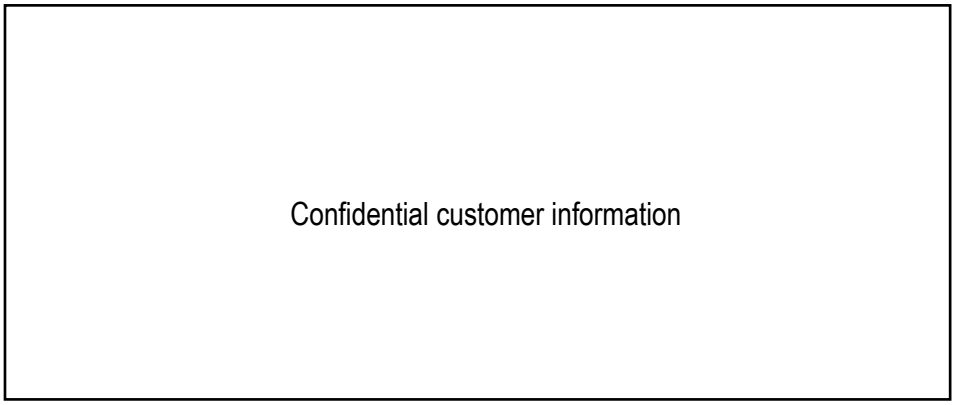
Analysis of logged customer flow data to determine a peak day period was required. In order to do this it was necessary to review the complete set of individual consumer data in graphic format, Figure 3.2details how this was undertaken.

Figure 3.2 - Column Graph Depicting Peak Data Review



All the data received was reviewed in this manner, and differing peak days were found for each of the different logged consumers. **Table 3.2** lists the day chosen for the generation of demand patterns for use within the model for each of the different consumers.

Table 3-2 - Peak Day chosen for Pattern Determination



Once the peak day had been decided upon, it was then necessary to use the data to generate a normalised profile for use within the model as shown in snapshot given in **Figure 3.3** below. This consisted of manipulating the data in spreadsheet format, allowing calculations to be made of average flow for the day and then dividing each time increment flow by that average. Once this was completed, the resultant normalised profile had an average value for the day equal to 1. These demand patterns were then utilised within the model for all logged consumers, enabling a greater accuracy to be achieved during the system assessment.

Figure 3.3 – Snapshot of Normalised Profile Calculation

Calcs for Normalised Profile Determination

Daily subtotal of Actual Data Kl/day		2,756.30			2,756.30		
Subtotal of Actual Data Ml/Day		2.756		Average of Actual Data l/s	31.902		
			Normalised Profile		Residual Demand (l/s)		
		Total Net Flow	1		31.902	Ave	
14/10/2004	0:00	24	0.7523		24.0000		
14/10/2004	0:05	24.3333	0.7628		24.3333		
14/10/2004	0:10	24.3333	0.7628		24.3333		
14/10/2004	0:15	24.3333	0.7628		24.3333		
14/10/2004	0:20	24.6667	0.7732		24.6667		
14/10/2004	0:25	33.6667	1.0553		33.6667		
14/10/2004	0:30	38	1.1912		38.0000		
14/10/2004	0:35	24.6667	0.7732		24.6667		
14/10/2004	0:40	24.3333	0.7628		24.3333		
14/10/2004	0:45	24	0.7523		24.0000		
14/10/2004	0:50	38.3333	1.2016		38.3333		
14/10/2004	0:55	37.3333	1.1703		37.3333		

	2004/05 Mlpa	2005/06 Mlpa	2006/07 Mlpa
Future Average Demand (Mlpa)	1000	1435	1,870.00
Future Average Demand (Kl/Day)	2739.73	3931.51	5123.29
Future Average Demand (l/s)	31.710	45.504	59.297
Actual Flow	Average Flow	Average Flow	Average Flow
23.9999	23.8556	34.2328	44.6100
24.3333	24.1870	34.7083	45.2296
24.3333	24.1870	34.7083	45.2296
24.3333	24.1870	34.7083	45.2296
24.6667	24.5183	35.1838	45.8493
33.6667	33.4643	48.0213	62.5782
37.9999	37.7714	54.2020	70.6326
24.6667	24.5183	35.1838	45.8493
24.3333	24.1870	34.7083	45.2296
23.9999	23.8556	34.2328	44.6100
38.3333	38.1028	54.6775	71.2522
37.3332	37.1087	53.2510	69.3933

Where it was not possible to obtain logged consumer information, an estimation of demand according to billing data and other customer information was adopted. In the absence of more detailed usage information, demand patterns for unlogged customers were allocated assumed patterns as follows:

- Constant unit daily profile
- 1 x 4 hr Maximum Hour fire flow profile
- 8 x 2 hr “peaked” daytime standpipe profile

4. System Performance

4.1 Awoonga to Gladstone Raw Water System

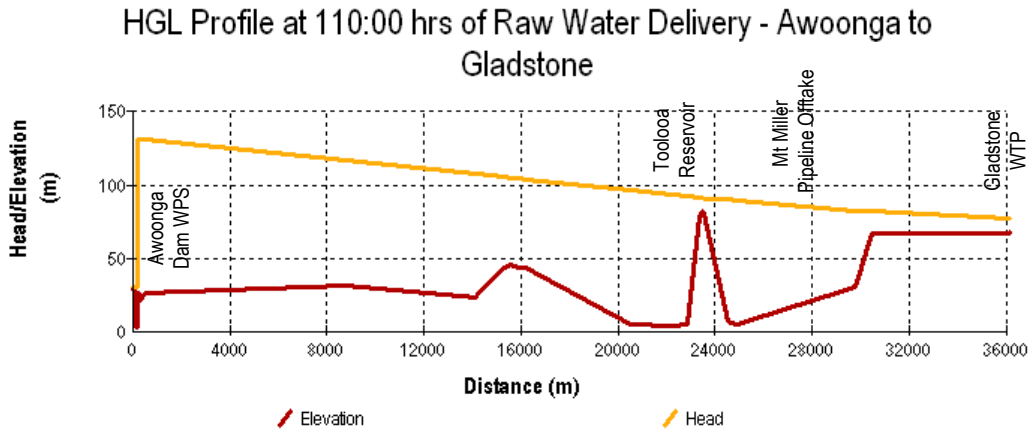
The Awoonga Dam to Gladstone raw water system is the primary delivery system for the entire Gladstone / Calliope region. The system comprises pumped supply from Awoonga Dam PS through one or two pump operation peaking at 3,600 L/s pumped through two bulk supply mains of 1440 / 1290mm and 700mm diameter to Toolooa Reservoir balancing storage. Supply then gravitates from Toolooa reservoir via 1086mm and 700mm trunk mains to the 900mm Mt Miller pipeline offtake and thence to Gladstone 50 ML and 16 ML raw water reservoirs.

At present only one pump is required to operate at Awoonga PS restricted between off-peak times of 9pm to 6am delivering a maximum energy managed daily volume Toolooa and Gladstone reservoirs of around 90 ML. As previously mention GAWB are currently implementing new controls at Gladstone reservoir FCVs to better utilise available storage at Gladstone whilst preserving storage at Toolooa reservoir. The hydraulic model developed for this study and subsequently analysed for existing and future year performance incorporates this operational amendment.

Modelling and future options assessment of this system has revealed the following fundamental operation and infrastructure issues:

1. Single pump operation at Awoonga PS between off-peak times of 9pm to 6am is not continuous with the pump only usually operating 70% of the off-peak time. This is brought about by the inherent low demands on storage in the system in the early hours of the morning and the resulting reduced turnover of Toolooa reservoir causing pumps to shutdown.
2. The capacity and performance of the Awoonga to Gladstone system has been observed to be heavily reliant on pump operation and the levels in Toolooa and Gladstone reservoirs elevating the Hydraulic Grade Line (HGL) of the system. An example of the HGL performance under single pump operation is given I **Figure 4.1** below.

Figure 4-1: Current Awoonga to Gladstone Hydraulic Grade Line



3. Performance and capacity of the delivery system approaching 2009/10 begins to become unsatisfactory with one pump operating during off-peak times only. This is evident with the emptying of Gladstone 50 ML reservoir and the need to operate Awoonga PS pumps for greater periods of time into peak times to replenish Toolooa reservoir.
4. The operation of the proposed new controls for Gladstone reservoir FCVs is observed to be extremely beneficial to utilisation of storage in the system. An adopted set point for closure of the FCVs at 80% depleted of Toolooa reservoir was found to be optimal for maximising supply from the higher Toolooa reservoir whilst still maintaining an adequate reserve storage.
5. Inflow to Gladstone reservoirs can be adversely affected by highly peaked demands occurring in the Mt Miller pipeline raw water system. These peaked demands need to be better managed to avoid large dips in the HGL between Toolooa and Gladstone reservoirs thus improving overall supply delivery from Awoonga.

4.2 Yarwun and Fishermans Landing Raw Water System

The Yarwun and Fishermans Landing raw water system is sourced from the 900mm diameter Mt Miller pipeline. This system services raw water customers in the Yarwun and Fishermans Landing area via 500mm and 450mm mains and currently remains isolated from the Hansons Rd to Yarwun system through a closed 300mm diameter cross connection at the railway bridge at Yarwun (near CAR offtakes).

Modelling and future options assessment of this system has revealed the following fundamental operation and infrastructure issues:

1. This system currently services a number of industries with highly peaked usage resulting from a lack of provision and/or poor operation of onsite storage (see Figure 4.2(a) and (b)). In addition, these mains also service fire flows to CA Fire, CAR TT2 and the Orica Ammonia Tank in the extremity of the system at Fishermans Landing via 450mm and 300mm diameter dead-end mains. Most of these industries already incorporate and operate significant internal pumped supply systems for their day to day supply and could easily adapt these systems to an onsite tank supply.
2. The performance of the 450mm and 300mm diameter mains under the worst condition of all peaks including fire flow occurring simultaneously with current known onsite storage is shown in Figure 4.3.
3. Peaking for bulk supply systems is normally incorporated into design flows through an allowance of approximately 1.5 times average day flows or MDMM supply. This system is operating beyond the conditions of its design assumptions and in most cases exceeding design capacities before time. To prolong the capacity life of the bulk supply system it is a fundamental assumption of planning that the authority will undertake action to maintain appropriate demands on its system through appropriate buffering storage. This can be either undertaken by the authority itself and charged back to customers / developers or requested as part of the conditions of development / connection to the system. It is understood that GAWB is currently in the process of establishing customer supply agreements which incorporate this requirement.
4. The 900mm diameter Mt Miller pipeline and its subsequent downstream raw water system are significantly and adversely effected by the operation of inlet facilities to Gladstone 50 ML reservoir. This inlet supply should be managed to optimise the driving head to this system whilst making the best use of storage as possible.

Figure 4-2: High Peaked Demands Applied to Modelled Network

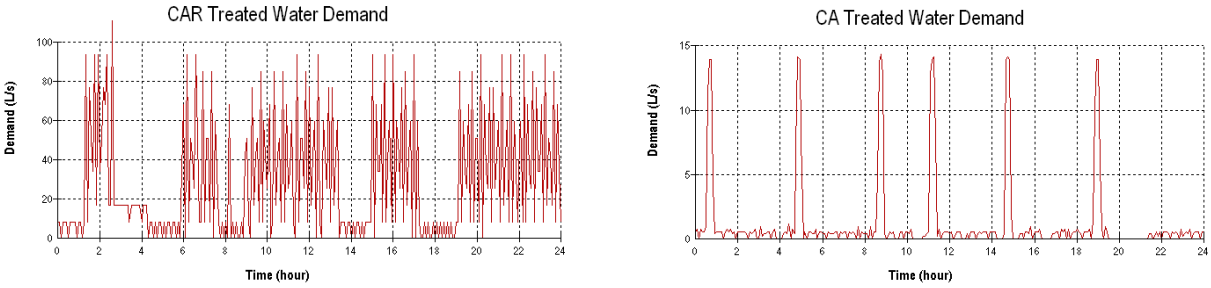
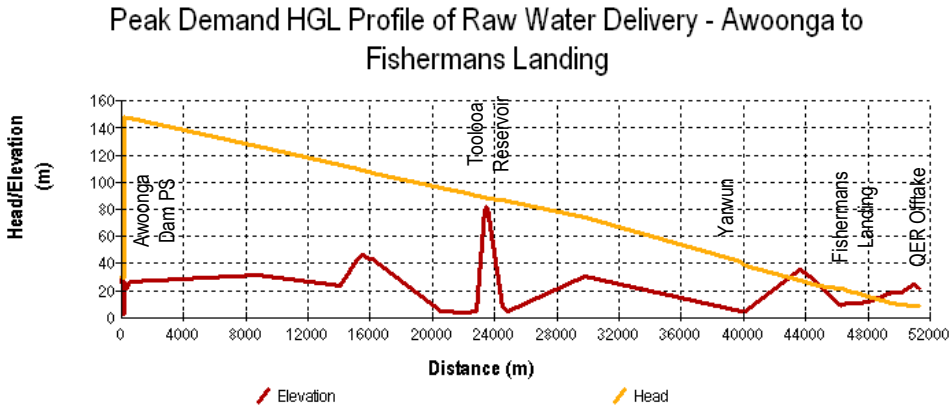


Figure 4-3: Impact of High Peaked Demands and Fire Flows on Hydraulic Grade Line



4.3 Hansons Rd to Yarwun Raw Water System

The Hansons Rd to Yarwun system forms part of the original supply to the Fishermans Landing area and currently supplies raw water supply to the Yarwun WTP forming the basis for treated water supply to Fishermans Landing and also East End and the Mt Larcom township. The system consists of 450/375/300mm diameter supply mains sourced from the higher 50 ML Gladstone raw water reservoir (or alternatively the lower 16 ML Fitsimmons Street reservoir at a lower supply capacity).

Modelling and future options assessment of this system has revealed the following fundamental operation and infrastructure issues:

1. The Hansons Rd main currently has limited capacity to service the Yarwun WTP depending on offtakes and also the supplying reservoir from which it is sourced. From the 10m higher 50 ML Gladstone reservoir an approximate capacity of 110 L/s has been assessed with approximately 80 L/s capacity assessed from the lower 16 ML Fitsimmons St reservoir.
2. The Hansons Rd main is currently isolated at two locations after the Yarwun WTP offtake from the Mt Miller pipeline raw water system to preserve its hydraulic capacity and HGL to maximise supply to Yarwun WTP. In the event of failure of the main (which has been frequently reported) these cross connections can provide alternate supply to Yarwun WTP. Alternatively, if the 900mm diameter Mt Miller pipeline requires shutdown,

the Hansons Rd can be opened up into downstream Fishermans Landing raw water system with reduced capacity and levels of service to raw water customers.

4.4 Yarwun and Mt Miller Treated Water System

The Yarwun / Mt Miller treated water system sources it supply from the Yarwun WTP from which treated water is pumped from the clear water tank directly to Mt Miller reservoir (TWL = 83.6m AHD) which provides the supply head necessary to service the Yarwun and Fishermans Landing areas. Boat Creek PS can further boost this head to enable periodic supply via the high level 300mm diameter main to East End reservoir and Mt Larcom township. This pumped supply is also periodically engaged to provide replenishment to CAR RMA storage.

Modelling and future options assessment of this system has revealed the following fundamental operation and infrastructure issues:

1. Capacity to this system is noted to be currently constrained by a 50 L/s single pumping capacity from Yarwun WTP to Mt Miller reservoir. Running the second unit to achieve approximately 80-90 L/s supply to Mt Miller reservoir currently exceeds existing process capacity of the WTP which is understood to be approximately 70 L/s. As noted in the Hansons Rd / Yarwun raw water system, inflow capacity to the WTP is also limited to 80-110 L/s depending upon the Gladstone reservoir from which it is sourced.
2. Through assessment of future demand scenarios it was noted that if the WTP did have process capacity and 2 pumps were operated to achieve approximately 100 L/s then future AD demands could be meet and storage levels in Mt Miller reservoir maintained. This would be subject to the rising main capacity (currently only 300mm diameter) which could be easily augmented with a cross connection to the existing 375mm and 200mm mains in Reid and Hansons Rds. This would effectively convert Mt Miller into a combined inlet / outlet pumped facility operating as a break of head for the system. It should be noted that eventual augmentation of the rising main to Mt Miller reservoir would be required and is a preferred alternative.
3. The treated water supply system is currently greatly impacted by the highly peaked usage from CAR and CA. CA located at the extremity of the system at Fishermans Landing has been modelled with a peaking of around 10 which is noted to significantly impact on the entire system. Orica appears to have reasonable peaking in the order of less than 1.5 with fairly constant demand requirements minimising its impact on the system.
4. Supply to Boat Creek PS is observed to be significantly impacted by the affects of excessive upstream demand draw from CAR. This does periodically pose problems for supply to East Reservoir along the 300mm high elevation pipeline which currently also services CAR RMA site by a manual demand notification. Accordingly, it is understood that Boat Creek PS is therefore operated manually through a request from CAR RMA site and/or the replenishment requirements of East Reservoir (which usually requires filling once a week). It was observed through modelling that depending on the suction pressure supplied to Boat Creek PS, the pumps did not always have the head to pump over some of the higher elevation points along the length of the 300mm diameter main.

Figure 4-4: Normal Pump Operation and HGL for Proposed Hansons Rd via Mt Miller Reservoir to East End Treated Water System

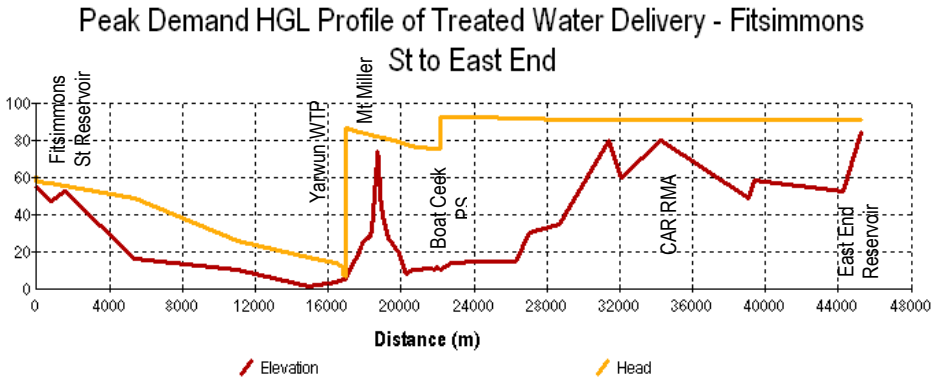
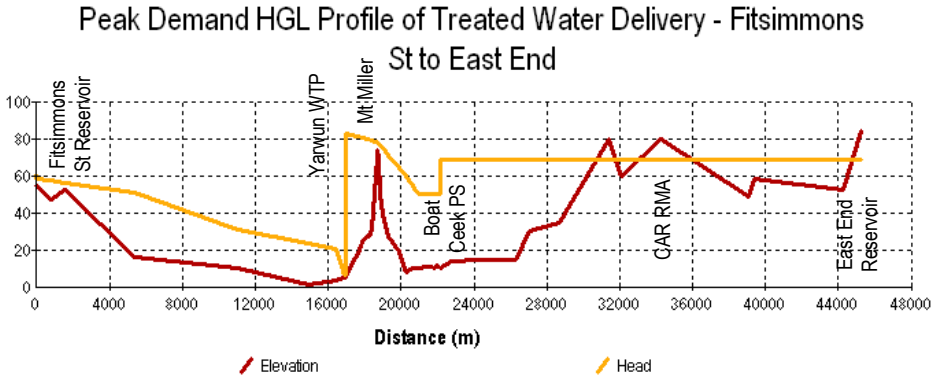


Figure 4-5: Impact of High Peaked Demands on Pump Operation and HGL for Proposed Hansons Rd via Mt Miller Reservoir to East End Treated Water System



4.5 Summary of System Capacities

As a result of observations made on system performance during modelling system capacities have been established for key trunk infrastructure as given in **Table 4.1** below.

Table 4-1: Summary of System Capacities

Key Infrastructure Item	Type	Size (mm)	Peak Capacity (L/s)	Average Daily Capacity (ML/d)
Awoonga to Toolooa Reservoir (1 pump)	Raw	1290 / 700	2,800	80.0
Awoonga to Toolooa Reservoir (2 pumps)	Raw	1290 / 700	3,600	110.0
Toolooa to Gladstone Reservoir	Raw	1086 / 700	1,330	115.0
Mt Miller Pipeline	Raw	900	650	55.0
Yarwun to Fishermans Landing mains	Raw	500-450	290	-
Hansons Rd main	Raw	450-300	110	8.5

Key Infrastructure Item	Type	Size (mm)	Peak Capacity (L/s)	Average Daily Capacity (ML/d)
Mt Miller Reservoir	Treated	375	100	8.5
Yarwun WTP PS	Treated	300	50 (80)[1]	4.3 (6.9)[1]
Mt Miller Reservoir Inlet	Treated	300	60	5.1
Mt Miller Reservoir to Boat Creek	Treated	375 & 300	70	6.0
Boat Creek PS	Treated	300	18[2]	1.5
Boat Creek to East End Reservoir	Treated	300	18 (70)[3]	1.5 (6.0)[3]
Boat Creek to Fishermans Landing mains	Treated	150	10	-

Notes: [1] Denotes figure in brackets is for 2 pump operation which leave Yarwun WTP PS without a standby unit.

[2] Denotes quoted for one pump only operating at Boat Ck PS.

[3] Denotes figure in brackets is quoted on the basis of pipeline velocity capacity.

5. Improvement Options

5.1 Awoonga to Gladstone Raw Water System

The Awoonga Dam PS delivery system via Toolooa to Gladstone Reservoirs was analysed in detail as part of this study. It was found that the performance of this system was heavily reliant on off-peak pump operation at Awoonga PS and the corresponding levels maintained in Toolooa and Gladstone reservoirs. A maximum delivery to Gladstone 50 ML reservoir of around 1,500 L/s was observed when Toolooa reservoir was full and the Mt Miller pipeline was flowing at a minimum.

The proposed new FCV control at Gladstone reservoir with provision for back feeding was found to be extremely effective in utilising available storage whilst maximising supply from the higher Toolooa reservoir. This strategy was found to be optimal if a FCV set point of 80% depleted (or 2m full) in Toolooa reservoir was adopted.

One pump operation of Awoonga PS between off-peak times was found to become inadequate by 2009/10 with Gladstone and Toolooa reservoirs emptying over a 5 day continuous maximum demand period (excluding fire flow). This staging year 2009/10 was therefore considered the first trigger point from where one of three improvement options were considered to be required, as follows:

1. Allow 2 pump off-peak operation only. This option would satisfy system requirements until 20014/15 at which time one of the following further improvement options would be required:
2. Allow 2 pump operation to commence earlier within peak times subject to level criteria in both Gladstone and Toolooa reservoirs (say 80% depleted for both reservoirs)
3. Construct an additional reservoir at Toolooa of approximately 30 ML capacity to bring total usable storage in system to approximately 130 ML equivalent to a 2025 average day demand requirement for Gladstone reservoir and Mt Miller pipeline supplies.

The suitability of a strategy resulting from selection of one or a combination of the above options is highly dependent on the benefits gained from energy management versus capital outlay. The current cost of pumping has been estimated as approximately $160,000 per annum based on a 3,400 kW pump operating for 6 hours a day at an off-peak usage charge of 2.11c per kWhr. This will increase to approximately $830,000 per annum based on 2 pumps operating for 11.5 hours per day (6 hours in off-peaks times).

Assuming a required capital outlay of $4.3M in 2009 for a new 30 ML reservoir at Toolooa with ongoing O&M costs of $0.3M pa (allowing for additional $140,000 pa maintenance costs) versus increasing O&M costs from $0.3M to $1.0M pa (constant until 2009 then linear increase to 2025), NPV analysis over 20 years at 6% interest gives a NPV comparison of around $7.5M for a new reservoir versus $5.7M for increased pumping, favouring the increased pumping options. This preliminary assessment does not consider intangible factors such as security of supply, which may have influence over the selection of a preferred option.

It was not considered part of the scope of this study, however, the treatment capacity requirements of Gladstone WTP would also need to be reviewed to ensure that adequate process and delivery capacity exists

within the plant to service future demand requirements. This demand requirement would be made up of the growth needs of Gladstone City, Calliope Shire and the Hanson Rd main, if converted to treated water.

5.2 Northern Area Treated and Raw Water Systems

Northern Area treated and raw water systems service the areas of Gladstone, Yarwun, Boat Creek, Fishermans Landing and the East End / Mt Larcom system. The Aldoga SDA is included in the area north of the current CAR red mud dam site.

Raw water supply to the Northern Area is generally sourced from the Mt Miller pipeline. This raw water system is currently isolated from the Gladstone / Hansons Rd raw water supply which currently services the Yarwun WTP. This action preserves the HGLs of both systems providing continuity of supply and manageable operations between GAWB and CSC. The treated water system is currently sourced from Yarwun WTP via Mt Miller reservoir. This system also services the East End / Mt Larcom treated water system via Boat Creek PS which is periodically operated to replenish tanks servicing customers in these areas. This system comprises some 21 km of 300mm diameter rising main which currently supplies treated water to the CAR RMA tank and East End reservoir. It is understood that some other connections to this pipeline exist to service construction work within the Aldoga SDA.

To provide treated and raw water supply to the proposed Aldoga SDA options have been developed in conjunction with those developed for the Yarwun / Fishermans Landing system. It has been assumed that there will be an approximate 20-80 split between the requirement for raw and treated water supply for the Aldoga SDA. The estimated total Aldoga SDA water supply requirement is 8,000 ML/a or 251.7 L/s (21.7 ML/d). With full uptake from say 2010 to 2025 the ultimate treated and raw water demands for the Aldoga are estimated as 50.3 L/s (4.3 ML/d) and 201.4 L/s (17.4 ML/d), respectively.

To service the Aldoga SDA for treated and raw water supply, several options have been developed on the basis of supply from the existing Awoonga Dam system, proposed supply from the Fitzroy system and a combination of both. Due to uncertainty associated with likely internal development in the area these options only consider treated and raw supply to centralised reservoir storage sites (i.e. Aldoga raw and treated reservoir storages), from which supply would then be distributed to customers through relevant trunk main infrastructure. A selected site for construction of reservoirs for raw and treated water supply purposes is proposed at Gladstone-Mt Larcom Rd & Flynn Rd at an approximate elevation of 130m AHD (See **Figures 3 to 5**).

The Fitzroy supply is currently being investigated by GAWB and is currently being considered as a viable alternative supply to the Awoonga Dam to Gladstone system within the next 5 to 10 years. Some uncertainty remains as to raw water quality and its suitability to service raw water requirements of customers. Timings for construction and the route of a Fitzroy supply pipeline is also only speculative at this stage. The development of options for servicing of the Aldoga SDA need to consider this supply alternative and also the possibility of backfeeding through existing mains to the Awoonga Dam to Gladstone system and also as a possible alternative to the Yarwun / Fishermans Landing treated water system via a new WTP.

The following three options were considered and subsequently modelled to determine infrastructure necessary to service future demands of the combined treated and raw water systems from Awoonga Dam system and also any northern Fitzroy supply:

5.2.1 Option 1 – Temporary Conversion of Hansons Rd Main to Treated Supply & Upgrade of Yarwun WTP and PS for Yarwun / Fishermans Landing Area (requires alternative Fitzroy supply source for the Aldoga SDA)

Yarwun / Fishermans Landing Raw and Treated Systems:

Option 1 proposes the temporary conversion of the 450/375/300mm Hansons Rd main along with the 16ML Fitsimmons St reservoir to treated water to supply Yarwun / Fishermans Landing industry currently serviced by Yarwun WTP. In the short term Yarwun WTP would be taken out of service to facilitate an upgrade of the plant and its pumping station to at least 100 L/s (or 8.6 ML/d) to service proposed future treated demands in the Yarwun Fishermans Landing area only.

Since Yarwun WTP supply would only be out of service for a minimum of 1-2 years, the conversion of the Hansons Rd main and Fitsimmons St reservoir to treated supply would only need to be temporary and could be reverted to raw supply once Yarwun WTP upgrade has been completed. If a more prolonged supply or an alternative to converting Fitsimmons St reservoir to treated water is required. GCC Round Hill reservoir could be possibly utilised or additional storage of around 5 ML constructed to service the treated water operation of the Hansons Rd main.

Pumped supply capacity from Yarwun WTP to Mt Miller reservoir is currently limited over extended periods to 50 L/s so that stand-by capacity of the PS can be maintained. It is understood, however, that during peak periods the stand-by pump is being occasionally operated enabling a peak pumping capacity of around 90 L/s. These pumps will need to remain in service to boost treated supply from the Hansons Rd main to Mt Miller reservoir whilst Yarwun WTP is out of service.

The proposed upgrade of Yarwun WTP PS from 50 L/s to at least 100 L/s will most likely require the construction of a new PS facility to house larger pumps and pipework but also to ensure that the existing PS facility remains operational while construction work is undertaken at Yarwun WTP. The existing WTP PS facility would need to be isolated from the WTP with pipework adjustments. The need and benefits associated with retaining the clear water tank for suction to the existing PS whilst Yarwun WTP is out of service, needs to be investigated further as would pipework adjustments. Suffice to say the benefits would be mainly operational to manage the Hansons Rd main HGLs whilst ensuring proper suction head to the pumps is maintained to retain designed pump efficiency.

Depending on the programmed timing for a Fitzroy supply, expansion of CAR and Orica and the uptake of the Aldoga SDA, a variation to this option would be to supplement an existing Yarwun WTP process capacity of 70 L/s with an estimated 80 L/s treated water supply from the Hansons Rd main, giving a total treated supply capacity of around 150 L/s. An increased pumping capacity would still be required, however, a capacity of 150 L/s would be more than adequate to supply projected 20 year treated water demands for area (100 L/s or 8.5 ML/d), including some initial requirements of the new Aldoga SDA up to around 50 L/s (4.0 ML/d).

The proposed Yarwun / Fishermans Landing Option 1 layout is presented in **Figure 3** (Appendix A).

1. This option would initially make use of the existing Yarwun WTP clear water storage and PS but would require eventual upgrade/augmenting of the PS. In the first few years the plant process could be shutdown and the plant overhauled for control and its filtration facilities and pipework.
2. The Yarwun WTP PS would need upgrading or a new PS constructed within a year (i.e. 2006/7) to 100 L/s (combined new and old PS capacity of 150 L/s) to facilitate transfer of treated supply to Mt Miller reservoir (and Aldoga SDA via existing PS and new mains).

3. Capacity from the converted treated water Hansons Rd main (i.e. 80 L/s) would be exceeded by 2007/8 (with the Orica supply upgrade) and would require recommissioning of the overhauled Yarwun WTP (with new inlet facilities) at this time to supplement treated supply.
4. Convert existing raw water 16ML Fitsimmons St reservoir to treated water through changing of pipework configuration from Gladstone WTP or alternatively make use of the GCC Round Hill reservoir in the short term through appropriate cross-connection to mains. If treated Hansons Rd supply is adopted for a longer period, the construction of an additional 5 ML tank at Round Hill might be considered. The converted Hansons Rd main with a lower head from Fitsimmons St Reservoir will supply approximately 80 L/s to Yarwun WTP. This will be slightly higher with supply sourced from Round Hill.
5. Upgrade of Yarwun WTP PS to at least 100 L/s capacity (with 100 L/s stand-by unit).
6. Upgrade Yarwun WTP to 100 L/s (8.6 ML/d) process capacity and 5 ML clear water storage
7. By 2009/10 additional raw water capacity of greater than 100 L/s will be required to service the upgraded Yarwun WTP. At this stage the Hansons Rd main would have reverted to raw water with a capacity of 80 L/s and to augment this capacity beyond 100 L/s it is proposed to open the 300mm diameter cross-connection on Hansons Rd at the railway bridge adjacent to the CAR complex. This supplementary connection could also supply the entire 100 L/s raw water requirement to Yarwun WTP if necessary, offering full redundancy of the raw water inflow capacity in the event that the Hansons Rd main suffered outage.
8. To assist with transfer of increased treated supply to Mt Miller reservoir up to 100 L/s in the short term the delivery arrangement would need to be changed to enable cross-connection to existing 375/200mm mains in Reid and Hansons Rd (near Orica offtake) to augment the rising main capacity. A 375mm diameter of approximately 90m length would be required to facilitate this change.
9. In the long term (by 2008/9 with the stage 2 CAR upgrade) a 200mm diameter augmentation (L=1,700m) of the existing 300mm rising main from Yarwun WTP PS to Mt Miller would also need to be undertaken.

Aldoga SDA Supply:

Option 1 also proposes to supply treated and raw water supply for the Aldoga SDA from a new Aldoga WTP to be constructed at the proposed Aldoga site at Gladstone-Mt Larcom Rd & Flynn Rd. This proposed WTP would be supplied with a new raw water supply from a Fitzroy catchment supply sourced from the north at a maximum estimated rate of 20-30,000 ML/a (54.8-82.2 ML/d). This raw supply is anticipated to be of high turbidity and would require preliminary treatment before forming a raw water supply for the Aldoga SDA.

As discussed above, some preliminary supply to the Aldoga SDA may be achieved from the Yarwun / Fishermans Landing treated and raw water systems augmented by a converted Hansons Rd treated water main.

The proposed Aldoga SDA Option 1 layout is presented in **Figure 3** (Appendix A).

1. Construct Fitzroy-Aldoga receiving raw water reservoir storage. From this receiving storage two forms of treatment would be required through the proposed Aldoga WTP which would then be transferred to two separate treated and raw water reservoirs before distribution into their respective treated and raw water systems.
2. Construct 50 ML raw water collection reservoir at Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd (approximate TWL=135m). Site should also allow for the construction of a further 50 ML reservoir at a later date.

3. Construct Aldoga WTP to service initial treated and raw water requirement of the Aldoga SDA (i.e. 4.3 ML/d and 17.4 ML/d) inclusive of transfer mains and pumping facilities to transfer treated and raw water supply to separate treated and raw water reservoir storages. Details of this treatment facility are out of the scope of this study and would require further detailed investigation.
4. Construct two separate Aldoga regional treated and raw water reservoirs with respective capacities of 5 ML and 20 ML and approximate TWL of 140m AHD (at elevation of approximately 130m AHD)
5. Construct 300mm diameter connecting main (L=580m) from Aldoga treated water reservoir to 300mm East End main to service CAR RMA and CSC Mt Larcom township treated water requirements. This work would effectively remove the need for Boat Creek PS and pumped supply from the Fishermans Landing system by allowing gravity supply to be provided to service the East End / Mt Larcom system. Back feed supply from Aldoga treated water reservoir to Fishermans Landing would also be possible as a contingency to the Yarwun WTP supply.
6. If the timing and quality of the Fitzroy supply do not support the take up of Aldoga SDA, a sustainable supply would need to be constructed from the Awoonga Dam to Gladstone system via the Mt Miller pipeline. This additional work would also allow back feeding of Fitzroy raw water supply directly to the Mt Miller pipeline and back to the Awoonga Dam to Gladstone system.
7. Construct raw water PS facility with 2 x 450 kW pumping units (duty point of 270 L/s at 130m) in Reid Rd Yarwun to pump raw water supply to Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd.
8. Construct 450mm diameter raw water rising main (L=6,480m) from raw water PS site in Reid Rd Yarwun to Aldoga raw water reservoir storage.

5.2.2 Option 2 – Temporary Conversion of Hansons Rd Main to Treated Supply & Major Upgrade of Yarwun WTP for Yarwun / Fishermans Landing Area Including Aldoga SDA

Yarwun / Fishermans Landing Raw and Treated Systems:

As with Option 1, Option 2 proposes the conversion of the 450/375/300mm Hansons Rd main and the 16ML Fitsimmons St reservoir to treated water in the short term. With an 80 L/s treated water supply capacity the Hansons Rd would facilitate the immediate decommissioning of Yarwun WTP (excluding PS) and the undertaking of major upgrade construction works. Within 2 years, however, it is anticipated that the capacity of the Hansons Rd main would be exceeded and accordingly the upgraded Yarwun WTP (or an alternative) would need to be commissioned prior to this time. Following commissioning of the upgraded Yarwun WTP the Hansons Rd main could be reverted to raw water to offer a contingency to the raw water system for supplying fire flows in Fishermans Landing area. Alternatively, the main could remain a treated supply if sufficient customers along its length made this viable but also offering contingency to the treated water system if required.

The proposed Yarwun / Fishermans Landing Option 2 layout is presented in **Figure 4** (Appendix A).

1. This option would initially make use of the existing Yarwun WTP clear water storage and PS but would require eventual upgrade/augmenting of the PS. In the first few years the plant process could be shutdown and the plant overhauled for control and its filtration facilities and pipework.
2. The Yarwun WTP PS would need upgrading or a new PS constructed within a year (i.e. 2006/7) to 100 L/s (combined new and old PS capacity of 150 L/s) to facilitate transfer of treated supply to Mt Miller reservoir (and Aldoga SDA via existing PS and new mains).

3. Capacity from the converted treated water Hansons Rd main (i.e. 80 L/s) would be exceeded by 2007/8 (with the Orica supply upgrade) and would require recommissioning of the overhauled Yarwun WTP (with new inlet facilities) at this time to supplement treated supply.
4. Convert existing raw water 16ML Fitsimmons St reservoir to treated water through changing of pipework configuration from Gladstone WTP or alternatively make use of the GCC Round Hill reservoir in the short term through appropriate cross-connection to mains. If treated Hansons Rd supply is adopted for a longer period, the construction of an additional 5 ML tank at Round Hill might be considered. The converted Hansons Rd main with a lower head from Fitsimmons St Reservoir will supply approximately 80 L/s to Yarwun WTP. This will be slightly higher with supply sourced from Round Hill.
5. Upgrade of Yarwun WTP PS to at least 100 L/s capacity (with 100 L/s stand-by unit).
6. Upgrade Yarwun WTP to 150 L/s (12.9) ML/d process capacity and 10 ML clear water storage.
7. By 2009/10 additional raw water capacity of greater than 100 L/s will be required to service the upgraded Yarwun WTP. At this stage the Hansons Rd main would have reverted to raw water with a capacity of 80 L/s and to augment this capacity beyond 100 L/s it is proposed to open the 300mm diameter cross-connection on Hansons Rd at the railway bridge adjacent to the CAR complex. This supplementary connection could also supply the entire 100 L/s raw water requirement to Yarwun WTP if necessary, offering full redundancy of the raw water inflow capacity in the event that the Hansons Rd main suffered outage.
8. To assist with transfer of increased treated supply to Mt Miller reservoir up to 100 L/s in the short term the delivery arrangement would need to be changed to enable cross-connection to existing 375/200mm mains in Reid and Hansons Rd (near Orica offtake) to augment the rising main capacity. A 375mm diameter of approximately 90m length would be required to facilitate this change.
9. In the long term (by 2008/9 with the stage 2 CAR upgrade) a 200mm diameter augmentation (L=1,700m) of the existing 300mm rising main from Yarwun WTP PS to Mt Miller would also need to be undertaken.
10. To supply the planned Aldoga SDA demands it is also proposed to construct separate treated and raw water Aldoga PS's and rising mains to transfer supply from the upgraded Yarwun WTP to proposed Aldoga reservoir storages. These works are discussed in the following section.

Aldoga SDA Supply:

Option 2 proposes all supply for the Aldoga SDA to be sourced from the existing Awoonga Dam System. With upgrade to the Yarwun WTP it is proposed to supply treated water to the Aldoga SDA via a separate 50 L/s PS located at Yarwun WTP or possibly through upgrade of the Boat Creek to East End system to 60 L/s, to a new 5 ML treated water reservoir located at the Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd. In either sub-option the use of the existing 50 L/s pumps and facility at Yarwun WTP could be considered to reduce capital outlay of this option.

Raw water supply to the Aldoga SDA is proposed to be made via a new PS to be constructed off the 900mm diameter Mt Miller pipeline at Yarwun. The new PS would deliver raw water to a new 15 ML reservoir to be constructed at the Aldoga site. Flexibility for back feeding of treated and raw water to the Fishermans Landing, Yarwun and Gladstone systems could also be provided along with easy integration to any Fitzroy supply that become available.

The proposed Aldoga SDA Option 2 layout is presented in **Figure 4** (Appendix A).

9. Construct treated water PS facility with 2 x 100 kW pumping units (duty point of 52 L/s at 150m) in Reid Rd Yarwun to pump treated water supply to Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd.

10. Construct 250mm diameter treated water rising main (L=6,500m) from raw water PS site in Reid Rd Yarwun to Aldoga raw water reservoir storage.
11. Construct 5 ML treated water reservoir at Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd (approximate elevation 130m AHD with TWL=140m AHD).
12. Construct raw water PS facility with 2 x 450 kW pumping units (duty point of 270 L/s at 130m) in Reid Rd Yarwun to pump raw water supply to Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd.
13. Construct 450mm diameter raw water rising main (L=6,480m) from raw water PS site in Reid Rd Yarwun to Aldoga raw water reservoir storage.
14. Construct 15 ML raw water reservoir at Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd (approximate elevation 130m AHD with TWL=140m AHD).
15. Construct 300mm diameter connecting main (L=580m) from Aldoga treated water reservoir to 300mm East End main to service CAR RMA and CSC Mt Larcom township treated water requirements. This work would effectively remove the need for Boat Creek PS and pumped supply from the Fishermans Landing system by allowing gravity supply to be supplied into the East End / Mt Larcom system.
16. Construct 375mm diameter backfeeding connections to treated and raw water rising mains from Aldoga reservoirs to facilitate contingency supply to Yarwun / Fishermans Landing system.

5.2.3 Option 3 – All Treated Water From New Adolga WTP

Yarwun / Fishermans Landing Raw and Treated Systems:

Option 3 proposes all treated water supply for the Yarwun / Fishermans Landing area to be eventually sourced from a new Aldoga WTP facility. The new facility would need to be constructed so as to accept source raw water supply from either the Awoonga Dam system via the Mt Miller pipeline or via the Fitzroy raw water supply from the north. This provision would be required to cater with uncertainties associated with timing, cost and service agreements for the Fitzroy supply.

Treated water supply from Aldoga WTP would be directed through a 450mm diameter trunk main to be constructed either along Gladstone-Mt Larcom Rd to existing 300/375mm treated water mains in Hansons Rd near Boat Creek PS or directly to Mt Miller reservoir via a similar route to that proposed for Aldoga rising mains in Option 2.

This option has significant benefits to be realised by decommissioning Yarwun WTP and providing gravity supply to Mt Miller Reservoir rather than the current pumped supply from Yarwun WTP, thus offering ongoing energy savings on pumping. Depending on timing for provision of these Aldoga works, an interim treated water supply measure might be provided from conversion of the Hansons Rd main to treated supply and making use of a combination of pumpage from Yarwun WTP PS and possibly Boat Creek PS. This would assist with avoiding any capital outlay on pumping infrastructure in the short term whilst the Aldoga works are being completed.

The proposed Yarwun / Fishermans Landing Option 3 layout is presented in **Figure 5** (Appendix A).

1. This option relies upon additional supply from northern Fitzroy raw water sources which would be directed to raw water storage in the proposed Aldoga SDA and treated via a new WTP located nearby. Treated and raw water supply would then be distributed to customers of within the Aldoga SDA and also treated water customers in the Yarwun / Fishermans Landing area. Raw water supply to the Yarwun / Fishermans

Landing area would still be maintained via existing raw water supply from the 900mm diameter Mt Miller pipeline.

2. Construct 450mm diameter treated water main (L=6,320m) from proposed Aldoga treated water reservoir to Mt Miller reservoir.
3. Amend Mt Miller reservoir outlet mains to incorporate 300mm diameter rising main from decommissioned Yarwun WTP PS that would otherwise become redundant. This would require construction of a 300mm diameter cross-connection (L=90m) with 375/200mm diameter mains in Reid and Hansons Rds to facilitate distribution past the decommissioned Yarwun WTP PS into the treated water system.
4. Undertake Aldoga SDA works as described in the following section.

Aldoga SDA Supply:

Option 3 proposes to supply all treated water supply for the Yarwun / Fishermans Landing / Aldoga area from a new Aldoga WTP to be constructed at the proposed Aldoga site at Gladstone-Mt Larcom Rd & Flynn Rd. This proposed WTP would be supplied with a new raw water supply from a Fitzroy catchment supply sourced from the north at a maximum estimated rate of 20-30,000 ML/a (54.8 - 82.2 ML/d). This raw supply is anticipated to be of high turbidity and would require preliminary treatment before being considered suitable for a raw water supply for the Aldoga SDA or back feeding to the Awoonga Dam to Gladstone system.

Feedback from GAWB on this option advises that the cost of water from the Fitzroy system will be more expensive than supply from the Awoonga Dam system and for this reason this option should also include a primary supply to the Aldoga site from the Mt Miller pipeline. This would be achieved with the construction of a PS and rising main somewhat larger than that proposed in Option 2 from the Mt Miller pipeline at Yarwun to the Aldoga site. This principle supply from the Awoonga Dam system will then give GAWB significant flexibility and security of supply.

The proposed Aldoga SDA Option 3 layout is presented in **Figure 5** (Appendix A).

1. This option would require the construction of a Fitzroy-Aldoga receiving raw water reservoir storage near the Aldoga site. From this storage raw water would require two forms of treatment through the proposed Aldoga WTP, a primary raw water treatment to cater for high turbidity water from Fitzroy catchment and a high level treatment for potable supply. Water from these two treatment processes would then be transferred to separate treated and raw water reservoirs before distribution into their respective treated and raw water systems.
2. Construct 50 ML receiving raw water reservoir near or at Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd (approximate TWL=135m). This reservoir will need to connect into the Fitzroy supply in some manner which is yet to be determined and beyond the scope of this study.
3. Construct Aldoga WTP to service initial requirement of treated water to Yarwun / Fishermans Landing / Aldoga SDA (i.e. 12.9 ML/d) and raw water to Aldoga SDA (i.e. 17.4 ML/d), inclusive of transfer mains and pumping facilities to transfer treated and raw water supply to separate reservoirs for distribution to Aldoga SDA. Details of this treatment and PS facilities are out of the scope of this study and would require further detailed investigation.
4. Construct separate Aldoga regional treated and raw water reservoirs with 15 ML and 20 ML capacity respectively, and approximate TWL of 140m AHD (at elevation of approximately 130m AHD)
5. Construct 300mm diameter connecting main (L=580m) from Aldoga treated water reservoir to 300mm East End main to service CAR RMA and CSC Mt Larcom township treated water requirements. This work would

effectively remove the need for Boat Creek PS and pumped supply from the Fishermans Landing system by allowing gravity supply to be supplied into the East End / Mt Larcom system.

6. Construct raw water PS facility with 2 x 550 kW pumping units (duty point of 310 L/s at 135m) in Reid Rd Yarwun to pump raw water supply to Aldoga site off Gladstone-Mt Larcom Rd & Flynn Rd.
7. Construct 500mm diameter raw water rising main (L=6,480m) from raw water PS site in Reid Rd Yarwun to Aldoga raw water reservoir storage.

5.3 Yarwun Distribution System Options

Modelling of the GAWB treated and raw bulk water delivery systems has shown that significant impacts on system performance are being experienced as a result of excessive demand peaking. This is particularly the case in the Yarwun / Fishermans Landing area where large industrial customers have been allowed to be connected directly to bulk supply mains without the provision of onsite storage to buffer peak water usage.

In addition, provision for fire flows to be drawn directly from the bulk supply system has been allowed at numerous locations including locations at the extremity of the system (e.g. Orica Ammonia Tank, CAR TT2 and CA) without the benefit of onsite storage and/or looped supply to reduce their impacts. Fire flows have particularly far reaching impacts by virtue of the need to make capacity allowance within the system for high magnitude flow which could otherwise be made available to increasing customer demands. The provision of onsite fire fighting storage in this regard provides significant benefit to preserving trunk main capacity for base daily customer demands and should be made a condition of the customer service agreement where ever possible.

GAWB is currently reviewing its customer service agreements to include a requirement for industry to better manage their storage to minimise peaking impacts on trunk water mains. Examples of where industry are currently not meeting this requirement are:

- Onsite storage depleted over a several days then replenished within a few hours producing large peaking within the GAWB trunk system
- Onsite storage are operated at 100% to retain storage for emergency backup, hence direct customer usage peaking is imposed directly onto the GAWB trunk system
- No onsite storage where customer pump and/or draw directly from the GAWB trunk system

The alternative to onsite storage would be the construction of mains augmentations to ensure capacity exists for growing daily industry demands which is a costly exercise in most cases. This option ensures that a residual pressure is maintained within the system for servicing of the flows on demand, and usually negates the need for the customer to provide onsite storage and pumping facilities. QF&R regulations and QDNR guidelines, however, usually require the provision of fire flow storage and pumping facilities, particularly in the case of high risk / hazard fire flows, and this will offset the need for maintaining a substantial residual pressure for this purpose.

Base existing daily demands, fire flow requirements and currently known onsite storage provision for existing customers serviced by the GAWB treated and raw bulk water delivery systems within the Yarwun / Fishermans Landing area is given in **Table 5.1** below:

Table 5-1: Demand and Current Onsite Storage Details for Yarwun / Fishermans Landing Area

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Two options have therefore been considered when assessing system augmentation requirements for high daily demand peaking and fire flows, namely, mains augmentation and the provision of onsite storage.

5.3.1 Option 1 – Mains Augmentation

Option 1 has considered the augmentation of mains to provide high peaked fire flow and industry demands. This would in most cases require duplication of mains along Hansons Rd from Mt Miller and Reid Roads to the Fishermans Landing in the north and has been detailed in the overall Capital Works Program given in Appendix A Table A1.

5.3.2 Option 2 – Onsite Storage

Option 2 has considered the provision of onsite storage for industry and fire flow demand requirements at key locations as given in **Table 5.2** below:

Table 5-2: Proposed Onsite Storage

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5.4 Estimated Cost of Options

The cost estimates for the works proposed under each option is given in **Appendix B**. The table outlines timing (or triggers) and capital cost estimates of infrastructure requirements for the above 3 systems / development areas in accordance with the options outlined in the proceeding sections.

A summary of the costs of each option is provided in Table 5-3. Cost estimated include on costs and contingency of 20%.

Table 5-3: Summary of Estimated Costs

Option Description	Estimated Capital Cost
Option 1:	
Yarwun / Fishermans Landing	$1,851,918
Aldoga SDA	$11,714,207
Total:	**$13,566,125**
Option 2:	
Yarwun / Fishermans Landing	$2,463,422
Aldoga SDA	$14,368,281
Total:	**$16,831,703**
Option 3:	
Yarwun / Fishermans Landing	$3,779,379
Aldoga SDA	$13,058,097
Total:	**$16,837,476**
Mains Augmentation with Onsite Storage:	
Mains augmentation	$526,896
Onsite storage	$1,713,885
Mains Augmentation with Onsite Storage:	
Mains augmentation	$5,166,128

5.5 Preferred Option

In view of the issues discussed in the proceeding sections and with consideration of capital costs the following strategy is preferred:

1. Undertake further investigations in relation to energy management of Awoonga PS to determine most cost effective improvement option for operation the Awoonga to Gladstone system toward 2025.
2. Undertake temporary conversion of Hansons Rd main to treated supply and undertake strategy as per Option 1, as follows:

- Construct through capital funding and/or forced customer agreement, onsite storage associated with 3 existing industry and fire flow connections to the Yarwun / Fishermans Landing treated and raw water supply systems, as follows:
  - CA treated
  - Orica Ammonia Tank fire
  - CAR TT2 fire
- As a condition to upgrade to stage 2 operations at CAR and Orica additional onsite storage should also be provided at:
  - CAR 500 Raw
  - CAR Treated
  - Orica Treated
- Construct 200mm mains augmentation to Yarwun PS to Mt Miller delivery system. Also construct 375mm cross-connection in Reid Rd.
- Construct 450mm and 300mm mains augmentations in Hansons Rd and Landing Rd respectively.
- Construct new Yarwun WTP PS with 100 L/s capacity, whilst keeping existing PS in service to boost Hansons Rd treated water to Mt Miller reservoir.
- Open cross connection between Hansons Rd and Mt Miller pipeline raw water system at around 2008 to supplement raw water supply to upgrade Yarwun WTP.
- Undertake Aldoga works as and when required (approximately 2006/7):
  - 50 ML raw water receiving reservoir
  - Aldoga WTP & PSs (5 ML/d & 18 ML/d treated & raw capacity)
  - 5 ML and 15 ML treated and raw water reservoirs
  - 300mm connection main to Boat Ck to East End pipeline
- Construct new PS and 450mm raw water RM from Mt Miller pipeline to Aldoga raw water storage.

The above strategy has been estimated to be lowest capital cost solution (i.e. $13.6M excluding WTP costs) and makes the best utilisation of existing infrastructure. With consideration to the uncertainty associated with the Aldoga SDA and its subsequent timing it is also believed that this option is better suited to cater for its servicing as and when required. Furthermore, this proposed strategy makes allowance for the use of the Fitzroy catchment supply which has significant benefits for the region for contingency planning and security of overall bulk supply to customers. Further investigations into this supply would need to be undertaken to ascertain its viability in this regard.

5.6 Proposed Capital Program for Forecast Demand to 2025

On the basis of options and associated delivery methodology described in the previous sections a Capital Works Program (CWP) has been developed. The CWP has been developed for a projected planning horizon of 20 years on the basis of currently known demand and industry development information for the region. The timing for these demands is somewhat uncertain and has been known to change with minimal forewarning as a result of the changing requirements of industry in the area. To cater for this lack of planning industry development triggers have also been quoted in the CWP to further assist GAWB with the planning of infrastructure requirements to the region.

Capital cost estimates have been made for combined treated and raw water infrastructure requirement for individual systems or development areas as follows:

1. Yarwun / Fishermans Landing (and East End) System
2. Aldoga SDA
3. Mains Augmentations

The proposed CWP for the base demand forecast (as supplied by GAWB) to 2025 is provided in Table 5-4. Works associated with the Aldoga SDA have not been included in this table as further work is necessary to define demands in this area.

Table 5-4: Recommended Capital Works Program

Item No.	Item Description	Likely Year	Size	Size	Qty	Cost Rate ($ / Qty)	Factor	Cost
Yarwun / Fishermans Landing Treated & Raw Water Systems								
1	Conversion of Hansons Rd main & 16 Ml Fitsimmons st reservoir	2005/6					1.0	$100,000
2	Replacement of Yarwun pumps 100 L/s @ 85m (110 kW)	2005/6	200	110 kW	1	313100	1.0	$313,100
3	Yarwun WTP upgrade (say 9 Ml/d treated process capacity)	2006/7		9 Ml/d	1		1.0	**Not Included**
4	Yarwun 3 Ml CWT	2006/7	25m x 8m	3 Ml	1	575537	1.6	$920,859
5	375mm cross-connection from Yarwun PS to existing 375mm main	2008/9	375		90	309	1.9	$52,839
6	200mm Yarwun PS to Mt Miller reservoir RM augmentation	2009/10	200		1,700	171	1.6	$465,120
								$1,851,918
Proposed Aldoga SDA System								
1	Aldoga 50 Ml raw water collection reservoir	2006/7	80m x 10m	50 Ml	1	3177618	1.2	$3,813,142
2	Aldoga WTP & PS's (5 Ml/d treated & & 18 Ml/d raw process capacity)	2006/7		22 Ml/d	1		1.0	**Not Included**
3	Aldoga 5 Ml treated water reservoir	2006/7	28m x 8m	5 Ml	1	784877	1.2	$941,852
4	Aldoga 20 Ml raw water reservoir	2006/7	50m x 10m	20 Ml	1	1821515	1.2	$2,185,818
5	300mm connecting main to East End main	2006/7	300		580	281	1.6	$260,768
6	Yarwun-Aldoga raw water PS 270 L/s @ 130m (450 kW)		375	450 kW	1	686835	1.0	$686,835
7	450mm raw water RM Yarwun to Aldoga raw water reservoir	2006/7	450		6,480	369	1.6	$3,825,792
								$11,714,207
								$13,566,125
Mains Augmentations with Onsite Storage:								
	450mm raw water augmentation Hansons Rd (Rlwy Bridge to CAR 500)	2008/09	450		390	369	1.6	$230,256
	375mm raw water augmentation Landing Rd (Timor to Serrant Rd)	2008/09	375		600	309	1.6	$296,640
	CA Treated	2005/6	8m x 4m	0.05 Ml	1	47885	1.0	$47,885
	Orica Ammonia Tank FF Raw	2005/6	12m x 6m	0.6 Ml	1	213000	1.0	$213,000
	CAR TT2 Raw	2005/6	12m x 6m	0.7 Ml	2	234000	1.0	$468,000
								$1,255,781

6. Conclusions and Recommendations

From the investigations undertaken during this study it is concluded that:

1. Existing customer demands from industry are excessively peaked beyond the normal provisions for a bulk water supply system (i.e. peaking of approximately 1.5) which is directly related to a minimal provision of onsite storage facilities.
2. The Awoonga to Gladstone raw water supply system is of adequate capacity to service projected demands for the next 4 years (until 2009/10) under current energy optimised single pump operation of Awoonga Dam PS. At this time one of the following options would be required:
   - Allow 2 pump off-peak operation only. This option would satisfy system requirements until 20014/15 at which time one of the following further improvement options would be required:
   - Allow 2 pump operation to commence earlier within peak times subject to level criteria in both Gladstone and Toolooa reservoirs (say 80% depleted for both reservoirs)
   - Construct an additional reservoir at Toolooa of approximately 30 ML capacity to bring total usable storage in system to approximately 130 ML equivalent to a 2025 average day demand requirement for Gladstone reservoir and Mt Miller pipeline supplies.
3. The reduction in performance of the Awoonga to Gladstone system (i.e. lower reservoir operating levels) was observed to have an immediate impact on the delivery of inflow to the Gladstone raw water reservoirs.
4. Off-peak energy managed pumping was found to become inadequate, even with 2 pump operation at Awoonga Dam PS, prior to 20014/15 where it was shown that Toolooa and Gladstone raw water reservoir begin to deplete beyond adequate recovery over a 7 day period. Removal of off-peak pumping restrictions correct this shortfall in supply.
5. The Yarwun / Fishermans Landing raw water supply system was assessed to have adequate capacity for the projected planning horizon provided demand peaking was managed and limited to a typical bulk supply performance criteria (i.e. peaking of 1.5) and the delivery system of Awoonga to Gladstone was maintained in its ongoing performance.
6. The Fitsimmons St to Yarwun (Hansons Rd) raw (and treated) water supply system was observed to have limited capacity up to 110 L/s if maintained from the high 50 ML Gladstone raw water reservoir and reduced to approximately 80-90 L/s when converted to treated water supply via the lower 16 ML Fitsimmons St reservoir.
7. The Yarwun / Fishermans Landing treated water system was observed to be at or near capacity on the basis of single 50 L/s pumping unit capacity at Yarwun WTP PS. With the use of standby pumping capacity this can be improved upon in the short term as a temporary measure but will require a permanent solution to satisfy long term performance.
8. The Boat Creek to East End system was observed to have adequate capacity for servicing projected demands provided that demand peaking within the upstream Yarwun / Fishermans Landing treated water supply system was managed. Excessive peaked demands in this upstream system were observed to have significant impact on Boat Creek PS pumping heads which prevented supply being delivered along the full length of this main to East End Reservoir.
9. Options assessment has established that three viable options exist for servicing the Gladstone Northern Area for the projected further to 2025. These are as follows:

- Upgrade Yarwun to 100 L/s capacity to service Yarwun / Fishermans Landing projected demands with temporary servicing of TW customers with a temporarily converted Hansons Rd treated water supply and servicing of Aldoga SDA via new Aldoga WTP facility supplied with raw water from either the Mt miller pipeline or future Fitzroy supply.
- Upgrade Yarwun WTP to 150 L/s capacity to service Yarwun / Fishermans Landing and Aldoga SDA with temporary servicing of TW customers with a temporarily converted Hansons Rd treated water supply and servicing of Aldoga SDA via proposed treated and raw water PSs and rising mains to Aldoga.
- Involves the eventual decommissioning of Yarwun WTP and the eventual servicing of the entire Northern Area from an Aldoga WTP facility supplied with raw water from either the Mt miller pipeline or future Fitzroy supply

10. A comparison of estimated capital cost of options gives the preferred option as Option 1 at $13.6M with assessment as follows (excluding WTP costs):
    - Option 1: $13,566,125
    - Option 2: $16,831,703
    - Option 3: $16,837,476
11. Infrastructure ownership issues between GAWB and Calliope Shire were noted to be of particular concern for the treated water supply system in the Yarwun, Mt Miller and Fishermans Landing areas. In these areas consistency of ownership were seen to be a likely ongoing problem with regard to operations and maintenance and management of capital upgrade.

On the basis of the above conclusions it is recommended that:

1. The proposed Capital Works Program with a total estimated cost of $14.85M be adopted for upgrade and improvement of the treated and raw water supply systems to meet the forecasted 2025 demands. Works included in the CWP include the following:
   - Construct through capital funding and/or forced customer agreement, onsite storage associated with 3 existing industry and fire flow connections to the Yarwun / Fishermans Landing treated and raw water supply systems, as follows:
     - CA treated
     - Orica Ammonia Tank fire
     - CAR TT2 fire
   - As a condition to upgrade to stage 2 operations at CAR and Orica additional onsite storage should also be provided at:
     - CAR 500 Raw
     - CAR Treated
     - Orica Treated
   - Construct 200mm mains augmentation to Yarwun PS to Mt Miller delivery system. Also construct 375mm cross-connection in Reid Rd.
   - Construct 450mm and 300mm mains augmentations in Hansons Rd and Landing Rd respectively.
   - Construct new Yarwun WTP PS with 100 L/s capacity, whilst keeping existing PS in service to boost Hansons Rd treated water to Mt Miller reservoir.
   - Open cross connection between Hansons Rd and Mt Miller pipeline raw water system at around 2008 to supplement raw water supply to upgrade Yarwun WTP.
   - Undertake Aldoga works as and when required (approximately 2006/7):
     - 50 ML raw water receiving reservoir
     - Aldoga WTP & PSs (5 ML/d & 18 ML/d treated & raw capacity)
     - 5 ML and 15 ML treated and raw water reservoirs
     - 300mm connection main to Boat Ck to East End pipeline
   - Construct new PS and 450mm raw water RM from Mt Miller pipeline to Aldoga raw water storage.
2. Further detailed investigation be undertaken in relation to cost optimisation for the following items.
   - Energy management of Awoonga Dam PS versus capital outlay on additional storage at Toolooa
   - Cost of source bulk water from either Awoonga Dam or Fitzroy catchment and the implication on pumping costs
3. A rationalisation of ownership between GAWB and CSC be undertaken on Mt Miller Reservoir and treated water supply mains in the Mt Miller and Yarwun areas to improve infrastructure management for these assets. In this regard it is recommended that GAWB purchase currently CSC owned assets in this area.

Appendix A – Figures

Figure 1: Gladstone Regional Layout

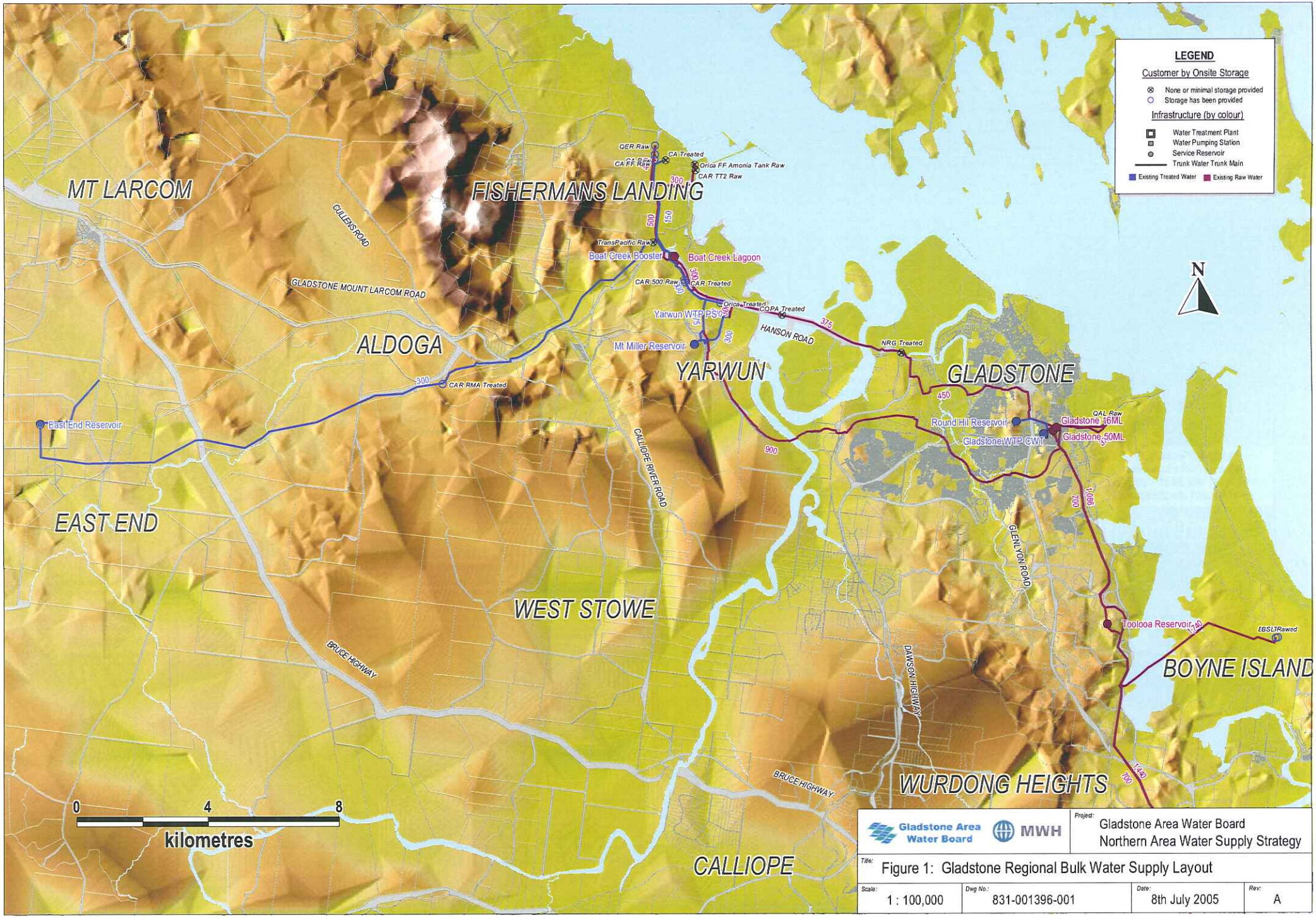

LEGEND
Customer by Onsite Storage
None or minimal storage provided
Storage has been provided
Infrastructure (by colour)
Water Treatment Plant
Water Pumping Station
Service Reservoir
Trunk Water Trunk Main
Existing Treated Water
Existing Raw Water
N
MT LARCOM
FISHERMANS LANDING
ALDOGA
YARWUN
GLADSTONE
EAST END
WEST STOWE
CALLIOPE
WURDONG HEIGHTS
BOYNE ISLAND
CULLENS ROAD
GLADSTONE MOUNT LARCOM ROAD
HANSON ROAD
CALLIOPE RIVER ROAD
GLENLYON ROAD
DAWSON HIGHWAY
BRUCE HIGHWAY
QER Raw
CA Treated
CA FF Raw
Orica FF Amonia Tank Raw
CAR TT2 Raw
TransPacific Raw
Boat Creek Booster
Boat Creek Lagoon
CAR 500 Raw
CAR Treated
Orica Treated
COPA Treated
Yarwun WTP PS
Mt Miller Reservoir
NRG Treated
CAR RMA Treated
East End Reservoir
Round Hil Reservoir
Gladstone WTP CWT
QAL Raw
Gladstone 16ML
Gladstone 50ML
Toolooa Reservoir
EBSLTRawed
300
500
150
375
450
900
700
1,066
1,440
0
4
8
kilometres
Gladstone Area Water Board
MWH
Project:
Gladstone Area Water Board
Northern Area Water Supply Strategy
Title:
Figure 1: Gladstone Regional Bulk Water Supply Layout
Scale:
1 : 100,000
Dwg No.:
831-001396-001
Date:
8th July 2005
Rev:
A

Figure 2: Gladstone Existing System Layout

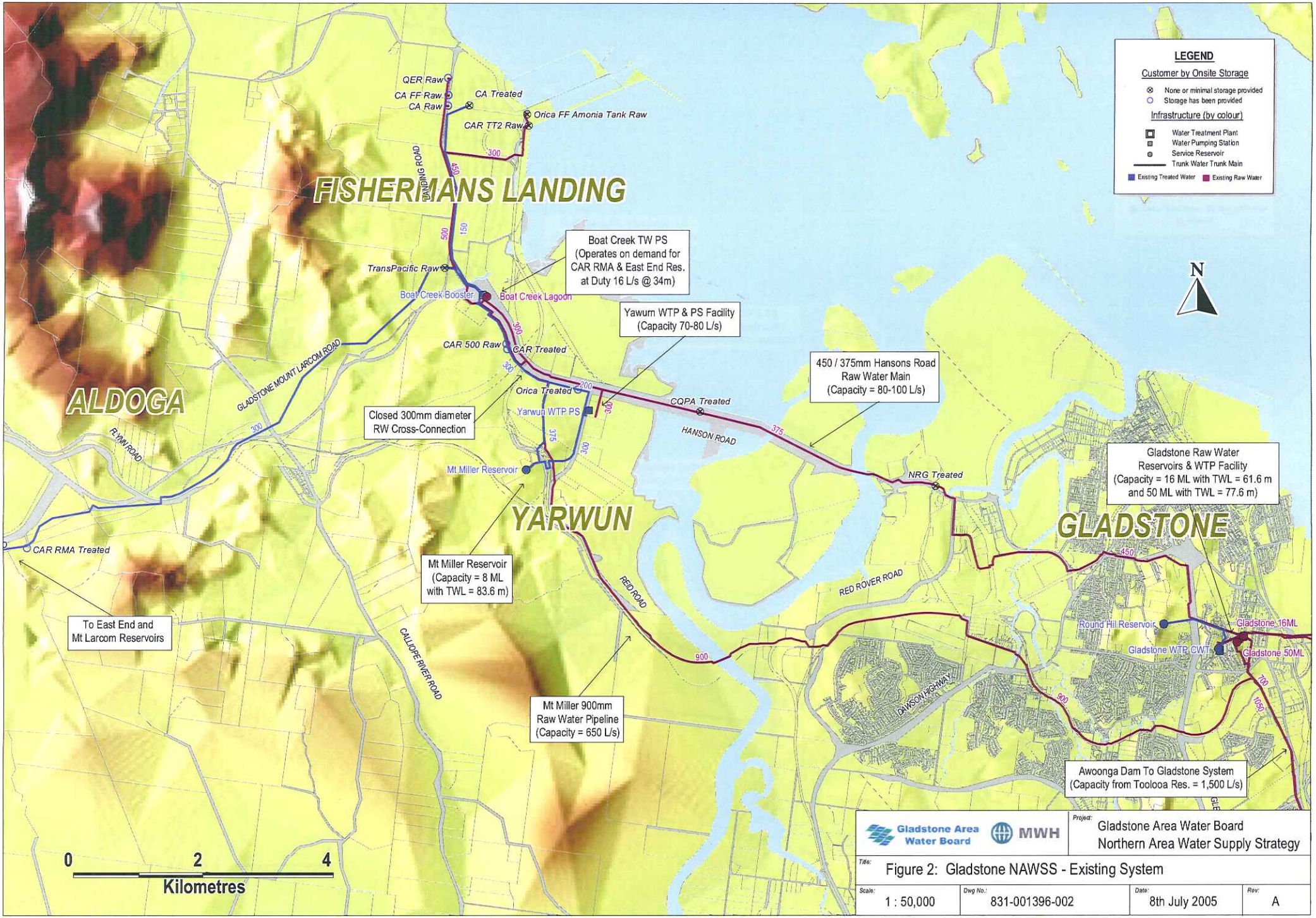

LEGEND
Customer by Onsite Storage
None or minimal storage provided
Storage has been provided
Infrastructure (by colour)
Water Treatment Plant
Water Pumping Station
Service Reservoir
Trunk Water Trunk Main
Existing Treated Water
Existing Raw Water
FISHERMANS LANDING
ALDOGA
YARWUN
GLADSTONE
QER Raw
CA FF Raw
CA Raw
CA Treated
Orica FF Amonia Tank Raw
CAR TT2 Raw
LANDING ROAD
TransPacific Raw
Boat Creek Booster
Boat Creek Lagoon
Boat Creek TW PS
(Operates on demand for
CAR RMA & East End Res.
at Duty 16 L/s @ 34m)
Yawurn WTP & PS Facility
(Capacity 70-80 L/s)
CAR 500 Raw
CAR Treated
Orica Treated
CQPA Treated
NRG Treated
Yarwun WTP PS
Closed 300mm diameter
RW Cross-Connection
450 / 375mm Hansons Road
Raw Water Main
(Capacity = 80-100 L/s)
HANSON ROAD
GLADSTONE MOUNT LARCOM ROAD
FLYNN ROAD
CAR RMA Treated
To East End and
Mt Larcom Reservoirs
Mt Miller Reservoir
Mt Miller Reservoir
(Capacity = 8 ML
with TWL = 83.6 m)
Mt Miller 900mm
Raw Water Pipeline
(Capacity = 650 L/s)
RED ROAD
RED ROVER ROAD
CALLIOPE RIVER ROAD
DAWSON HIGHWAY
Gladstone Raw Water
Reservoirs & WTP Facility
(Capacity = 16 ML with TWL = 61.6 m
and 50 ML with TWL = 77.6 m)
Round Hill Reservoir
Gladstone 16ML
Gladstone WTP CWT
Gladstone 50ML
Awoonga Dam To Gladstone System
(Capacity from Toolooa Res. = 1,500 L/s)
N
0
2
4
Kilometres
Gladstone Area Water Board
MWH
Project: Gladstone Area Water Board
Northern Area Water Supply Strategy
Title: Figure 2: Gladstone NAWSS - Existing System
Scale: 1 : 50,000
Dwg No.: 831-001396-002
Date: 8th July 2005
Rev: A

Figure 3: Option 1 Layout

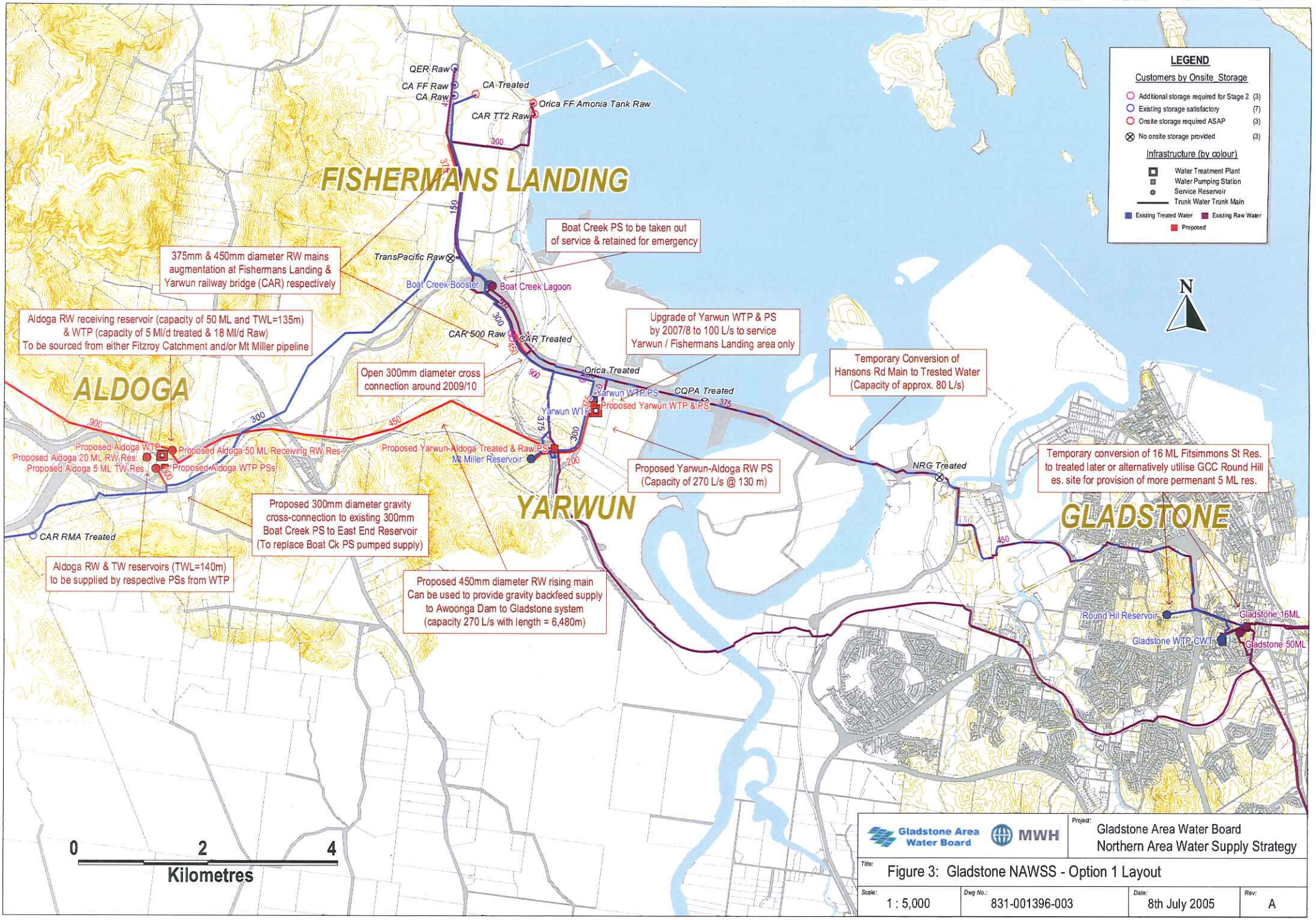

FISHERMANS LANDING
ALDOGA
YARWUN
GLADSTONE
QER Raw
CA FF Raw
CA Raw
CA Treated
Orica FF Amonia Tank Raw
CAR TT2 Raw
TransPacific Raw
Boat Creek Booster
Boat Creek Lagoon
CAR 500 Raw
CAR Treated
Orica Treated
Yarwun WTP PS
Proposed Yarwun WTP & PS
CQPA Treated
NRG Treated
Proposed Aldoga WTP
Proposed Aldoga 20 ML RW Res
Proposed Aldoga 5 ML TW Res
Proposed Aldoga 50 ML Receiving RW Res
Proposed Aldoga WTP PSs
Proposed Yarwun-Aldoga Treated & Raw PS
Mt Miller Reservoir
CAR RMA Treated
Round Hil Reservoir
Gladstone 16ML
Gladstone WTP CWT
Gladstone 50ML
Boat Creek PS to be taken out of service & retained for emergency
375mm & 450mm diameter RW mains augmentation at Fishermans Landing & Yarwun railway bridge (CAR) respectively
Aldoga RW receiving reservoir (capacity of 50 ML and TWL=135m) & WTP (capacity of 5 Ml/d treated & 18 Ml/d Raw) To be sourced from either Fitzroy Catchment and/or Mt Miller pipeline
Upgrade of Yarwun WTP & PS by 2007/8 to 100 L/s to service Yarwun / Fishermans Landing area only
Open 300mm diameter cross connection around 2009/10
Temporary Conversion of Hansons Rd Main to Trested Water (Capacity of approx. 80 L/s)
Temporary conversion of 16 ML Fitsimmons St Res. to treated later or alternatively utilise GCC Round Hill es. site for provision of more permenant 5 ML res.
Proposed Yarwun-Aldoga RW PS (Capacity of 270 L/s @ 130 m)
Proposed 300mm diameter gravity cross-connection to existing 300mm Boat Creek PS to East End Reservoir (To replace Boat Ck PS pumped supply)
Aldoga RW & TW reservoirs (TWL=140m) to be supplied by respective PSs from WTP
Proposed 450mm diameter RW rising main Can be used to provide gravity backfeed supply to Awoonga Dam to Gladstone system (capacity 270 L/s with length = 6,480m)
LEGEND
Customers by Onsite Storage
Additional storage required for Stage 2 (3)
Existing storage satisfactory (7)
Onsite storage required ASAP (3)
No onsite storage provided (3)
Infrastructure (by colour)
Water Treatment Plant
Water Pumping Station
Service Reservoir
Trunk Water Trunk Main
Existing Treated Water
Existing Raw Water
Proposed
N
0 2 4
Kilometres
Gladstone Area Water Board
MWH
Project: Gladstone Area Water Board Northern Area Water Supply Strategy
Title: Figure 3: Gladstone NAWSS - Option 1 Layout
Scale: 1 : 5,000
Dwg No.: 831-001396-003
Date: 8th July 2005
Rev: A

Figure 4: Option 2 Layout

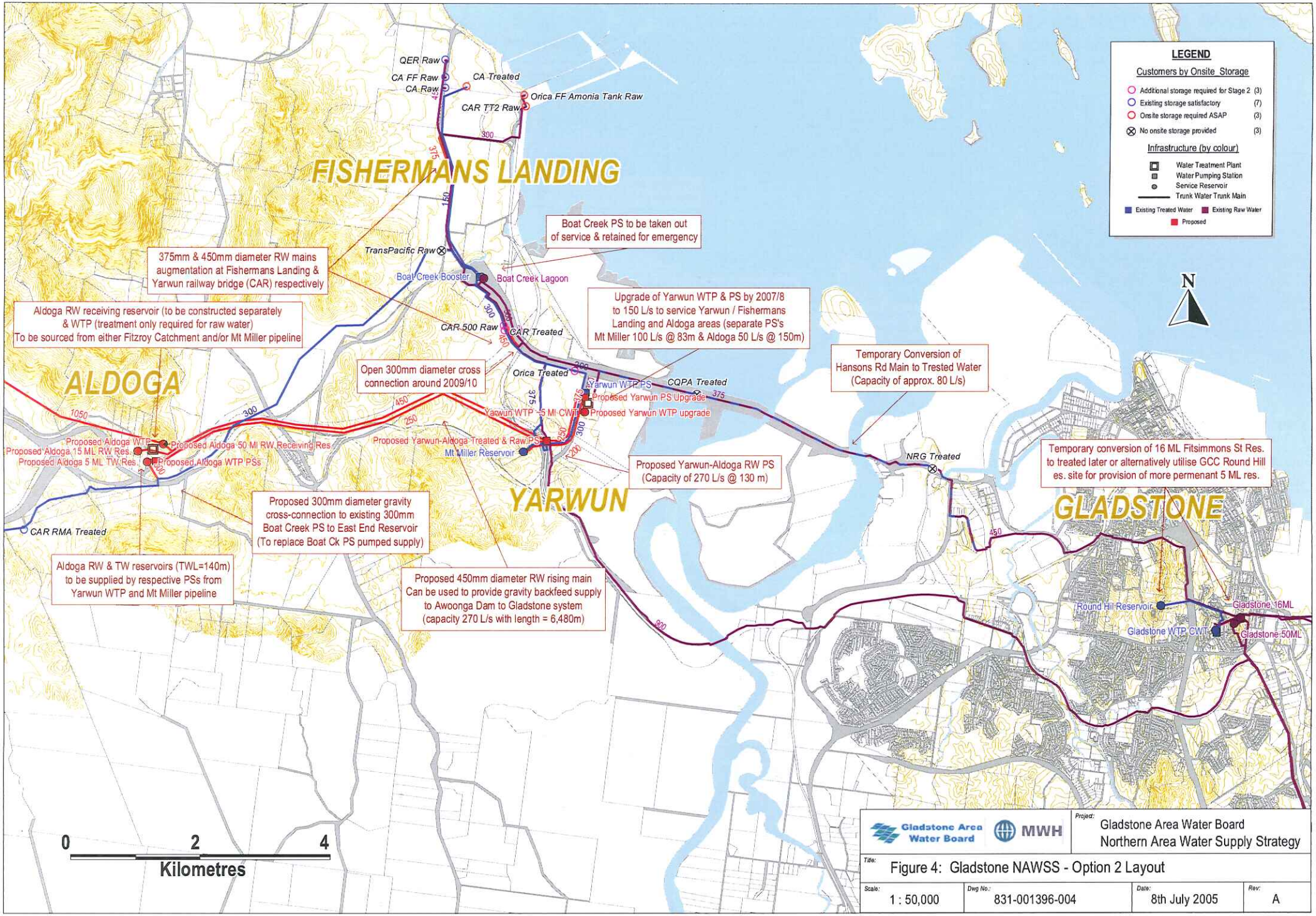
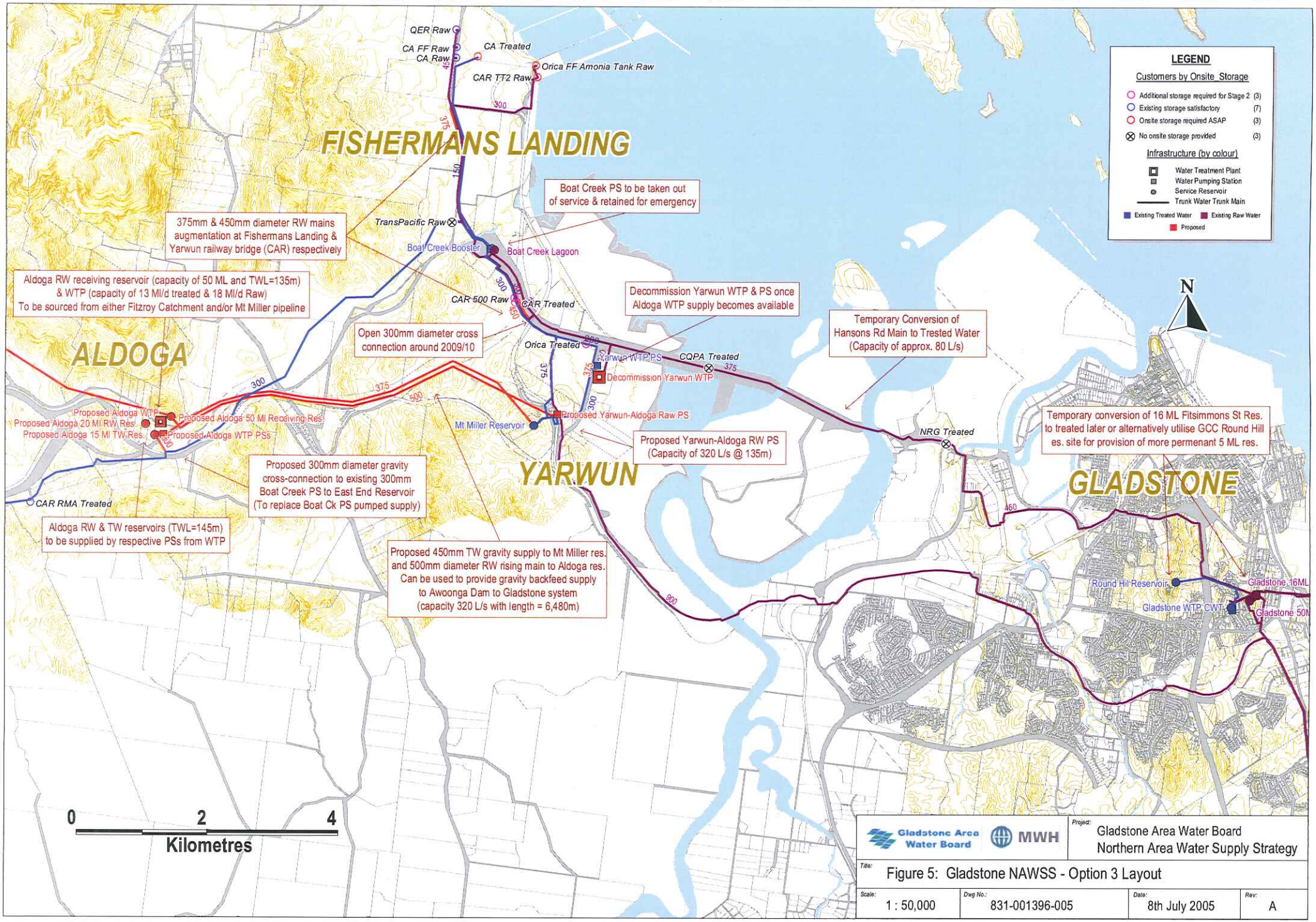

LEGEND
Customers by Onsite Storage
Additional storage required for Stage 2 (3)
Existing storage satisfactory (7)
Onsite storage required ASAP (3)
No onsite storage provided (3)
Infrastructure (by colour)
Water Treatment Plant
Water Pumping Station
Service Reservoir
Trunk Water Trunk Main
Existing Treated Water
Existing Raw Water
Proposed
FISHERMANS LANDING
ALDOGA
YARWUN
GLADSTONE
QER Raw
CA FF Raw
CA Raw
CA Treated
Orica FF Amonia Tank Raw
CAR TT2 Raw
TransPacific Raw
Boat Creek Booster
Boat Creek Lagoon
CAR 500 Raw
CAR Treated
Orica Treated
Yarwun WTP PS
CQPA Treated
Proposed Yarwun PS Upgrade
Yarwun WTP -5 Ml CWT
Proposed Yarwun WTP upgrade
Proposed Yarwun-Aldoga Treated & Raw PS
Mt Miller Reservoir
NRG Treated
Proposed Aldoga WTP
Proposed Aldoga 50 Ml RW Receiving Res.
Proposed Aldoga 15 ML RW Res.
Proposed Aldoga 5 ML TW Res.
Proposed Aldoga WTP PSs
CAR RMA Treated
Round Hill Reservoir
Gladstone 16ML
Gladstone WTP CWT
Gladstone 50ML
Boat Creek PS to be taken out of service & retained for emergency
375mm & 450mm diameter RW mains augmentation at Fishermans Landing & Yarwun railway bridge (CAR) respectively
Aldoga RW receiving reservoir (to be constructed separately & WTP (treatment only required for raw water) To be sourced from either Fitzroy Catchment and/or Mt Miller pipeline
Upgrade of Yarwun WTP & PS by 2007/8 to 150 L/s to service Yarwun / Fishermans Landing and Aldoga areas (separate PS's Mt Miller 100 L/s @ 83m & Aldoga 50 L/s @ 150m)
Temporary Conversion of Hansons Rd Main to Trested Water (Capacity of approx. 80 L/s)
Open 300mm diameter cross connection around 2009/10
Proposed Yarwun-Aldoga RW PS (Capacity of 270 L/s @ 130 m)
Temporary conversion of 16 ML Fitsimmons St Res. to treated later or alternatively utilise GCC Round Hill es. site for provision of more permenant 5 ML res.
Proposed 300mm diameter gravity cross-connection to existing 300mm Boat Creek PS to East End Reservoir (To replace Boat Ck PS pumped supply)
Aldoga RW & TW reservoirs (TWL=140m) to be supplied by respective PSs from Yarwun WTP and Mt Miller pipeline
Proposed 450mm diameter RW rising main Can be used to provide gravity backfeed supply to Awoonga Dam to Gladstone system (capacity 270 L/s with length = 6,480m)
N
0 2 4
Kilometres
Gladstone Area Water Board
MWH
Project: Gladstone Area Water Board Northern Area Water Supply Strategy
Title: Figure 4: Gladstone NAWSS - Option 2 Layout
Scale: 1 : 50,000
Dwg No.: 831-001396-004
Date: 8th July 2005
Rev: A

Figure 5: Option 3 Layout


FISHERMANS LANDING
ALDOGA
YARWUN
GLADSTONE
QER Raw
CA FF Raw
CA Raw
CA Treated
Orica FF Amonia Tank Raw
CAR TT2 Raw
TransPacific Raw
Boat Creek Booster
Boat Creek Lagoon
CAR 500 Raw
CAR Treated
Orica Treated
Yarwun WTP PS
Decommission Yarwun WTP
CQPA Treated
NRG Treated
Proposed Aldoga WTP
Proposed Aldoga 20 Ml RW Res
Proposed Aldoga 15 Ml TW Res
Proposed Aldoga 50 Ml Receiving Res
Proposed Aldoga WTP PSs
Mt Miller Reservoir
Proposed Yarwun-Aldoga Raw PS
CAR RMA Treated
Round Hil Reservoir
Gladstone WTP CWT
Gladstone 16ML
Gladstone 50M
Boat Creek PS to be taken out of service & retained for emergency
375mm & 450mm diameter RW mains augmentation at Fishermans Landing & Yarwun railway bridge (CAR) respectively
Aldoga RW receiving reservoir (capacity of 50 ML and TWL=135m) & WTP (capacity of 13 Ml/d treated & 18 Ml/d Raw) To be sourced from either Fitzroy Catchment and/or Mt Miller pipeline
Open 300mm diameter cross connection around 2009/10
Decommission Yarwun WTP & PS once Aldoga WTP supply becomes available
Temporary Conversion of Hansons Rd Main to Trested Water (Capacity of approx. 80 L/s)
Temporary conversion of 16 ML Fitsimmons St Res. to treated later or alternatively utilise GCC Round Hill es. site for provision of more permenant 5 ML res.
Proposed Yarwun-Aldoga RW PS (Capacity of 320 L/s @ 135m)
Proposed 300mm diameter gravity cross-connection to existing 300mm Boat Creek PS to East End Reservoir (To replace Boat Ck PS pumped supply)
Aldoga RW & TW reservoirs (TWL=145m) to be supplied by respective PSs from WTP
Proposed 450mm TW gravity supply to Mt Miller res. and 500mm diameter RW rising main to Aldoga res. Can be used to provide gravity backfeed supply to Awoonga Dam to Gladstone system (capacity 320 L/s with length = 6,480m)
LEGEND
Customers by Onsite Storage
Additional storage required for Stage 2 (3)
Existing storage satisfactory (7)
Onsite storage required ASAP (3)
No onsite storage provided (3)
Infrastructure (by colour)
Water Treatment Plant
Water Pumping Station
Service Reservoir
Trunk Water Trunk Main
Existing Treated Water
Existing Raw Water
Proposed
N
0 2 4
Kilometres
Gladstone Area Water Board
MWH
Project: Gladstone Area Water Board Northern Area Water Supply Strategy
Title: Figure 5: Gladstone NAWSS - Option 3 Layout
Scale: 1 : 50,000
Dwg No.: 831-001396-005
Date: 8th July 2005
Rev: A

Appendix B – Estimated Costs of Options

Item No.	Item Description	Trigger	Likely Year	Diameter	Size	Qty	Cost Rate ($ / Qty)	Factor	Cost
Awoonga to Gladstone System (Base Requirement For All Options):									
	New Toolooa 30 ML Reservoir		2009/10	48m x 10m	30 ML	1	2330092	1.6	$3,728,147
Option 1:									
Yarwun / Fishermans Landing Treated & Raw Water Systems									
1	Conversion of Hansons Rd main & 16 Ml Fitsimmons st reservoir	Orica Stage 2	2005/6					1.0	$100,000
2	Replacement of Yarwun pumps 100 L/s @ 85m (110 kW)	Orica Stage 2	2005/6	200	110 kW	1	313100	1.0	$313,100
3	Yarwun WTP upgrade (say 9 Ml/d treated process capacity)	CAR Stage 2	2006/7		9 Ml/d	1		1.0	**Not Included**
4	Yarwun 3 Ml CWT	CAR Stage 2	2006/7	25m x 8m	3 Ml	1	575537	1.6	$920,859
5	375mm cross-connection from Yarwun PS to existing 375mm main	CAR Stage 2	2008/9	375		90	309	1.9	$52,839
6	200mm Yarwun PS to Mt Miller reservoir RM augmentation	CAR Stage 2	2009/10	200		1,700	171	1.6	$465,120
									$1,851,918
Proposed Aldoga SDA System									
1	Aldoga 50 Ml raw water collection reservoir	Significant Aldoga Demand	2006/7	80m x 10m	50 Ml	1	3177618	1.2	$3,813,142
2	Aldoga WTP & PS's (5 Ml/d treated & & 18 Ml/d raw process capacity)	Significant Aldoga Demand	2006/7		22 Ml/d	1		1.0	**Not Included**
3	Aldoga 5 Ml treated water reservoir	Significant Aldoga Demand	2006/7	28m x 8m	5 Ml	1	784877	1.2	$941,852
4	Aldoga 20 Ml raw water reservoir	Significant Aldoga Demand	2006/7	50m x 10m	20 Ml	1	1821515	1.2	$2,185,818
5	300mm connecting main to East End main	Significant Aldoga Demand	2006/7	300		580	281	1.6	$260,768
6	Yarwun-Aldoga raw water PS 270 L/s @ 130m (450 kW)			375	450 kW	1	686835	1.0	$686,835
7	450mm raw water RM Yarwun to Aldoga raw water reservoir	Significant Aldoga Demand	2006/7	450		6,480	369	1.6	$3,825,792
									$11,714,207
									$13,566,125

Item No.	Item Description	Trigger	Likely Year	Diameter	Size	Qty	Cost Rate ($ / Qty)	Factor	Cost
Option 2:									
Yarwun / Fishermans Landing Treated & Raw Water Systems									
1	Conversion of Hansons Rd main & 16 Ml Fitsimmons st reservoir	Orica Stage 2	2005/6					1.0	$100,000
2	Replacement of Yarwun pumps 100 L/s @ 85m (110 kW)	Orica Stage 2	2005/6	200	110 kW	1	313100	1.0	$313,100
3	Yarwun WTP upgrade (say 13 Ml/d treated process capacity)	CAR Stage 2	2006/7		13 Ml/d	1		1.0	**Not Included**
4	Yarwun 7 Ml CWT	CAR Stage 2	2006/7	33m x 8m	7 Ml	1	957727	1.6	$1,532,363
5	375mm cross-connection from Yarwun PS to existing 375mm main	CAR Stage 2	2008/9	375		90	309	1.9	$52,839
6	200mm Yarwun PS to Mt Miller reservoir RM augmentation	CAR Stage 2	2009/10	200		1,700	171	1.6	$465,120
									$2,463,422
Proposed Aldoga SDA System									
1	Aldoga 50 Ml raw water collection reservoir	Significant Aldoga Demand	2014/15	80m x 10m	50 Ml	1	3177618	1.2	$3,813,142
2	Yarwun-Aldoga raw water PS 270 L/s @ 130m (450 kW)	Significant Aldoga Demand	2006/7	375	450 kW	1	686835	1.0	$686,835
3	Yarwun-Aldoga treated water PS 52 L/s @ 135m (90 kW)	Significant Aldoga Demand	2006/7	200	90 kW	1	290170	1.0	$290,170
4	450mm raw waterRM Yarwun to Aldolga raw water reservoir	Significant Aldoga Demand	2006/7	450		6,480	369	1.6	$3,825,792
5	250mm treated water RM Yarwun to Aldolga treated water reservoir	Significant Aldoga Demand	2006/7	250		6,480	228	1.6	$2,363,904
6	Aldoga 5 Ml treated water reservoir	Significant Aldoga Demand	2006/7	28m x 8m	5 Ml	1	784877	1.2	$941,852
7	Aldoga 20 Ml raw water reservoir	Significant Aldoga Demand	2006/7	50m x 10m	20 Ml	1	1821515	1.2	$2,185,818
8	300mm connecting main to East End main	Significant Aldoga Demand	2009/10	300		580	281	1.6	$260,768
									$14,368,281
									$16,831,703

Item No.	Item Description	Trigger	Likely Year	Diameter	Size	Qty	Cost Rate ($ / Qty)	Factor	Cost
Option 3:									
Yarwun / Fishermans Landing Treated & Raw Water Systems									
1	450mm main Aldoga WTP CWT to Mt Miller reservoir	CAR Stage 2	2006/7	450		6,320	369	1.6	$3,731,328
2	300mm cross-connection from Yarwun PS to existing 375mm main	CAR Stage 2	2006/7	300		90	281	1.9	$48,051
									$3,779,379
Proposed Aldoga SDA System									
1	Aldoga 50 Ml raw water collection reservoir	Significant Aldoga Demand	2006/7	80m x 10m	50 Ml	1	3177618	1.2	$3,813,142
2	Aldoga WTP (13 Ml/d treated & 18 raw water process capacity)	Significant Aldoga Demand	2006/7		31 Ml/d	1		1.0	**Not Included**
3	Aldoga 15 Ml treated water reservoir	Significant Aldoga Demand	2006/7	44m x 10m	15 Ml	1	1529528	1.2	$1,835,434
4	Aldoga 20 Ml raw water reservoir	Significant Aldoga Demand	2006/7	35m x 10m	10 Ml	1	1821515	1.2	$2,185,818
5	Yarwun-Aldoga raw water PS 320 L/s @ 150m (550 kW)	Significant Aldoga Demand	2006/7	375	550 kW	1	795000	1.0	$795,000
6	500mm raw waterRM Yarwun to Aldolga raw water reservoir	Significant Aldoga Demand	2006/7	500		6,480	402	1.6	$4,167,936
7	300mm connecting main to East End main	Significant Aldoga Demand	2009/10	300		580	281	1.6	$260,768
									$13,058,097
									$16,837,476

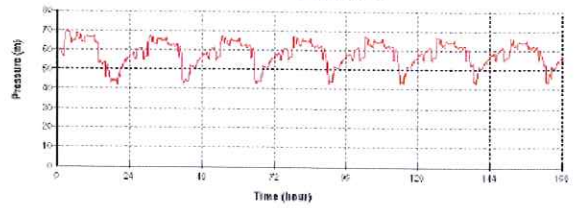
Item No.	Item Description	Trigger	Likely Year	Diameter	Size	Qty	Cost Rate ($ / Qty)	Factor	Cost
Mains Augmentation With Onsite Storage:									
1	450mm raw water augmentation Hansons Rd (Rlwy Bridge to CAR 500)		2008/09	450		390	369	1.6	$230,256
2	375mm raw water augmentation Landing Rd (Ticor to Serrant Rd)		2008/09	375		600	309	1.6	$296,640
3	CAR 500 Raw	Stage 2	2006/7	38m x 8m	1.9 Ml	1	435000	1.0	$435,000
4	CAR Treated	Stage 2	2006/7	12m x 6m	0.9 Ml	1	275000	1.0	$275,000
5	Orica Treated	Stage 2	2006/7	14m x 6m	0.9 Ml	1	275000	1.0	$275,000
6	CA Treated	Current peaking	2005/6	8m x 4m	0.05 Ml	1	47885	1.0	$47,885
7	Orica Ammonia Tank FF Raw	Current peaking	2005/6	12m x 6m	0.6 Ml	1	213000	1.0	$213,000
8	CAR TT2 Raw	Current peaking	2005/6	12m x 6m	0.7 Ml	2	234000	1.0	$468,000
									$2,240,781
Mains Augmentation for Peaking & FF wthout Onsite Storage:									
1	150mm treated water augmentation Boat Ck to Fishermans Landing	Current peaking	2005/6	150		3,450	140	1.6	$772,800
2	500mm raw water augmentation Mt Miller Rd to Obodin Rd	Current peaking	2005/6	500		3,220	402	1.6	$2,071,104
3	450mm raw water augmentation Obodin Rd to QER	Current peaking	2005/6	450		1,770	369	1.6	$1,045,008
4	500mm raw water augmentation Serrant Rd (Hansons Rd to CAR TT2)	Current peaking	2005/6	500		1,790	402	1.6	$1,151,328
5	300mm raw water augmentation Serrant Rd (CAR TT2 to Orica)	Current peaking	2005/6	300		280	281	1.6	$125,888
									$5,166,128

Appendix C – Model Output

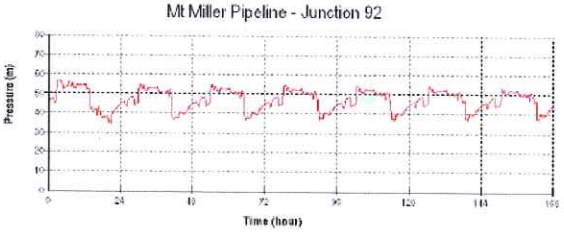
2004-05 FF and Storage Assessment Scenarios

Storage Assessment Run:

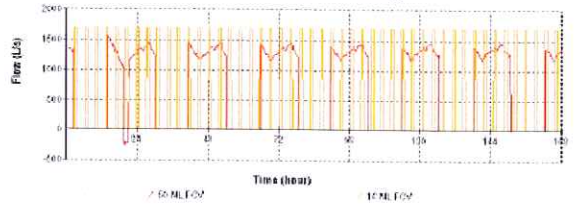
QER Offtake - Junction 1034



Mt Miller Pipeline - Junction 92

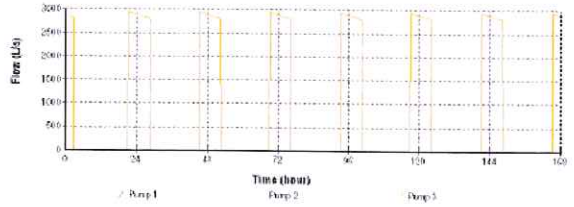


Gladstone Inlet Control / Throttling

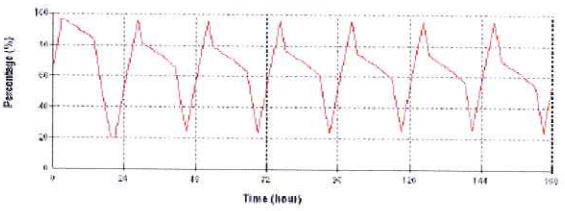


Yarwun Inlet Delivery

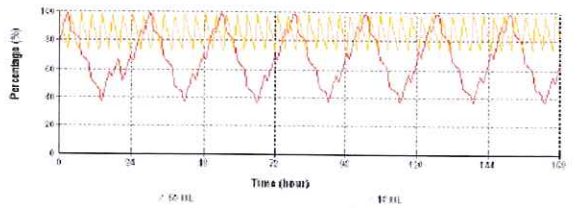
Awoonga Dam PS Delivery



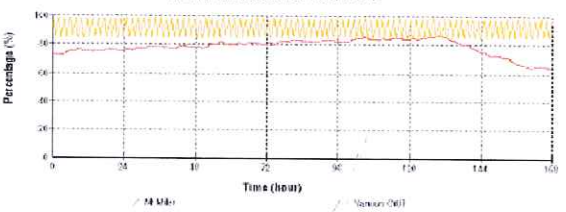
Toolooa Reservoir



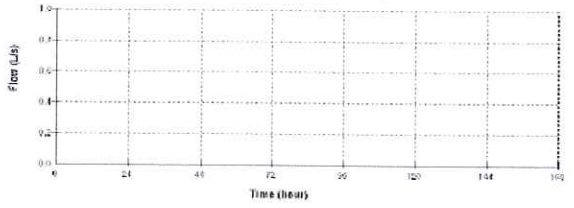
Gladstone Reservoirs



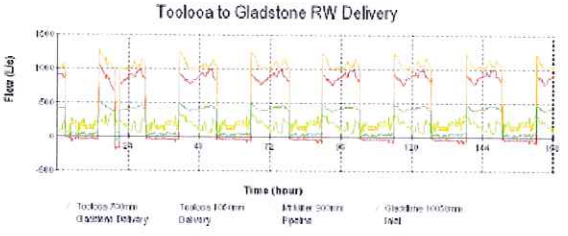
Mt Miller Res. & Yarwun CWT



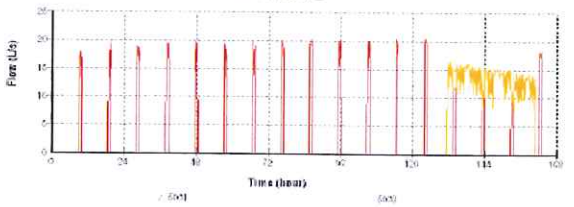
Hansen Rd RW Cross Connection - Pipe 3016 3



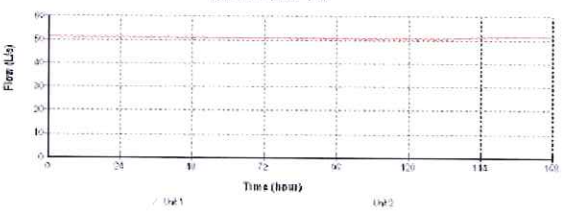
Toolooa to Gladstone RW Delivery



Boat Creek PS



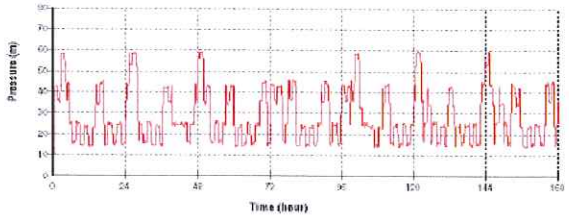
Yarwun WTP PS



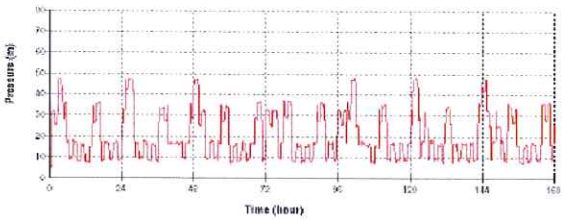
2024-25 FF and Storage Assessment Scenarios

Storage Assessment Run:

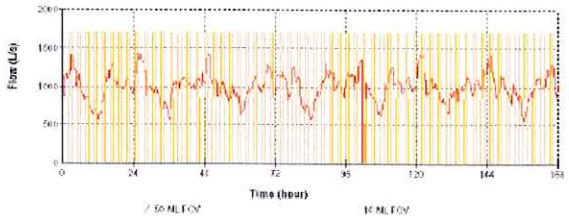
QER Offtake - Junction 1034



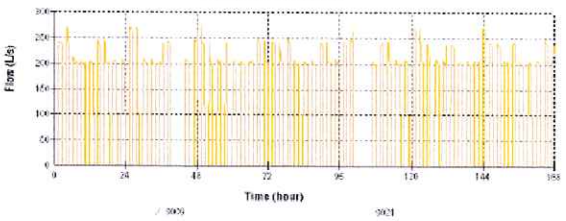
Mt Miller Pipeline - Junction 92



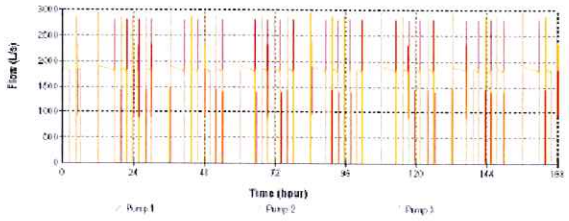
Gladstone Inlet Control / Throttling



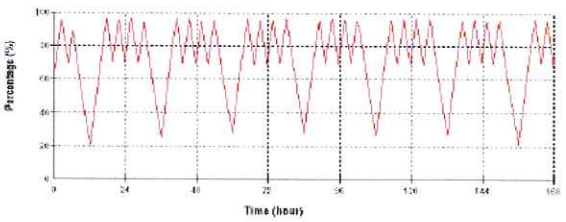
Yarwun Inlet Delivery



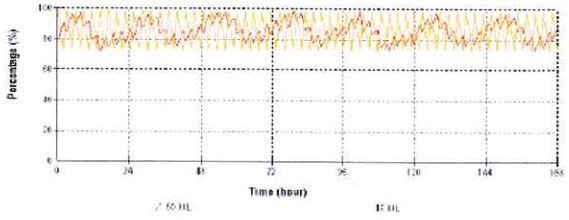
Awoonga Dam PS Delivery



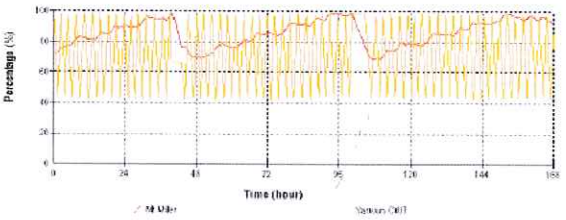
Toolooa Reservoir



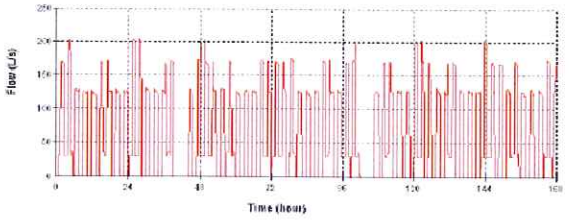
Gladstone Reservoirs



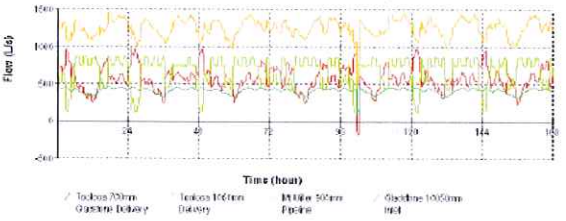
Mt Miller Res. & Yarwun CWT



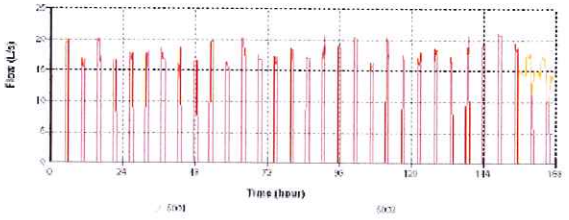
Hansen Rd RW Cross Connection - Pipe 3016 3



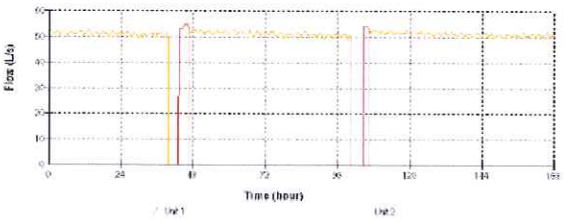
Toolooa to Gladstone RW Delivery



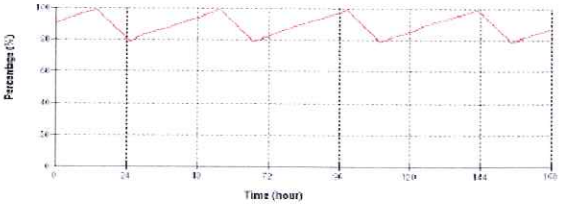
Boat Creek PS



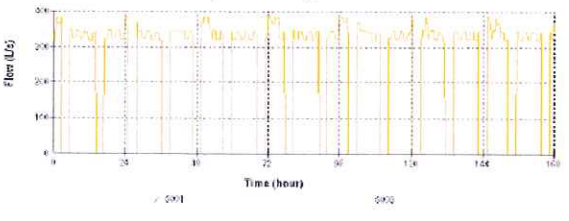
Yarwun WTP PS



Aldoga Reservoir

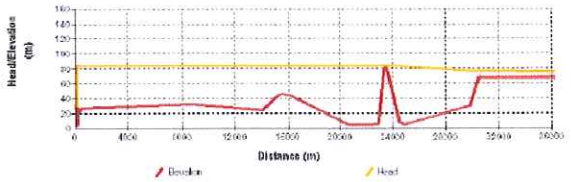


Yarwun to Aldoga PS

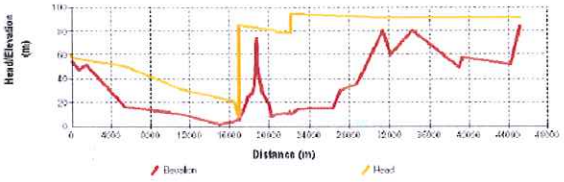


FF Assessment Run:

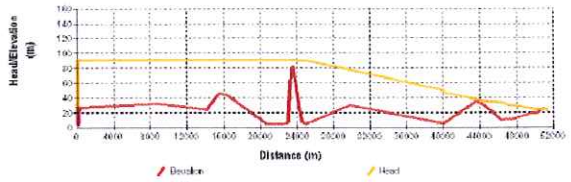
Minimum HGL Profile of Raw Water Delivery - Awoonga PS to Gladstone



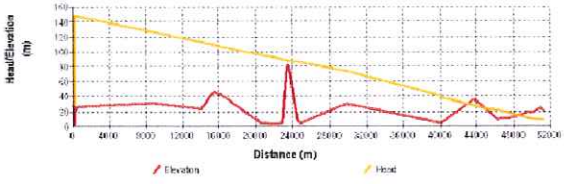
Minimum HGL Profile of Treated Water Delivery - Fitsimmons St to East End



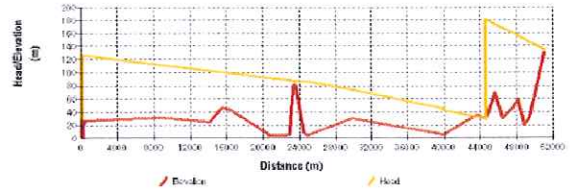
Minimum HGL Profile of Raw Water Delivery - Awoonga to Fishermans Landing



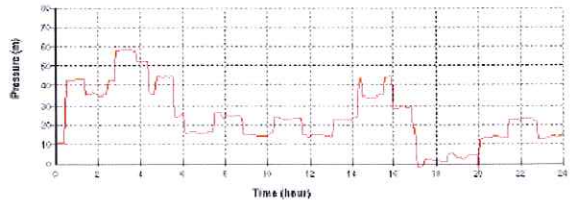
Peak Demand HGL Profile of Raw Water Delivery - Awoonga to Fishermans Landing



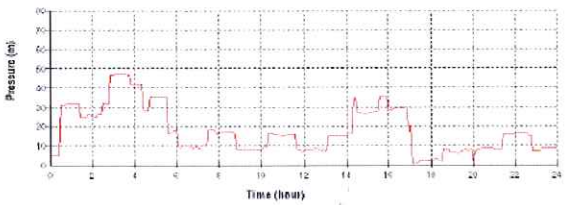
Peak Demand HGL Profile of Raw Water Delivery - Awoonga via Yarwun PS to Aldoga



QER Offtake - Junction 1034



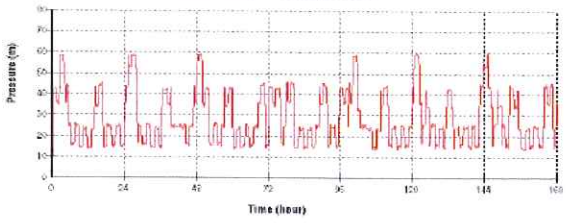
Mt Miller Pipeline - Junction 92



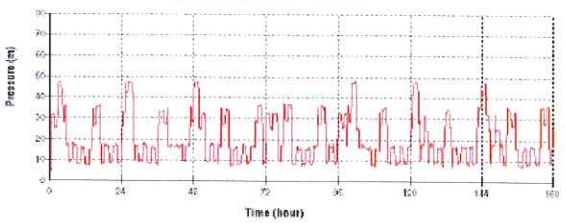
2024-25 FF and Storage Assessment Scenarios

Storage Assessment Run:

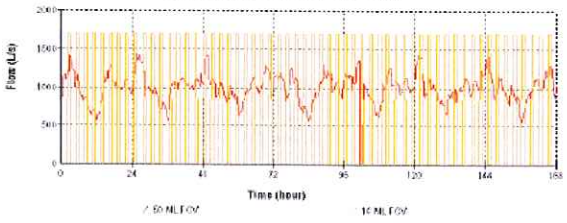
QER Offtake - Junction 1034



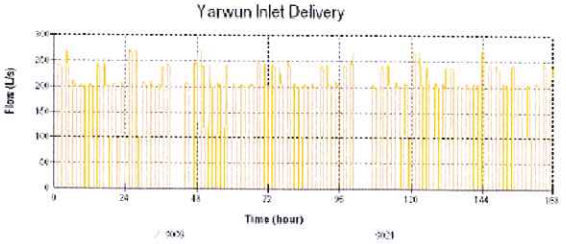
Mt Miller Pipeline - Junction 92



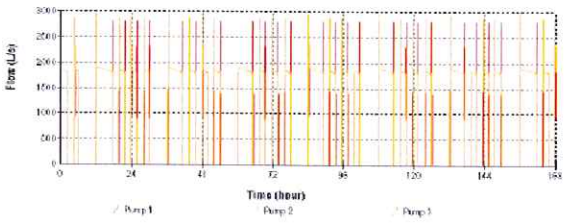
Gladstone Inlet Control / Throttling



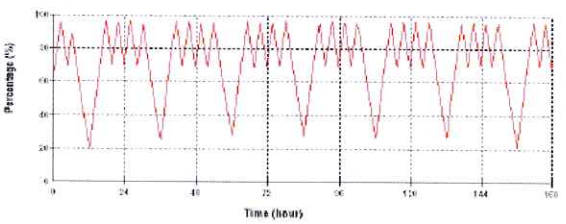
Yarwun Inlet Delivery



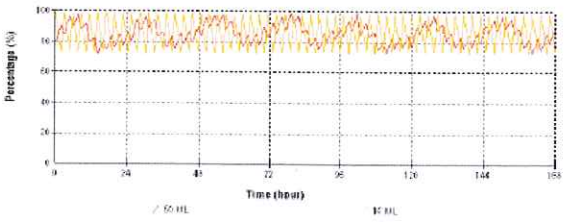
Awoonga Dam PS Delivery



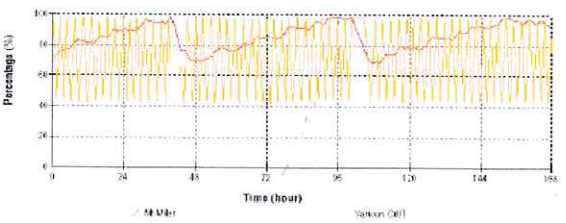
Toolooa Reservoir



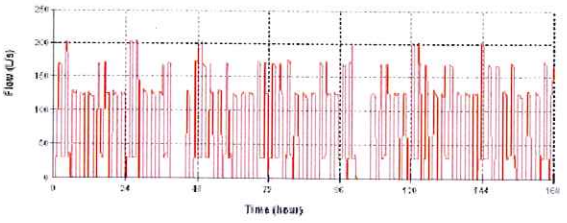
Gladstone Reservoirs



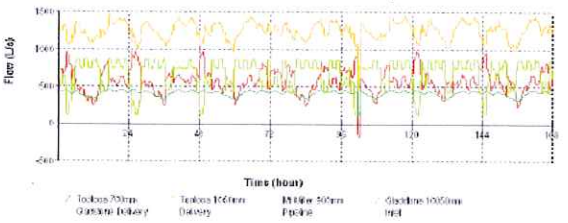
Mt Miller Res. & Yarwun CWT



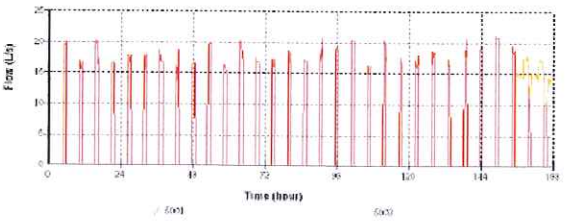
Hansen Rd RW Cross Connection - Pipe 3016 3



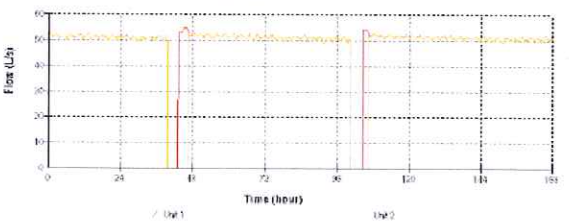
Toolooa to Gladstone RW Delivery



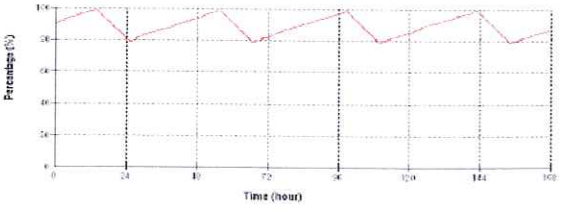
Boat Creek PS



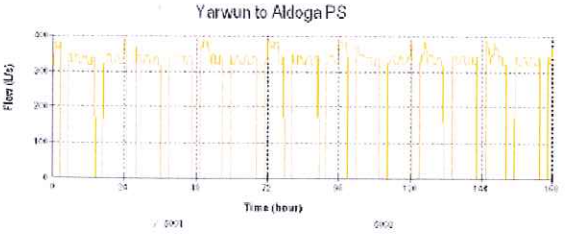
Yarwun WTP PS



Aldoga Reservoir

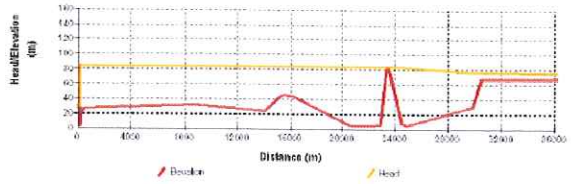


Yarwun to Aldoga PS

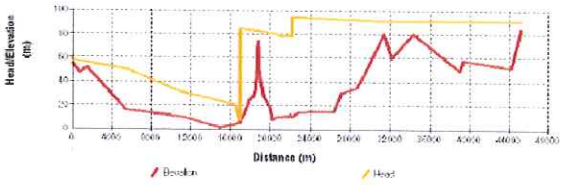


FF Assessment Run:

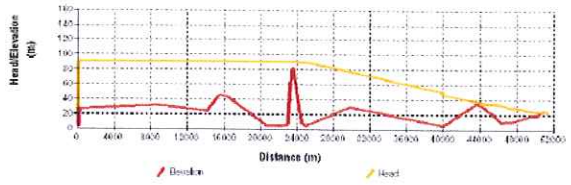
Minimum HGL Profile of Raw Water Delivery - Awoonga PS to Gladstone



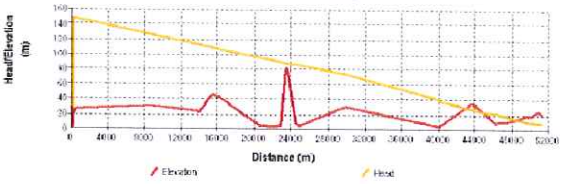
Minimum HGL Profile of Treated Water Delivery - Fitsimmons St to East End



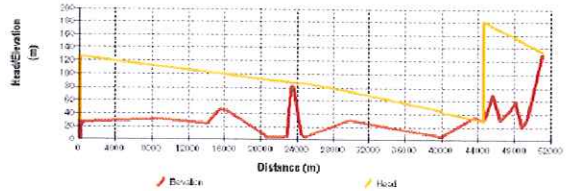
Minimum HGL Profile of Raw Water Delivery - Awoonga to Fishermans Landing



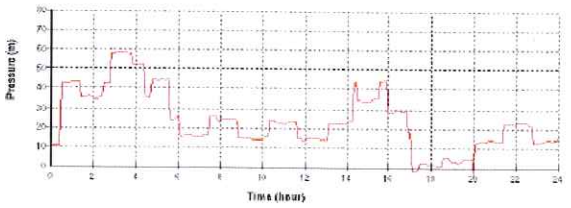
Peak Demand HGL Profile of Raw Water Delivery - Awoonga to Fishermans Landing



Peak Demand HGL Profile of Raw Water Delivery - Awoonga via Yarwun PS to Aldoga



QER Offtake - Junction 1034



Mt Miller Pipeline - Junction 92