BUILDING A BETTER WORLD

REPORT

Water Supply Strategic Infrastructure Plan - Gladstone Water Supply Scheme

Prepared for Gladstone Regional Council

February 2015

QUALITY STATEMENT

BRISBANE
Level 3 35 Boundary Street, PO Box 3602, South Brisbane, QLD 4101
TEL +61 7 3029 5000, FAX +61 7 3029 5050

PROJECT MANAGER	PROJECT TECHNICAL LEAD
John Ciccotelli	Phillip Hall

PREPARED BY		
Phillip Hall / Anjila Finan	………………………………..............	……/……/……
CHECKED BY		
Hayden Knight	………………………………..............	……/……/……
REVIEWED BY		
Phillip Hall	………………………………..............	……/……/……
APPROVED FOR ISSUE BY		
John Ciccotelli	………………………………..............	……/……/……

REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file).			
			Prepared by	Checked by	Reviewed by	Approved by
0	Jan 15	Updated Draft	AF/PH	PH	PH	JC

Executive Summary

MWH were engaged by Gladstone Regional Council in 2014 to develop water supply and sewerage strategic infrastructure plans for the Gladstone and Agnes Water networks. As part of this engagement 4 individual reports were produced as follows:

- Water Supply Strategic Infrastructure Plan – Gladstone Water Supply Scheme
- Water Supply Strategic Infrastructure Plan – Agnes Water Water Supply Scheme
- Sewerage Strategic Infrastructure Plan – Gladstone City Area
- Sewerage Strategic Infrastructure Plan – Agnes Water

This report represents the water supply strategic infrastructure plan for the Gladstone water supply scheme and documents the inputs, methodology, assumptions and approach adopted along with the water supply infrastructure outcomes.

All above listed reports have been prepared for the joint purpose of supporting Gladstone Regional Council's submission of the Local Government Infrastructure Plan (LGIP) for which updated water supply and sewerage infrastructure planning was required in the Gladstone City and Agnes Water networks.

Based on the outcomes of this study the following is concluded:

1. A demand model for the Gladstone area was developed and allocated to the H2OMAP hydraulic model for use in existing and future performance assessment and the identification of augmentation requirements. A summary of the project demands per current water zones is provided within **Table ES-1**. The current demand of the Gladstone water supply network of 24,637 ET was identified with an Ultimate demand of 43,372 ET.

Table ES-1: Current Water Zoning Demand Summary

Current Water Zone	Total ET						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone BC	2,980	3,159	3,851	4,468	4,984	5,320	5,320
Zone D	6,790	7,045	7,477	7,989	8,173	8,492	10,379
Clinton Park	5,925	6,643	6,704	7,493	8,474	8,877	10,952
NRG	2,352	2,391	2,464	2,793	4,667	4,667	5,245
Zone A	5,300	5,578	6,176	6,682	7,035	7,997	9,291
Fisher Street	1,280	1,517	1,761	1,761	1,940	2,184	2,184
Total	**24,627**	**26,333**	**28,433**	**31,186**	**35,274**	**37,537**	**43,372**

2. An assessment of current storage capacities based on current zoning identified that current reservoir storage shortfalls exist within the Zone BC, Clinton Park, Fisher Street and Zone A. Demand within the existing Zone D extent is projected to exceed the capacity of the available Zone D storage by 2016. A significant amount of excess storage capacity is currently available in the NRG water supply zone with storage shortfall not projected until Ultimate levels of development.

3. An overall network strategy to resolve current and existing storage deficiencies was developed. This strategy was based upon the zoning strategy previously developed by GRC and provided to MWH upon project start-up. The intention of developing a whole of network storage and zoning strategy is to make best use of spare capacity in existing assets and to ensure any capital expenditure deferment opportunities are realised. The proposed ultimate storage and zoning strategy is summarised below:

- Supply the Fisher Street water supply zone (WSZ) from the NRG zone (Zone F).
- Construct a new reservoir for Zone BC/Paterson water zone and supply the north of the Gladstone CBD from this zone alleviating immediate storage deficiencies experienced at Zone A reservoirs. Rezoning also assists to alleviate some areas of low pressure through improved connectivity.
- Supply the northern CBD area from the Paterson water zone using the 450 mm diameter water main which previously provided supply to the Fisher Street WSZ (new Zone BC).
- Use the Fisher Street reservoir to support Zone A storage requirements in the short term.
- Separate Zone A (to be supplied by Fisher Street and Radar Hill) from a new Ferris Hill water zone (Zone G). The rezoned Zone A was sized based on the storage capacity of Fisher Street and Radar Hill water zones.
- Construct new storage at Ferris Hill as required to accommodate future demand growth.
- Combine Zone D and Clinton Park water zones into a combined Zone D water zone (new Zone D)
- Undertake works to convert the Clinton Park inlet/out main into a dedicated inlet main.
- Construct new storages for Zone D at the identified Kirkwood Road site (at the same level as the existing reservoirs), South Gladstone reservoir facility and Round Hill reservoir facility as required.

4. Upon establishment of the Ultimate zoning strategy, network deficiencies under maximum hour and fire flow demands were identified and resolved through local augmentation works.
5. Cost estimation for proposed infrastructure was undertaken. Table ES-2 summarises cost estimates per zone. Table ES-3 summarises cost estimates per planning horizon. The total cost estimate for proposed water supply infrastructure is **$39.7 Million** based on the adopted methodology. Cost estimation summaries specifically for LGIP and IPP classed infrastructure are provided within Section 10. The total capital cost estimate for LGIP infrastructure is **$30.9 Million**. The total capital cost estimate for IPP infrastructure is **$8.8 Million**.

Table ES-2: Total/combined augmentations cost estimation summary per zone

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$760,000			$20,000		$40,000		**$820,000**
Zone BC	$7,160,000	$50,000	$20,000			$100,000		**$7,330,000**
Zone D	$10,380,000	$130,000	$70,000	$370,000	$7,740,000	$60,000	$5,990,000	**$24,740,000**
Zone F	$1,470,000				$3,730,000			**$5,200,000**
Zone G	$310,000	$50,000	$100,000	$10,000	$1,180,000			**$1,650,000**
TOTAL	**$20,080,000**	**$230,000**	**$190,000**	**$400,000**	**$12,650,000**	**$200,000**	**$5,990,000**	**$39,740,000**

Table ES-2: Total/combined augmentation cost estimation summary per planning horizon

Asset Type	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Water mains	$10,010,000		$70,000	$400,000	$4,620,000	$160,000	$1,960,000	**$17,220,000**
Fire flow mains	$2,070,000	$230,000	$120,000			$40,000		**$2,460,000**
Reservoirs	$7,670,000				$7,400,000		$3,880,000	**$18,950,000**
Pump Stations	$330,000				$630,000		$150,000	**$1,110,000**
TOTAL	**$20,080,000**	**$230,000**	**$190,000**	**$400,000**	**$12,650,000**	**$200,000**	**$5,990,000**	**$39,740,000**

6. Some potential limitations related to this study were identified and are provided as follows:
    - The demand model adopted within this study was developed in line with the Office of Economic and Statistical Research (OESR) growth projections for each SA2 area. The model is based on a number of assumptions and the best available information at the time however, the demand model will not be accurate in its development projections, land use and timing for all properties within the study area. The development methodology is provided within Section 4 of the report and the document - 'Gladstone Regional Council Demand Model Development Technical Memo (MWH, July 2014)'.
    - With the exception of a few proposed assets, no optioneering of solutions has been undertaken within this study. Therefore, preferred or alternative solutions may be available.
    - Cost estimates have been developed at a unit rate level only. The cost estimates have not considered individual alignments and site conditions, or infrastructure for which trenchless construction methods will be required.
    - The feasibility and practical constructability of proposed assets has generally not been assessed within this study. There may be some proposed assets that require alternative solutions to be developed based on future site and environmental constraints.
    - The timing of proposed infrastructure matches the 5 year planning horizons assessed within this study. For construction of "just in time" infrastructure these 5 year planning horizons may not be suitable to GRC and future assessment into timing may be required.
    - Zone boundary updates have been proposed within this study without assessment of valve localities.
    - Fire flow demand allocation was informed by the developed demand model. As the land uses within the demand model are not accurate for all parcels, the allocation of fire flows may be incorrect in places.

    Report outcomes should be viewed with consideration to the above limitations.

Based on the conclusions of this study the following is recommended:

1. The outcomes of this report are viewed as the best and most up-to-date water supply planning for the Gladstone water supply network. The outcomes, should however, be viewed with consideration to the identified limitations.
2. GRC consider the following opportunities for improving the outcomes of future planning studies in the Gladstone water network. The following opportunities will also assist in ensuring the most prudent and efficient infrastructure solutions are identified for delivery. Opportunities:
    - Future update of the demand model developed for input into this water supply master planning study. As new information becomes available relating to land uses, development timing and sequencing, and state growth projections, it is envisaged that benefits will be identified by GRC in updating the demand model for input into future and ongoing infrastructure planning studies.
    - Prior to delivering major infrastructure items identified within this report it is recommended that specific detailed planning and feasibility studies be undertaken to ensure the preferred and most efficient solutions are being delivered. The detailed planning studies may also be used to assess the 'just in time' delivery of infrastructure, and develop more detailed/accurate cost estimates.
    - The assessment within this report was undertaken based on the GRC adopted standards of service. It has been identified across other Queensland water authorities and councils that a review of service standards in respect to appropriate levels of conservatism can result in significant capital cost savings on infrastructure delivery. GRC may see benefit in undertaking a review of the planning based standards of service currently adopted. Activities involved would include a demand tracking assessment for review of unit planning demand and peaking factors, and a risk based approach to reviewing performance based standards of service.

- Much recent infrastructure within the Gladstone hydraulic model was included without confirmation of asset attributes (diameter, material, etc.) from the GRC GIS. As the GIS data is populated with asset information in the future it is recommended that the attributes assigned within the hydraulic model are also updated.

Report outcomes should be viewed giving consideration to the above limitations.

Gladstone Regional Council

Water Supply Strategic Infrastructure Plan -

Gladstone Water Supply Scheme

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1 Introduction

MWH were engaged by Gladstone Regional Council in 2014 to develop water supply and sewerage strategic infrastructure plans for the Gladstone and Agnes Water networks. As part of this engagement 4 individual reports were produced as follows:

- Water Supply Strategic Infrastructure Plan – Gladstone Water Supply Scheme
- Water Supply Strategic Infrastructure Plan – Agnes Water Water Supply Scheme
- Sewerage Strategic Infrastructure Plan – Gladstone City Area
- Sewerage Strategic Infrastructure Plan – Agnes Water

This report represents the water supply strategic infrastructure plan for the Gladstone water supply scheme and documents the inputs, methodology, assumptions and approach adopted along with the water supply infrastructure outcomes.

All above listed reports have been prepared for the joint purpose of supporting Gladstone Regional Council's submission of the Local Government Infrastructure Plan (LGIP) for which updated water supply and sewerage infrastructure planning was required in the Gladstone City and Agnes Water networks.

Within this study, infrastructure solutions have been developed for both pre-existing performance issues and future performance issues resulting from proposed development. Infrastructure solutions have been separated into two categories within this study as follows:

1. LGIP Infrastructure – Trunk water supply infrastructure requirements as a result of development or network rezoning driven by development. The LGIP timeframe is for planned trunk infrastructure up to and including the 2031 planning horizon.

2. Internal Project Planning (IPP) Only Infrastructure – Any infrastructure not categorised as LGIP infrastructure (i.e. reticulation infrastructure, infrastructure proposed for resolution of pre-existing performance issues, or infrastructure proposed as required beyond the LGIP timeframe).

1.1 Background

Gladstone Regional Council (GRC) was formed in 2008 from the amalgamation of Calliope Shire Council, Gladstone City Council and Miriam Vale Shire Council. GRC is drafting a planning scheme for the whole of Gladstone Region, to replace the individual planning schemes for the three former shires. As part of GRC's submission of the draft planning scheme for its first State Interest Review in August 2014, one of the submission requirements is to prepare a Local Government Infrastructure Plan (LGIP), formerly known as a Priority Infrastructure Plan (PIP).

The LGIP outlines the necessary infrastructure required to service the next 10 to 15 years of growth outlined within the planning scheme. The LGIP outlines the local government's plans for providing trunk infrastructure to service urban development growth in a coordinated, efficient and orderly way. Trunk infrastructure is generally defined as 'higher order' infrastructure that is shared between developments, whereas non-trunk infrastructure is 'lower order' and is internal to developments which connects to 'higher order' trunk infrastructure. All infrastructure requirements are identified within this study with LGIP infrastructure noted.

To achieve this, the LGIP outlines the following infrastructure types:

- Water supply
- Sewerage
- Stormwater
- Transport
- Public parks and land for community facilities.

GRC engaged MWH to prepare a Water Supply Strategic Infrastructure Plan to enable the water supply component of the LGIP to be completed. The preparation of strategic infrastructure plans is in accordance with the *Sustainable Planning Act 2009,* Department of Local Government and Planning: Statutory Guideline 01/11 – Priority Infrastructure Plans, Queensland Planning Provisions (QPP) and the State Planning Regulatory Provision (SPRP).

1.1.1 Terms of Reference

The Local Government Infrastructure Plan (LGIP) is structured as follows:

- *Planning Assumptions*, which clearly outlines the type, scale, location and timing of future development and growth and how these align with the local government's preferred land use pattern.
- *Priority Infrastructure Area* (PIA), which defines the parts of a local government area intended to accommodate the next 10-15 years growth for urban purposes.
- *Desired Standard of Service* (DSS), which details the applicable design and service standards to the respective trunk and non-trunk infrastructure networks.
- *Plans for Trunk Infrastructure* (PFTI), which identifies the existing and future trunk infrastructure to service urban development within the PIA.

This Water Strategic Infrastructure Plan supports the *Plans for Water Infrastructure* component of the LGIP. The terms of reference to prepare the Water Strategic Infrastructure Plan require the following tasks:

- Outline the development and growth factors affecting the need for additional water supply assets for the amalgamated GRC.
- Outline the desired water supply conditions to accommodate the region's needs.
- Identify water supply initiatives from previously prepared Priority Infrastructure Plans (PIPs).
- Provide a high level of assessment on the initiatives to determine their relative priority and year of implementation need.
- Deliver the water supply Strategic Infrastructure Plan to support the development of GRC's LGIP.

1.1.2 Previous Studies

Within the past 10 years there have been two major city wide water supply planning studies for the Gladstone City water supply network. These studies are listed as follows:

- Gladstone City Council Water and Wastewater planning studies 2030 – Water Supply Report (KBR; 2004)
- Gladstone Regional Council Water Modelling Hydraulic Calculation Report (Parsons Brinkerhoff; 2012)

The drivers behind undertaking an updated water supply strategic planning study for the Gladstone City area are as follows:

- The need for an updated infrastructure assessment based a newly developed demand model. The demand model was developed as part of this study and aligns with projected state populations projections developed by Office of Economic and Statistical Research (OESR).
- Assessment of water supply infrastructure requirements following adjustments to the proposed water supply zoning strategy.
- Assessment of water supply infrastructure using an updated hydraulic model for performance assessment and augmentation identification.

1.2 Project Scope

The primary objective of the Water Supply Strategic Infrastructure Plan is to identify the water supply infrastructure required to service the existing and future service area demands in accordance with the Desired Standards of Service (DSS).

In order to achieve the purpose of this study, the key tasks required are:

- Review previous reports and strategic servicing plans
- Define and confirm current network operation through initial stakeholder workshops
- Update the current hydraulic Gladstone City hydraulic water supply model in H20MAP Water
- Within the same model, develop scenarios for planning horizons; 2014 (Current), 2016, 2021, 2026, 2031, 2036 and Ultimate.
- Allocate loading in the model for all planning horizons based on the latest GIS based demand model
- Assess the performance of the network at each planning horizon against GRC desired standards of service (DSS) to identify current and future capacity shortfalls.
- Develop infrastructure and/or non-infrastructure solutions to ensure DSS requirements are achieved over all planning horizons. Solutions will generally align with strategic direction informed by GRC.
- Provide capital cost estimates for proposed infrastructure solutions.
- Prepare water supply infrastructure planning report with associated infrastructure plans

1.3 Assessment Assumptions

The following assumptions, both general and technical, have been adopted for the purposes of this assessment:

- A demand model was developed concurrently to this study to align with state Office of Economics and Statistical Research (OESR) population projections. This demand model was adopted for the purposes of infrastructure assessment in this study. The demand model was developed based on a number of assumptions. These assumptions are detailed within Section 4 of this report and within the technical memorandum 'Gladstone Regional Council Demand Model Development Technical Memo (MWH, July 2014)'
- The base hydraulic model for use within this study was provided by GRC. The following was assumed correct within the hydraulic model:
    - Controls assigned to active assets
    - Sizes and attributes of existing assets represented within the model
    - Setup of existing zone boundaries and other closed network valves (reviewed as part of the model update exercise undertaken and described within Section 5 of this report)
- The future water supply zoning strategy provided by GRC within the document "Gladstone Water Zoning – 3 March 2014" was generally followed within this study. Where future proposed solutions differed from this strategy, these were discussed and agreed with GRC stakeholders.
- The current GRC demand and performance based desired standards of service (DSS) were adopted in this study. No review or re-assessment of these standards of service was undertaken.
- Gladstone Area Water Board (GAWB) infrastructure included within the current model was not reviewed for setup or operation. Within this study comments will be made in regard to GAWB infrastructure performance and potential capacity shortfalls. Solutions to resolve capacity issues within the GAWB infrastructure have generally not been developed.

- The existing Patterson Street reservoir has little remaining useful life. This assumption has been adopted within the planning such that removal or replacement is required within the short term.
- Assumed flow exports from the Gladstone water supply system to Calliope and Tannum Sands, Boyne Island, Benaraby and Wurdong were provided by GRC and have been included within this model for assessment. Stand pipe demands have also been included within infrastructure assessment based on flows and demands from the provided model.

As stated is Section 1, within this study, infrastructure solutions have been developed for both pre-existing performance issues and future performance issues resulting from proposed development. Infrastructure solutions have been separated into two categories within this study as follows:

- LGIP Infrastructure – Trunk water supply infrastructure requirements as a result of development or network rezoning driven by development. The LGIP timeframe is for planned trunk infrastructure up to and including the 2031 planning horizon.

- Internal Project Planning (IPP) Only Infrastructure – Any infrastructure not categorised as LGIP infrastructure (i.e. reticulation infrastructure, infrastructure proposed for resolution of pre-existing performance issues, or infrastructure proposed as required beyond the LGIP timeframe).

2 Standards of Service

Water network performance analysis was undertaken in line with Gladstone Regional Council's standard assumptions for water modelling and through other standards confirmed through discussion with GRC. This section describes the desired standards of service (DSS) applied in this study.

2.1 Demand Base Standards

The GRC Desired Standards of Service specify an Average Day (AD) water usage of 1,450 L/ET for Gladstone.

The Maximum Day (MD) diurnal demand profiles for Residential, Commercial, Industrial, Park and School end uses, provided by GRC were applied in this assessment. The Maximum Day and Peak Hour (PH) to Average Day peaking factors shown in **Table 2-1** are inherent in these profiles. The Mean Day Maximum Month (MDMM) to Average Day peaking factors were supplied by GRC.

Table 2-1: Gladstone Water Demand Peaking Factors

Demand Type	MDMM/AD	MD/AD	PH/AD
Residential	1.5	2	4.2
Commercial	1.0	1.3	2.5
Industrial	1.0	1.2	1.6
Park	1.0	1.3	2.5
School	1.0	1.3	2.5

The firefighting capacity assessment was based on the following firefighting demands:

- 15 L/s for residential properties three (3) storeys or less
- 30 L/s for all commercial properties (including residential accommodation facilities with commercial kitchens) and residential properties of four (4) or more storeys.

Within this study fire flow assessment was undertaken assuming a peak hour background demand and assuming the full fire flow requirement is delivered through a single hydrant. Hydrants locations were not accurately represented in the network hydraulic model at all locations. Fire flow demands were allocated to model junctions and if failure was identified the "realness" of the fire flow capacity issue was assessed based on location to the nearest hydrant. If fire flow failure was identified to occur at a location at which no hydrant was present (i.e. at the end of a small diameter property connection main) these failures were discounted from solution development.

2.2 Performance Based Standards

The modelled water network must achieve desired standards of service for both operational and firefighting scenarios. The water network performance standards of service utilised for the performance assessment of the Gladstone water supply network are summarised in **Table 2-2** below.

Table 2-2: Gladstone Water Supply Desired Standards of Service

Parameter	Guideline Standard	Notes
Network Performance		
Minimum Operational Pressure	25 m	Under operational Peak Hour demands
Minimum Residual Pressure (Fire Flow)	12 m at the fire node and 6 m elsewhere in the system.	Under firefighting demands with Peak Hour background demand

Parameter	Guideline Standard	Notes
Maximum head loss per km	5 m/km	Under operational Peak Hour demands (Applied for sizing of new infrastructure. This criteria has not been adopted within this study for triggering the upgrade of existing infrastructure except in instances were high head losses are identified to result in low pressure or create operational issues such as high head gain requirements from pump stations).
Maximum Velocity	2.5 m/s	Under operational Peak Hour demands
Water Pump Stations		
Servicing Ground Level Reservoirs	Supply of MDMM Demand over 20 hours	
Direct Booster Pump Stations	Peak Hour demand + Fire flow capacity	
Future Kirkwood Road High Level Pump Station	Supply of MDMM Demand over 10 hours	Sized to allow overnight pumping (informed by GRC).
Storage Reservoirs		
Reservoir Storage	3 Minimum Days (0.6xAD) + Firefighting Storage	
Additional Allowance for Pumped Reservoir with Gravity Reservoir Downstream	Difference in inflow and outflow rates = 4 hours @ MDMM Demands	Adopted 4 hours assumes pumping 20 hour/day and gravity feed 24 hour/day for MDMM
Special Case: Kirkwood High Level Reservoir	Max Day + Firefighting storage	Advised by GRC
Special Case: Kirkwood Low Level Reservoir	3 Minimum Days (0.6xAD) + Firefighting storage + 10 hours @ MDMM Kirkwood High Level Demand	Advised by GRC
Firefighting Storage – Residential only service area	2 hours @ 15 L/s	108 kL
Firefighting Storage – mixed use service area	4 hours @ 30 L/s	432 kL

3 System Description

3.1 Network Overview

The existing Gladstone water supply network is shown within **Figure 1**. **Appendix C** contains a schematic of the existing Gladstone water supply network operation.

The water supply source for the entire Gladstone water supply network is the Gladstone Area Water Board owned and operated Gladstone Water Treatment Plant (WTP). Treated water produced by the Gladstone WTP is delivered to the Gladstone Water Supply network via two pump sets, named the GAWB high lift pumps and the GAWB low lift pumps. A number of the water supply trunk mains used to convey water from both the high and low lift pump stations into the Gladstone water supply network are GAWB owned. GAWB owned assets are shown within **Figure 1** and within the schematic contained within **Appendix G.**

Figure B1 of **Appendix B** provides the existing zone boundaries without mapping of any infrastructure.

3.1.1 High Lift Water Supply Zones

The high lift pumps at the Gladstone WTP have a current capacity of approximately 600 L/s. These pumps deliver water to the Round Hill and South Gladstone reservoirs. Both reservoirs operate with a top water level (TWL) of 91.4m. From these reservoirs water supply is transferred further downstream to other water supply zones or directly into the network for the supply to customers. The following water supply zones receive supply from the high lift pump stations:

- Zone BC
- Zone D
- Clinton Park
- NRG.

Exports from the Gladstone water supply network to the Calliope and Tannum Sands, Boyne Island, Benarby and Wurdong (TBBW) water supply networks exist. These exports are supplied via the high lift pumps and occur downstream of the South Gladstone reservoir. The South Gladstone reservoir is a GAWB owned asset.

3.1.1.1 Zone D

Zone D services customers located within the south east of the Gladstone water supply network, incorporating suburbs such as Kin Kora, Sun Valley, Telina, Toolooa, South Trees and Glen Eden. Zone D receives bulk water supply from the Round Hill and South Gladstone Reservoirs, the details of which are provided in **Table 3-1**. Currently, water is exported from Zone D to the Zone BC, Clinton Park and NRG supply zones.

3.1.1.2 Clinton Park

The Clinton Park water supply zone covers a rapidly developing part of the network and includes the more established suburbs of Clinton and New Auckland along with land parcels flagged for significant future development within the area south of Kirkwood Road.

Clinton Park water supply zone receives bulk supply from Zone D via the Auckland Creek Booster pump station. The Auckland Creek Booster pump station operates based on levels within Clinton reservoir (Vol: 13.2 ML, TWL: 91.4 m) and delivers supply to both the Clinton reservoir and directly into the water supply zone, due to the combined inlet/outlet operation of the reservoir supply main.

3.1.1.3 Zone BC

Zone BC supplies customers in the suburb of West Gladstone.

Zone BC receives bulk supply from Zone D downstream of the Round Hill reservoir. Supply is via the Paterson Street reservoir (Vol: 4.9 ML, TWL: 79.3 m). Due to the difference in HGL between Zone D and the Paterson Street reservoir, supply to the reservoir can be delivered via gravity.

It is understood that the Paterson Street reservoir is due for replacement or decommissioning due to its current physical condition.

3.1.1.4 NRG Zone

The NRG Zone is a predominantly industrial water supply zone within the north west of the Gladstone. The zone provides supply to customers within Callemondah including the NRG Gladstone Power Station.

The NRG Zone receives bulk supply from Zone D downstream of the Round Hill reservoir via gravity. Storage within the zone is provided by the NRG reservoir (Vol: 13.0 ML, TWL: 51.8 m).

3.1.2 Low Lift Water Supply Zones

The low lift pumps at the Gladstone WTP have an approximate capacity of 157 L/s. The low lift pump deliver supply to the Fisher Street reservoir, and Radar Hill and Ferris Hill reservoirs for supply to the Fisher Street and Zone A water supply zones respectively. Supply to these reservoirs is delivered through bulks supply water mains in Glenlyon Road. These zones generally operate at a lower HGL than the high lift supplied water zones. The TWL of all three low lift supplied reservoirs is 61.3 m.

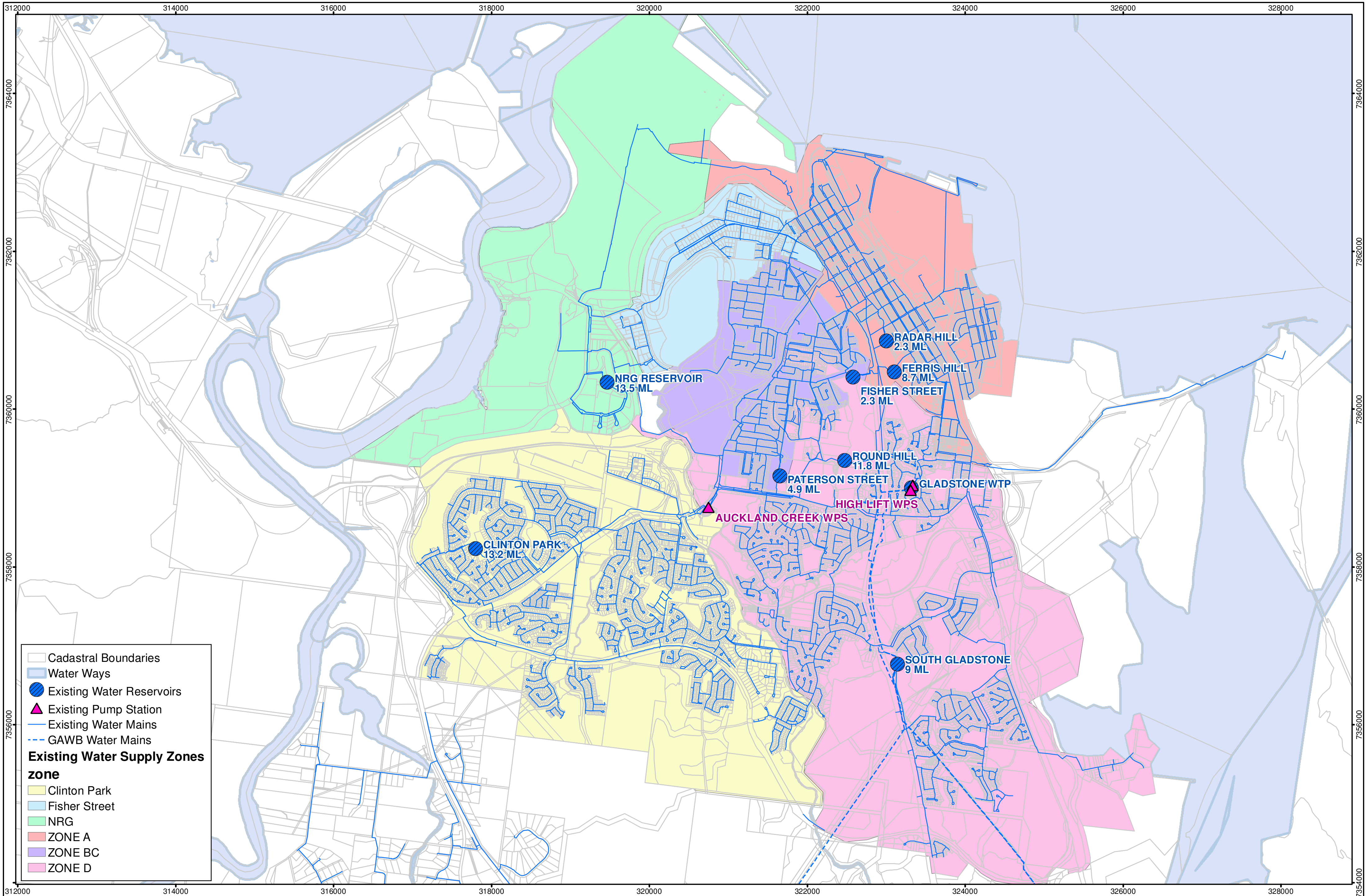
3.1.2.1 Zone A

Zone A receives supply from both the Radar Hill reservoir (Vol: 2.3 ML, TWL 61.3 m) and the Ferris Hill reservoir (Vol: 8.7 ML, TWL: 61.3 m). Zone A delivers supply to customers within the Gladstone CBD, South Gladstone, and Barney Point, as well as providing service to the Marina area. It is noted that the Radar Hill and Ferris Hill reservoirs have different bottom water levels which has the potential to create operational and future capacity issues due to unusable volume within the Ferris Hill reservoir.

3.1.2.2 Fisher Street Zone

The Fisher Street water supply zone is located some distance north of the Fisher Street reservoir site (Vol: 2.3 ML, TWL: 61.3 m). Supply from the reservoir site to the water supply zone is conveyed via a 450 mm diameter main along Glenlyon Road. The Fisher Street water supply zone consists of prominently commercial and industrial properties and is bound by Auckland Inlet in the north and Auckland Creek in the south. Hanson Road is the predominant road through the Fisher Street water supply zone.

Figure 1: Existing Gladstone Water Supply Network



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:42,000

File Name: GLAD_ExistingWaterLayout

GLADSTONE

Existing Gladstone Water Supply Network

1

3.2 Asset Overview

3.2.1 Reservoirs

Currently there are 8 reservoirs servicing Gladstone City. The operation of these reservoirs was discussed previously in **Section 3.1**. **Table 3-1** summarises the dimensions and the water supply zones serviced by the existing reservoirs within Gladstone.

Table 3-1: Gladstone Reservoir Details

Reservoir Name	Model ID	Current Zone Serviced	Diameter (m)	Top Water Level (m)	Bottom Water Level (m)	Volume (ML)
Ferris Hill	W-RE-SG-2	Zone A	36.3	61.3	52.9	8.7
Radar Hill	RES4	Zone A	23.0	61.3	55.7	2.3
Paterson Street	RES6	Zone BC	35.4	79.3	74.3	4.9
Fisher Street	RES5	Fisher Street Zone	23.1	61.3	55.7	2.3
South Gladstone	RES09	Zone D	44.1	91.4	85.49	9.0
Round Hill	RES10	Zone D	50.0	91.4	85.4	11.8
Clinton	RES12	Clinton Park Zone	53.0	91.4	85.4	13.2
NRG	RES11	Zone F	43.9	51.8	42.9	13.5

3.2.2 Pump Stations

There are currently only three operational pump stations within the Gladstone water supply network. The GAWB owned high lift and low lift WTP pump stations and the Auckland Creek booster pump station used to supply the Clinton Park water zone. The export pump stations to the Calliope and TBBW have been excluded from assessment within this study. The capacities of the low lift and high lift GAWB WTP pump stations were not confirmed as part of this study. Future capacity requirements for these GAWB pump stations will be identified as part of this study in terms of Gladstone City demands. however, upgrades will not be included as part of the augmentation plan. It has been noted by GRC that the high lift pump stations deliver supply to some industrial users in addition to supply to the Gladstone City and TBBW water networks.

Table 3-2 summarises the pump stations within the Gladstone supply network.

Table 3-2: Gladstone Pump Station Details

Pump Station	Model ID	Capacity (L/s)
Low Lift PS	PS2	157
High Lift PS	HL1 & HL2	600
Auckland Creek PS	Auckland_PS1 & Auckland_PS2	130

3.2.3 Pipe Assets

There is currently approximately 438 km of mains in the Gladstone City water supply network. **Table 3-3** summarises the size distribution of these mains.

Table 3-3: Summary of Diameter of Water Main

Pipe Diameter (mm)	Total Length of Modelled Water Main (m)	Percentage by Length (%)
<100	13,460	3.1%
100	163,709	37.4%
150	87,018	19.9%
200	36,705	8.4%
225	197	0.0%
250	13,866	3.2%
300	46,049	10.5%
375	46,905	10.7%
400	207	0.0%
450	9,887	2.3%
475	7,173	1.6%
500	4,105	0.9%
525	429	0.1%
600	8,296	1.9%
Total	**438,064**	**100%**

4 Demand Development and Outcomes

4.1 Demand Development

The development of the GIS based demand model for the current and future demand horizons is described in detail in the 'Gladstone Regional Council Demand Model Development Technical Memo (MWH, July 2014)'. The methodology detailed within this report is summarised as follows:

1. The demand model was based on the future ultimate development GIS cadastre file supplied by GRC;

2. Each lot was designated a lot based land use as follows:
    a. The land uses were simplified and mapped to the model diurnal demand profile categories as shown in **Table 4-1** below;
    b. Any areas outside of the study area or not serviced by water or sewerage currently and into the future were designated with a RURAL land use type to indicate this;

Table 4-1: Land Use Code Mapping

GRC Land Use	Diurnal Pattern Profile
Single Family Residential	Residential
Multi-Family Residential	Residential
Commercial	Commercial
Mixed	Residential & Commercial
Industrial	Industrial
Community	Commercial
Public Open Space	Park
Schools	School

    c. The GRC existing customer accounts were used to identify whether an existing residential lot was single family residential (RES) or multi-family residential (RES-M);
    d. For multi-family residential and mixed use blocks, the GIS cadastre file contains a polygon for each individual residence and at least one for the lot area. To avoid over allocation of demand the lot polygons were designated a Land Use 'BLOCK';
    e. The land use for future development lots was determined from future development information supplied by GRC;

3. Existing (2014) Demand Development:
    a. For residential lots the following Equivalent Tenement (ET) ratios were adopted for existing lots in line with the GRC's Water and Wastewater Master Planning Guidelines;
        Single Family Residential = 1 ET/dwelling; and
        Multi-family Residential = 0.8125 ET/dwelling
       For the current horizon, demand was only allocated to lots with existing accounts.
    b. For existing non-residential lots ET was determined from the ET data provided by GRC. This ET had been determined from 2012/13 consumption data and ET derived using the average day water usage of 1,450 L/ET/day.

4. The demand model was extended to 2016, 2021, 2026, 2031, 2036 and Ultimate growth horizons.

a. The future residential demand was grown in-line with the published Office of Economic and Statistical Research (OESR) population growth figures for each SA2 zone.
b. The future non-residential demand was grown in line with the Gladstone Priority Infrastructure Plan (PIP) employment projections.

5. Information on all future identified development locations and was provided by GRC along with an order of expected development for each SA2 area. ET demand was provided for a number of these parcels by GRC. For others ET was assigned based on an ET/gross ha development density derived with support of GRC. Developments were generally brought online in the demand model in order based on advice provided by GRC, with regard to likelihood and ease of development, ease of service, and possible yield.

6. As a validation of the demand model, residential ET was converted to an equivalent persons (EP) value to allow comparison with the published Office of Economic and Statistical Research (OESR) population projections. In most zones the persons per dwelling number determined by the Australian Bureau of Statistics (ABS) from the 2011 Census were applied. In the cases of Clinton – New Auckland and Telina – Toolooa these original high occupancy rates resulted in a much higher population than the OESR data predicts. Discussion with GRC indicated that the ABS numbers from 2011 represent a time when a high number of migrant workers were living in the area and may not be representative of the current occupancy. In these cases the Gladstone City average of 2.6 EP/dwelling was adopted as detailed in **Table 4-2.**

Table 4-2: Persons Per Dwelling

SA2 Zone	ABS 2011 Census	Adopted Value
Clinton - New Auckland	2.8	2.6
Gladstone	2.3	2.3
Kin Kora - Sun Valley	2.9	2.9
Telina - Toolooa	3	2.6
West Gladstone	2.5	2.5

Figure 2 to **Figure 6** show that the resulting EP growth profiles compare well to the OESR population growth for these SA2 areas when these person per dwelling values are applied.

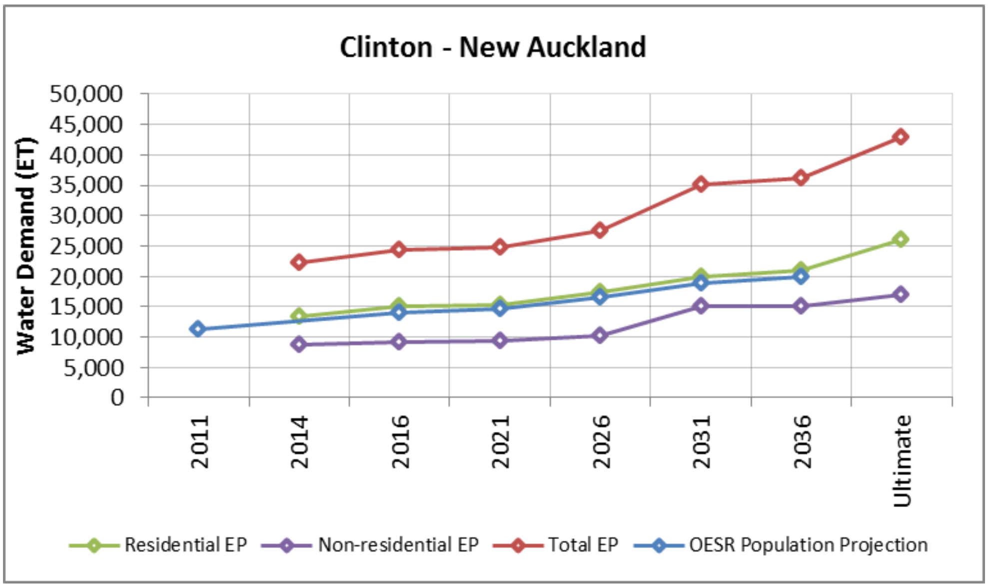


Figure 2: EP Growth Profile – Clinton – New Auckland SA2 Area

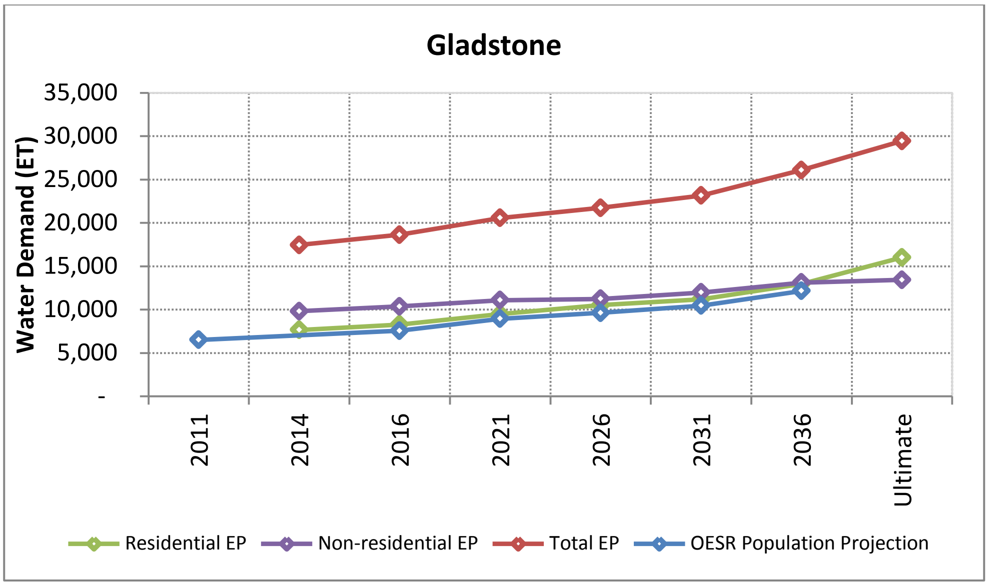


Figure 3: EP Growth Profile – Gladstone SA2 Area

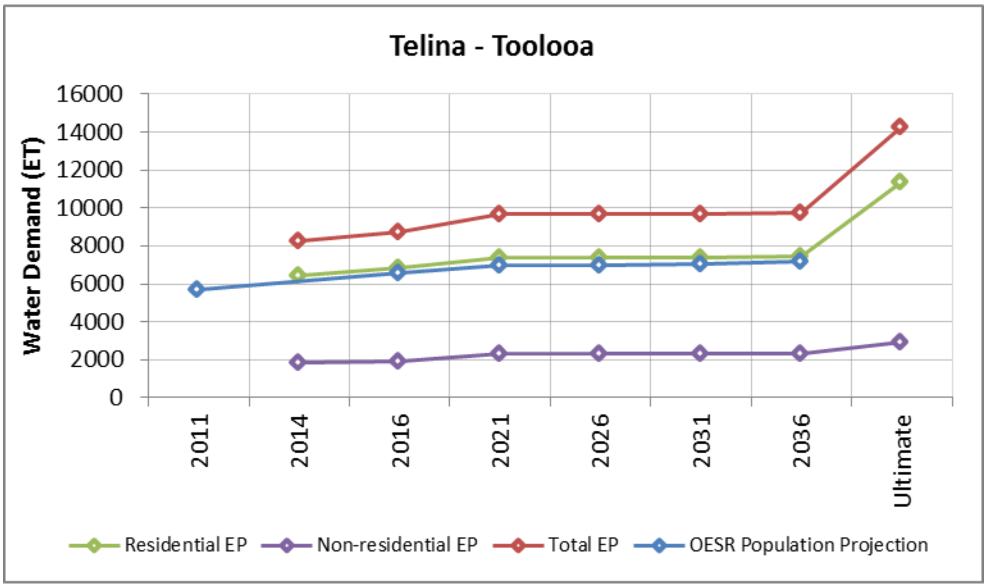


Figure 4: EP Growth Profile – Telina Toolooa SA2 Area

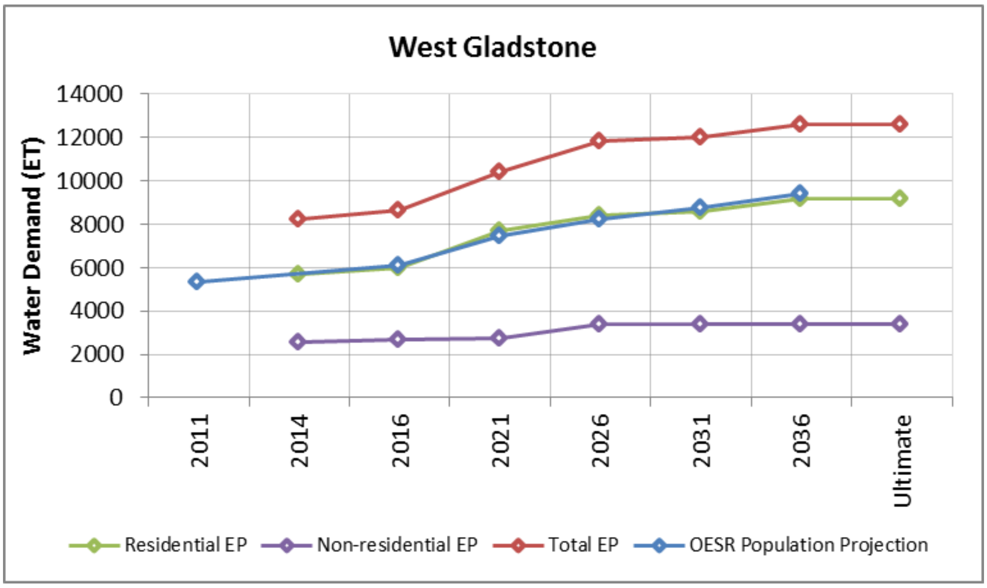


Figure 5: EP Growth Profile – West Gladstone SA2 Area

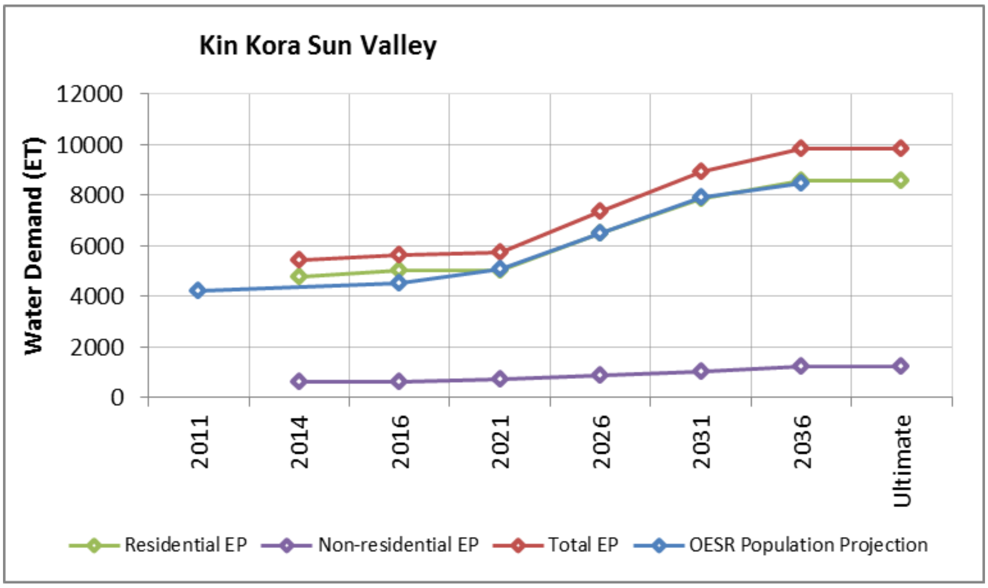


Figure 6: EP Growth Profile – Kin Kora – Sun Valley SA2 Area

4.2 Demand Outcomes – Demand Summaries per Current WSZ.

Table 4-3 shows the demand model ET summarised by existing WSZ for each demand horizon. **Table 4-4**, **Table 4-5** and **Table 4-6** show the average day, mean day maximum month and maximum day demands respectively for each demand horizon in litres per second based on the average day demand figure of 1,450 L/ET/day as specified in the GRC Desired Standards of Service.

Zone boundary changes are proposed within future planning horizons and are discussed within later report sections. The zonal network demands reflecting the future zone boundary changes at each planning horizon are provided within Appendix G.

Table 4-3: Total ET per Existing WSZ

Water Zone	Total ET						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	5,300	5,578	6,176	6,682	7,035	7,997	9,291
Zone BC	2,980	3,159	3,851	4,468	4,984	5,320	5,320
Zone D	6,790	7,045	7,477	7,989	8,173	8,492	10,379
NRG	2,352	2,391	2,464	2,793	4,667	4,667	5,245
Fisher Street	1,280	1,517	1,761	1,761	1,940	2,184	2,184
Clinton Park	5,925	6,643	6,704	7,493	8,474	8,877	10,952
Total	**24,627**	**26,333**	**28,433**	**31,186**	**35,274**	**37,537**	**43,372**

Table 4-4: Average Day Demands – Existing Zones

Water Zone	Average Day Demand (L/s)						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	88.9	93.6	103.6	112.1	118.1	134.2	155.9
Zone BC	50.0	53.0	64.6	75.0	83.6	89.3	89.3
Zone D	114.0	118.2	125.5	134.1	137.2	142.5	174.2
NRG	39.5	40.1	41.3	46.9	78.3	78.3	88.0
Fisher Street	21.5	25.5	29.6	29.6	32.6	36.6	36.6
Clinton Park	99.4	111.5	112.5	125.7	142.2	149.0	183.8
Total	**413.3**	**441.9**	**477.2**	**523.4**	**592.0**	**630.0**	**727.9**

Table 4-5: Mean Day Max Month – Existing Zones

Water Zone	Mean Day Max Month Demand (L/s)						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	110.0	116.9	131.4	143.6	152.0	174.4	205.8
Zone BC	67.6	71.6	88.9	104.0	116.9	125.4	125.4
Zone D	156.8	163.1	172.3	183.0	186.4	193.6	239.4
NRG	39.5	40.1	41.3	46.9	78.3	78.3	88.0
Fisher Street	22.0	25.9	30.0	30.0	33.0	37.1	37.1
Clinton Park	142.5	160.0	161.1	181.0	205.7	215.8	267.0
Total	**538.3**	**577.7**	**625.1**	**688.4**	**772.4**	**824.6**	**962.7**

Table 4-6: Maximum Day – Existing Zones

Water Zone	Maximum Day Demand (L/s)						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	145.1	154.3	173.5	189.8	201.0	230.7	272.6
Zone BC	89.6	94.9	118.0	138.0	155.4	166.6	166.6
Zone D	208.2	216.5	228.7	242.8	247.2	256.8	317.7
NRG	51.3	52.2	53.7	60.9	101.8	101.8	114.4
Fisher Street	28.6	33.8	39.1	39.1	43.0	48.3	48.3
Clinton Park	189.5	212.9	214.3	240.8	273.7	287.2	355.4
Total	**712.3**	**764.6**	**827.3**	**911.4**	**1,022.1**	**1,091.4**	**1,275.0**

5 Model Update

A review and update of the Gladstone water supply model was undertaken so that the latest known infrastructure was included within the model, the model best reflected current operation, and the model aligned with the DSS.

5.1 GIS Infrastructure Review

Existing infrastructure within the H2OMAP hydraulic model was compared against the following GIS files:

- WaterMainsAssetData.TAB
- GRCWaterRetic.TAB

The file "WaterMainsAssetData.TAB" contained asset attribute data for all pipes but did not include recently installed water mains. GRCWaterRetic.TAB included a significant number of additional pipes, however there was no available attribute data within this GIS layer. An enquiry to GRC was made for provision of attribute data for this GIS layer. The attribute data had yet to be processed and assigned to the GIS layer and was therefore not available.

The WaterMainsAssetData.TAB file was used to review asset sizing of existing infrastructure in the model. It was identified the extent existing model infrastructure covered the extent of this GIS layer. Where inconsistencies between the GIS and the model were identified, the attribute information in the GIS was assumed correct and the model was updated to reflect the GIS

The GRCWaterRetic.TAB was used to identify the assets within the model that are existing and should be active in the existing planning horizon. This GIS layer was also used to assess the alignment and connectivity of the network. The H2OMAP model provided by GRC included internal water supply networks for the majority of future development parcels. These internal networks within the model included attribute information. As no better attribute information was available those within the model were adopted. The connectivity and alignment of the internal development networks were adjusted to reflect the GIS.

Figure 7 shows both the new pipes added to the hydraulic model and those bought forward and included within the existing planning horizon (existing query set). Green pipes within **Figure 7** represent future pipes associated with development areas, contained within the received model, but identified not be existing following GIS review.

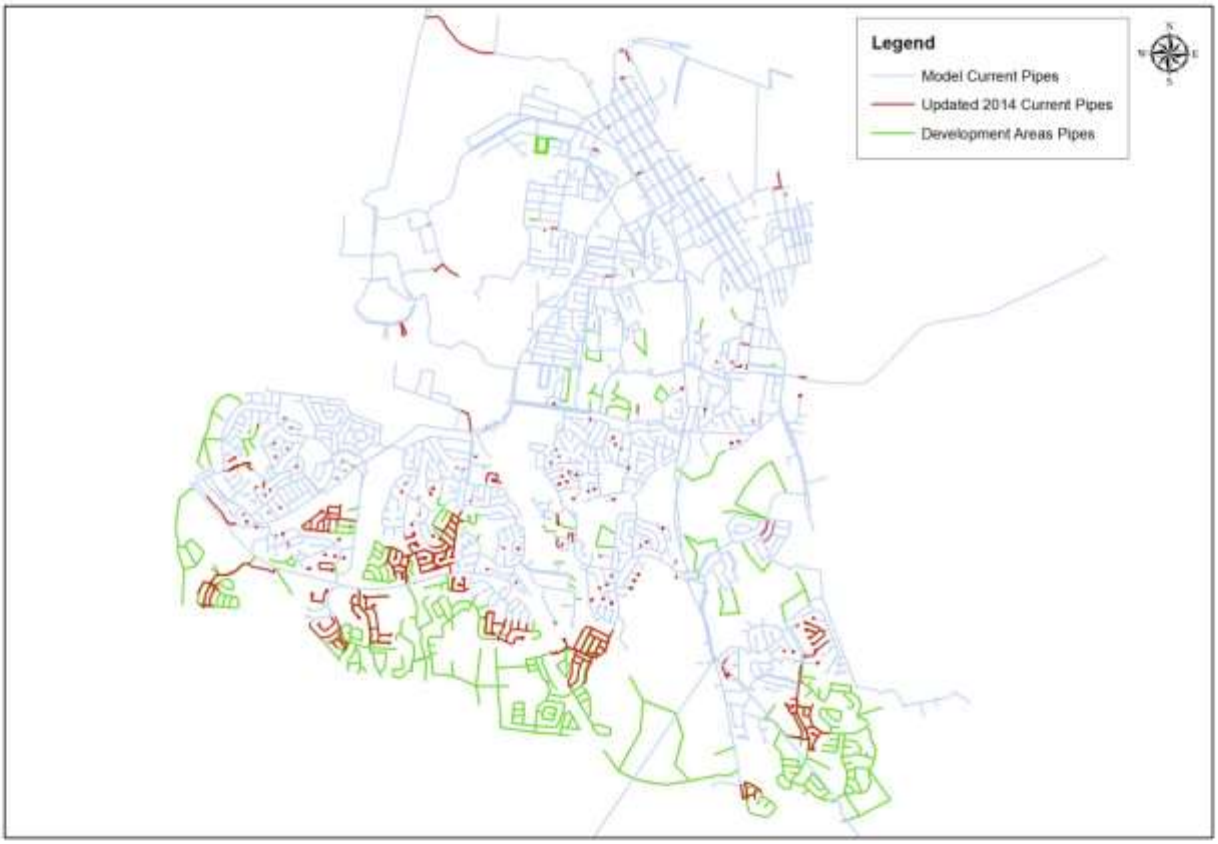


Figure 7: GIS Infrastructure Review of Hydraulic Model Outcomes.

5.2 Roughness Coefficient and Internal Diameter Review

Where sufficient information on pipe material was available the hydraulic diameters of the pipes represented within the model were updated to align with **Table 5-1** based on advice from GRC. Where existing pipes were outside of the categories provided within **Table 5-1** the internal diameters and applied roughness coefficients existing in the model were generally assumed correct.

Table 5-1: Pipe Hydraulic Attributes for Model Update

Pipeline Nominal Diameter	AS4130:2003 PE100 PN16, blue-line		AS1477:2006 uPVC Series 2 PN16 RRJ		AS2280:2004 DICL PN35 RRJ	
	Mean Internal Diameter (mm)	Hz-W "C" Coefficient (Roughness)	Mean Internal Diameter (mm)	Hz-W "C" Coefficient (Roughness)	Mean Internal Diameter (mm)	Hz-W "C" Coefficient (Roughness)
50	40.4	120				
63	51	120				
75	61	120				
100			104.3	100		
150			152	100		
200			202.3	110		
250			249.2	110		
300					322	110
375					401	120
450					480	120
600					636	120
750					790	125

5.3 Controls and Active Asset Review

Following initial workshops with GRC staff and the review of existing planning reports and other supporting documents, network controls within the models were reviewed to ensure alignment with the current operation. This generally involved the review of control on pump stations and control valves.

Zone boundaries were also reviewed to facilitate alignment with current water zone boundaries supplied by GRC.

5.4 Scenario Setup

A scenario structure was created within the Gladstone hydraulic model to facilitate the assessment of performance at each planning horizon. This scenario structure is provided within **Table 5-2**.

Table 5-2: Gladstone H2OMAP Model Scenario Structure

Scenario Level	Scenarion Name	Description
1	Existing	Header Scenario
1.1	Existing_AD	2014 AD demand, existing assets, no network upgrades
1.1	Existing_MDMM	2014 MDMM demand, existing assets, no network upgrades
1.1	Existing_MD	2014 MD demand, existing assets, no network upgrades
1	2014	Header Scenario
1.1	2014_AD	2014 AD demand, existing assets and network upgrades and controls changes to achieve DSS at 2014
1.1	2014_MDMM	2014 MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at 2014
1.1	2014_MD	2014 MD demand, existing assets and network upgrades and controls changes to achieve DSS at 2014
1	2016	Header Scenario
1.1	2016_AD	2016 AD demand, existing assets and network upgrades and controls changes to achieve DSS at 2016
1.1	2016_MDMM	2016 MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at 2016
1.1	2016_MD	2016 MD demand, existing assets and network upgrades and controls changes to achieve DSS at 2016
1	2021	Header Scenario
1.1	2021_AD	2021 AD demand, existing assets and network upgrades and controls changes to achieve DSS at 2021
1.1	2021_MDMM	2021 MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at 2021
1.1	2021_MD	2021 MD demand, existing assets and network upgrades and controls changes to achieve DSS at 2021
1	2026	Header Scenario
1.1	2026_AD	2026 AD demand, existing assets and network upgrades and controls changes to achieve DSS at 2026
1.1	2026_MDMM	2026 MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at 2026
1.1	2026_MD	2026 MD demand, existing assets and network upgrades and controls changes to achieve DSS at 2026
1	2031	Header Scenario
1.1	2031_AD	2031 AD demand, existing assets and network upgrades and controls changes to achieve DSS at 2031
1.1	2031_MDMM	2031 MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at 2031
1.1	2031_MD	2031 MD demand, existing assets and network upgrades and controls changes to achieve DSS at 2031
1	2036	Header Scenario
1.1	2036_AD	2036 AD demand, existing assets and network upgrades and controls changes to achieve DSS at 2036
1.1	2036_MDMM	2036 MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at 2036
1.1	2036_MD	2036 MD demand, existing assets and network upgrades and controls changes to achieve DSS at 2036
1	Ultimate	Header Scenario
1.1	Ultimate_AD	Ultimate AD demand, existing assets and network upgrades and controls changes to achieve DSS at Ultimate
1.1	Ultimate_MDMM	Ultimate MDMM demand, existing assets and network upgrades and controls changes to achieve DSS at Ultimate
1.1	Ultimate_MD	Ultimate MD demand, existing assets and network upgrades and controls changes to achieve DSS at Ultimate

The development of scenarios is summarised as follows:

- Unique data sets were created and assigned for each planning horizon for the following:
    - Demand sets
    - Control sets
    - Fire flow sets
- AD, MDMM and MD operation sets containing associated diurnal profiles were created and assigned to the corresponding scenarios
- Planning horizon attribute information fields (Existing through to Ultimate) were created and populated for all link elements (pipes, pumps and valve). Query sets were created based on these planning horizons information fields for activation of each asset (existing and proposed) in the correct scenarios.
- Within the model setup. Auto node inclusion was activated such that query sets acted based on link assets alone.

5.5 Model Demand Allocation and Handling

The parcel based demand model developed and discussed in Section 4 was allocated to the Gladstone water supply hydraulic model using the H2OMAP demand allocation tool and a closest pipe to closest junction allocation routine. The demand sets created for each planning horizons were allocated to the projected demand at that same planning horizon from the demand model. All demand was allocated to the model in ET. Previous versions of the model had demand represented in kL/year.

Table 5-3: Demand Type Allocation and Diurnal Pattern Assignment

Demand Type	H2OMAP Demand Field	Pattern Name
Detached Residential	1	RESIDENTIAL
Attached Residential	2	RESIDENTIAL
Commercial	3	COMMERCIAL
Industrial	4	MED_HEAVY_IND
Community	5	COMMUNITY
Schools	6	SCHOOL_TEMP
Public and Parks	7	PUBLIC_OPEN_SPACE

The allocated demand in ET was converted to L/s through the global demand multiplier. A multiplier of 0.01677092 was required for the conversion of 1450 L/ET/day to a L/s demand. Diurnal profiles in line with the GRC DSS were assigned to the model to reflect AD, MDMM and MD demands in the appropriate scenarios. Diurnal patterns were created based on a half hourly time step.

5.6 Network Exports and Standpipe Setup

5.6.1 Network Exports

Exports from the Gladstone water supply hydraulic model to the Calliope, Tannum Sands and Boyne Island, and Benaraby and Wurdong networks were setup in the model as fixed flow demands derived from existing strategic plans. The demands adopted for each planning horizon at the export points are provided below in **Table 5-4**.

Table 5-4: Model export demands

Planning Horizon	Gladstone Model Export Point Demands (L/s)		
	Calliope	Tannum Sands / Boyne Island	Benaraby / Wurdong
2014		175	33
2016	120	175	33
2021	120	200	33
2026	120	200	33
2031	120	250	91
2036	120	250	91
Ultimate	120	250	91

5.6.2 Standpipes

Two standpipes were included within the model. Demand and diurnal profiles for standpipe use was adopted from the previous Gladstone City models. Standpipes and demands area as follows:

- Red Rover Standpipe (NRG Zone) – 46.3 ET
- Glenlyon road Standpipe (Zone D) – 10.9 ET

6 Bulk Supply Performance Assessment

6.1 Storage Assessment (Existing Zoning)

An initial assessment of the available reservoir storage for each existing water supply zone was undertaken. From this assessment both current and future deficiencies in reservoir storage could be identified when maintaining current zoning. Results of this assessment are provided in **Table 6-1.**

Table 6-1 identifies that current reservoir storage shortfalls exist within the Zone BC, Clinton Park, Fisher Street and Zone A. Demand within the existing Zone D extent is projected to exceed the capacity of the available Zone D storage by 2016. A significant amount of excess storage capacity is currently available in the NRG water supply zone with storage shortfall not projected until Ultimate.

Table 6-1: Reservoir Storage Assessment – Current Zoning

Water Zone	Existing Storage (ML)	Value	Planning Horizon						
			2014	2016	2021	2026	2031	2036	Ultimate
Zone D	20.8	Required Operational Storage (ML)	20.1	20.9	22.3	23.9	25.0	26.0	31.0
		Excess / Deficiency (ML)	0.7	-0.1	-1.5	-3.1	-4.2	-5.2	-10.2
Zone BC	4.9	Required Storage (ML)	8.2	8.7	10.5	12.1	13.4	14.3	14.3
		Excess / Deficiency (ML)	-3.3	-3.8	-5.6	-7.2	-8.5	-9.4	-9.4
Clinton Park	13.2	Required Storage (ML)	15.9	17.8	17.9	20.0	22.5	23.6	29.0
		Excess / Deficiency (ML)	-2.7	-4.6	-4.7	-6.8	-9.3	-10.4	-15.8
NRG	13.5	Required Storage (ML)	6.6	6.7	6.9	7.7	12.6	12.6	14.1
		Excess / Deficiency (ML)	6.9	6.8	6.6	5.8	0.9	0.9	-0.6
Fisher Street	2.3	Required Storage (ML)	3.8	4.4	5.0	5.0	5.5	6.1	6.1
		Excess / Deficiency (ML)	-1.5	-2.1	-2.7	-2.7	-3.2	-3.8	-3.8
Zone A	11	Required Storage (ML)	14.3	15.0	16.6	17.9	18.8	21.3	24.7
		Excess / Deficiency (ML)	-3.3	-4.0	-5.6	-6.9	-7.8	-10.3	-13.7

6.2 Ultimate Storage and Zoning Solution

An overall network strategy to resolve current and existing storage deficiencies was developed. This strategy was based upon the zoning strategy previously developed by GRC and provided to MWH upon project start-up. The intention of developing a whole of network storage and zoning strategy is to make best use of spare capacity in existing assets and to ensure any capital expenditure deferment opportunities are realised.

In developing the Ultimate storage and zoning strategy the following items were considered:

- Available new reservoir sites:
    - A new reservoir site located within Council land south of Kirkwood Road has been identified for provision of future storage to the Clinton Park and Zone D water zones.
    - A new reservoir site has been secured by GRC at 390 Glenlyon Road.
- Available space at existing reservoir sites. Based on previous planning studies it is assumed that space is available for second reservoirs at the following sites:

  - South Gladstone reservoir facility
  - Round Hill reservoir facility
  - NRG Power Station reservoir facility
  - Ferris Hill reservoir facility
- The condition of the Paterson Street reservoir.
- Potential issues to the Clinton Park water supply zone with the continued operation of the combined inlet/outlet arrangement to the Clinton reservoir if additional storage was to be constructed for the zone.
- The issues created by the different bottom water levels of the Radar Hill and Ferris Hill reservoirs currently both providing supply to Zone A.
- Opportunities to use the large diameter water main in Glenlyon Road from the Fisher Street reservoir to the Fisher Street water zone for supply to other zones in the event of rezoning.

The proposed ultimate storage and zoning strategy is summarised below. Each element is described in more detailed within Sections 6.2.1 and 6.2.2. Strategy summary:

- Supply the Fisher Street water zone from the NRG zone.
- Construct a new reservoir for Zone BC/Paterson water zone and supply the north of the Gladstone CBD from this zone alleviating immediate storage from Zone A reservoirs.
- Supply the northern CBD area from the Paterson water zone using the 450 mm diameter water main which previously provided supply to the Fisher Street WSZ.
- Use the Fisher Street reservoir to support Zone A in the short term.
- Separate Zone A (to be supplied by Fisher Street and Radar Hill) from a new Ferris Hill water zone. The rezoned Zone A was sized to meet the storage capacity of Fisher Street and Radar Hill water zones.
- Construct new storage at Ferris Hill as required to accommodate future demand growth.
- Combine Zone D and Clinton Park water zones into a combined Zone D water zone.
- Undertake works to convert the Clinton Park inlet/out main into a dedicated inlet main.
- Construct new storage for Zone D at the identified Kirkwood Road site, South Gladstone reservoir facility and Round Hill reservoir facility as required.

The Ultimate proposed zoning derived from this assessment is shown geographically in **Appendix A** and **Appendix B (Figure B2)**. The ultimate zoning strategy is described in the following sections.

Following establishment of the proposed water supply zoning strategy and identification of the trunk infrastructure required for the zone establishment within this section of the report, local maximum hour and fire flow augmentation requirements are identified within Sections 7 and 8 respectively.

6.2.1 NRG, Fisher Street, Zone BC and Zone A Strategy

6.2.1.1 Zone F – Extended NRG Water Zone

A closed 375 mm diameter main in Hanson Road has the potential to connect the Fisher Street water zone to the NRG water zone. With the Fisher Street water zone currently experiencing an identified shortfall in storage of approximately 1.5 ML sourcing supply from the NRG water zone, which has current available storage capacity, resolves this immediate storage deficiency.

The Fisher Street water zone covers an area of low elevation. Although the NRG reservoir (TWL 51.8 m) operates at a HGL approximately 10 m below that of the Fisher Street reservoir (TWL 61.3 m), desired standards of serviced for residual pressure under maximum hour demands were identified to be maintained within the combined zone following this proposed re-zoning.

With the NRG reservoir also accommodating the former Fisher Street water zone (designated Zone F), the current storage capacity of the NRG reservoir will be exceed by zone demand at the 2031 planning horizon. Storage assessment under the proposed re-zoning is provided in **Table 6-9**.

The storage assessment for the NRG reservoir (summarised in **Table 6-9)** incorporates consideration of the current commercial agreement with the NRG power station. The details of this agreement in regard to supply of water demand to the power station were provided by GRC as follows:

- Maximum Day Demand = 8 ML/day
- Average Day Demand = 5.5 ML/day
- Minimum Day Demand = 2 ML/day

The demand model developed for this study has an assigned ET demand for the power plant of 2250 ET. In assessment of storage requirements and timing this demand has been over-written by the demands contained within the commercial agreement. In assessment of bulk supply to Zone F a maximum day demand of 8 ML/day at the Power Station has been assumed and modelled.

Based on demand assessment a 6.8 ML reservoir is required to meet storage DSS at the Ultimate planning horizon. However, for the purposes of this study and to allow additional storage for supply security at the power station, following direction from GRC a second 13.5 ML reservoir (WRS_F_204) has been proposed at 2031.

No water mains capital works are required to facilitate this proposed re-zoning of Fisher Street water zone onto the NRG water zone.

Design of a new supply main to Zone F from the Round Hill reservoir along Patterson Street is currently in planning and design by GRC. The purposes of this new supply main to Zone F is to alleviate the reliance on water mains in Philip Street for conveying supply from the Round Hill reservoir to the west of Zone D and into Zone F. It is understood that road upgrades are proposed in Philip Street which further complicate the ability for new infrastructure in this road. Therefore, GRC have decided to provide a new supply to Zone F via Patterson Street.

A connection to the Paterson Street reservoir used to Supply Zone BC from this proposed main from Round Hill to Zone F is proposed to further reduce the flow requirement on the existing Round Hill reservoir outlet and the water mains in Philip Street. The Patterson Reservoir is currently supplied via a connection to water mains in Philip Street. The proposed supply strategy for Zone BC is discussed further below.

The proposed sizing of the new supply mains to Zone F and the Paterson reservoir from the Round Hill reservoir for meeting desired standards of service and maintaining levels in both the NRG reservoir and the Paterson reservoir is as follows:

- Round Hill to Paterson Street (WTM_F_091) - 860 m of 375 mm diameter main
- Paterson Street inlet main (WTM_BC_094) - 230 m of 200 mm diameter main
- Paterson Street to Zone F (WTM_F_092) - 830 m of 300 mm diameter main

6.2.1.2 Zone BC (extension to include CBD)

Storage deficiencies exist for the current Zone BC and Zone A water zones. Additionally, it is understood that the Paterson Street reservoir requires removal or replacement in the short term due to condition issues. A secured site for new storage exists at 390 Glenlyon Road. It is understood that this new site has an elevation capable of matching that of the existing Paterson Street reservoir site and has sufficient available space for a reasonably large structure.

Within the north of Zone A, in the vicinity of the Gladstone CBD there are a number of properties at high elevations (> 35 m) which struggle to maintain an existing minimum pressure above 25 m when supplied by the Zone A reservoirs (TWL 61.3 m). For the purposes of both resolving these pressure failures and alleviating storage deficiencies within Zone A, supply to the Gladstone CBD area from Zone BC is proposed. To facilitate this extension to Zone BC new storage for the extended zone is required. It is proposed that this new storage be constructed at the Glenlyon Road site. The Glenlyon Road reservoir site is in near proximity to the existing 450 mm diameter outlet main from the Fisher Street reservoir which will no longer be required for supply to the Fisher Street water zone. As this 450 mm diameter main runs north toward the CBD area there is the potential to connect to the main from Zone BC and use it to supply the Gladstone CBD extension area. Hydraulic modelling identified this arrangement to have the necessary hydraulic capacity when setup with the required connections into the CBD area.

A new 20 ML reservoir (WRS_BC_202) is proposed at the Glenlyon Road reservoir site. The construction of a 20 ML reservoir along with the continued use of the 4.9 ML reservoir at Paterson Street provides the required ultimate storage capacity for the extended Zone BC extent. As discussed previously it is proposed that the existing Paterson Reservoir is supplied from a connection to the supply main from the Round Hill reservoir to the NRG water zone. Similarly, it is proposed to supply the Glenlyon Road reservoir via a 375 mm diameter main running north east from the Round Hill reservoir.

Downstream of the reservoirs, the outlet supply from the Paterson Street reservoir will continue in its current arrangement. The outlet from the Glenlyon road reservoir will connect to the existing and re-zoned 450 mm diameter main in Glenlyon road which will then be used to supply north into Zone BC toward the CBD area. Connections from this main into the reticulation network such as WTM_BC_058 at Breslin Street (375mm diameter) are also proposed to provide the required connectivity to enable desired standards of service for pressure to be met under the new zoning arrangement.

The 450 mm diameter main in Glenlyon Road is currently used to provide supply to the Fisher Street, Radar Hill and Ferris Hill reservoirs. It is proposed that the 450 mm diameter main continue to provided this supply south of the Glenlyon Road reservoir outlet. At this location it is proposed that offline 300 mm diameter main in Glenlyon be replaced with a new 375 mm diameter main. A connection to the 450 mm diameter main south of the Glenlyon Road reservoir outlet is proposed to enable the 375 mm diameter replacement main to operate as a dedicated supply path to the above mentioned reservoirs of Fisher Street, Radar Hill and Ferris Hill. A closed valve is required on the 450 mm diameter main in Glenlyon Road north of the connection to the 375 mm diameter replacement main and south of the Glenlyon Road outlet main connection.

Other arrangements for supply to and from the Glenlyon Road reservoir and in relation to the setup of Zone BC were reviewed within this study. Alternative options included:

- Decommissioning the existing Paterson Street reservoir and supplying the entire Zone BC from the Glenlyon Road reservoir site. This option required the construction of both northern and western outlets from the Glenlyon Road reservoir and correspondence from GRC indicated a concern with the amount of critical water supply infrastructure contained within the same easement with the western outlet following the same alignment as the Round Hill to NRG supply main.
- Supply to the Glenlyon Road reservoir via a new pump station and dedicated rising main from the Gladstone WTP was also considerd. Additional infrastructure and energy cost is associated with this supply option. Including a pump station, a rising main to the start of the 450 mm diameter main in Glenlyon Road, and replacement of the entire length of the 300 mm diameter main in Glenlyon Road in comparison to the replacement of the 300 mm diameter main from the location of the Glenlyon Road reservoir outlet only.
- Maintaining supply to the existing Paterson Street reservoir via the existing inlet arrangement, connecting from water mains in Philip Street. This arrangement was seen to be responsible for increasing head loss through the round Hill reservoir outlet and within the mains along Philip Street. A number of pressure failures within Zone D were identified to be resolved through changing the inlet supply to the Paterson Street to the proposed main from Round Hill to the NRG WSZ.

The strategy for the new Zone BC reservoir in Glenlyon Road and its inlet and outlet arrangements may be subject to further discussion and detailed planning by GRC. Further dedicated planning studies will assist in confirming the most cost effective strategy is adopted and that any constructability, social and environmental constraints are identified and considered.

Table 6-2: Zone BC Extension - Establishment Works

Water Mains							
ID	**LGIP / IPP**	**Year**	**Dia (mm)**	**Len (m)**	**Address**	**Commentary**	**ET Trigger and Commentary**
WTM_BC_043	LGIP	2014	450	160	Glenlyon Road Reservoir Site - Glenlyon Road	Glenlyon Road Reservoir outlet	Required with construction of Glenlyon Road Reservoir to resolve existing storage deficiencies in Paterson Street WSZ and Low Lift WSZs. An existing requirement. Zone BC ET > 1877 ET
WTM_BC_044	LGIP	2014	450	500	151 Glenlyon Street	Glenlyon Road reservoir outlet trunk main connection	Required at the timing of the Zone BC extension for zone setup and establishment. Zone BC WSZ ET > 1877 ET
WTM_BC_046	LGIP	2014	300	40	William St & Glenlyon St Gladstone Central	Internal trunk main connection to facilitate supply into the CBD area	Required at the timing of the Zone BC extension for zone setup and establishment Zone BC ET > 1877 ET
WTM_BC_047	LGIP	2014	300	220	William Street, Gladstone Central	Zone BC internal trunk main, to facilitate supply into the CBD area	Required at the timing of the Zone BC extension for zone setup and establishment Zone BC ET > 1877 ET
WTM_BC_048	LGIP	2014	300	60	Hanson Road and Yaroon Street	Zone BC Internal Trunk Connection	Required at the timing of the Paterson WSZ extension for zone setup and establishment Zone BC ET > 1877 ET
WTM_BC_049	LGIP	2014	300	410	Yaroon Street	Zone BC Internal Trunk Connection	Required at the timing of the Paterson WSZ extension for zone setup and establishment Zone BC WSZ ET > 1877 ET
WTM_BC_058	LGIP	2014	375	450	Breslin Street & Glenlyon Street	Connection from Glenlyon Road Reservoir to internal Zone BC network	Required at the timing of the Glenlyon Road Reservoir for zone setup and establishment. Zone BC ET > 1877 ET
WRM_BC_083	LGIP	2014	200	110	Yaroon Street	Zone BC Internal Trunk Connection	Required at the timing of the Zone BC extension for zone setup and establishment. Zone BC ET > 1877 ET
WTM_BC_093	LGIP	2014	375	870	Round Hill reservoir to Glenlyon Road reservoir	Inlet main to the proposed Glenlyon Road reservoir from the Round Hill reservoir	Required upon construction of the Glenlyon Road reservoir
WTM_BC_094	LGIP	2014	200	230	Paterson Street	New Paterson Street reservoir inlet main	Proposed for construction at the timing of the new supply main from Round Hill reservoir to Zone F (NRG)
Reservoirs							
ID	**LGIP / IPP**	**Year**	**Volume (ML)**		**Address**	**Commentary**	**ET Trigger and Commentary**
WRS_BC_202	LGIP	2014	20		Glenlyon Road Reservoir site	Paterson St WSZ Glenlyon Road Reservoir - new storage (20.0 ML)	Proposed second reservoir for Zone BC. Facilitates the extension of the Paterson Street WSZ to accommodate part of the Zone A WSZ and remove storage pressure from Zone A. Deficiencies currently exist (2014). Zone BC ET > 1800 ET.

Also required at the time of establishment of the Zone BC extension is the 375 mm diameter inlet main (WTM_A_089) in Glenlyon Road to the Zone A reservoirs of Fisher Street, Radar Hill and Ferris Hill.

6.2.1.3 Zone A (re-zoned) and creation of Zone G

As discussed above, the CBD area of Zone A is proposed for re-zoning onto the extended Zone BC to alleviate immediate storage deficiencies. To provide further storage support to Zone A, it is proposed that the Fisher Street reservoir is used to assist supply to Zone A as it is no longer required to supply its own zone. An interconnection from the Fisher Street outlet across Glenlyon Road to Zone A water mains (WTM_A_021) is proposed to achieve the connection of the Fisher Street reservoir to Zone A.

A new 375 mm diameter main in Glenlyon Road is proposed as the supply main to the Zone A reservoirs as it is proposed that the current 450 mm diameter supply main is used for supply to the Glenlyon Road Reservoir.

The combined volume of the Fisher Street, Radar Hill and Ferris Hill reservoirs is 13.3 ML. This volume is capable of servicing demand of the reduced Zone A (without CBD) until 2036 before storage deficiency first occurs. However, as the Ferris Hill reservoir has a bottom water level at approximately 3 m below the Fisher Street and Radar Hill reservoirs an amount of this volume is potentially unusable and operational storage deficiency occurs by 2026. At this time separating the Zone A – to be supplied by Radar Hill and Fisher Street, and Zone G (Ferris Hill) – to be supplied by the Ferris Hill reservoir is proposed.

The proposed reduced Zone A extent to be supplied by Fisher Street and Radar Hill reservoirs alone was developed to maximise the use of storage within these reservoirs up to the Ultimate planning horizon. The balance of the original zone is proposed for supply from Ferris Hill. To achieve the propose zoning of Zone A away from Ferris Hill, a number of valve status changes and two small cross connections are proposed within Auckland Street (WTM_G_084 and WTM_A_085). The reduced Zone A extent generally covers the southern CBD area, The Valley area and down to the elevated properties within the vicinity of the Radar Hill reservoir in the south.

Following the separation of Zone A from the new Ferris Hill water zone, an additional 2 ML of storage is proposed for the Ferris Hill water zone at Ferris Hill in 2031 (WRS_G_203).

Due to the small volume of additional storage required at Ferris Hill, GRC may wish to consider a larger reservoir to make best use of available land. Additionally, due to the potential operational issues associated with operating zonal reservoirs with different bottom water levels, GRC may wish to accelerate the separation of Zone A from the proposed Zone G and implement this prior to 2026.

Capital works required for the re-zoning of Zone A and establishment of Zone G are provided in **Table 6-3** and can be geographically referenced in **Appendix A**.

Table 6-3: Zone A and Zone G Establishment Works

Water Mains							
ID	**LGIP / IPP**	**Planning Horizon**	**Diameter (mm)**	**Length (m)**	**Address**	**Commentary**	**ET Trigger and Commentary**
WTM_A_045	LGIP	2014	300	30	166 Glenlyon Road	Fisher Street Reservoir to Zone A connection	Required at the timing of rezone of the Fisher Street WSZ to the NRG WSZ, such that the Fisher Street reservoir then supports Radar Hill and Ferris Hill reservoirs in supply to Zone A. An existing requirement. Current Fisher Street WSZ ET > 881
WTM_A_089	LGIP	2014	375	1140	Glenlyon Road	Replacement of 300 mm diameter main in Glenlyon road with a 375 mm diameter main as the inlet to Fisher Street, Radar Hill and Ferris Hill reservoirs	Required upon commissioning with the construction of the Glenlyon Road Reservoir
WTM_A_085	LGIP	2026	300	20	Corner of Tank Street and Auckland Street	Zone A rezoning establishment	Required for the segmentation of Zone G and Zone A WSZs. Proposed at 2026 before storage requirements become critical due to different bottom water levels. Combined Zone ET > 4250 ET

WTM_G_084	LGIP	2026	300	10	Corner of Herbert Street and Auckland Street	Zone G inter-connection for rezone establishment	Required for the segmentation of Zone G and Zone A WSZs. Proposed at 2026 before storage requirements become critical due to different bottom water levels. Combined Zone ET > 4250 ET
WTM_G_035	LGIP	2031	500	50	Ferris Hill reservoir site	Ferris Hill No. 2 Pipework	Required with construction of Ferris Hill reservoir 2 proposed for 2031. Zone G ET > 3100 ET.
Reservoirs							
ID	**LGIP / IPP**	**Planning Horizon**	**Volume (ML)**		**Address**	**Commentary**	**ET Trigger and Commentary**
WRS_G_203	LGIP	2031	2		Ferris Hill reservoir site	Ferris Hill No. 2 Reservoir (2.0 ML)	Proposed second reservoir at Ferris Hill to resolve storage deficiencies first experienced at 2031. Zone G ET > 3100 ET

6.2.2 Zone D and Clinton Park Strategy

The Clinton, Round Hill and South Gladstone reservoirs have at the same top water level (TWL). This provides the opportunity to look at the benefits of a combined Zone D incorporating the Clinton Park water zone.

The Clinton Park water zone currently operates with a storage deficiency. Zone D currently has sufficient storage capacity until the 2016 planning horizon. There is an opportunity to defer the construction of additional storage in Zone D by combining Zone D and the Clinton Park WSZ and providing combined storage for both zones. This would address both the deficit in the Clinton Park zone and defer the requirement for additional storage in Zone D and would be likely to result in financial savings to GRC. This approach was, therefore, adopted within this study. The name of the combined zone will be maintained as Zone D for the purpose of this study.

An identified reservoir site exists within Council land to the south of Kirkwood Road (Lot 319 CL 40130 Haddock Drive). Construction of a new 11 ML reservoir (WRS_D_200) at this site is proposed in the short term to resolve existing storage shortfalls. There is a significant amount of development occurring within the Kirkwood Road area. The construction of a proposed Kirkwood Road reservoir and associated connection mains was also identified to resolve upcoming pressure performance deficiencies associated with supply from the Clinton reservoirs alone into this growth area of the network.

The proposed size of the Kirkwood Road reservoir was identified through assessment of a likely supply extent from the reservoir. The sizing of the future storage needs for Zone D at South Gladstone and Round Hill were identified through the same approach with the intention of facilitating healthy reservoir turnover at all four reservoir sites supplying Zone D.

To facilitate additional storages working in conjunction with the Clinton reservoir for supply to a common zone, the current inlet/out reservoir supply arrangement to the Clinton reservoir from the Auckland Creek booster pump station requires re-configuration to a dedicated inlet arrangement. This can be achieved through the construction of a number of interconnections along the reservoir supply main which connect existing reticulation and bypass the dedicated supply main. With the loss of the supply main as an outlet, in order to maintain minimum pressure standards in parts of the zone, a new outlet main from the Clinton reservoir is required at the time of establishing the combined Zone D.

Other options involving using the 375 mm diameter inlet as the outlet main and constructing a smaller diameter inlet to the Clinton reservoir were trialled at the request of GRC. A larger outlet main size was, however, required due to the maximum hour demand on the reservoir and the requirement for low head loss for maintaining pressure related desired standards of service in areas throughout Zone D. The option of using the current inlet/outlet as an outlet was therefore, not progressed further.

Following the construction of the proposed 11 ML reservoir (WRS_D_200) at the new Kirkwood Road site additional storage is proposed for Zone D as follows:

- 7.2 ML at Round Hill reservoir facility in 2031 (WRS_D_206)
- 9.0 ML at South Gladstone reservoir facility at Ultimate (WRS_D_201)

Construction at Round Hill reservoir is proposed prior to South Gladstone based on assessment of the demand growth within the general service extents for each of the reservoirs. Longer term growth is expected within the south east of Gladstone network in the Glen Eden area. The South Gladstone reservoir is deferred until Ultimate to facilitate this growth.

Kirkwood Road reservoir and supply mains:

It is proposed to supply the Kirkwood Road reservoir from a connection to the water trunk main used to export supply from South Gladstone Reservoir to Calliope. A pump station at the connection point is required to deliver inflow to the Kirkwood Road reservoir. From assessment it was identified that the suction HGL at the Kirkwood Road reservoir supply pump station falls to a level unsuitable to provide sufficient supply to the Kirkwood Road reservoir and, likely Calliope, at 2031. At this time upgrade of the GAWB owned supply main from the South Gladstone reservoir to the Kirkwood Road pump station is proposed. At the same time (2031) upgrade of the Kirkwood Road pump station proposed. This is subject to review in conjunction with the strategic planning for Calliope's water network as this planning has previously identified upgrades for this infrastructure.

A 500/450 mm diameter outlet main from the Kirkwood Road reservoir is proposed for construction along Kirkwood Road for connection to the existing 375 mm diameter main in Kirkwood Road. This outlet main is required at the same time as the Kirkwood Road reservoir, inlet main and pump station.

The infrastructure items required to establish the combined Zone D water zone are provided in **Table 6-4**. The capital works are provided graphically in **Appendix A**.

It is also of note that supply to land parcels of high elevations within the Kirkwood Road area is proposed through the establishment of a high level zone the within Zone D named the Kirkwood Road high level zone. Development of these areas is not anticipated until the Ultimate planning horizon. The establishment of the high level zone is not discussed in detail within this section as it is not considered part of the water supply and zoning strategy.

Table 6-4: Zone D Water Zone Establishment Works

Water Mains							
ID	**LGIP / IPP**	**Year**	**Dia (mm)**	**Len (m)**	**Address**	**Commentary**	**ET Trigger and Commentary**
WTM_D_019	LGIP	2014	500	540	Kirkwood Road	Internal trunk main for connection of the Kirkwood low reservoir to the Zone D water supply network	Required with construction of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_020	LGIP	2014	500	550	Kirkwood Road	Internal trunk main for connection of the Kirkwood low reservoir to the Zone D water supply network	Required with construction of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_028	LGIP	2014	500	60	Lot 319 CL 40130 Haddock Drive	Kirkwood Low reservoir outlet	Required with construction of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_054	LGIP	2014	500	770	Kirkwood Road	Kirkwood Low reservoir outlet	Required with construction of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_055	LGIP	2014	500	30	Lot 319 CL 40130 Haddock Drive	Kirkwood Low reservoir outlet	Required with construction of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_059	LGIP	2014	500	1320	Clinton reservoir to J Hickey Avenue	Clinton reservoir outlet to replace dedicated inlet main	Required as a replacement for the current inlet/outlet main to Clinton reservoir once made a dedicated supply. Combined Zone D WSZ ET > 13000 ET
WTM_D_018	LGIP	2014	450	780	Kirkwood Road	Internal trunk main for connection of the Kirkwood low reservoir to the Zone D water supply network	Required with construction of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_030	LGIP	2014	375	880	Haddock Drive	Kirkwood Low Reservoir Inlet	Required with construction of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_033	LGIP	2014	375	90	Haddock Drive	Kirkwood Low Reservoir Inlet	Required with construction of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET
WTM_D_052	LGIP	2014	300	30	20 Ballantine Street	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13027 ET
WTM_D_050	LGIP	2014	200	50	Shaw Street, New Auckland	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13027 ET
WTM_D_051	LGIP	2014	200	20	2 Ballantine Street	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13027 ET
WTM_D_053	LGIP	2014	200	20	Shaw Street, New Auckland	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13000 ET

WTM_D_060	LGIP	2026	375	440	Chapman Drive	Extension of Clinton reservoir outlet to replace dedicated inlet main	Required in 2021 as a extension of the Clinton reservoir outlet main. Connects outlet main to the 300 mm diameter main in Harvey Road facilitating supply from Clinton reservoir to the south. Combined Zone D WSZ ET > 14000 ET
WTM_D_021	LGIP	2031	450	3100	Glenlyon Road to Haddock Drive	Augmentation of 375 mm diameter supply to Calliope and Kirkwood Road Low Level Supply	Required at the timing of the pump station upgrade at Kirkwood Road Low WPS (2031) to maintain HGL to the suction side of pump station and maintain HGL in supply to Calliope. Approximate ET in Zone D ~ 16880 ET
WTM_D_034	LGIP	2031	450	880	Glenlyon Road	Augmentation of 375 mm diameter supply to Calliope and Kirkwood Road Low	Required at the timing of the pump station upgrade at Kirkwood Road Low WPS (2031) to maintain HGL to the suction side of pump station and maintain HGL in supply to Calliope. Approximate ET in Zone D ~ 16880 ET
WTM_D_038	LGIP	2031	450	20	Round Hill reservoir site	Round Hill 2 pipework	Required with construction of Round Hill 2 reservoir (7.2 ML) to resolve 2031 storage deficiencies in Zone D. Combined Zone D ET > 17241 ET
WTM_D_039	LGIP	2031	450	30	Round Hill reservoir site	Round Hill 2 pipework	Required with construction of Round Hill 2 reservoir (7.2 ML) to resolve 2031 storage deficiencies in Zone D. Combined Zone D ET > 17241 ET
WTM_D_077	IPP	2040	300	30	South Gladstone reservoir site	South Gladstone 2 reservoir outlet main	Required with construction of the South Gladstone 2 reservoir (9 ML) at Ultimate to resolve storage deficiencies. Combined Zone D ET > 20000 ET
Pump Stations							
ID	**LGIP/ IPP**	**Planning Horizon**	**Flow (L/s)**	**Head (m)**	**Address**	**Commentary**	**ET Trigger and Commentary**
WPS_D_102	LGIP	2014	80	35	Kirkwood Road WPS - Haddock Drive	New WPS Kirkwood Road Low	Required at the time of the Kirkwood Low level reservoir. Combined Zone D ET > 13000 ET.
WPS_D_102 a	LGIP	2031	160	40	Kirkwood Road WPS - Haddock Drive	New WPS Kirkwood Road - Upgrade 2	Required at 2031. Combined Zone D ET > 32000 ET
Reservoirs							
ID	**LGIP/ IPP**	**Planning Horizon**	**Volume (ML)**		**Address**	**Commentary**	**ET Trigger and Commentary**
WRS_D_200	LGIP	2014	11		Lot 319 CL 40130 Haddock Drive	Kirkwood Low Reservoir (11 ML)	Proposed to resolve storage deficiencies within the Clinton WSZ along with the merging of the Zone D and Clinton WSZs into a single zone. Storage deficiencies currently exist. Reservoir is proposed in the short term (2014). Combined Zone D ET > 13000 ET
WRS_D_206	LGIP	2031	9.1		Round Hill reservoir site	Round Hill 2 (7.2 ML)	Proposed in 2031 to provide additional storage to Zone D. Combined Zone D ET > 17200 ET
WRS_D_201	IPP	2040	9		South Gladstone Reservoir site	South Gladstone Reservoir 2 (9.0 ML)	Proposed in Ultimate to provide additional storage to Zone D. Combined Zone D ET > 20000 ET

6.3 Demand Summary for Ultimate Zoning

Table 6-5 summarises the ET under the proposed ultimate zoning scenario. It is noted that the total ET under the ultimate scenarios is slightly higher than under the existing zoning scenario. This is due to a small (approximately 200 ET) increase to the overall service area covered by the zones under the proposed ultimate zoning.

Table 6-5: Total ET per Ultimate WSZs

Water Zone	Total ET						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	974	974	974	1,207	1,257	1,365	1,524
Zone BC	4,677	5,012	6,302	6,849	7,438	8,265	9,110
Zone D	12,662	13,636	14,128	15,656	16,880	17,602	20,819
Zone F	3,679	3,955	4,272	4,601	6,655	6,933	7,512
Zone G	2,817	2,939	2,939	3,055	3,250	3,578	3,841
Kirkwood HLZ							774
Total	**24,810**	**26,516**	**28,616**	**31,369**	**35,480**	**37,743**	**43,580**

Table 6-6 to **Table 6-8** summarise the Average Day, MDMM and Maximum Day demands respectively under the proposed ultimate zoning.

Table 6-6: Average Day Demands – Ultimate Zones

Water Zone	Average Day Demand (L/s)						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	16.4	16.4	16.4	20.3	21.1	22.9	25.6
Zone BC	78.5	84.1	105.8	114.9	124.8	138.7	152.9
Zone D	212.5	228.8	237.1	262.7	283.3	295.4	349.4
Zone F	61.7	66.4	71.7	77.2	111.7	116.4	126.1
Zone G	47.3	49.3	49.3	51.3	54.5	60.0	64.5
Kirkwood HLZ							13.0
Total	**416.4**	**445.0**	**480.2**	**526.4**	**595.4**	**633.4**	**731.4**

Table 6-7: Mean Day Max Month – Ultimate Zones

Water Zone	Mean Day Max Month Demand (L/s)						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	19.7	19.7	19.7	25.3	26.4	28.7	32.4
Zone BC	102.2	110.1	141.9	155.5	170.2	190.8	211.3
Zone D	298.0	321.8	332.2	367.9	397.5	414.8	493.2
Zone F	62.1	66.8	72.1	77.6	112.1	117.0	126.7
Zone G	59.3	62.3	62.3	65.2	69.9	77.0	83.4
Kirkwood HLZ							19.3
Total	**541.4**	**580.8**	**628.2**	**691.5**	**776.0**	**828.2**	**966.4**

Table 6-8: Maximum Day – Ultimate Zones

Water Zone	Maximum Day Demand (L/s)						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone A	26.0	26.0	26.0	33.4	34.8	37.8	42.8
Zone BC	135.3	145.7	188.0	206.2	225.9	253.2	280.6
Zone D	396.0	427.7	441.3	488.8	528.1	551.2	655.5
Zone F	80.8	86.9	93.8	101.0	145.8	152.2	164.8
Zone G	78.2	82.3	82.3	86.2	92.4	101.8	110.3
Kirkwood HLZ							25.7
Total	**716.3**	**768.6**	**831.4**	**915.5**	**1,026.9**	**1,096.2**	**1,279.8**

6.4 Storage Assessment for Ultimate Zoning

Water reservoir storage assessment based on the proposed Ultimate zoning is provided within **Table 6-9**. Red cells indicate the introduction of new storage as discussed in Section 6.2. **Appendix D** provides a full storage assessment.

Table 6-9: Storage Assessment for Ultimate Water Zoning

Water Zone	Current Storage (ML)	Value	Planning Horizon						
			2014	2016	2021	2026	2031	2036	Ultimate
Zone D	34	Planned Storage (ML)	45	45	45	45	54.1	54.1	63.1
		Required Storage (ML)	37.3	40.2	42.0	45.0	50.6	52.9	62.7
		Excess / Deficiency (ML)	7.7	4.8	3.0	0.0	3.5	1.2	0.4
Zone BC	4.9	Planned Storage (ML)	25	25	25	25	25	25	25
		Required Storage (ML)	12.6	13.5	16.9	18.3	19.8	22.0	24.2
		Excess / Deficiency (ML)	12.4	11.5	8.1	6.7	5.2	3.0	0.8
Zone F	13.5	Planned Storage (ML)	13.5	13.5	13.5	13.5	27.0	27.0	27.0
		Required Storage (ML)	10.2	10.9	11.7	12.6	17.9	18.7	20.2
		Excess / Deficiency (ML)	3.3	2.6	1.8	0.9	9.1	8.3	6.8
Zone G	8.7	Planned Storage (ML)	8.7	8.7	8.7	8.7	10.7	10.7	10.7
		Required Storage (ML)	7.8	8.1	8.1	8.4	8.9	9.8	10.5
		Excess / Deficiency (ML)	0.9	0.6	0.6	0.3	1.8	0.9	0.2
Zone A	4.6	Planned Storage (ML)	4.6	4.6	4.6	4.6	4.6	4.6	4.6
		Required Storage (ML)	3.0	3.0	3.0	3.6	3.7	4.0	4.4
		Excess / Deficiency (ML)	1.6	1.6	1.6	1.0	0.9	0.6	0.2

6.5 Major Pump Station Assessment

An assessment of pump station capacity was undertaken. Full pump station capacity assessment is provided within **Appendix D**. The GAWB owned pump station capacities were assessed, however, within this study no proposed augmentations have been identified. Assessment of the high lift pump station capacity requirements are provided for Gladstone City customers only and exclude supply to Calliope, TBBW and other industrial customers with direct supply agreements with GAWB. **Table 6-10** provides a summary of the pump station capacity assessment. **Table 6-11** provides a summary of the proposed pump station upgrades.

Table 6-10 shows that with the proposed zoning and supply strategy implemented including a new Kirkwood Road reservoir and pump station, existing capacity issues associated with the low lift pump station and the Auckland Creek pump station are alleviated. Table 6-6 also provides the required capacities for proposed pump stations including a proposed high level pump station to supply a future Kirkwood Road high level zone (discussed further is **Section 7**).

Full pump station capacity assessment tables are provided within **Appendix E.**

Table 6-10: Gladstone Pump Station Capacity Assessment Summary

Water Pump Station	Current Capacity (L/s)	Value	Planning Horizon							
			Existing Zoning	2014	2016	2021	2026	2031	2036	Ultimate
GAWB High Lift Station^	600	Required capacity (L/s)^	488	678	731	826	908	1020	1096	1251
		Excess / deficiency (L/s)	112	-78	-131	-226	-308	-420	-496	-651
GAWB Low Lift Station	157	Required capacity (L/s)	158	95	98	98	109	115	127	139
		Excess / deficiency (L/s)	-1	63	59	59	49	42	31	19
Auckland Creek Booster Pump Station	130	Required capacity (L/s)	171	85	88	89	98	103	108	116
		Excess / deficiency (L/s)	-41	45	42	41	32	27	22	14
Future Kirkwood Reservoir Pump Station	N/a	Required capacity (L/s)	0	43	61	61	76	102	109	136
Future Kirkwood High Level Pump Station^^	N/a	Required capacity (L/s)	0	0	0	0	0	0	0	46

^ Excludes GAWB supply to Calliope, TBBW and a number of directly supplied industrial customers. Therefore required capacity refers the requirement of GRC customers in the Gladstone water supply network only.
^^ As not required until Ultimate the future Kirkwood Road high level pump station is not LGIP infrastructure.

Table 6-11: Proposed Water Pump Station Upgrades

ID	LGIP or IPP	Year	Duty Flow (L/s)	Duty Head (m)	Power (kW)	Address	Commentary	ET Trigger and Commentary
WPS_D_102	LGIP	2014	80	35	39.2	Kirkwood Road WPS - Haddock Drive	New WPS Kirkwood Road Low	Required at the time of the Kirkwood Low level reservoir. Combined Zone D ET > 13000 ET.
WPS_D_102a	LGIP	2031	160	40	89.6	Kirkwood Road WPS - Haddock Drive	New WPS Kirkwood Road - Upgrade 2	Required at 2031. Combined Zone D ET > 32000 ET
WPS_D_104	IPP	2040	50	25	17.5	Kirkwood Road	Kirkwood high level Booster	Required first lot (1 ET) in Kirkwood Road HLZ. Ultimate

7 Maximum Hour Network Performance and Augmentation Assessment

Other than the zone bulk supply and zone establishment infrastructure requirements identified within **Section 6** a number of augmentations were identified as required to resolve low minimum pressures under maximum hour demands. The most significant of these maximum hour augmentation upgrades are discussed within this section.

The complete infrastructure schedules are provided/referenced within **Section 9**. These infrastructure schedules provide individual reasoning and descriptions for each proposed augmentation.

Infrastructure maps are provided within **Appendix A.**

7.1 Zone D Water Supply Zone

For the purposes of performance assessment it was assumed that the establishment of the combined Zone D including the proposed Kirkwood Road reservoir and outlet mains had occurred at 2014.

With the establishment of the combined Zone D the following was observed in relation to network performance under maximum hour demands:

- With increasing demands, maximum hour pressure failures were identified within the high elevations areas of the network in the precinct west of the golf course and east of Briffney Creek and between Dawson Highway and Kirkwood Road. These failures were identified due to the loss of the inlet/outlet main arrangement to Clinton Park reservoir resulting in loss of larger diameter mains feeding the area from the Dawson Highway. To resolve the low pressures the following is proposed:
    - 2014:
        - Ensure that the Auckland Creek pumps station can be bypassed and valving is available such that gravity supply from the Round Hill reservoir can supply into this area with a connection into Shaw Street / Beak Street. There are multiple mains to the west of the Auckland Creek pump station that appear as though they can be isolated from the Clinton reservoir inlet supply.
    - 2026:
        - Further improving supply paths from the Clinton reservoir are required at 2026. The initial outlet main from the Clinton reservoir is proposed at the 2014 planning horizon as a 500 mm diameter main connecting into the network at J Hickey Avenue. A 375 mm extension of this main along Chapman Drive and connecting to the 300 mm diameter main in Harvey Road is proposed at 2026 to alleviate low pressures in the network (WTM_D_060).
    - 2031:
        - Provide a connection from the 300 mm diameter main in Harvey Road across the sporting ovals and connecting to water mains in Daintree Boulevard (WTM_D_087). This will facilitate the better delivery of supply from the Clinton reservoir into this area and alleviate pressure failures occurring in Brindabella Place. The proposed main involves the crossing of Briffney Creek which will likely require approvals and trenchless construction.
        - A 200 mm diameter main is proposed from Boonderee Place to Penda Avenue (WTM_D_088) to further facilitate supply into the area from the Clinton reservoir and resolve low pressures within the vicinity of Goodnight Place.
- Low pressures were identified to start occurring within the Kin Kora area of the network from the 2016 planning horizon in areas with elevation of above 60 m. Augmentation solutions for parts of the network above 60 m in elevation were not developed.
- WRM_D_081 in Philip Street is proposed in 2014 to resolve low pressure in Marian Close. This proposed augmentation alleviates a pre-existing low pressure point.

- Low pressures were identified in the vicinity of St Clements Close and Birmingham Close. Following comments provided by GRC it is understood works in Dixon Road are underway to address these low pressure issues. Therefore, no solutions for these failures were developed as part of this study.
- At Ultimate some significant supply infrastructure will be required to service future development. A significant portion of developable land located south of Kirkwood Road is too high to be serviced by the existing Zone D reservoirs. To service this area a new Kirkwood Road high level tank and high level pump station is proposed with the high level zone to be serviced by supply from the Kirkwood Road high level tank. It is envisaged that a significant amount of more detailed planning will be undertaken over the coming years associated with the supply of water to this high level area. The infrastructure proposed for service of the high level zone in this study is as follows:
  - High level pump station supply main (300 mm diameter) – WTM_D_070, WTM_D_024, WTM_ZoneD_023. This main also provides service to lower elevation areas of the development via future connections prior to boosting.
  - High level reservoir supply main (250 mm diameter) – WTM_D_025, WTM_D_026.
  - Kirkwood Road High Level Pump Station – 50 L/s @ 25 m head (17.5 kW) – WPS_D_104.
  - Kirkwood Road High Level Reservoir – 2.3 ML – WRS_D_207.
- Ultimate development in the south east of Zone D, east of Glenlyon Road, was also identified to require a significant amount of new infrastructure in order to service projected demands. Proposed mains to service this area are as follows:
  - WTM_D_071, WTM_D_072, WTM_D_073, WTM_D_074.

7.2 Zone F Water Supply Zone

Assuming the ultimate extent of Zone F is created by re-zoning of the Fisher Street water supply zone onto an Zone F (NRG water supply zone) at 2014, No maximum hour pressure failures were identified within the zone up to and including the Ultimate planning horizon. In addition, no maximum hour pressure failures were identified prior to re-zoning (existing planning horizon only).

The model did show some junctions with minimum pressures below 25 m. However, following input from GRC it is understood the available asset data in the model for this area of the network is questionable and it is unlikely real low pressures are experienced. Therefore solutions for these model identified low pressures were not developed.

7.3 Zone BC Water Supply Zone

With the proposed extended Zone BC (re-zoned to include Gladstone CBD) setup and operational at the 2014 planning horizon as described within **Section 6** and with the inclusion of sufficient capacity in connections from the 450 mm diameter former Fisher Street main into the CBD area, no maximum hour pressure failures were identified within the zone up to and including the Ultimate planning horizon.

7.4 Zone A Water Supply Zone

With the proposed reduced Zone A established as described within **Section 6**, no maximum hour pressure failures were identified within this zone up to and including the Ultimate planning horizon. In addition, no maximum hour pressure failures were identified prior to re-zoning (existing planning horizon only).

7.5 Zone G Water Supply Zone

With the proposed Zone G water zone established as described within **Section 6**, no maximum hour pressure failures were identified within this zone up to and including the Ultimate planning horizon. In addition, no maximum hour pressure failures were identified prior to re-zoning when operating as a combined zone with Zone A as per Section 7.4 (existing planning horizon only).

7.6 Zone Boundary Changes

For resolution of low zonal pressures, both maximum hour and fire flow, some changes to the water supply zone boundaries between Zone BC and Zone D, and Zone G and Zone D have been proposed to avoid capital solutions. The proposed zone boundary changes are proposed to make best use of existing infrastructure connectivity.

Proposed Ultimate zone boundaries are provided within the **Appendix A** maps and within **Figure B1** of **Appendix B**. The identification of available valving for establishing the proposed zoning has not been undertaken within the scope of this study. GRC may wish to undertake further assessments to optimise the proposed boundaries based on available valving.

Similarly to the above, the required valving alterations to establish the reduced Zone A (through re-zoning the CBD onto Zone BC) and the separation of Zone G from Zone A, has not been assessed as part of this study . New valves may be required for zone establishment. New valves have not been identified or allowed for in cost estimates as part of this assessment.

8 Fire Flow Performance Assessment

8.1 Fire Flow Assessment Methodology

The firefighting capacity assessment was undertaken based on the following firefighting demands:

- 15 L/s for residential properties three (3) storeys or less
- 30 L/s for all commercial properties (including residential accommodation facilities with commercial kitchens) and residential properties of four (4) or more storeys.

Within this study fire flow assessment was undertaken assuming a peak hour background demand and assuming the full fire flow requirement is delivered through a single hydrant. Hydrant locations were not accurately represented in the network hydraulic model at all locations. Fire flow demands were allocated to model junctions and if failure was identified the "realness" of the fire flow capacity issue was assessed based on location to the nearest hydrant. If fire flow failure was identified to occur at a location at which no hydrant was present (i.e. at the end of a small diameter property connection main) these failures were discounted from solution development.

Allocation of fire flow demand to junctions within the hydraulic model was based on land uses within the developed demand model. As there are some limitations to the demand model land uses, it is a possibility that not all junctions are allocated the appropriate fire flow demands. Within this study no further verification of fire flow demand allocation was undertaken through the use of aerial photography, google street view or other means.

8.2 Fire Flow Augmentation Outcomes Summary

A total of 40 augmentations are proposed as part of this study to resolve fire flow deficiencies within the Gladstone water supply network as identified within the hydraulic model. 31 of these augmentations were identified as required within the 2014 planning horizon. An additional 6 fire flow augmentations in 2016, 1 fire flow augmentation in 2021 and 2 fire flow augmentations in 2036.

Table 8-1 provides a summary of the proposed fire flow augmentations.

Table 8-1: Proposed Fire Flow Gladstone Water Supply Fire Flow Augmentations

ID	LGIP or IPP	Planning Horizon	Dia (mm)	Length (m)	Address	Commentary
WRM_D_FF_321	IPP	2014	150	230	South Trees Drive	Upgrade to solve existing FF issue - South Trees Drive industrial area
WRM_D_FF_323	IPP	2014	150	190	South Trees Drive	Upgrade to solve existing FF issue - South Trees Drive industrial area
WRM_D_FF_324	IPP	2014	150	550	South Trees Drive	Upgrade to solve existing FF issue - South Trees Drive industrial area
WRM_D_FF_325	IPP	2014	200	670	Unnamed Road Glen Eden	Upgrade to solve existing FF issue - South Trees Drive industrial area
WRM_D_FF_326	IPP	2014	150	180	Boys Road	Upgrade to solve existing FF issue - South Trees Drive industrial area
WRM_D_FF_327	IPP	2014	150	470	Gladstone Benaraby Road	FF upgrade - Gladstone Benarby Road Industrial Demand
WRM_D_FF_328	IPP	2014	150	300	Soppa Street	FF upgrade - Soppa Street single 100 mm diameter
WRM_D_FF_329	IPP	2014	150	360	Ganley Street and Hixon Street	FF upgrade - Ganley Street and Hixon Street industrial area
WRM_D_FF_330	IPP	2014	150	270	Philip Street to Windward Passage	FF upgrade - for existing FF failure in Windward Passage
WRM_D_FF_333	IPP	2016	100	270	Archer Street	FF upgrade for existing FF issues Neluna Rise
WRM_D_FF_335	IPP	2014	150	260	Oxley Drive	FF upgrade for existing FF failures in vicinity of Koppabella Close Solonika Court and Adelaide Street.
WRM_G_FF_301	IPP	2014	150	190	Sanctuary Place	FF upgrade for existing FF failures in Sanctuary Place vicinity

ID	LGIP or IPP	Planning Horizon	Dia (mm)	Length (m)	Address	Commentary
WRM_G_FF_302	IPP	2014	150	240	Lyons Street to Dawson Highway	FF upgrade for Lyons Street, Supports fire flow capacity for the local area.
WRM_G_FF_303	IPP	2014	150	260	Young Street	FF upgrade - to industrial customer in Young Street for existing FF shortfall.
WRM_F_FF_307	IPP	2014	150	70	Rollo Street to Hanson Road	FF upgrade for properties in Rollo Street
WRM_F_FF_308	IPP	2014	150	170	Hilliard Street	FF upgrade for Hilliard Street
WRM_F_FF_309	IPP	2014	150	340	Rooksby Street	FF upgrade Rooksby Street. GRC GIS indicates a hydrant exists at the end of this main.
WRM_BC_FF_316	IPP	2014	150	110	30 Dawson Road	FF upgrade - to hydrant at end of school connection
WRM_A_FF_320	IPP	2014	150	450	West Gladstone	FF upgrade to Industrial Demand
WRM_BC_FF_317	IPP	2021	100	80	151 Glenlyon Street - Higgins Street to Fisher Street	FF upgrade for properties in Higgins Street due to development in zone.
WRM_G_FF_304	IPP	2014	150	160	Off Lane off of Herbert Street	FF upgrade for existing FF failure for properties in Off Lane
WRM_BC_FF_318	IPP	2016	100	190	Stewart Street to Wenitong Street	FF upgrade for failures in Wenitong Street
WRM_D_FF_338	IPP	2016	150	170	Warren Street	FF upgrade for commercial FF in Warren Street
WRM_G_FF_305	IPP	2016	150	130	Yaralla Street	FF upgrade for properties in Yaralla Street
WRM_G_FF_306	IPP	2021	150	270	McLintock Street	FF upgrade for hydrant at supply to McLintock Street Industrial Customer
WRM_A_FF_319	IPP	2036	150	110	Central Lane	FF upgrade for at northern end of Central Lane

9 Infrastructure Schedules

Staged schedules for the water supply infrastructure proposed to maintain standards of service within the Gladstone water supply network up to and including the Ultimate planning horizon are provided within **Appendix F**. Infrastructure items contained within the schedules provided within **Appendix F** are shown geographically within the **Appendix A** maps and can be cross referenced through unique IDs.

Appendix F infrastructure schedules:

- **Table F1** – Water main augmentations
- **Table F2** – Fire flow augmentations
- **Table F3** – Reservoir augmentations
- **Table F4** – Pump stations augmentations

10 Cost Estimation

10.1 Cost Estimation Methodology

Cost estimates for augmentations proposed within this report have been developed based on the following assumptions:

- Unit rates contained within the Harrison Grierson Unit Rates Report 2010 were adopted.
- Rates were indexed to 2014 rates (11% increase)
- No geology assessment was undertaken for soil factor multipliers in this study (unavailable). A clay soil factor was assumed for all augmentations. Harrison Grierson Unit Rates Report 2010 recommends the following multipliers based on soil type:

Hard Rock	1.36
Soft Rock	1.1
Clay	1
Sand	0.88

- The cost estimates contain no contingency based on advice within Harrison Grierson Report.
- No assessment of geology at reservoir sites was undertaken. Therefore hard rock multipliers were not included for any site.
- Where water main construction within greenfield areas was assumed no allowance for road and pavement reinstatement has been allowed. The additional rate for road and pavement construction has been allowed for water mains considered within developed/urban areas.
- Cost Estimates for pump stations are developed using unit rates per kW. A pump efficiency of 70% is assumed to calculate the pump station power requirement.

In water main cost estimates no assessment or allowance for trenchless construction requirements has been undertaken. As no contingency has been included within the cost estimates, there is a risk that the cost of delivery of some mains has been underestimated.

10.2 Summary Cost Estimation Outcomes

Individual cost estimation outcomes for each proposed infrastructure item are provided within the **Appendix F** infrastructure schedules.

The following tables provide infrastructure cost estimation summaries per asset type, ultimate zone and planning horizon. A number of the summary tables also breakdown the infrastructure cost estimates into LGIP and IPP infrastructure also. Please see earlier report sections for the definition of LGIP and IPP infrastructure. Summary tables are as follows:

- **Table 10-1**: Water main augmentations cost estimation summary - All
- **Table 10-2**: Fire flow augmentations cost estimation summary - All
- **Table 10-3**: Reservoir augmentations cost estimation summary - All
- **Table 10-4**: Pump station augmentation cost estimation summary – All
- **Table 10-5**: Total/combined augmentations cost estimation summary per zone – All
- **Table 10-6**: Total/combined augmentation cost estimation summary per planning horizon – All
- **Table 10-7**: LGIP augmentation cost estimation summary per planning horizon
- **Table 10-8**: LGIP augmentation cost estimation summary per planning horizon
- **Table 10-9**: IPP augmentation cost estimation summary per planning horizon
- **Table 10-10**: IPP augmentation cost estimation summary per planning horizon

Total estimated capital expenditure is $43.5 Million using the adopted cost estimation methodology.

Table 10-1: Water Main Augmentations Cost Estimation Summary

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$600,000			$20,000				**$620,000**

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone BC	$2,420,000					$100,000		**$2,520,000**
Zone D	$5,730,000		$70,000	$370,000	$4,350,000	$60,000	$1,960,000	**$12,540,000**
Zone F	$1,260,000				$110,000			**$1,370,000**
Zone G				$10,000	$160,000			**$170,000**
TOTAL	**$10,010,000**	**$0**	**$70,000**	**$400,000**	**$4,620,000**	**$160,000**	**$1,960,000**	**$17,220,000**

Table 10-2: Fire-flow Augmentations Cost Estimation Summary

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$160,000					$40,000		**$200,000**
Zone BC	$40,000	$50,000	$20,000					**$110,000**
Zone D	$1,350,000	$130,000						**$1,480,000**
Zone F	$210,000							**$210,000**
Zone G	$310,000	$50,000	$100,000					**$460,000**
TOTAL	**$2,070,000**	**$230,000**	**$120,000**	**$0**	**$0**	**$40,000**	**$0**	**$2,460,000**

Table 10-3: Reservoir Augmentation Cost Estimation Summary

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A								**$0**
Zone BC	$4,700,000							**$4,700,000**
Zone D	$2,970,000				$2,760,000		$3,880,000	**$9,610,000**
Zone F					$3,620,000			**$3,620,000**
Zone G					$1,020,000			**$1,020,000**
TOTAL	**$7,670,000**	**$0**	**$0**	**$0**	**$7,400,000**	**$0**	**$3,880,000**	**$18,950,000**

Table 10-4: Pump Station Augmentation Cost Estimation Summary

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A								**$0**
Zone BC								**$0**
Zone D	$330,000				$630,000		$150,000	**$1,110,000**
Zone F								**$0**
Zone G								**$0**
TOTAL	**$330,000**	**$0**	**$0**	**$0**	**$630,000**	**$0**	**$150,000**	**$1,110,000**

Table 10-5: Total/Combined Augmentations Cost Estimation Summary per Supply Zone

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$760,000			$20,000		$40,000		**$820,000**
Zone	$7,160,000	$50,000	$20,000			$100,000		**$7,330,000**

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
BC								
Zone D	$10,380,000	$130,000	$70,000	$370,000	$7,740,000	$60,000	$5,990,000	**$24,740,000**
Zone F	$1,470,000				$3,730,000			**$5,200,000**
Zone G	$310,000	$50,000	$100,000	$10,000	$1,180,000			**$1,650,000**
TOTAL	**$20,080,000**	**$230,000**	**$190,000**	**$400,000**	**$12,650,000**	**$200,000**	**$5,990,000**	**$39,740,000**

Table 10-6: Total/Combined Augmentation Cost Estimation Summary per Planning Horizon

Asset Type	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Water mains	$10,010,000		$70,000	$400,000	$4,620,000	$160,000	$1,960,000	**$17,220,000**
Fire flow mains	$2,070,000	$230,000	$120,000			$40,000		**$2,460,000**
Reservoirs	$7,670,000				$7,400,000		$3,880,000	**$18,950,000**
Pump Stations	$330,000				$630,000		$150,000	**$1,110,000**
TOTAL	**$20,080,000**	**$230,000**	**$190,000**	**$400,000**	**$12,650,000**	**$200,000**	**$5,990,000**	**$39,740,000**

Table 10-7: LGIP Augmentations Cost Estimation Summary per Supply Zone

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$600,000			$20,000				**$620,000**
Zone BC	$7,120,000							**$7,120,000**
Zone D	$8,860,000			$370,000	$7,740,000			**$16,970,000**
Zone F	$1,260,000				$3,730,000			**$4,990,000**
Zone G				$10,000	$1,180,000			**$1,190,000**
TOTAL	**$17,840,000**	**$0**	**$0**	**$400,000**	**$12,650,000**	**$0**	**$0**	**$30,890,000**

Table 10-8: LGIP Augmentation Cost Estimation Summary per Planning Horizon

Asset Type	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Water mains	$9,840,000			$400,000	$4,620,000			**$14,860,000**
Fire flow mains								**$0**
Reservoirs	$7,670,000				$7,400,000			**$15,070,000**
Pump Stations	$330,000				$630,000			**$960,000**
TOTAL	**$17,840,000**	**$0**	**$0**	**$400,000**	**$12,650,000**	**$0**	**$0**	**$30,890,000**

Table 10-9: IPP Augmentations Cost Estimation Summary per Supply Zone

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$160,000					$40,000		**$200,000**

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone BC	$40,000	$50,000	$20,000			$100,000		**$210,000**
Zone D	$1,520,000	$130,000	$70,000			$60,000	$5,990,000	**$7,770,000**
Zone F	$210,000							**$210,000**
Zone G	$310,000	$50,000	$100,000					**$460,000**
TOTAL	**$2,240,000**	**$230,000**	**$190,000**	**$0**	**$0**	**$200,000**	**$5,990,000**	**$8,850,000**

Table 10-10: IPP Augmentation Cost Estimation Summary per Planning Horizon

Asset Type	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Water mains	$170,000	$0	$70,000	$0	$0	$160,000	$1,960,000	**$2,360,000**
Fire flow mains	$2,070,000	$230,000	$120,000	$0	$0	$40,000	$0	**$2,460,000**
Reservoirs	$0	$0	$0	$0	$0	$0	$3,880,000	**$3,880,000**
Pump Stations	$0	$0	$0	$0	$0	$0	$150,000	**$150,000**
TOTAL	**$2,240,000**	**$230,000**	**$190,000**	**$0**	**$0**	**$200,000**	**$5,990,000**	**$8,850,000**

11 Discussion

The limitations, future opportunities and parked items identified through this assessment are noted within this section of the report.

11.1 Limitations

This report reflects a high level strategic planning study. Due to scope, time constraints and available information, there are a number of potential limitations associated with the outcomes of this study. These potential limitations are provided as follows:

- The demand model adopted within this study was developed based on a number of assumptions. Although based upon the best available information at the time the demand model will not be accurate in its development projections, land use and timing for all properties within the study area. The development methodology is provided within Section 4 of the report and the document - 'Gladstone Regional Council Demand Model Development Technical Memo (MWH, July 2014)'.
- With the exception of a few proposed assets, no optioneering of solutions has been undertaken within this study. Therefore, preferred or alternative solutions may be available. GRC may wish undertaking specific and detailed planning studies in relation to some of the larger proposed solutions.
- Cost estimates have been developed at a unit rate level only. The cost estimates have not considered individual alignments and site conditions, or infrastructure for which trenchless construction methods will be required.
- The feasibility and practical constructability of proposed assets has generally not been assessed within this study. There may be some proposed assets that require alternative solutions to be developed based on future site and environmental constraints.
- The timing of proposed infrastructure matches the 5 year planning horizons assessed within this study. For construction of "just in time" infrastructure these 5 year planning horizons may not be suitable to GRC and future assessment into timing may be required.
- Zone boundary updates have been proposed within this study without assessment of valve localities.
- Fire flow demand allocation was informed by the developed demand model. As the land uses within the demand model are not accurate for all parcels, the allocation of fire flows may be incorrect in places.

It is recommended that the outcomes of this report be viewed as the best and most up-to-date water supply planning for the Gladstone water supply network. The outcomes, should however, be viewed with consideration to the above limitations.

11.2 Future Opportunities

A number of opportunities were identified which may assist GRC in improving the outcomes of ongoing and future planning studies associated with the Gladstone water supply network. Potential opportunities include:

- Future update of the demand model developed for input into this water supply master planning study. As new information becomes available relating to land uses, development timing and sequencing, and state growth projections, it is envisaged that benefits will be identified by GRC in updating the demand model for input into future and ongoing infrastructure planning studies.
- Prior to delivering major infrastructure items identified within this report it is recommended that specific detailed planning and feasibility studies be undertaken to ensure the preferred and most efficient solutions are being delivered. The detailed planning studies may also be used to assess the 'just in time' delivery of infrastructure, and develop more detailed/accurate cost estimates.

- The assessment within this report was undertaken based on the GRC adopted standards of service. It has been identified across other Queensland water authorities and councils that a review of service standards in respect to appropriate levels of conservatism can result in significant capital cost savings on infrastructure delivery. GRC may see benefit in undertaking a review of the planning based standards of service currently adopted. Activities involved would include a demand tracking assessment for review of unit planning demand and peaking factors, and a risk based approach to reviewing performance based standards of service.
- Much recent infrastructure within the Gladstone hydraulic model was included without confirmation of asset attributes (diameter, material, etc.) from the GRC GIS. As the GIS data is populated with asset information it in the future is recommended that the attributes assigned within the hydraulic model are also updated.

12 Conclusions

Based on the outcomes of this study the following is concluded:

1. A demand model for the Gladstone area was developed and allocated to the H2OMAP hydraulic model for use in existing and future performance assessment and the identification of augmentation requirements. A summary of the project demands per current water zones is provided within Table 12-1. The current demand of the Gladstone water supply network of 24,637 ET was identified with an Ultimate demand of 43,372 ET.

Table 12-1: Current water supply zone demand summary.

Water Zone	Total ET						
	2014	2016	2021	2026	2031	2036	Ultimate
Zone BC	2,980	3,159	3,851	4,468	4,984	5,320	5,320
Zone D	6,790	7,045	7,477	7,989	8,173	8,492	10,379
Clinton Park	5,925	6,643	6,704	7,493	8,474	8,877	10,952
NRG	2,352	2,391	2,464	2,793	4,667	4,667	5,245
Zone A	5,300	5,578	6,176	6,682	7,035	7,997	9,291
Fisher Street	1,280	1,517	1,761	1,761	1,940	2,184	2,184
Total	**24,627**	**26,333**	**28,433**	**31,186**	**35,274**	**37,537**	**43,372**

2. An assessment of current storage capacities based on current zoning identified that current reservoir storage shortfalls exist within the Zone BC, Clinton Park, Fisher Street and Zone A. Demand within the existing Zone D extent is projected to exceed the capacity of the available Zone D storage by 2016. A significant amount of excess storage capacity is currently available in the NRG water supply zone with storage shortfall not projected until Ultimate.

3. An overall network strategy to resolve current and existing storage deficiencies was developed. This strategy was based upon the zoning strategy previously developed by GRC and provided to MWH upon project start-up. The intention of developing a whole of network storage and zoning strategy is to make best use of spare capacity in existing assets and to ensure any capital expenditure deferment opportunities are realised. The proposed ultimate storage and zoning strategy is summarised below. Each element is described in more detailed within Sections 6.2.1 and 6.2.2. Strategy summary:
    - Supply the Fisher Street water zone from the NRG zone.
    - Construct a new reservoir for Zone BC and supply the north of the Gladstone CBD from this zone alleviating immediate storage from Zone A reservoirs.
    - Supply the northern CBD area from Zone BC using the 450 mm diameter water main which previously provided supply to the Fisher Street WSZ.
    - Use the Fisher Street reservoir to support Zone A in the short term.
    - Separate Zone A (to be supplied by Fisher Street and Radar Hill) from a new Ferris Hill water zone. The rezoned Zone A was sized to meet the storage capacity of Fisher Street and Radar Hill water zones.
    - Construct new storage at Ferris Hill as required to accommodate future demand growth.
    - Combine Zone D and Clinton Park water zones into a combined Zone D water zone.
    - Undertake works to convert the Clinton Park inlet/out main into a dedicated inlet main.

- Construct new storage for Zone D at the identified Kirkwood Road site, South Gladstone reservoir facility and Round Hill reservoir facility as required.

4. Upon establishment of the Ultimate zoning strategy, network deficiencies under maximum hour and fire flow demands were identified and resolved through local augmentation works.
5. Cost estimation for proposed infrastructure was undertaken. Table 12-2 summarises cost estimates per zone. Table 12-3 summarises cost estimates per planning horizon. The total cost estimate for proposed water supply infrastructure is **$39.7 Million** based on the adopted methodology. Cost estimation summaries specifically for LGIP and IPP classed infrastructure are provided within Section 10. The total capital cost estimate for LGIP infrastructure is **$30.9 Million**. The total capital cost estimate for IPP infrastructure is **$8.8 Million**.

Table 12-2: Total/combined augmentations cost estimation summary per zone

Water Supply Zone	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Zone A	$760,000			$20,000		$40,000		**$820,000**
Zone BC	$7,160,000	$50,000	$20,000			$100,000		**$7,330,000**
Zone D	$10,380,000	$130,000	$70,000	$370,000	$7,740,000	$60,000	$5,990,000	**$24,740,000**
Zone F	$1,470,000				$3,730,000			**$5,200,000**
Zone G	$310,000	$50,000	$100,000	$10,000	$1,180,000			**$1,650,000**
TOTAL	**$20,080,000**	**$230,000**	**$190,000**	**$400,000**	**$12,650,000**	**$200,000**	**$5,990,000**	**$39,740,000**

Table 12-3: Total/combined augmentation cost estimation summary per planning horizon

Asset Type	Planning Horizon							
	2014	2016	2021	2026	2031	2036	Ultimate	TOTAL
Water mains	$10,010,000		$70,000	$400,000	$4,620,000	$160,000	$1,960,000	**$17,220,000**
Fire flow mains	$2,070,000	$230,000	$120,000			$40,000		**$2,460,000**
Reservoirs	$7,670,000				$7,400,000		$3,880,000	**$18,950,000**
Pump Stations	$330,000				$630,000		$150,000	**$1,110,000**
TOTAL	**$20,080,000**	**$230,000**	**$190,000**	**$400,000**	**$12,650,000**	**$200,000**	**$5,990,000**	**$39,740,000**

6. Some potential limitations related to this study were identified and are provided as follows:
   - The demand model adopted within this study was developed based on a number of assumptions. Although based upon the best available information at the time the demand model will not be accurate in its development projections, land use and timing for all properties within the study area. The development methodology is provided within Section 4 of the report and the document - ‘Gladstone Regional Council Demand Model Development Technical Memo (MWH, July 2014)’.
   - With the exception of a few proposed assets, no optioneering of solutions has been undertaken within this study. Therefore, preferred or alternative solutions may be available.
   - Cost estimates have been developed at a unit rate level only. The cost estimates have not considered individual alignments and site conditions, or infrastructure for which trenchless construction methods will be required.
   - The feasibility and practical constructability of proposed assets has generally not been assessed within this study. There may be some proposed assets that require alternative solutions to be developed based on future site and environmental constraints.

- The timing of proposed infrastructure matches the 5 year planning horizons assessed within this study. For construction of “just in time” infrastructure these 5 year planning horizons may not be suitable to GRC and future assessment into timing may be required.
- Zone boundary updates have been proposed within this study without assessment of valve localities.
- Fire flow demand allocation was informed by the developed demand model. As the land uses within the demand model are not accurate for all parcels, the allocation of fire flows may be incorrect in places.

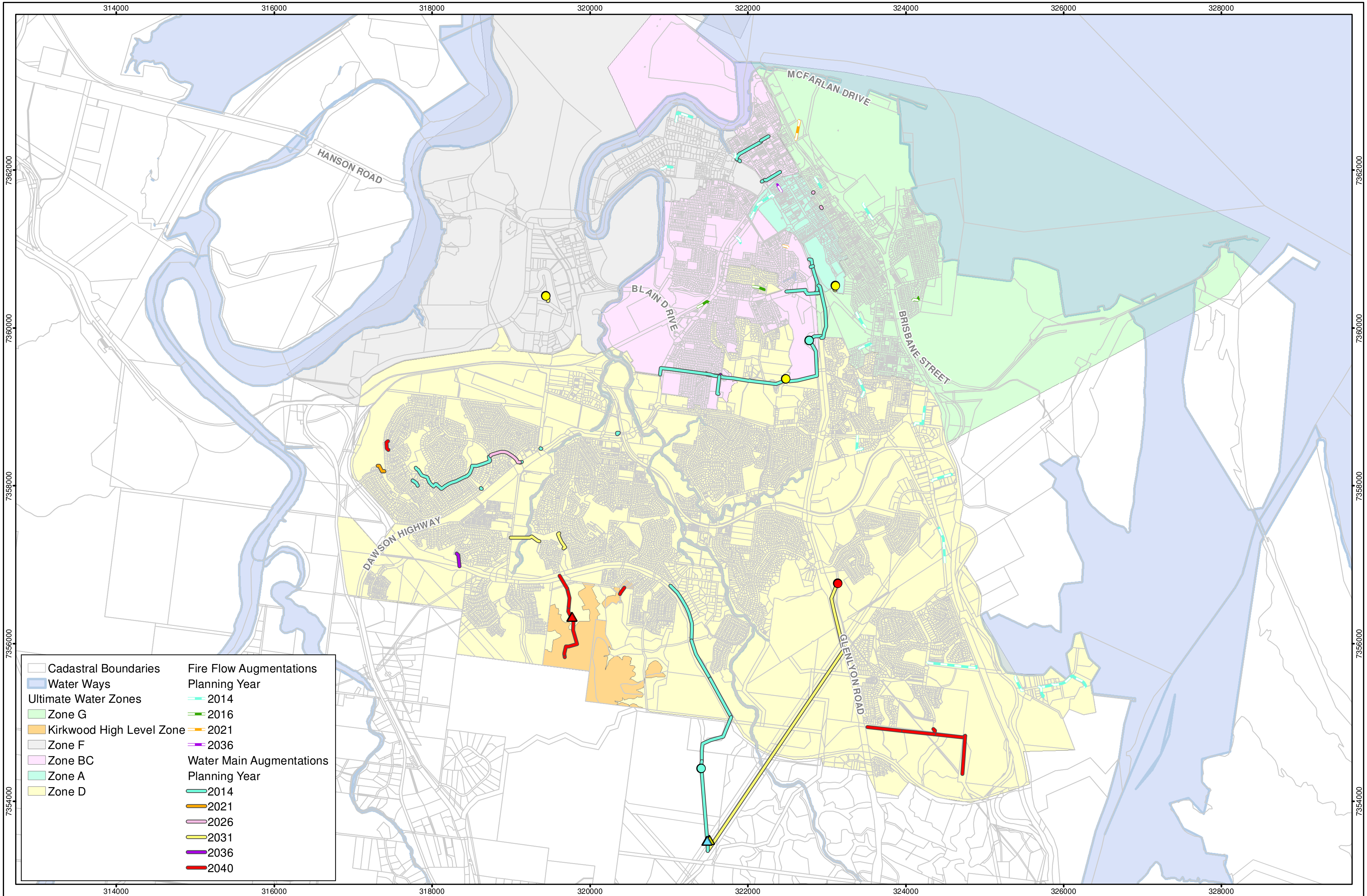
Report outcomes should be viewed giving consideration to the above limitations.

13 Recommendations

Based on the conclusions of this study the following is recommended:

1. The outcomes of this report are viewed as the best and most up-to-date water supply planning for the Gladstone water supply network. The outcomes, should however, be viewed with consideration to the identified limitations.
2. GRC consider the following opportunities for improving the outcomes of future planning studies in the Gladstone water network. The following opportunities will also assist in ensuring the most prudent and efficient infrastructure solutions are identified for delivery. Opportunities:
   - Future update of the demand model developed for input into this water supply master planning study. As new information becomes available relating to land uses, development timing and sequencing, and state growth projections, it is envisaged that benefits will be identified by GRC in updating the demand model for input into future and ongoing infrastructure planning studies.
   - Prior to delivering major infrastructure items identified within this report it is recommended that specific detailed planning and feasibility studies be undertaken to ensure the preferred and most efficient solutions are being delivered. The detailed planning studies may also be used to assess the 'just in time' delivery of infrastructure, and develop more detailed/accurate cost estimates.
   - The assessment within this report was undertaken based on the GRC adopted standards of service. It has been identified across other Queensland water authorities and councils that a review of service standards in respect to appropriate levels of conservatism can result in significant capital cost savings on infrastructure delivery. GRC may see benefit in undertaking a review of the planning based standards of service currently adopted. Activities involved would include a demand tracking assessment for review of unit planning demand and peaking factors, and a risk based approach to reviewing performance based standards of service.
   - Much recent infrastructure within the Gladstone hydraulic model was included without confirmation of asset attributes (diameter, material, etc.) from the GRC GIS. As the GIS data is populated with asset information in the future it is recommended that the attributes assigned within the hydraulic model are also updated.

Appendix A Augmentation Maps



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 10/02/2015 tunnahpa

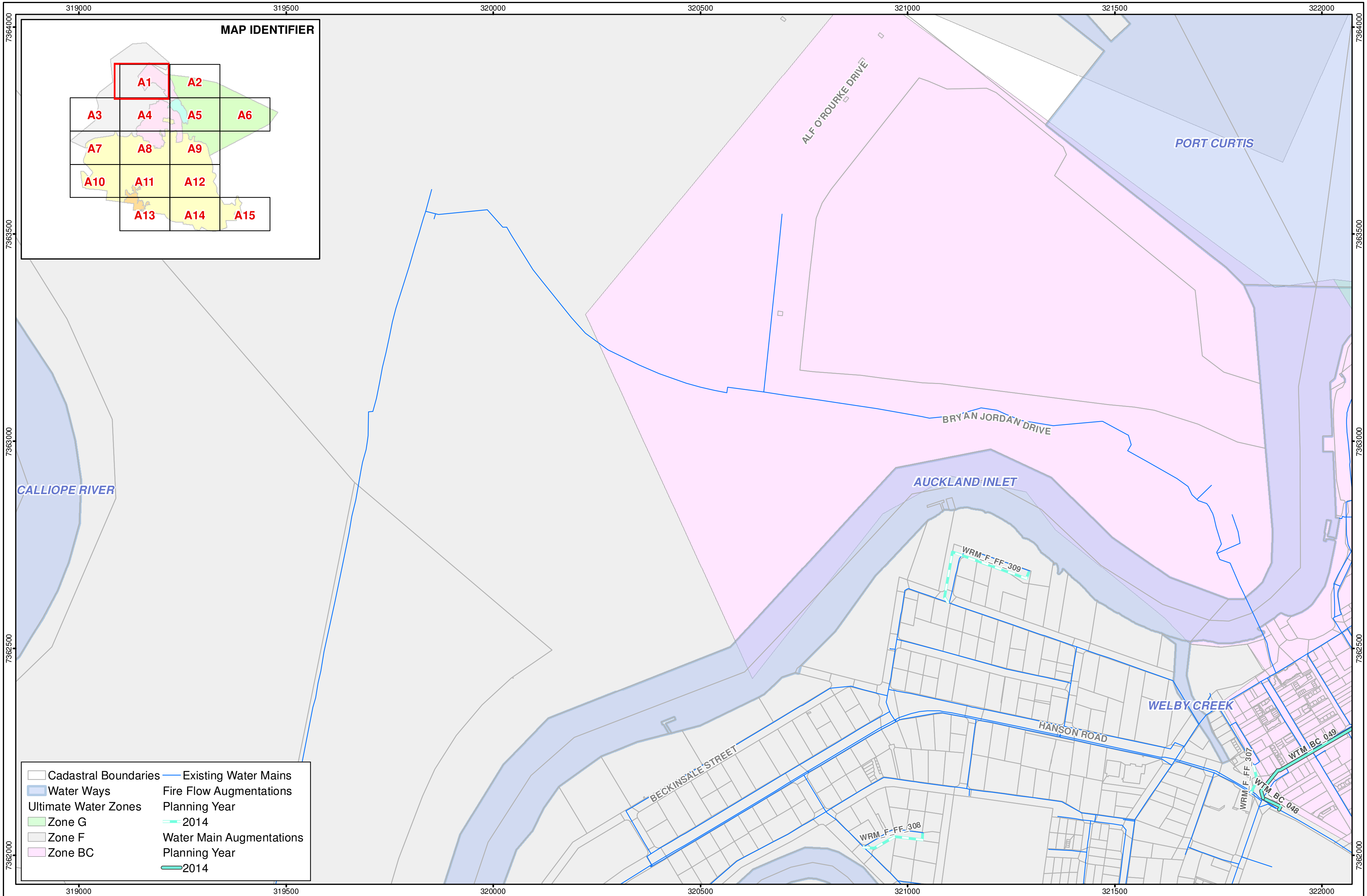
Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:42,000

File Name: GLAD_AugmentationPlan_Master

Gladstone Water Supply Scheme - Water Supply Augmentation Plan

A0



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

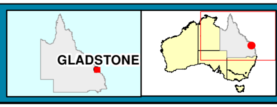
MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created:
9/02/2015 tunnahpa

Coordinate System:
GDA 1994 MGA Zone 56

A4 Scale:
1:8,002

File Name:
GLAD_AugmentationPlan_A1



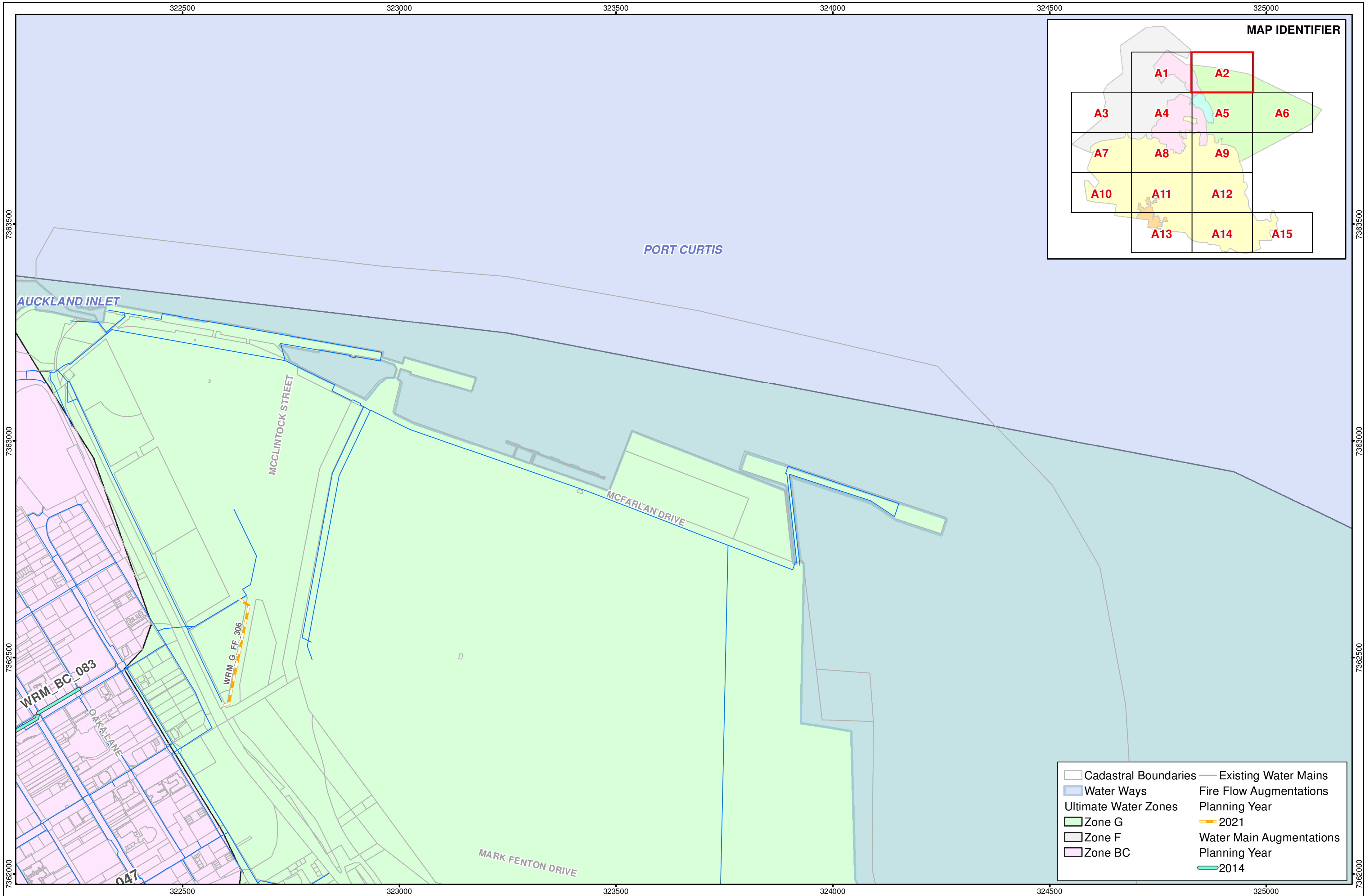
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

N

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A1



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

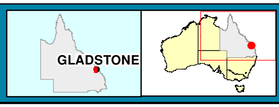
MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:7,650

File Name: GLAD_AugmentationPlan_A2



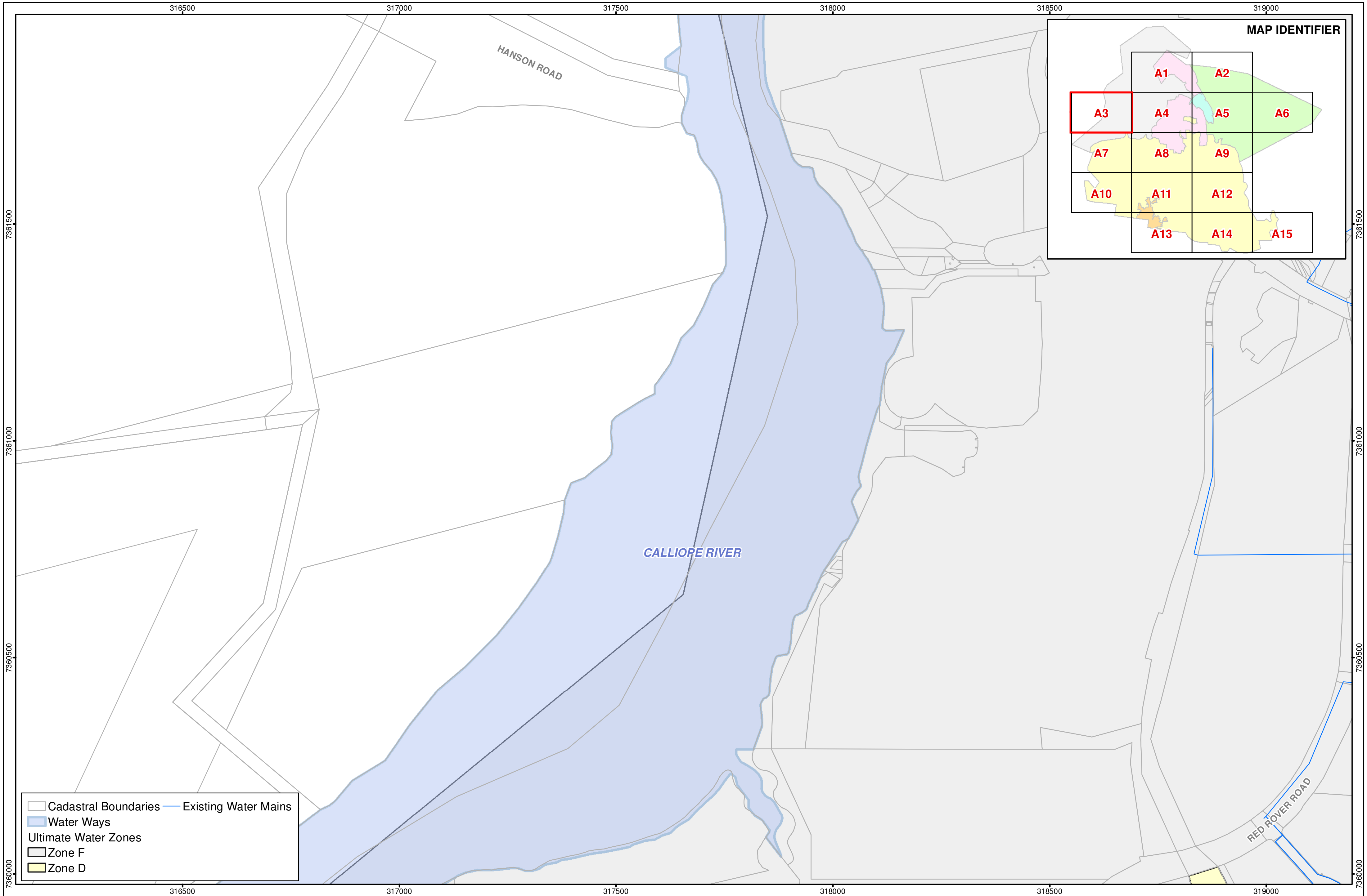
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

N

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A2



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

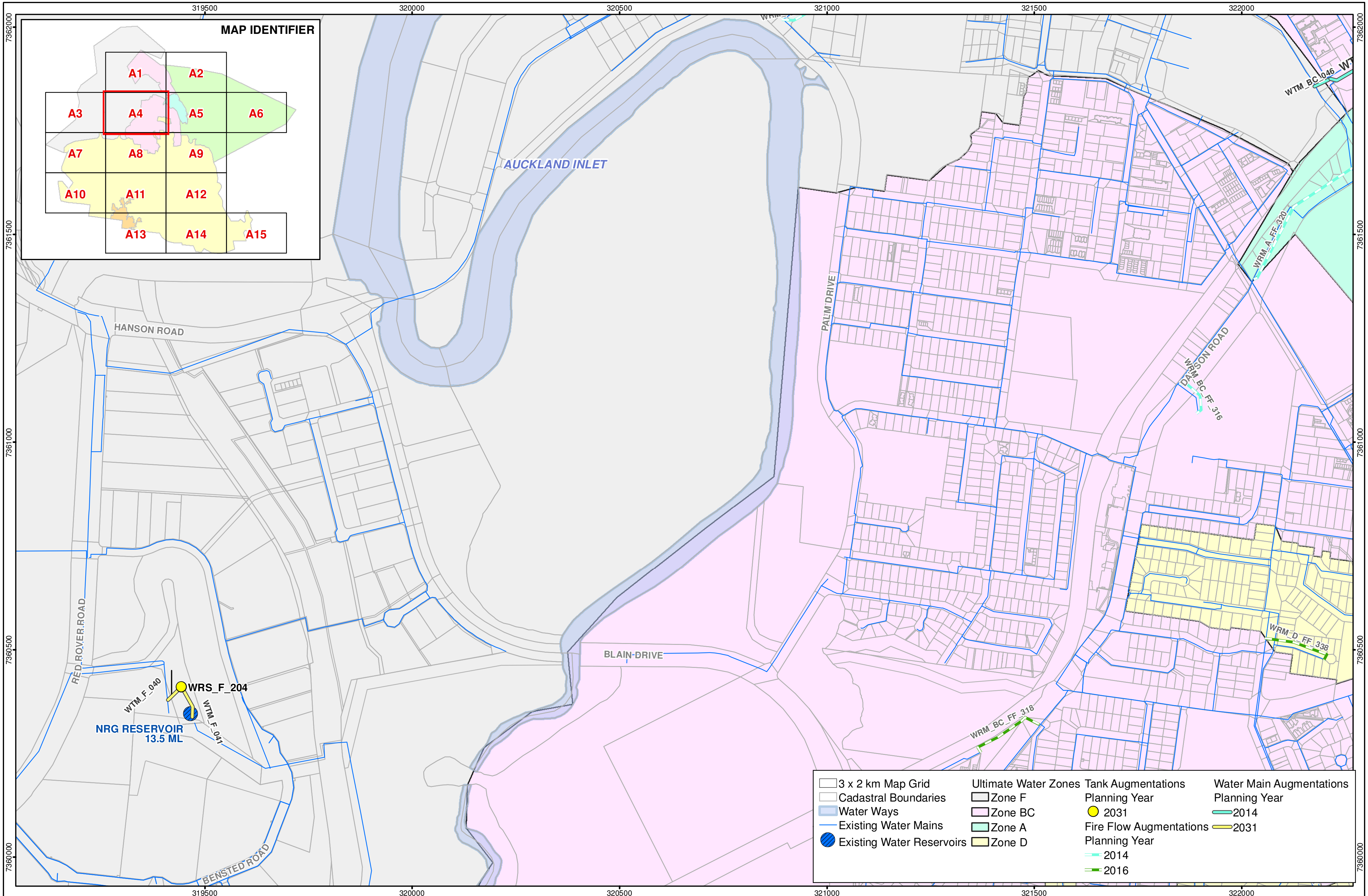
Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:7,650

File Name: GLAD_AugmentationPlan_A3

Gladstone Water Supply Scheme - Water Supply Augmentation Plans

A3



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:8,000

File Name: GLAD_AugmentationPlan_A4

GLADSTONE

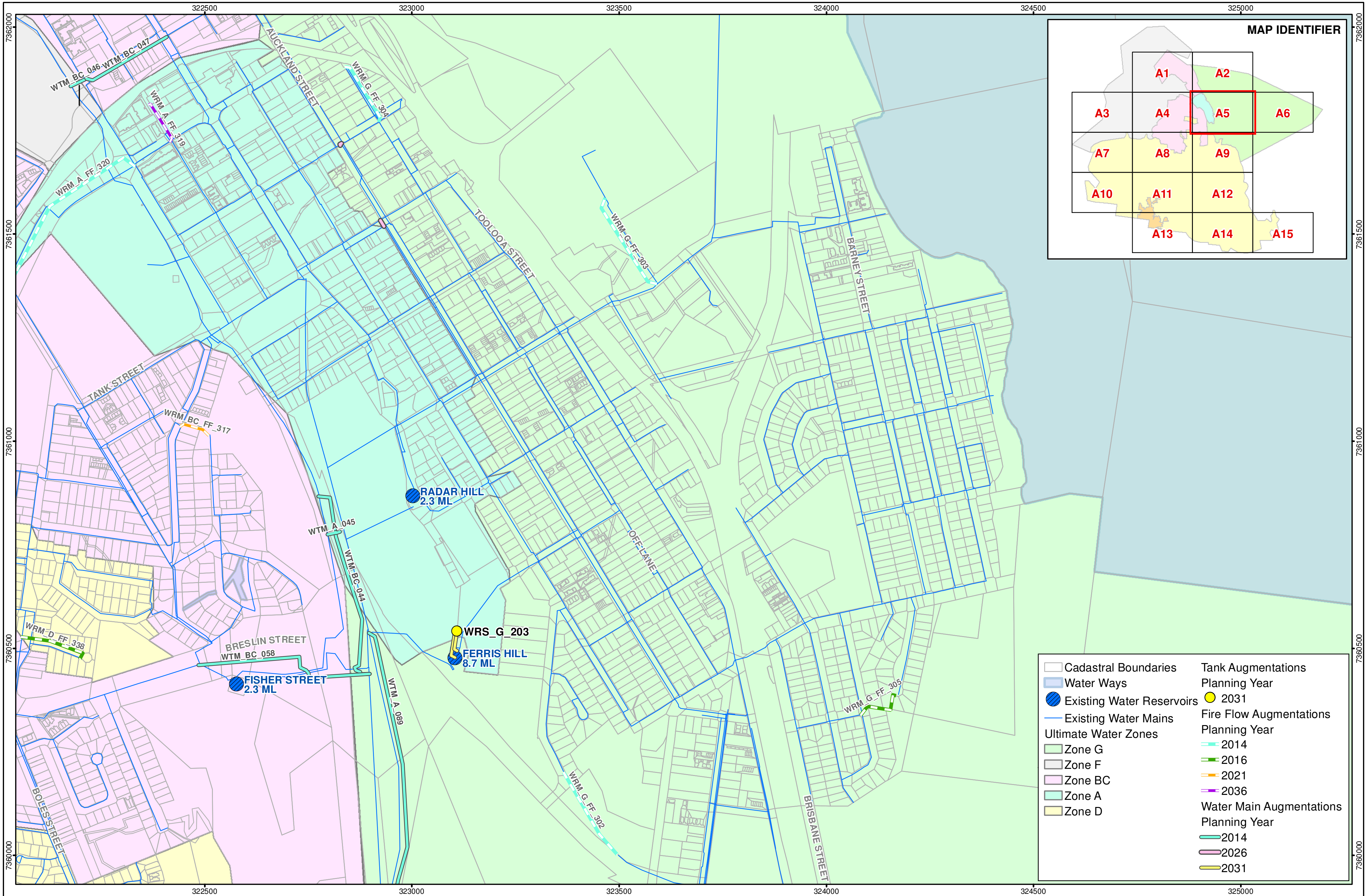
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

N

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A4



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:8,000

File Name: GLAD_AugmentationPlan_A5

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

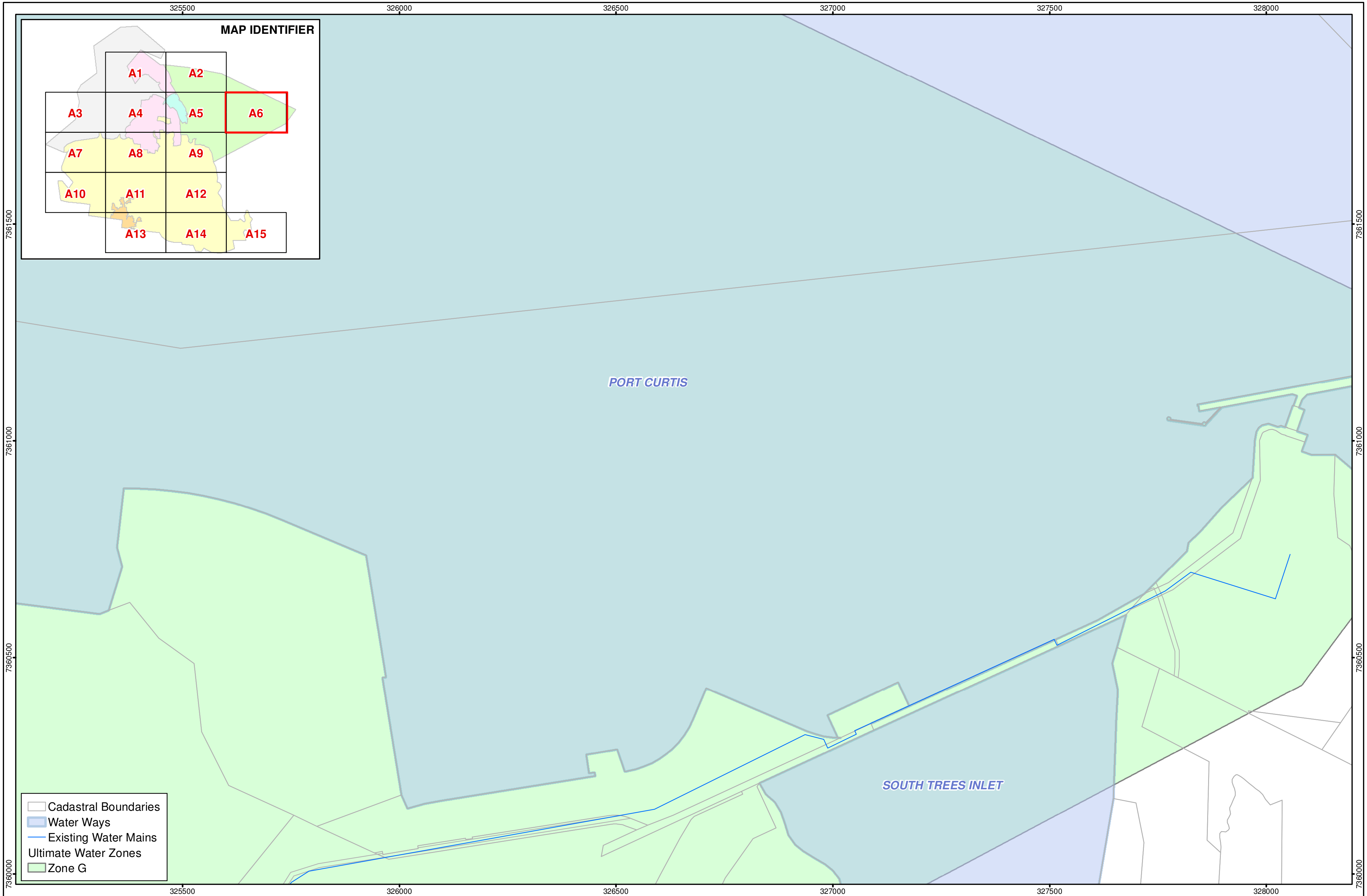
GLADSTONE

Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A5



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:7,650

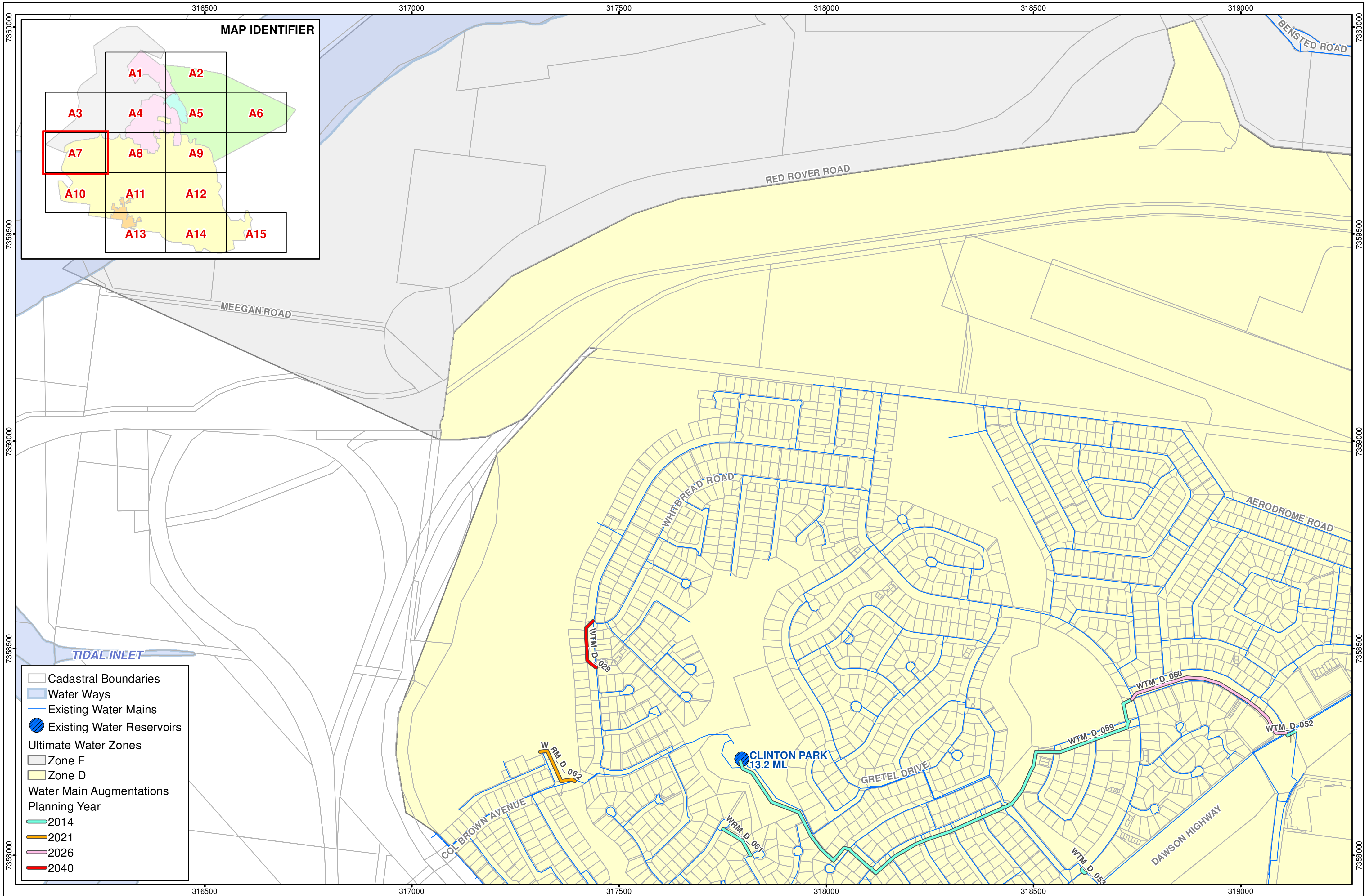
File Name: GLAD_AugmentationPlan_A6

GLADSTONE

Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

A6



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created:
9/02/2015 tunnahpa

Coordinate System:
GDA 1994 MGA Zone 56

A4 Scale:
1:8,000

File Name:
GLAD_AugmentationPlan_A7

GLADSTONE

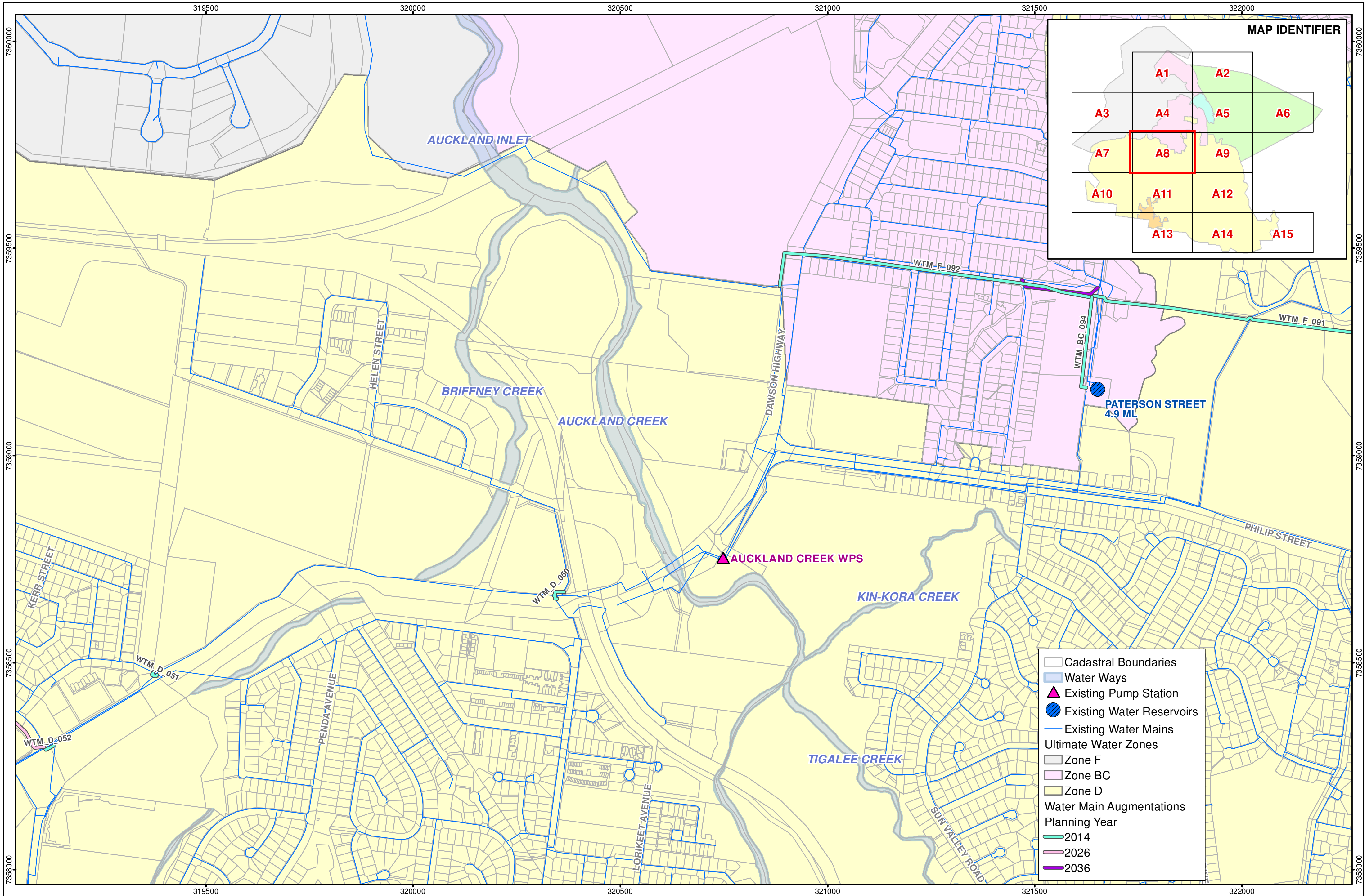
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

N

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A7



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:8,000

File Name: GLAD_AugmentationPlan_A8

GLADSTONE

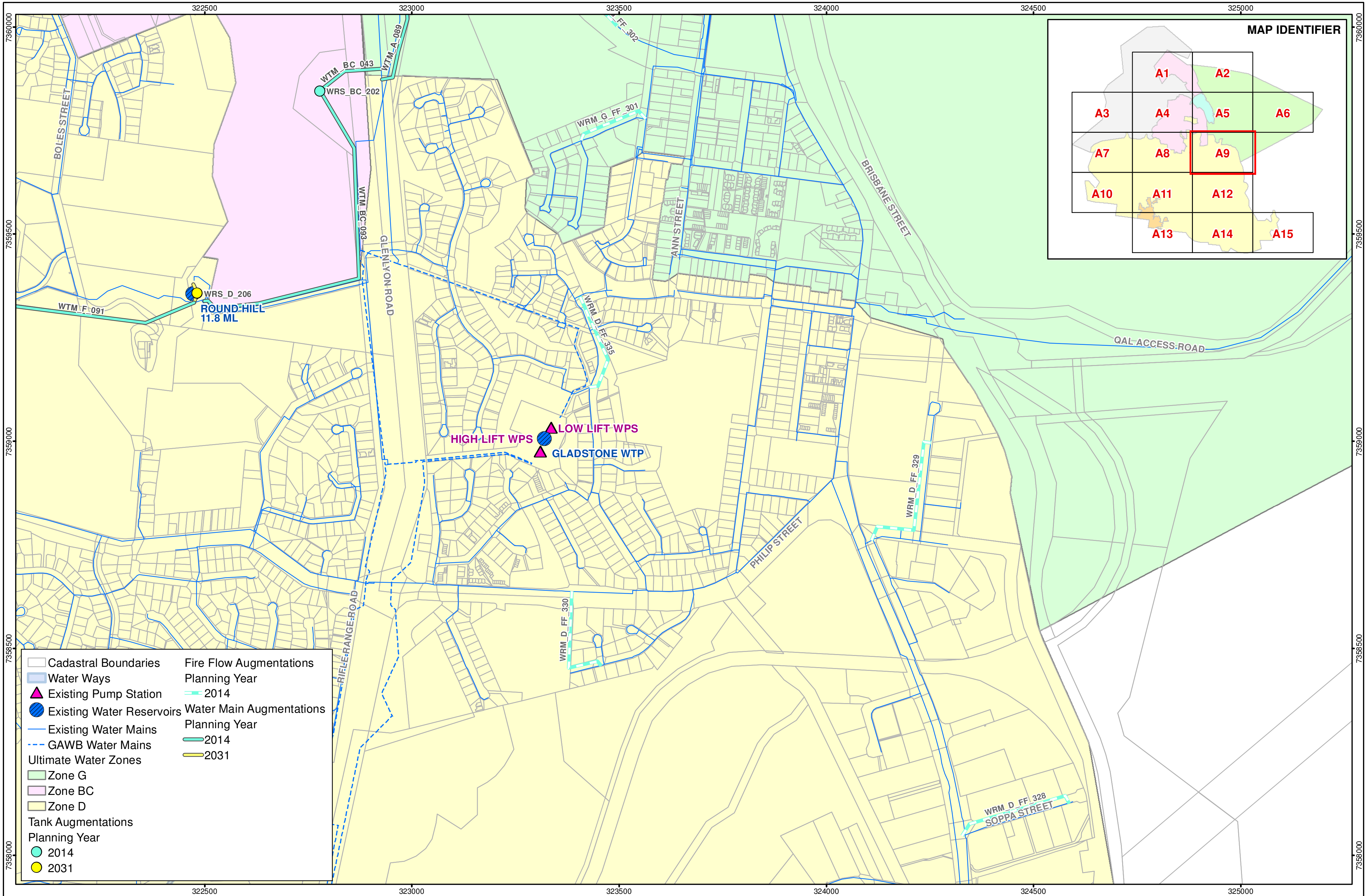
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

N

GLADSTONE REGIONAL COUNCIL

A8



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 9/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:8,000

File Name: GLAD_AugmentationPlan_A9

GLADSTONE

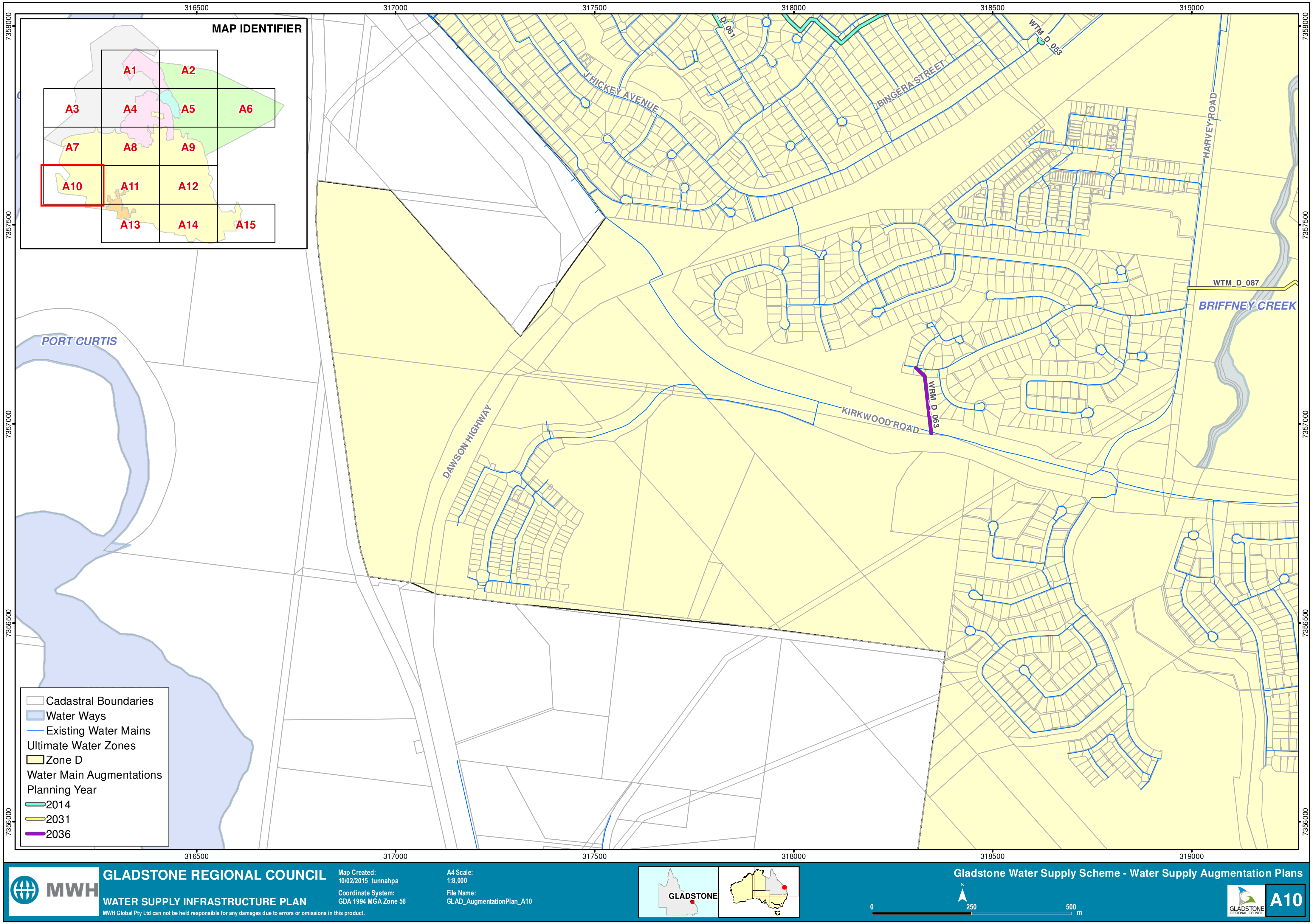
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

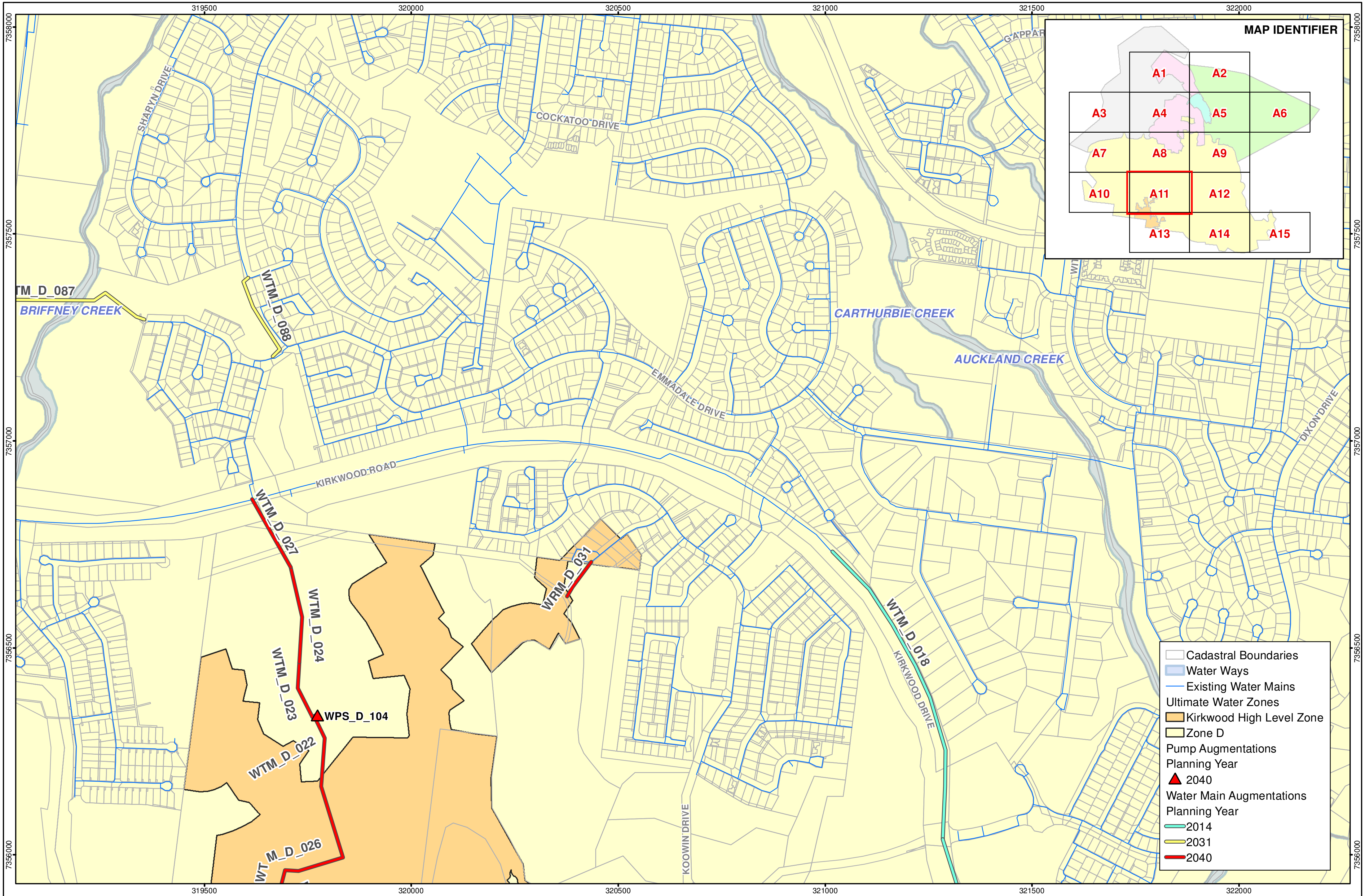
N

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A9


MAP IDENTIFIER
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
J HICKEY AVENUE
BINGERA STREET
HARVEY ROAD
WTM_D_053
D_061
WTM_D_087
BRIFFNEY CREEK
PORT CURTIS
DAWSON HIGHWAY
KIRKWOOD ROAD
WRM_D_063
316500
317000
317500
318000
318500
319000
7358000
7357500
7357000
7356500
7356000
Cadastral Boundaries
Water Ways
Existing Water Mains
Ultimate Water Zones
Zone D
Water Main Augmentations
Planning Year
2014
2031
2036
MWH
GLADSTONE REGIONAL COUNCIL
WATER SUPPLY INFRASTRUCTURE PLAN
MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.
Map Created:
10/02/2015 tunnahpa
Coordinate System:
GDA 1994 MGA Zone 56
A4 Scale:
1:8,000
File Name:
GLAD_AugmentationPlan_A10
GLADSTONE
Gladstone Water Supply Scheme - Water Supply Augmentation Plans
0
250
500
m
A10



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 10/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:8,000

File Name: GLAD_AugmentationPlan_A11

GLADSTONE

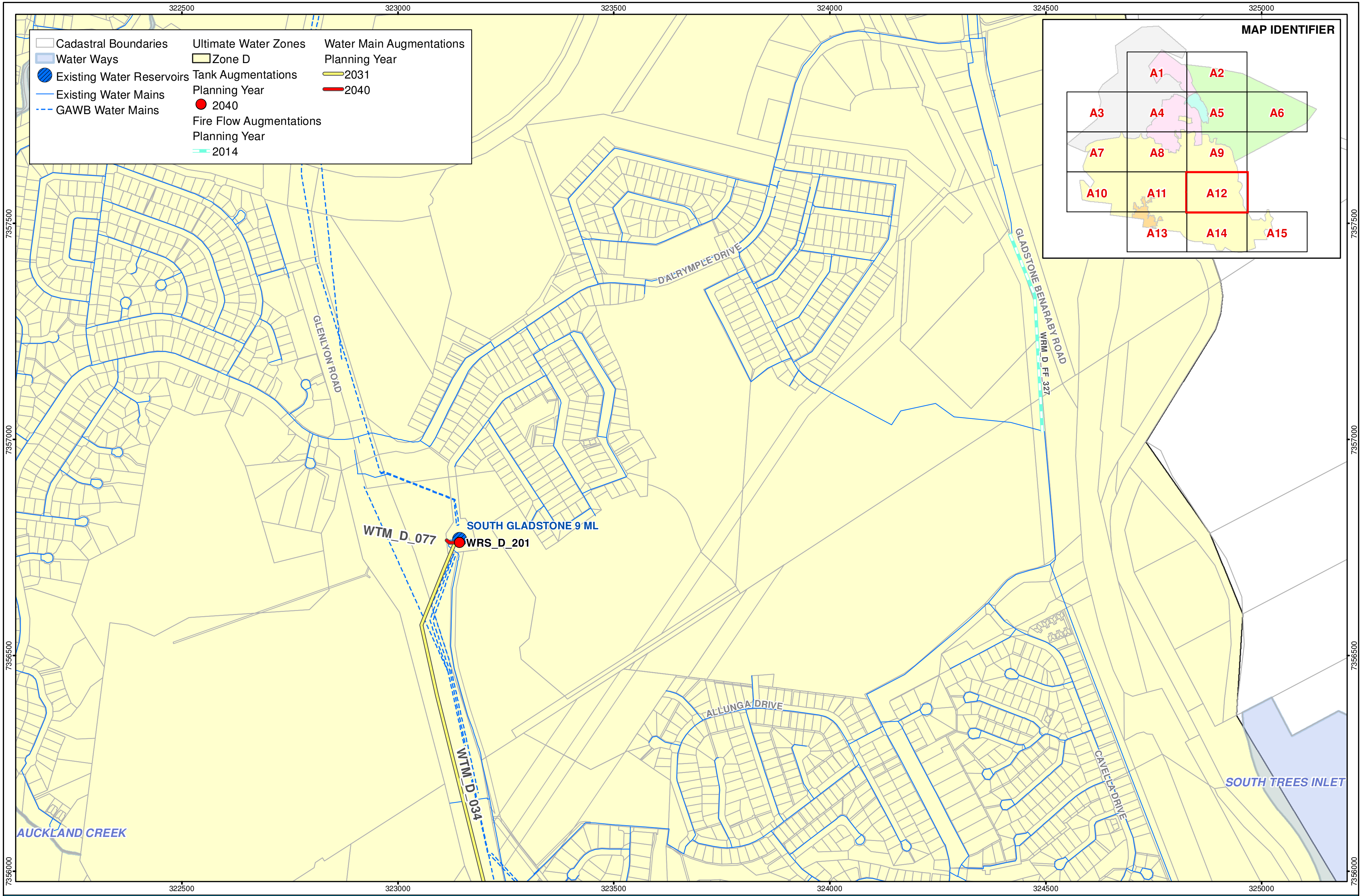
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

N

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A11



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 10/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:7,650

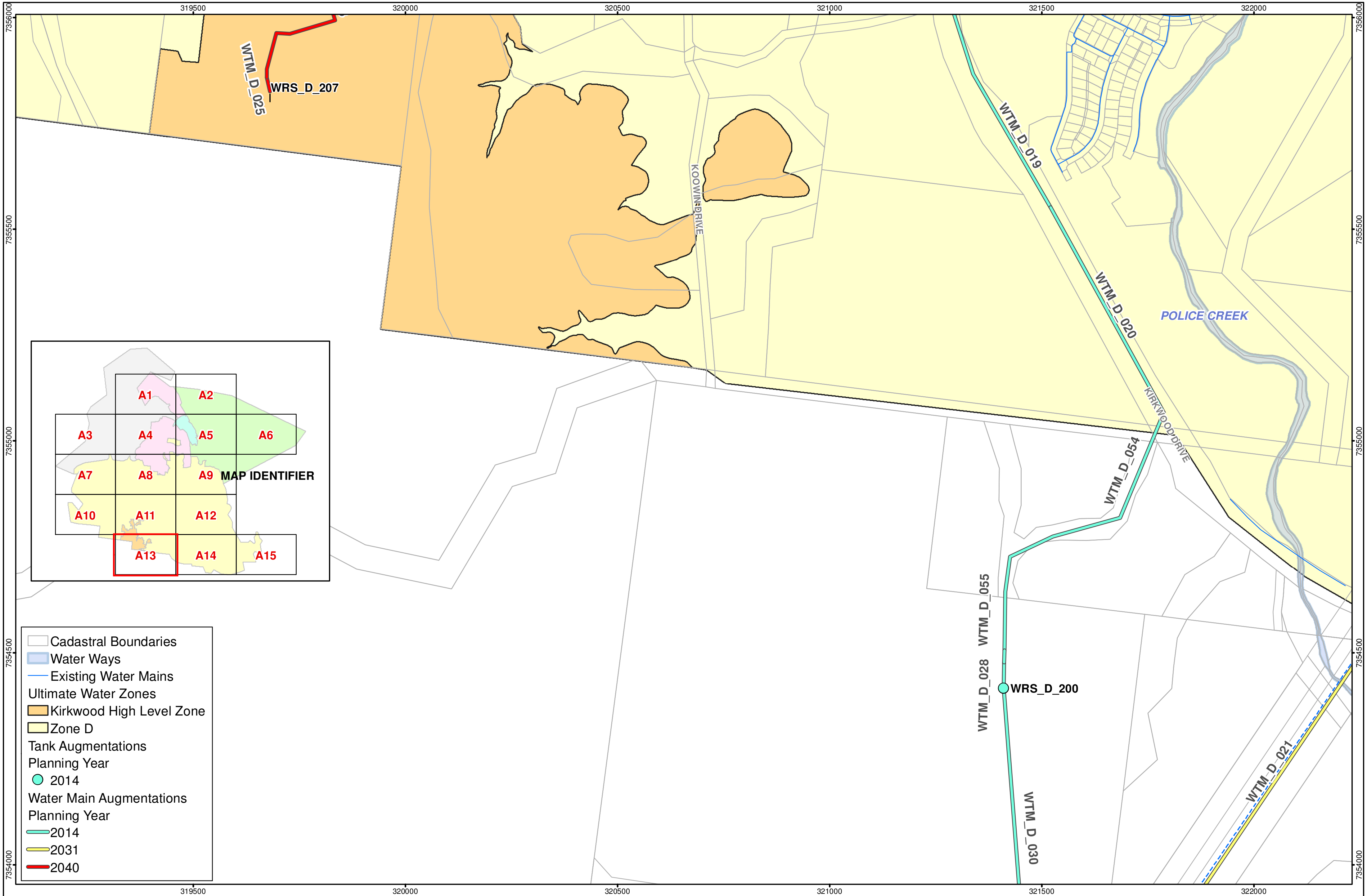
File Name: GLAD_AugmentationPlan_A12

GLADSTONE

Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

A12



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

Map Created: 10/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:7,817

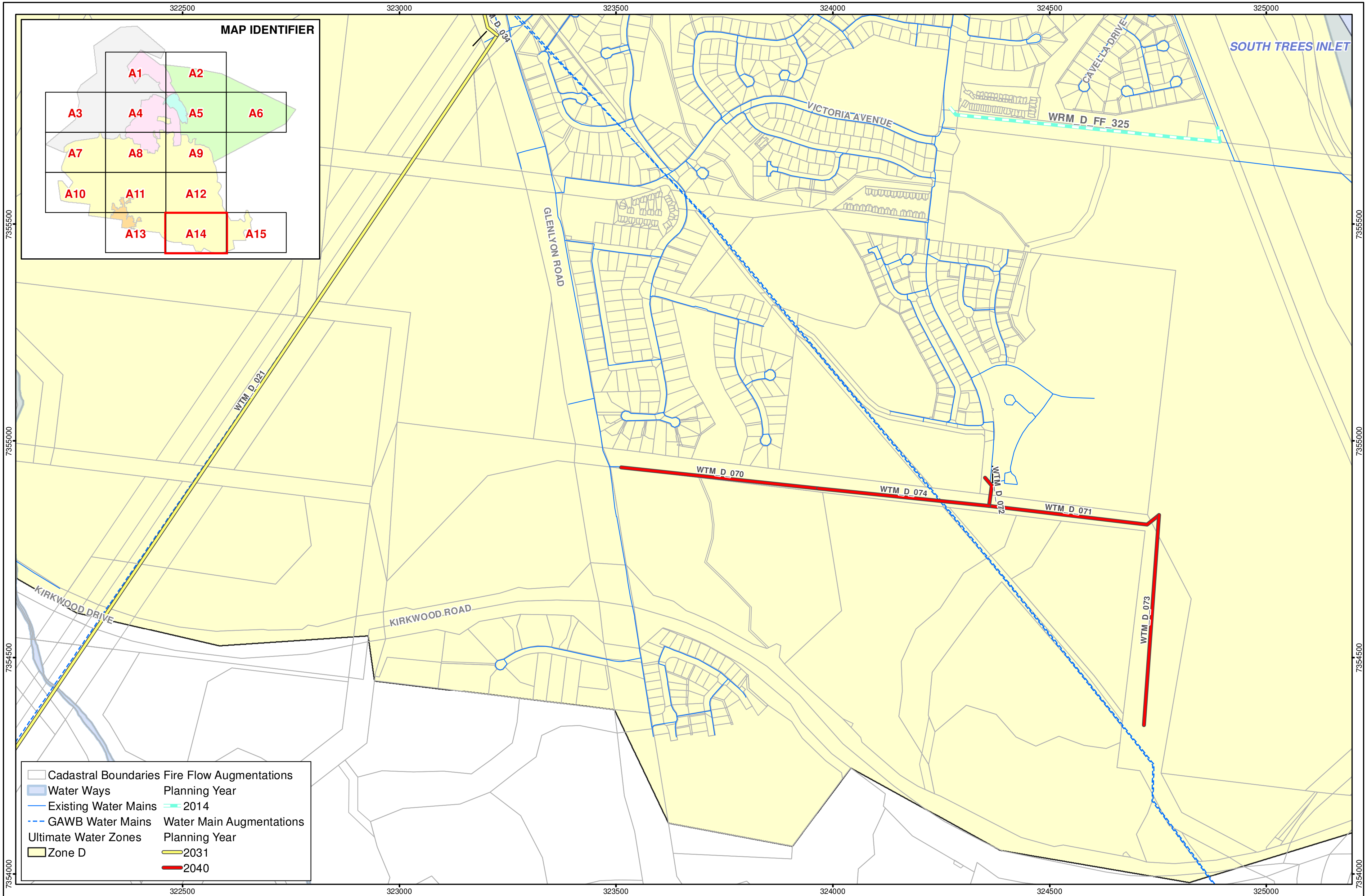
File Name: GLAD_AugmentationPlan_A13

GLADSTONE

Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

A13



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created:
10/02/2015 tunnahpa

Coordinate System:
GDA 1994 MGA Zone 56

A4 Scale:
1:7,650

File Name:
GLAD_AugmentationPlan_A14

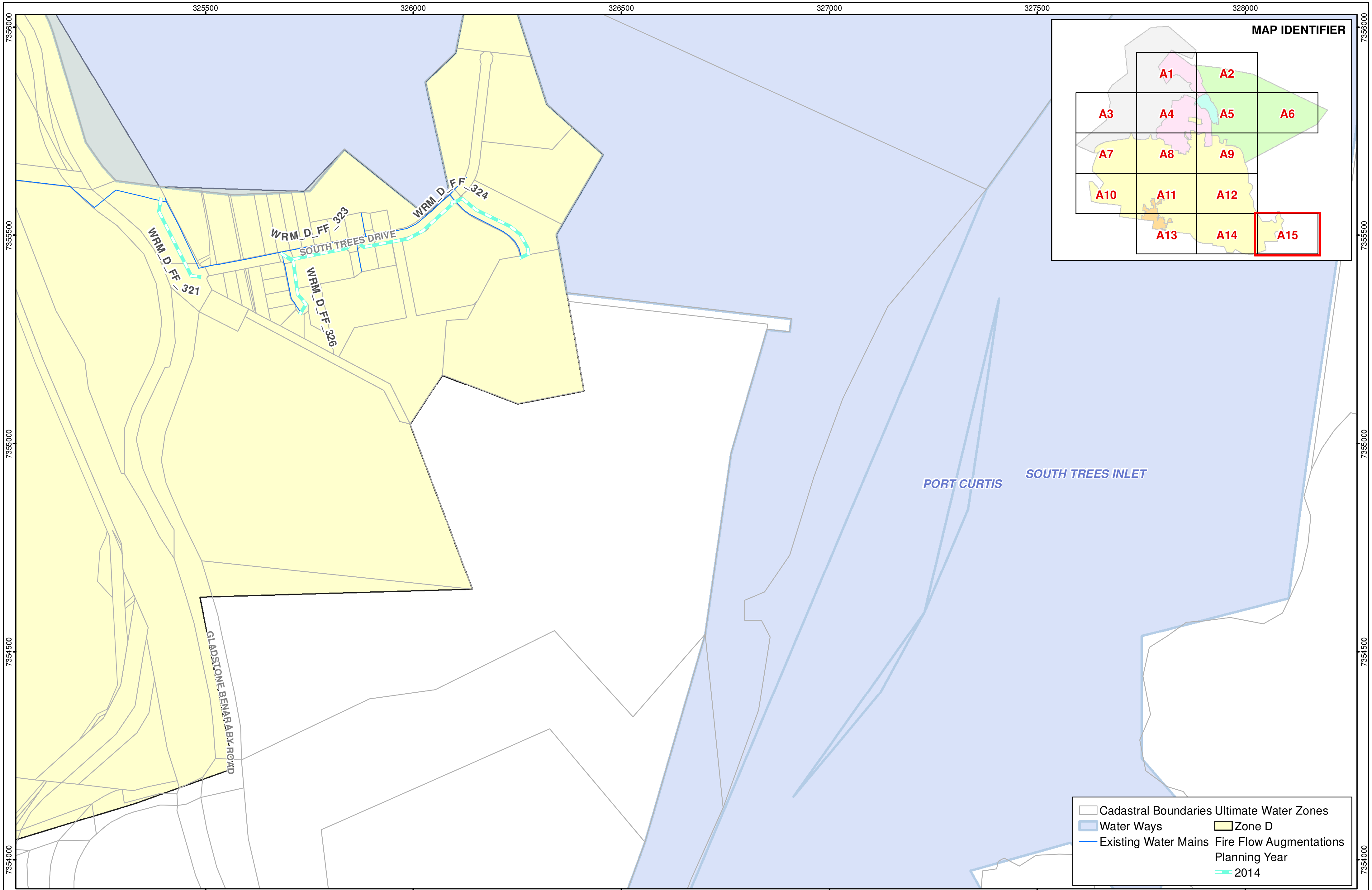
GLADSTONE

Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A14



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 10/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:8,000

File Name: GLAD_AugmentationPlan_A15

GLADSTONE

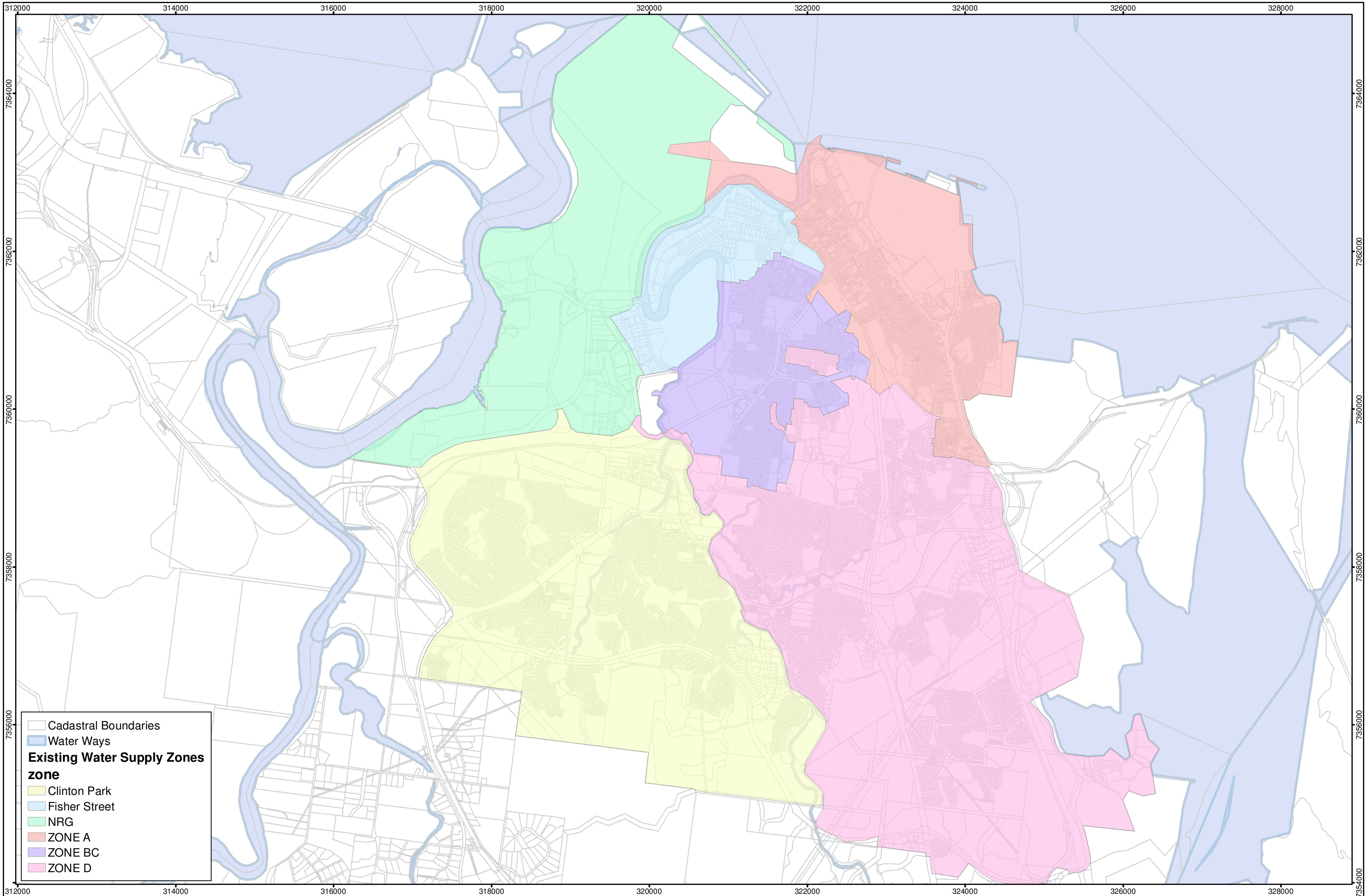
Gladstone Water Supply Scheme - Water Supply Augmentation Plans

0 250 500 m

GLADSTONE REGIONAL COUNCIL

A15

Appendix B Water Supply Zoning Maps



GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

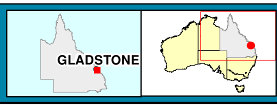
MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

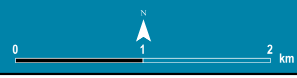
Map Created: 10/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:42,000

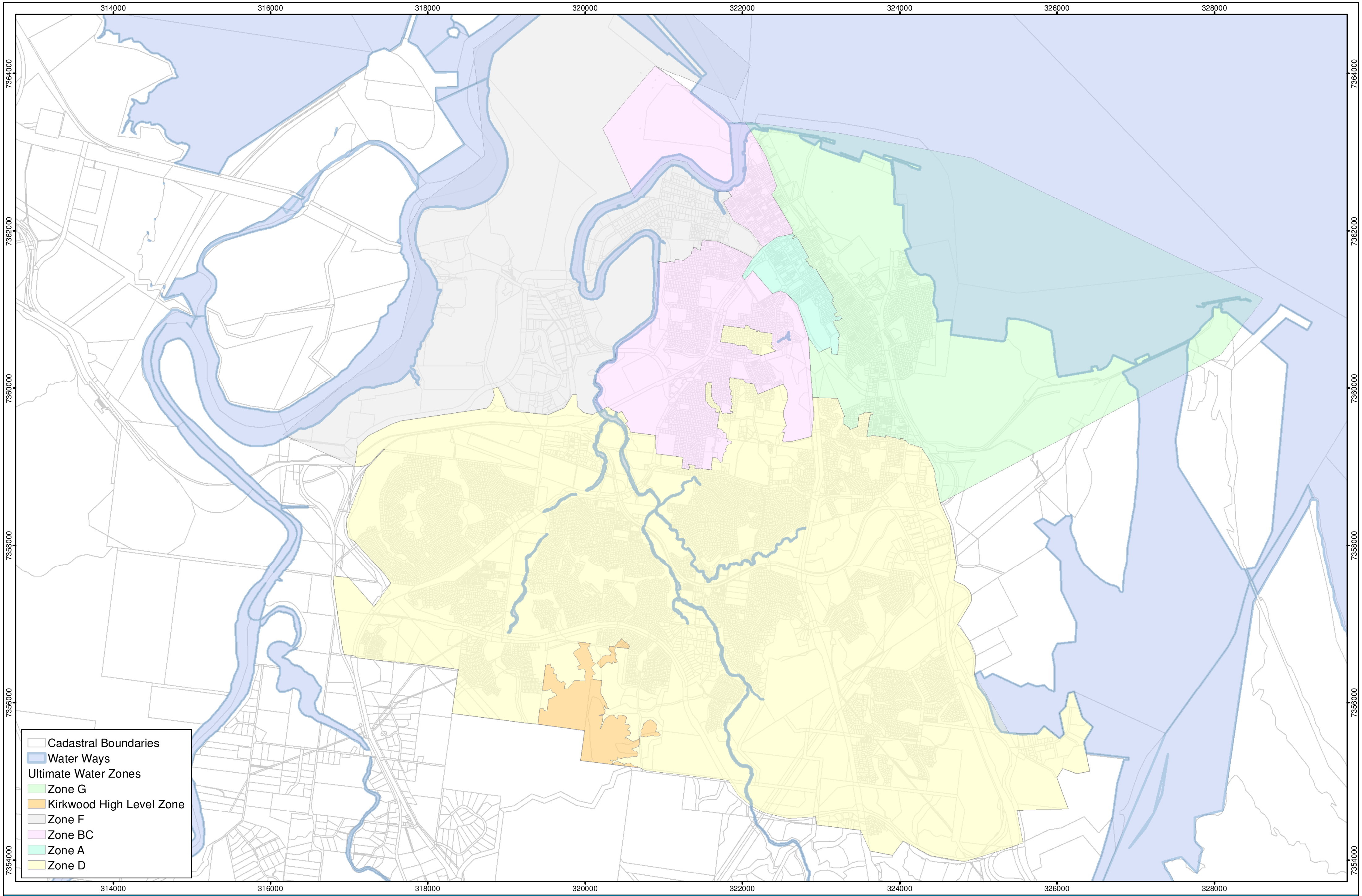
File Name: Existing Zones B1





Existing Gladstone Water Supply Zones

B1



MWH

GLADSTONE REGIONAL COUNCIL

WATER SUPPLY INFRASTRUCTURE PLAN

MWH Global Pty Ltd can not be held responsible for any damages due to errors or omissions in this product.

Map Created: 10/02/2015 tunnahpa

Coordinate System: GDA 1994 MGA Zone 56

A4 Scale: 1:42,000

File Name: Ultimate Zoning B2

GLADSTONE

Gladstone Water Supply Scheme - Ultimate Water Zone

N

0 1 2 km

GLADSTONE REGIONAL COUNCIL

B2

Appendix C GRC Correspondence

Phillip Hall

From: Phillip Hall
Sent: Thursday, 23 October 2014 12:05 PM
To: 'ashleight@gladstonerc.qld.gov.au'
Cc: 'emmah@gladstonerc.qld.gov.au'; Anjila Finan
Subject: FW: New Main - Round Hill to NRG Water Zone Query
Attachments: Zone BC Supply Strategy.pdf

Hello Ashleigh

Please find the attached sketches of a proposed strategy for supply to zone BC.

The major differentiator between this strategy and previous strategies is that Zone BC reservoirs (particularly the Glenlyon Road res) are proposed for supply from Round Hill reservoir. Benefits are as follows:

- No dedicated supply main or WPS to the Glenlyon Road reservoir (large cost savings)
- Only one proposed main along the Round Hill to Paterson Street infrastructure corridor (resulting in further cost savings)

This option does , however, put some additional capacity requirement onto the GAWB high life pump stations. And may bring forward some upgrade to the GAWB HL pumps.

We have not completed mains sizing as yet until the strategy is agreed by yourself and other GRC stakeholders. I believe that this is the most cost effective solution for supply to Zone BC.

Following your review of the proposed supply philosophy and the attached sketches please do not hesitate to contact me to talk these through or ask any questions. I would appreciate if you could also confirm the ability to adjust the size for the soon to be constructed Round Hill to NRG supply main.

If you are happy to progress with the proposed approach, please confirm via return email and we will progress finalisation of the report on this basis.

Thanks Ashleigh,
Best Regards

Phil

From: Phillip Hall
Sent: Thursday, 23 October 2014 10:10 AM
To: 'ashleight@gladstonerc.qld.gov.au'
Cc: 'emmah@gladstonerc.qld.gov.au'
Subject: New Main - Round Hill to NRG Water Zone Query

Hello Ashleigh

I'm just preparing a sketch for your review on what I think may be a preferred supply solution for Zone BC considering the main from Round Hill to NRG.

For the solution to work however we may need a larger than currently proposed size for the supply main from Round Hill to NRG. From speaking to Phil B previously I understood that this main was proposed as a 300 mm diameter. Is there opportunity to increase the size of this main at this stage? Particularly the section between Round Hill and the existing Paterson Street reservoir.

I will prepare the sketch of my thoughts and will send this through shortly as well as documenting the changes and potential benefits.

Best Regards
Phil

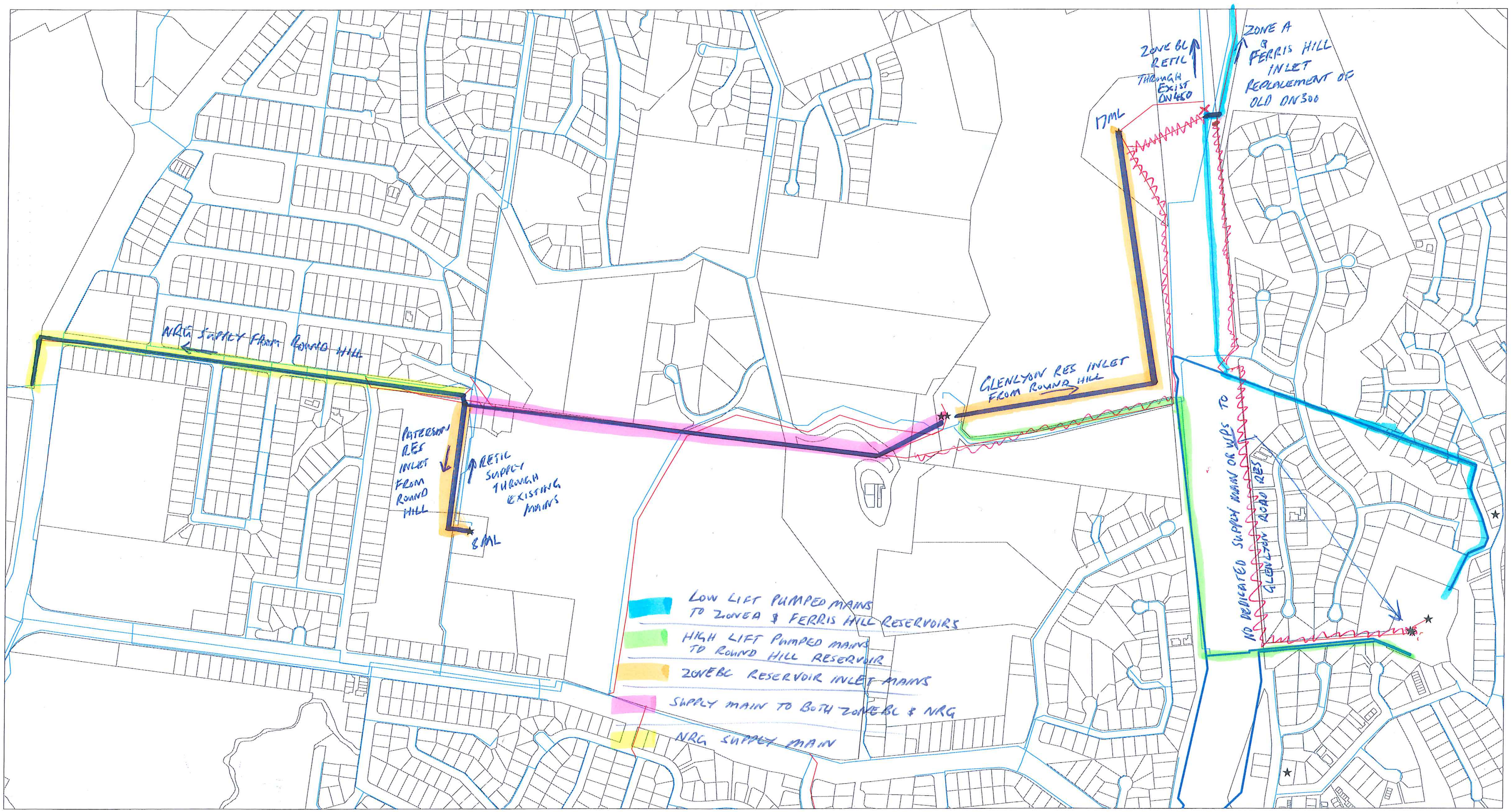
MWH

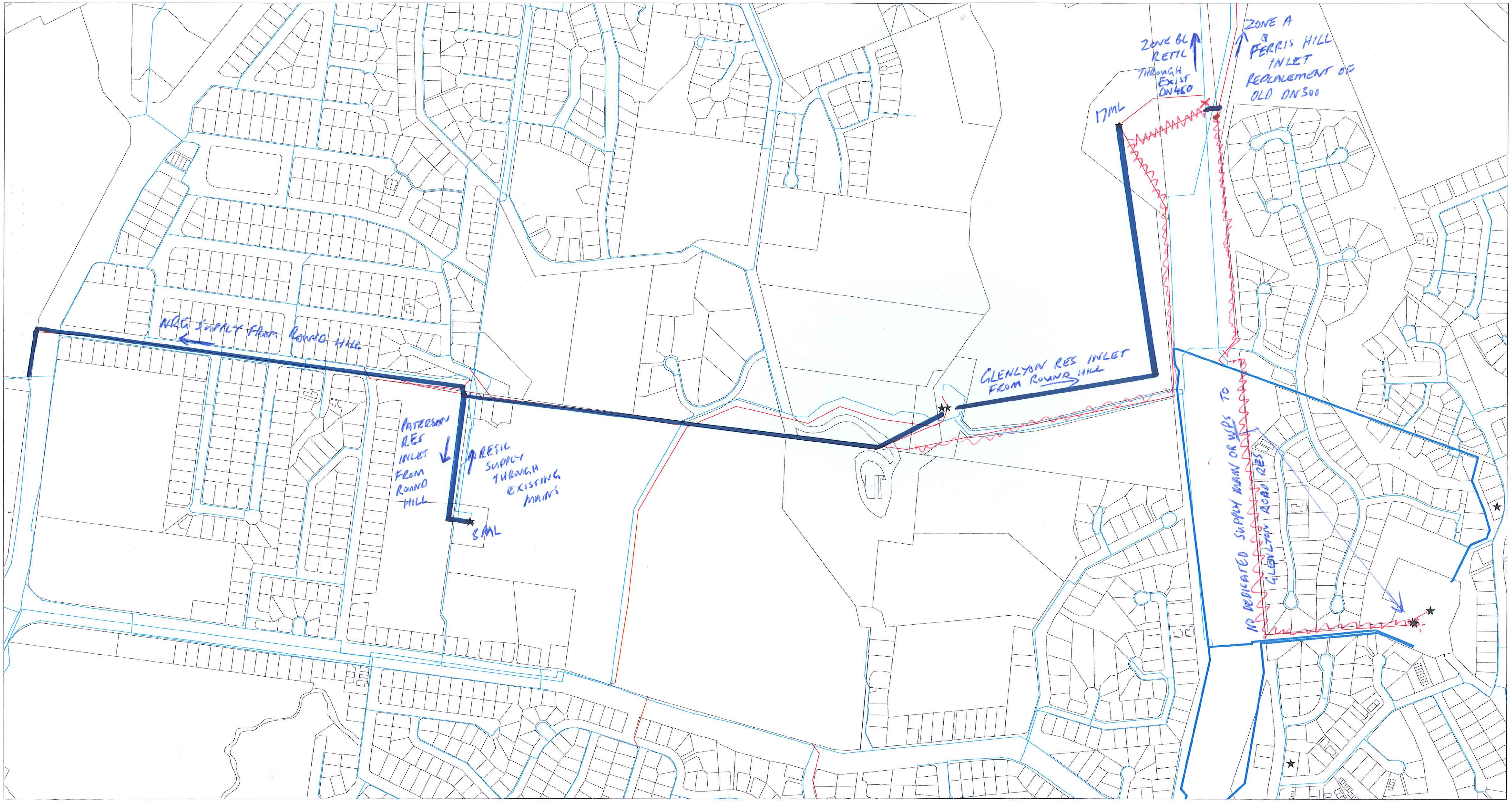
BUILDING A BETTER WORLD

Phil Hall

Planning Leader QLD

Level 3	Phone:	+61 (0) 7 3029 5139
35 Boundary St	Fax:	+61 (0) 7 3029 5050
South Brisbane	Mobile:	+61 (0) 437 837 360
QLD 4101	Email:	Phillip.T.Hall@mwhglobal.com
AUSTRALIA	Web:	www.mwhglobal.com.au


ZONE BC RETIC THROUGH EXIST DN450
ZONE A & FERRIS HILL INLET REPLACEMENT OF OLD DN300
17ML
NRG SUPPLY FROM ROUND HILL
GLENLYON RES INLET FROM ROUND HILL
PATERSON RES INLET FROM ROUND HILL
RETIC SUPPLY THROUGH EXISTING MAINS
8ML
NO DEDICATED SUPPLY MAIN OR WPS TO GLENLYON ROAD RES
LOW LIFT PUMPED MAINS TO ZONE A & FERRIS HILL RESERVOIRS
HIGH LIFT PUMPED MAINS TO ROUND HILL RESERVOIR
ZONE BC RESERVOIR INLET MAINS
SUPPLY MAIN TO BOTH ZONE BC & NRG
NRG SUPPLY MAIN


ZONE 6L RETIC THROUGH EXIST DN450
ZONE A & FERRIS HILL INLET REPLACEMENT OF OLD DN300
17ML
NRG SUPPLY FROM ROUND HILL
GLENLYON RES INLET FROM ROUND HILL
PATERSON RES INLET FROM ROUND HILL
RETIC SUPPLY THROUGH EXISTING MAINS
8ML
NO DEDICATED SUPPLY MAIN OR WPS TO GLENLYON ROAD RES

Phillip Hall

From: Phillip Hall
Sent: Friday, 20 June 2014 3:28 PM
To: 'Ashleigh Tomkins'
Cc: Emma Hamilton
Subject: RE: Adopted Paterson Zone Setup for infrastructure plans

Thanks for the response Ashleigh.

The below previous assessment just looked at the discussed new supply to NRG supplying NRG alone with no connection to Paterson 1 (i.e. Paterson 1 still supplied from Philip Street mains)

If Paterson 1 was to be maintained and supplied from the new NRG main MDMM demand at Ultimate through the new main to supply both NRG and Paterson 1 would be ~ 200 L/s at Ultimate. So looking at 450 main to keep below design head loss of 5 m/km for section – Round Hill to Paterson 1. An upgrade from the 300 currently going in.

This would result in the same mains requirement from Round Hill as I have proposed below for single Paterson reservoir option and new western supply main:

- No upgrades of Philip Street
- New 450 duplication of 600 mm from Round Hill reservoir to Philip Street.

This option would still require outlet upgrade from Paterson 1 (say $250 K) and an inlet connection from the NRG supply main (say $150 K) and the extra ($1 M capital) involved in 2 reservoirs. Also the upgrade to the NRG main from Round Hill to Paterson in the future at some time (say 750 m x 375 m ~ $600K….. assume 375 mm duplication to be close to equivalent bore of 450 mm)… So again comparable in Capex to the other options below and no clear cost differentiator.

I propose sticking with the single new reservoir (Paterson 2) at this time for this project. Just for some of the potential operational efficiencies listed below (pumping to a lower reservoir etc).

Again, however, I would recommend GRC look at a dedicated optioneering study for identification of a preferred option at some stage.

Please don't hesitate to call should you wish to clarify.

Thank you

Phil

From: Ashleigh Tomkins [mailto:AshleighT@gladstonerc.qld.gov.au]
Sent: Friday, 20 June 2014 2:54 PM
To: Phillip Hall
Cc: Emma Hamilton
Subject: RE: Adopted Paterson Zone Setup for infrastructure plans

Phil,

Is the below considering feeding existing Paterson from the new main to NRG? If we feed the existing Paterson from the new line does this eliminate any upgrades on Philip St or the Round Hill outlet? Does this trigger an upgrade of the line to NRG?

Otherwise I'm fairly happy with this way forward for the current schedules. Will forward to Phil B for comment.

Thanks,

Ashleigh Tomkins
Engineer - Development
GLADSTONE REGIONAL COUNCIL
PO Box 29 Gladstone Qld 4680
Phone 07 4975 8170 l Fax 07 4975 8760
Email: ashleight@gladstonerc.qld.gov.au l Website: www.gladstone.qld.gov.au

---

From: Phillip Hall [mailto:Phillip.T.Hall@mwhglobal.com]
Sent: Friday, 20 June 2014 11:42 AM
To: Ashleigh Tomkins
Cc: Emma Hamilton
Subject: Adopted Paterson Zone Setup for infrastructure plans

Hi Ashleigh

Following conversation with Phil B yesterday. I've had a look the future setup of the Paterson WSZ

Summary outcomes:

- There is no opportunity to service the Paterson WSZ without the existing reservoir through the single 450 mm diameter main outlet north from Paterson 2. Pressure failure occurs through the zone from early planning horizons and at Ultimate 450 main runs at 3 m/s velocity. Internal mains also run at high headloss and widespread failures occur through the zone. The single new reservoir option would require significant network upgrades to support zone. Main in below figure is proposed. Estimate ($1.7 M)

- However, there are benefits of decommissioning Paterson 1.
    - Less pressure on Round Hill outlet mains, meaning deferment and downsizing of the 600 mm diameter outlet duplication to a 450 mm duplication required (2026 and not 2021). Upgrade of outlet from reservoir to Philip Street is still required with new 300 mm from Round Hill to NRG in operation. Previously proposed mains in Philip Street are not ($450 K saving).
    - Proposed upgrade of outlet from existing Paterson reservoir is not required ($250 K saving)
    - Would require a single 25 ML reservoir at Glenlyon Road – estimate ($5.7 M), if Paterson 1 is decommissioned. Otherwise 2 reservoirs (Paterson 2 and replacement 1) estimate ($6.7 M) ($1 M saving)
    - Total saving ($1.7 M)

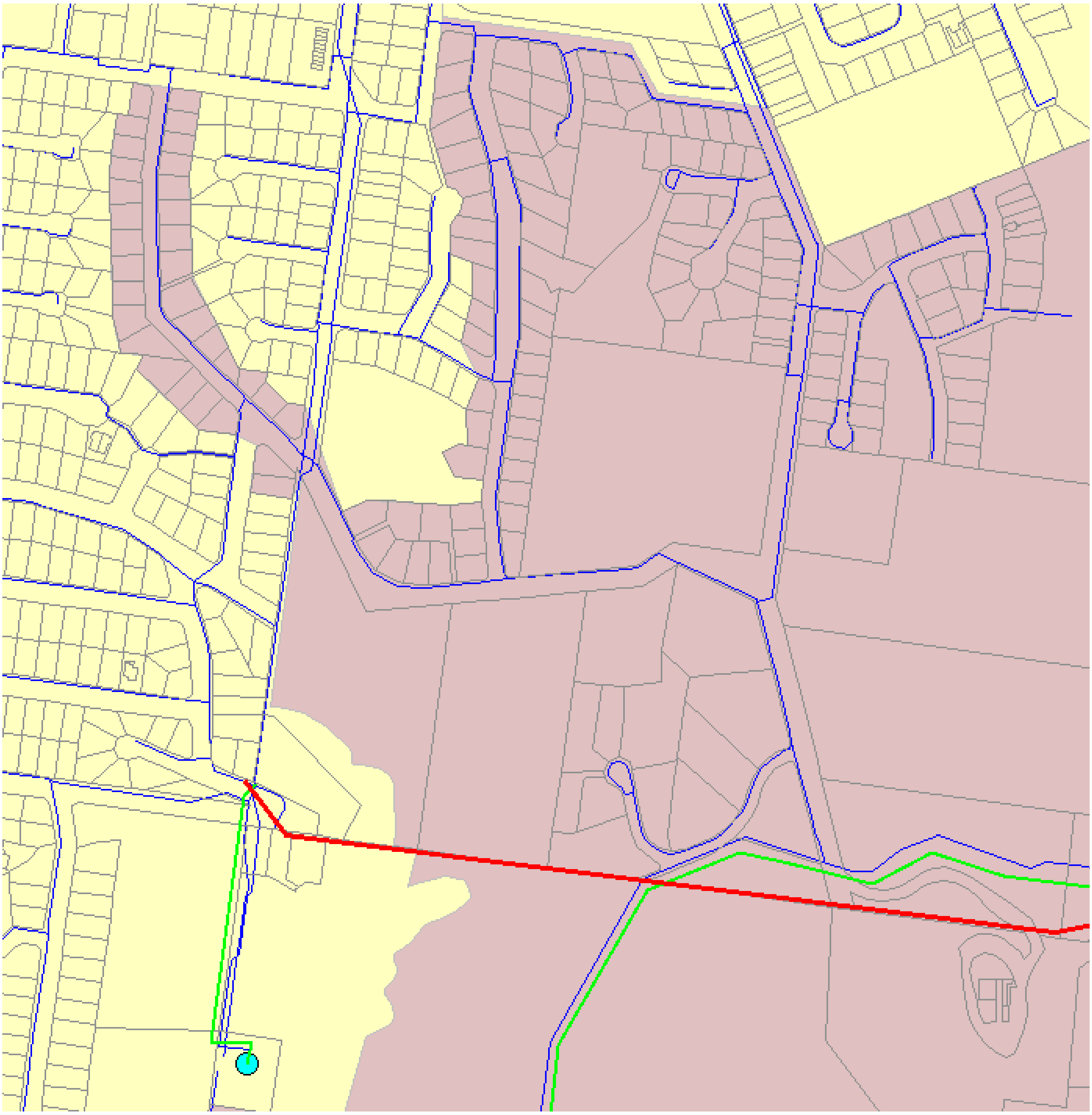
- So quick cost comparison of both options suggests no clear cost differentiator. ($1.7 M new main vs $1.7 M cost saving)

- I plan to prepare draft plans and PIP inputs with the single new reservoir and the new internal trunk main shown below. Feel this probably the preferred operational setup – single supply source so simple flow meter coverage. Some pressure off of Round Hill outlet so frees some capacity for rest of zone. Also we are not pumping to a higher reservoir before gravitating to the lower reservoir, likely to result in improved energy and pumping efficiency with reduced required head gain.

- My recommendation, however, is that GRC identify a preferred option through a separate specific study or business case assessment which is outside of our project commission. This quick assessment for inclusion in our PIP and infrastructure plans is not sufficient for GRC to commit to the single reservoir as the preferred financial option.

As above I plan to progress the plans with the single reservoir supply and proposed large internal trunk main connection to the west of the zone (see below). Please do not hesitate to call should you require.

Regards Phil



MWH

BUILDING A BETTER WORLD

Phil Hall

Planning Leader QLD

Level 3	Phone:	+61 (0) 7 3029 5139
35 Boundary St	Fax:	+61 (0) 7 3029 5050
South Brisbane	Mobile:	+61 (0) 437 837 360
QLD 4101	Email:	Phillip.T.Hall@mwhglobal.com
AUSTRALIA	Web:	www.mwhglobal.com.au

Phillip Hall

From: Phillip Hall
Sent: Thursday, 29 May 2014 3:50 PM
To: 'Ashleigh Tomkins'
Cc: 'emmah@gladstonerc.qld.gov.au'
Subject: RE: Future Paterson, Fisher Street and Ferris Hill (Zone A) supply and zoning

Hi Ashleigh

Thanks again for going back and forward with me on this zoning discussion today.

After testing a few of the zoning arrangements discussed, I feel the best option to move forward with is Zoning Option 2 (as per Ultimate Demand Zones CBD rezone option 2.tab) with just a few minor extensions.

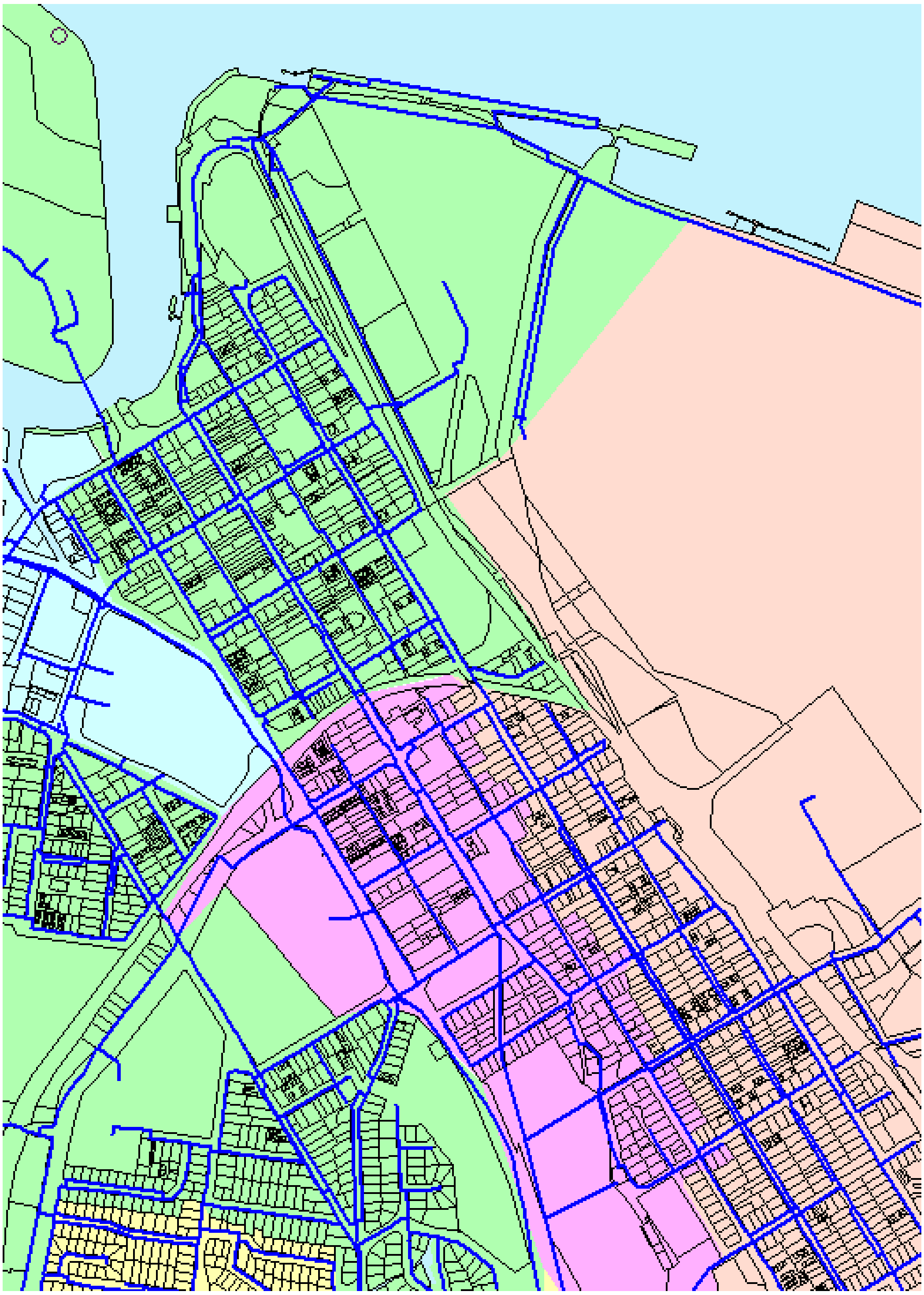
Thanks again for you input today.

Best Regards
Phil

From: Ashleigh Tomkins [mailto:AshleighT@gladstonerc.qld.gov.au]
Sent: Thursday, 29 May 2014 2:19 PM
To: Phillip Hall
Cc: Emma Hamilton
Subject: RE: Future Paterson, Fisher Street and Ferris Hill (Zone A) supply and zoning

Phil,

Having a look at the map you provided If we're going to split the large loop through GPC to the east I'd think connecting it to Paterson St zone would be a preferable solution (looping, trunk main utilisation etc.) See below (tab attached):



We also need to keep the area on radar hill identified in fisher street in ultimate zones 13 in this zone since its required to ensure that there is no reduction of service in this area.

Thanks,

Ashleigh Tomkins
Engineer - Development
GLADSTONE REGIONAL COUNCIL
PO Box 29 Gladstone Qld 4680
Phone 07 4975 8170 l Fax 07 4975 8760
Email: ashleight@gladstonerc.qld.gov.au l Website: www.gladstone.qld.gov.au

From: Phillip Hall [mailto:Phillip.T.Hall@mwhglobal.com]
Sent: Thursday, 29 May 2014 1:47 PM
To: Ashleigh Tomkins
Cc: Emma Hamilton
Subject: RE: Future Paterson, Fisher Street and Ferris Hill (Zone A) supply and zoning

Thank you Ashleigh

Appreciate the direction and the quick response.

I'll test those 2 boundaries. Initial thoughts are that the large zone for the Fisher Street and Radar Hill reservoirs might be a bit large to keep additional storage requirements for this site low (to the 16 m diameter stated). I'll test out the smaller one also and see what this means for storage and upgrades. We might land somewhere in-between, similar to the zone picture I've sent through in last email, but will keep you informed.

If you have any reservations around the zone extent we developed please let me know. The benefit of a zone this size (matched to meet storage capacity) is that we don't need new storage for this zone and additional storage at Ferris Hill is not required until beyond 2036. However, I'll need to test fully for hydraulic performance in the model.

Phil

From: Ashleigh Tomkins [mailto:AshleighT@gladstonerc.qld.gov.au]
Sent: Thursday, 29 May 2014 1:06 PM
To: Phillip Hall
Cc: Emma Hamilton
Subject: RE: Future Paterson, Fisher Street and Ferris Hill (Zone A) supply and zoning

Phil,

As discussed on the phone, we'd like to go with a similar proposal but with a couple of tweaks.

- Existing Fisher St zone serviced from NRG (capacity for 2 extra reservoirs of similar size on the NRG res site). This allows utilisation of 450 trunk for Paterson St feed to CBD.
- Fisher St and Radar Hill combined zone, zoned so minimal extra storage (16m diam res on disused res site on Goondoon street).
- Ferris hill as its own zone. This res has a different BWL to Radar Hill & Fisher St, needs to be a separate zone to "unlock" this extra capacity, possibly provide additional reservoir for this zone.
- Paterson st zone as per GRC provided ultimate zoning

I've attached a two zonings tabs for this option (with the boundary between Zone A and Ferris drawn in different places)

Hope this helps,

Ashleigh Tomkins
Engineer - Development
GLADSTONE REGIONAL COUNCIL

PO Box 29 Gladstone Qld 4680
Phone 07 4975 8170 I Fax 07 4975 8760
Email: ashleight@gladstonerc.qld.gov.au I Website: www.gladstone.qld.gov.au

From: Phillip Hall [mailto:Phillip.T.Hall@mwhglobal.com]
Sent: Thursday, 29 May 2014 11:05 AM
To: Emma Hamilton; Ashleigh Tomkins
Subject: Future Paterson, Fisher Street and Ferris Hill (Zone A) supply and zoning

Hello Emma and Ashleigh (apologise in advance for the long email below, Just thought I'd get it on paper before calling to discuss).

We are looking currently looking at Ultimate zoning for the above mentioned WSZs. GRC has provided an Ultimate zones boundary layer (Ultimate Demand Zones 13.tab). In our start-up meetings Celisa mentioned that there is no need to deviate from the Ultimate zoning strategy provided. However, we have had a look at an alternative which we believe will carry a number of advantages to GRC.

Ultimate storage assessment based on the provided Ultimate zones shows the following:

- 19.3 ML additional storage is required at the Paterson Reservoir 2 site (above Paterson 1 Volume)
- 5.4 ML additional storage is required for zone A (above Ferris Hill 8.7 ML)
- 2.0 ML additional storage is required for Fishers Street WSZ additional to (Fisher Street and Radar Hill existing volumes)
- There are current storage deficiencies in all zones based on current demand and current reservoir supply.
- If the Ultimate provided WSZ zoning was to be implemented now and only the Paterson 2 reservoir was built there would remain current storage deficiency in Zone A and there would be deficiency in Fisher Street by 2016.
- Therefore, we would be looking at requiring additional storage at Ferris Hill at the same time and a deficiency would remain in Fisher Street unless some further rezoning onto Paterson or Zone A was to occur.

Additionally to setup the above provided zoning a long 450 mm diameter outlet (3.5 km) from the Paterson 2 reservoir is necessary, while there is a currently under used 450 mm diameter main up to Fisher Street WSZ from the Fisher Street reservoir.

The alternative strategy I would like to propose is as follows:

- Incorporate the Fisher Street WSZ into the Paterson WSZ. Build the Paterson 2 large enough to meet storage requirements of extended zone
- Use the Fisher Street 450 mm outlet to supply to the north of this extended zone removing the need for the new 3.5 km 450 mm main previously proposed.
- Manage high pressure concerns in the former Fisher Street WSZ area through a PRV export.
- Meet the Ultimate Ferris Hill storage deficiency through the using both Radar Hill and Fisher Street reservoir for Zone A as well. This will provided adequate storage to at least 2036 and potentially to Ultimate if we rezone an addtional small area of Zone A to Paterson.

Benefits

- Bulid just 1 large reservoir at Paterson Street in short term instead of 2 or 3. Ferris Hill 2 can be deferred until at least until beyond 2036 if required at all.
- All Storage requirements are met and no need for new storage for Fisher Street WSZ
- No need for the construction of the large 3.5 km 450 mm outlet from Paterson and ultising an underused asset.
- The new Paterson reservoir would need to be 25 ML. If there is room at the site this could be staged in two 12.5 ML if GRC see cost benefits in deferment with the second reservoir required after 2021.
- Should results in significant CAPEX savings.

I've checked performance of the network in the model and the alternative setup does not create additional pressure failures in comparison to the previously proposed Ultimate zone.

Could you please provided some direction to the approach to Ultimate zoning you would like us to take. Would you like us to continue based on the GRC current strategy or are you OK for us to deviate from this strategy with similar to the approach discussed above.

I've attached a simple mark up of a schematic which might help communicate the alternative approach above. I've also attached a draft working spreadsheet being used for storage calculations which shows deficiencies under current and Ultimate zoning strategy GRC provided boundaries. This spreadsheet will continue to be updated as storage and zoning updates are worked through.

Thank you

Phil

MWH

BUILDING A BETTER WORLD

Phil Hall

Planning Leader QLD

Level 3	Phone:	+61 (0) 7 3029 5139
35 Boundary St	Fax:	+61 (0) 7 3029 5050
South Brisbane	Mobile:	+61 (0) 437 837 360
QLD 4101	Email:	Phillip.T.Hall@mwhglobal.com
AUSTRALIA	Web:	www.mwhglobal.com.au

Phillip Hall

From:	Ashleigh Tomkins <AshleighT@gladstonerc.qld.gov.au>
Sent:	Wednesday, 14 May 2014 5:17 PM
To:	Phillip Hall; Emma Hamilton
Cc:	Anjila Finan
Subject:	RE: Confirmation of Water Supply pumping and storage design criteria
Attachments:	Capacity of Bulk Water Assets v2.xls

Phil,

For reservoirs we normally size for 3 min days storage (3x0.6xAD) + fire fighting. (this should be >3(MD-MDMM)) Firefighting is usually 432kL (4hrs@30L/s) unless there is no commercial etc. in the zone (I think the only one of these zones in Gladstone or agnes is Kirkwood high level) where we use 108kL (2hrs @ 15L/s).For zones with more than 1 res I'd normally allow for firefighting in each res unless they're close together (i.e. I'd allow for it in individually in Roundhill, South Gladstone Clinton and Kirkwood low level but would consider the firefighting storage of Fisher Street and Radar Hill together).

For pumped reservoirs that have gravity fed reservoirs downstream I usually allow for the difference in flow rates: extra storage (ML) = (gravity res inflow rate L/s)*4*60*60/1000/1000

For pumping rates happy to use MDMM over 20hrs for gravity fed res MDMM over 24hrs

Kirkwood high level res is a bit special in that it's been designed to allow for overnight pumping. I believe you'll need to size based on Max Day + firefighting for the storage volume and MDMM over 10hrs for the pump rate (overnight pumping)

I don't think we'll have any elevated reservoirs proposed in the Gladstone or Agnes systems, but as its something I've never had to deal with if you could give me a bit of guidance on the rationale for the 150kL it would be appreciated.

I've attached my current sizing sheet for your reference.

Regards,

Ashleigh Tomkins
Engineer - Development
GLADSTONE REGIONAL COUNCIL
PO Box 29 Gladstone Qld 4680
Phone 07 4975 8170 I Fax 07 4975 8760
Email: ashleight@gladstonerc.qld.gov.au I Website: www.gladstone.qld.gov.au

---

From: Phillip Hall [mailto:Phillip.T.Hall@mwhglobal.com]
Sent: Wednesday, 14 May 2014 4:26 PM
To: Ashleigh Tomkins; Emma Hamilton
Cc: Anjila Finan
Subject: Confirmation of Water Supply pumping and storage design criteria

Hi Ashleigh

Apologies if I have requested a similar response from you previously. As we now move into the performance assessment phase of the project, the modelling guidelines provided by GRC are not specific about the criteria used to assess water storage and pump capacity. I was anticipating we use the DEWS guidelines which remain similar to those used previously in water planning studies. Could I please get your confirmation in using these guidelines or could you please direct me to others if required.

I was also wanting any input from yourself in regard to emergency and fire fighting storage adopted by GRC for storage calculations. In SEQ the guidelines are to adopt the greater of 4 hours @ MDMM or 0.5 ML for ground level resevoirs. For elevated reservoirs, an emergency storage of 150 kL is proposed.

Thank you for your guidance here Ashleigh.

Best Regards
Phil

DEWS extract below:

Component	Sizing	Co
Treated water pumps feeding an elevated reservoir	Capacity (L/s) = $\frac{\text{6PH – reservoir operating volume}}{6 \times 3600}$ Volume in litres	
Trunk mains feeding ground level reservoir	MDMM (gravity) MDMM over 20 hours (pumped supply)	
Trunk mains feeding elevated reservoir	Capacity of treated water pumps	
Reservoirs (ground level)	3 (PD-MDMM) + (greater of Emergency Storage/Firefighting Storage) 2156_Fact sheets-blue-2	This sizing rela level. Emergen risk assessmer Firefighting sto be incorporate reservoirs.
Elevated reservoir	$6 \left(PH - \frac{MDMM}{12}\right)$ + firefighting reserve	A firefighting re determined thr modelling and assessment by Based on the p variable speed cells, elevated be economicall

BUILDING A BETTER WORLD

Phil Hall
Planning Leader QLD

Level 3	Phone:	+61 (0) 7 3029 5139
35 Boundary St	Fax:	+61 (0) 7 3029 5050
South Brisbane	Mobile:	+61 (0) 437 837 360
QLD 4101	Email:	Phillip.T.Hall@mwhglobal.com
AUSTRALIA	Web:	www.mwhglobal.com.au

Appendix D Detailed Reservoir Capacity Assessment

ZONE BC

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	1586	508	2094	886	2980	50.0	67.6	89.6	30.0	184.2	4.3	5.8	7.7	2.6	4.9	7.8	0.4	0	8.2	-3.3
2016	1681	531	2213	946	3159	53.0	71.6	94.9	31.8	195.1	4.6	6.2	8.2	2.7	4.9	8.2	0.4	0	8.7	-3.8
2021	2362	531	2894	958	3851	64.6	88.9	118.0	38.8	243.3	5.6	7.7	10.2	3.4	4.9	10.1	0.4	0	10.5	-5.6
2026	2728	725	3452	1016	4468	75.0	104.0	138.0	45.0	285.0	6.5	9.0	11.9	3.9	4.9	11.7	0.4	0	12.1	-7.2
2031	3243	725	3968	1016	4984	83.6	116.9	155.4	50.2	321.2	7.2	10.1	13.4	4.3	4.9	13.0	0.4	0	13.4	-8.5
2036	3574	725	4299	1021	5320	89.3	125.4	166.6	53.6	344.6	7.7	10.8	14.4	4.6	4.9	13.9	0.4	0	14.3	-9.4
Ultimate	3574	725	4299	1021	5320	89.3	125.4	166.6	53.6	344.6	7.7	10.8	14.4	4.6	4.9	13.9	0.4	0	14.3	-9.4

ZONE D

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	4765	346	5110	1680	6790	114.0	156.8	208.2	68.4	429.3	9.8	13.6	18.0	5.9	20.8	17.7	0.9	1.542	20.1	0.7
2016	5001	346	5347	1698	7045	118.2	163.1	216.5	70.9	446.6	10.2	14.1	18.7	6.1	20.8	18.4	0.9	1.608	20.9	-0.1
2021	5239	346	5585	1892	7477	125.5	172.3	228.7	75.3	471.5	10.8	14.9	19.8	6.5	20.8	19.5	0.9	1.876	22.3	-1.5
2026	5447	384	5831	2158	7989	134.1	183.0	242.8	80.4	499.9	11.6	15.8	21.0	7.0	20.8	20.9	0.9	2.172	23.9	-3.1
2031	5483	384	5867	2306	8173	137.2	186.4	247.2	82.3	508.7	11.9	16.1	21.4	7.1	20.8	21.3	0.9	2.812	25.0	-4.2
2036	5702	384	6086	2406	8492	142.5	193.6	256.8	85.5	528.3	12.3	16.7	22.2	7.4	20.8	22.2	0.9	2.933	26.0	-5.2
Ultimate	7360	406	7766	2613	10379	174.2	239.4	317.7	104.5	654.9	15.1	20.7	27.4	9.0	20.8	27.1	0.9	3.073	31.0	-10.2

CLINTON PARK

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	4764	366	5130	795	5925	99.4	142.5	189.5	59.7	393.3	8.6	12.3	16.4	5.2	13.2	15.5	0.4	0	15.9	-2.7
2016	5412	371	5783	860	6643	111.5	160.0	212.9	66.9	441.9	9.6	13.8	18.4	5.8	13.2	17.3	0.4	0	17.8	-4.6
2021	5419	371	5790	914	6704	112.5	161.1	214.3	67.5	444.7	9.7	13.9	18.5	5.8	13.2	17.5	0.4	0	17.9	-4.7
2026	6208	371	6579	914	7493	125.7	181.0	240.8	75.4	500.0	10.9	15.6	20.8	6.5	13.2	19.6	0.4	0	20.0	-6.8
2031	7189	371	7560	914	8474	142.2	205.7	273.7	85.3	568.9	12.3	17.8	23.6	7.4	13.2	22.1	0.4	0	22.5	-9.3
2036	7592	371	7963	914	8877	149.0	215.8	287.2	89.4	597.1	12.9	18.6	24.8	7.7	13.2	23.2	0.4	0	23.6	-10.4
Ultimate	8944	966	9910	1043	10952	183.8	267.0	355.4	110.3	739.1	15.9	23.1	30.7	9.5	13.2	28.6	0.4	0	29.0	-15.8

NRG

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	0	0	0	2352	2352	39.5	39.5	51.3	23.7	99.1	3.4	3.4	4.4	2.0	13.5	6.1	0.4	0	6.6	6.9
2016	0	0	0	2391	2391	40.1	40.1	52.2	24.1	100.7	3.5	3.5	4.5	2.1	13.5	6.2	0.4	0	6.7	6.8
2021	0	0	0	2464	2464	41.3	41.3	53.7	24.8	103.8	3.6	3.6	4.6	2.1	13.5	6.4	0.4	0	6.9	6.6
2026	0	0	0	2793	2793	46.9	46.9	60.9	28.1	117.7	4.1	4.1	5.3	2.4	13.5	7.3	0.4	0	7.7	5.8
2031	0	0	0	4667	4667	78.3	78.3	101.8	47.0	196.6	6.8	6.8	8.8	4.1	13.5	12.2	0.4	0	12.6	0.9
2036	0	0	0	4667	4667	78.3	78.3	101.8	47.0	196.6	6.8	6.8	8.8	4.1	13.5	12.2	0.4	0	12.6	0.9
Ultimate	0	0	0	5245	5245	88.0	88.0	114.4	52.8	221.0	7.6	7.6	9.9	4.6	13.5	13.7	0.4	0	14.1	-0.6

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	0	0	0	101	101	65.3	65.3	94.8	24.2	182.9	5.6	5.6	8.2	2.1	13.5	6.3	0.4	0	6.7	6.8
2016	0	0	0	140	140	66.0	66.0	95.6	24.6	184.6	5.7	5.7	8.3	2.1	13.5	6.4	0.4	0	6.8	6.7
2021	0	0	0	213	213	67.2	67.2	97.2	25.3	187.7	5.8	5.8	8.4	2.2	13.5	6.6	0.4	0	7.0	6.5
2026	0	0	0	542	542	72.8	72.8	104.4	28.6	201.5	6.3	6.3	9.0	2.5	13.5	7.4	0.4	0	7.8	5.7
2031	0	0	0	2416	2416	104.2	104.2	145.3	47.5	280.5	9.0	9.0	12.6	4.1	13.5	12.3	0.4	0	12.7	0.8
2036	0	0	0	2416	2416	104.2	104.2	145.3	47.5	280.5	9.0	9.0	12.6	4.1	13.5	12.3	0.4	0	12.7	0.8
Ultimate	0	0	0	2995	2995	113.9	113.9	157.9	53.3	304.8	9.8	9.8	13.6	4.6	13.5	13.8	0.4	0	14.2	-0.7

ZONE A

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	1293	1214	2507	2793	5300	88.9	110.0	145.1	53.4	293.5	7.7	9.5	12.5	4.6	11.0	13.8	0.4	0	14.3	-3.3
2016	1415	1363	2778	2800	5578	93.6	116.9	154.3	56.2	312.8	8.1	10.1	13.3	4.9	11.0	14.6	0.4	0	15.0	-4.0
2021	1578	1725	3303	2873	6176	103.6	131.4	173.5	62.2	352.7	9.0	11.3	15.0	5.4	11.0	16.1	0.4	0	16.6	-5.6
2026	1691	2061	3752	2930	6682	112.1	143.6	189.8	67.3	386.6	9.7	12.4	16.4	5.8	11.0	17.4	0.4	0	17.9	-6.9
2031	1853	2191	4045	2991	7035	118.1	152.0	201.0	70.8	409.7	10.2	13.1	17.4	6.1	11.0	18.4	0.4	0	18.8	-7.8
2036	1947	2841	4789	3208	7997	134.2	174.4	230.7	80.5	471.1	11.6	15.1	19.9	7.0	11.0	20.9	0.4	0	21.3	-10.3
Ultimate	2073	3873	5946	3345	9291	155.9	205.8	272.6	93.6	558.0	13.5	17.8	23.5	8.1	11.0	24.3	0.4	0	24.7	-13.7

Fisher Street

Existing Zoning Storage Assessment

						Demand (L/s)					Demand (ML/d)									
Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	38	20	58	1222	1280	21.5	22.0	28.6	12.9	55.5	1.9	1.9	2.5	1.1	2.3	3.3	0.4	0	3.8	-1.5
2016	38	20	58	1459	1517	25.5	25.9	33.8	15.3	65.5	2.2	2.2	2.9	1.3	2.3	4.0	0.4	0	4.4	-2.1
2021	38	20	58	1703	1761	29.6	30.0	39.1	17.7	75.8	2.6	2.6	3.4	1.5	2.3	4.6	0.4	0	5.0	-2.7
2026	38	20	58	1703	1761	29.6	30.0	39.1	17.7	75.8	2.6	2.6	3.4	1.5	2.3	4.6	0.4	0	5.0	-2.7
2031	38	20	58	1882	1940	32.6	33.0	43.0	19.5	83.3	2.8	2.9	3.7	1.7	2.3	5.1	0.4	0	5.5	-3.2
2036	38	20	58	2126	2184	36.6	37.1	48.3	22.0	93.6	3.2	3.2	4.2	1.9	2.3	5.7	0.4	0	6.1	-3.8
Ultimate	38	20	58	2126	2184	36.6	37.1	48.3	22.0	93.6	3.2	3.2	4.2	1.9	2.3	5.7	0.4	0	6.1	-3.8

TOTAL

Planning Horizon	Detached Res ET	Attached Res ET	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML)
2014	12445	2453	14898	9729	24627	413.3	538.3	712.3	248.0	1454.9	35.7	46.5	61.5	21.4	65.7	64.3	3.0	1.5	68.8	-3.1
2016	13549	2630	16179	10154	26333	441.9	577.7	764.6	265.2	1562.7	38.2	49.9	66.1	22.9	65.7	68.7	3.0	1.6	73.4	-7.7
2021	14637	2992	17629	10804	28433	477.2	625.1	827.4	286.3	1691.8	41.2	54.0	71.5	24.7	65.7	74.2	3.0	1.9	79.1	-13.4
2026	16112	3560	19672	11514	31186	523.4	688.4	911.5	314.0	1865.0	45.2	59.5	78.8	27.1	65.7	81.4	3.0	2.2	86.6	-20.9
2031	17807	3690	21497	13777	35274	592.0	772.4	1022.1	355.2	2088.4	51.1	66.7	88.3	30.7	65.7	92.1	3.0	2.8	97.9	-32.2
2036	18854	4340	23194	14342	37537	630.0	824.6	1091.4	378.0	2231.3	54.4	71.2	94.3	32.7	65.7	98.0	3.0	2.9	103.9	-38.2
Ultimate	21989	5990	27979	15393	43372	727.9	962.7	1274.9	436.7	2611.2	62.9	83.2	110.2	37.7	65.7	113.2	3.0	3.1	119.3	-53.6

2014 - Rezoning Implemented Storage Assessment

Patterson Street - Ultimate

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7

NRG Future - Extended

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	13.5	9.2
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	13.5	8.5
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	13.5	7.0

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8

Zone D / Clinton

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4

Zone A and Ferris Hill Combined

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	1829	1963	3792	63.6	79.0	104.2	38.2	211.0	5.5	6.8	9.0	3.3	13.3	9.9	0.4	0	10.3	3.0	0	3.0
2016	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	13.3	10.2	0.4	0	10.6	2.7	0	2.7
2021	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	13.3	10.2	0.4	0	10.6	2.7	0	2.7
2026	2265	1997	4262	71.5	90.5	119.6	42.9	243.0	6.2	7.8	10.3	3.7	13.3	11.1	0.4	0	11.6	1.7	0	1.7
2031	2454	2053	4507	75.6	96.2	127.2	45.4	258.6	6.5	8.3	11.0	3.9	13.3	11.8	0.4	0	12.2	1.1	2	3.1
2036	2704	2238	4943	83.0	105.6	139.6	49.8	284.0	7.2	9.1	12.1	4.3	13.3	12.9	0.4	0	13.3	0.0	2	2.0
Ultimate	3072	2294	5365	90.0	115.8	153.1	54.0	312.1	7.8	10.0	13.2	4.7	13.3	14.0	0.4	0	14.4	-1.1	2	0.9

Patterson Street - Ultimate

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7

NRG Future - Extended

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	13.5	9.2
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	13.5	8.5
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	13.5	7.0

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8

Zone D / Clinton

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4

Zone A and Ferris Hill Combined

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	1829	1963	3792	63.6	79.0	104.2	38.2	211.0	5.5	6.8	9.0	3.3	13.3	9.9	0.4	0	10.3	3.0	0	3.0
2016	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	13.3	10.2	0.4	0	10.6	2.7	0	2.7
2021	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	13.3	10.2	0.4	0	10.6	2.7	0	2.7
2026	2265	1997	4262	71.5	90.5	119.6	42.9	243.0	6.2	7.8	10.3	3.7	13.3	11.1	0.4	0	11.6	1.7	0	1.7
2031	2454	2053	4507	75.6	96.2	127.2	45.4	258.6	6.5	8.3	11.0	3.9	13.3	11.8	0.4	0	12.2	1.1	2	3.1
2036	2704	2238	4943	83.0	105.6	139.6	49.8	284.0	7.2	9.1	12.1	4.3	13.3	12.9	0.4	0	13.3	0.0	2	2.0
Ultimate	3072	2294	5365	90.0	115.8	153.1	54.0	312.1	7.8	10.0	13.2	4.7	13.3	14.0	0.4	0	14.4	-1.1	2	0.9

Patterson Street - Ultimate

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7

NRG Future - Extended

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	13.5	9.2
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	13.5	8.5
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	13.5	7.0

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8

Zone D / Clinton

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4

Zone A and Ferris Hill Combined

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	1829	1963	3792	63.6	79.0	104.2	38.2	211.0	5.5	6.8	9.0	3.3	13.3	9.9	0.4	0	10.3	3.0	0	3.0
2016	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	13.3	10.2	0.4	0	10.6	2.7	0	2.7
2021	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	13.3	10.2	0.4	0	10.6	2.7	0	2.7
2026	2265	1997	4262	71.5	90.5	119.6	42.9	243.0	6.2	7.8	10.3	3.7	13.3	11.1	0.4	0	11.6	1.7	0	1.7
2031	2454	2053	4507	75.6	96.2	127.2	45.4	258.6	6.5	8.3	11.0	3.9	13.3	11.8	0.4	0	12.2	1.1	2	3.1
2036	2704	2238	4943	83.0	105.6	139.6	49.8	284.0	7.2	9.1	12.1	4.3	13.3	12.9	0.4	0	13.3	0.0	2	2.0
Ultimate	3072	2294	5365	90.0	115.8	153.1	54.0	312.1	7.8	10.0	13.2	4.7	13.3	14.0	0.4	0	14.4	-1.1	2	0.9

Patterson Street - Ultimate

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7

NRG Future - Extended

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	13.5	9.2
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	13.5	8.5
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	13.5	7.0

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8

Zone D / Clinton

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4

Zone A - Fisher Street and Radar Hill

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	401	574	3792	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2016	401	574	3913	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2021	401	574	3913	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2026	601	605	4262	20.3	25.3	33.4	12.2	67.7	1.7	2.2	2.9	1.0	4.6	3.1	0.4	0	3.6	1.0	0	1.0
2031	629	628	4507	21.1	26.4	34.8	12.7	70.6	1.8	2.3	3.0	1.1	4.6	3.3	0.4	0	3.7	0.9	0	0.9
2036	685	680	4943	22.9	28.7	37.8	13.7	76.7	2.0	2.5	3.3	1.2	4.6	3.6	0.4	0	4.0	0.6	0	0.6
Ultimate	814	710	5365	25.6	32.4	42.8	15.3	87.0	2.2	2.8	3.7	1.3	4.6	4.0	0.4	0	4.4	0.2	0	0.2

Ferris Hill

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	1428	1389	2817	47.3	59.3	78.2	28.4	158.7	4.1	5.1	6.8	2.5	8.7	7.4	0.4	0	7.8	0.9	0	0.9
2016	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6
2021	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6
2026	1663	1392	3055	51.3	65.2	86.2	30.8	175.3	4.4	5.6	7.4	2.7	8.7	8.0	0.4	0	8.4	0.3	0	0.3
2031	1826	1425	3250	54.5	69.9	92.4	32.7	188.1	4.7	6.0	8.0	2.8	8.7	8.5	0.4	0	8.9	-0.2	2	1.8
2036	2019	1559	3578	60.0	77.0	101.8	36.0	207.3	5.2	6.7	8.8	3.1	8.7	9.3	0.4	0	9.8	-1.1	2	0.9
Ultimate	2258	1583	3841	64.5	83.4	110.3	38.7	225.1	5.6	7.2	9.5	3.3	8.7	10.0	0.4	0	10.5	-1.8	2	0.2

Patterson Street - Ultimate

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7

NRG Future - Extended

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	7	2.7
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	7	2.0
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	7	0.5

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8

Zone D / Clinton

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4

Zone A - Fisher Street and Radar Hill

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	401	574	3792	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2016	401	574	3913	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2021	401	574	3913	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2026	601	605	4262	20.3	25.3	33.4	12.2	67.7	1.7	2.2	2.9	1.0	4.6	3.1	0.4	0	3.6	1.0	0	1.0
2031	629	628	4507	21.1	26.4	34.8	12.7	70.6	1.8	2.3	3.0	1.1	4.6	3.3	0.4	0	3.7	0.9	0	0.9
2036	685	680	4943	22.9	28.7	37.8	13.7	76.7	2.0	2.5	3.3	1.2	4.6	3.6	0.4	0	4.0	0.6	0	0.6
Ultimate	814	710	5365	25.6	32.4	42.8	15.3	87.0	2.2	2.8	3.7	1.3	4.6	4.0	0.4	0	4.4	0.2	0	0.2

Ferris Hill

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s)					Demand (ML/d)				Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
				AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day								
2014	1428	1389	2817	47.3	59.3	78.2	28.4	158.7	4.1	5.1	6.8	2.5	8.7	7.4	0.4	0	7.8	0.9	0	0.9
2016	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6
2021	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6
2026	1663	1392	3055	51.3	65.2	86.2	30.8	175.3	4.4	5.6	7.4	2.7	8.7	8.0	0.4	0	8.4	0.3	0	0.3
2031	1826	1425	3250	54.5	69.9	92.4	32.7	188.1	4.7	6.0	8.0	2.8	8.7	8.5	0.4	0	8.9	-0.2	2	1.8
2036	2019	1559	3578	60.0	77.0	101.8	36.0	207.3	5.2	6.7	8.8	3.1	8.7	9.3	0.4	0	9.8	-1.1	2	0.9
Ultimate	2258	1583	3841	64.5	83.4	110.3	38.7	225.1	5.6	7.2	9.5	3.3	8.7	10.0	0.4	0	10.5	-1.8	2	0.2

2036 Zoning Storage Assessment

Patterson Street - Ultimate

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7

NRG Future - Extended

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	7	2.7
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	7	2.0
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	7	0.5

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8

Zone D / Clinton

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4

Zone A - Fisher Street and Radar Hill

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	401	574	3792	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2016	401	574	3913	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2021	401	574	3913	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2026	601	605	4262	20.3	25.3	33.4	12.2	67.7	1.7	2.2	2.9	1.0	4.6	3.1	0.4	0	3.6	1.0	0	1.0
2031	629	628	4507	21.1	26.4	34.8	12.7	70.6	1.8	2.3	3.0	1.1	4.6	3.3	0.4	0	3.7	0.9	0	0.9
2036	685	680	4943	22.9	28.7	37.8	13.7	76.7	2.0	2.5	3.3	1.2	4.6	3.6	0.4	0	4.0	0.6	0	0.6
Ultimate	814	710	5365	25.6	32.4	42.8	15.3	87.0	2.2	2.8	3.7	1.3	4.6	4.0	0.4	0	4.4	0.2	0	0.2

Ferris Hill

				Demand (L/s)					Demand (ML/d)											
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	1428	1389	2817	47.3	59.3	78.2	28.4	158.7	4.1	5.1	6.8	2.5	8.7	7.4	0.4	0	7.8	0.9	0	0.9
2016	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6
2021	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6
2026	1663	1392	3055	51.3	65.2	86.2	30.8	175.3	4.4	5.6	7.4	2.7	8.7	8.0	0.4	0	8.4	0.3	0	0.3
2031	1826	1425	3250	54.5	69.9	92.4	32.7	188.1	4.7	6.0	8.0	2.8	8.7	8.5	0.4	0	8.9	-0.2	2	1.8
2036	2019	1559	3578	60.0	77.0	101.8	36.0	207.3	5.2	6.7	8.8	3.1	8.7	9.3	0.4	0	9.8	-1.1	2	0.9
Ultimate	2258	1583	3841	64.5	83.4	110.3	38.7	225.1	5.6	7.2	9.5	3.3	8.7	10.0	0.4	0	10.5	-1.8	2	0.2

Ultimate Zones Storage Assessment

NRG - existing

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	0	2418	2418	40.6	40.6	52.8	24.4	101.9	3.5	3.5	4.6	2.1	13.5	6.3	0.4	0	6.7	6.8	0	6.8
2016	0	2457	2457	41.2	41.2	53.6	24.7	103.5	3.6	3.6	4.6	2.1	13.5	6.4	0.4	0	6.8	6.7	0	6.7
2021	0	2530	2530	42.5	42.5	55.2	25.5	106.6	3.7	3.7	4.8	2.2	13.5	6.6	0.4	0	7.0	6.5	0	6.5
2026	0	2860	2860	48.0	48.0	62.4	28.8	120.5	4.1	4.1	5.4	2.5	13.5	7.5	0.4	0	7.9	5.6	0	5.6
2031	0	4734	4734	79.4	79.4	103.3	47.7	199.4	6.9	6.9	8.9	4.1	13.5	12.4	0.4	0	12.8	0.7	7	7.7
2036	0	4734	4734	79.4	79.4	103.3	47.7	199.4	6.9	6.9	8.9	4.1	13.5	12.4	0.4	0	12.8	0.7	7	7.7
Ultimate	0	5312	5312	89.2	89.2	115.9	53.5	223.8	7.7	7.7	10.0	4.6	13.5	13.9	0.4	0	14.3	-0.8	7	6.2

NRG - Extension (Former Fisher Street)

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	48	1212	1260	21.2	21.6	28.1	12.7	54.5	1.8	1.9	2.4	1.1	0.0	3.3	0.4	0	3.7	-3.7	0	-3.7
2016	48	1449	1497	25.1	25.5	33.2	15.1	64.4	2.2	2.2	2.9	1.3	0.0	3.9	0.4	0	4.3	-4.3	0	-4.3
2021	48	1693	1741	29.2	29.6	38.6	17.5	74.7	2.5	2.6	3.3	1.5	0.0	4.5	0.4	0	5.0	-5.0	0	-5.0
2026	48	1693	1741	29.2	29.6	38.6	17.5	74.7	2.5	2.6	3.3	1.5	0.0	4.5	0.4	0	5.0	-5.0	0	-5.0
2031	48	1872	1921	32.2	32.6	42.5	19.3	82.3	2.8	2.8	3.7	1.7	0.0	5.0	0.4	0	5.4	-5.4	0	-5.4
2036	81	2118	2199	36.9	37.6	48.9	22.1	94.9	3.2	3.2	4.2	1.9	0.0	5.7	0.4	0	6.2	-6.2	0	-6.2
Ultimate	81	2118	2199	36.9	37.6	48.9	22.1	94.9	3.2	3.2	4.2	1.9	0.0	5.7	0.4	0	6.2	-6.2	0	-6.2

NRG - future

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage	
2014	48	3630	3679	61.7	62.1	80.8	37.0	156.3	5.3	5.4	7.0	3.2	13.5	9.6	0.4	0	10.0	3.5	0	3.5	
2016	48	3906	3955	66.4	66.8	86.9	39.8	168.0	5.7	5.8	7.5	3.4	13.5	10.3	0.4	0	10.8	2.7	0	2.7	
2021	48	4223	4272	71.7	72.1	93.8	43.0	181.3	6.2	6.2	8.1	3.7	13.5	11.1	0.4	0	11.6	1.9	0	1.9	
2026	48	4553	4601	77.2	77.6	101.0	46.3	195.2	6.7	6.7	8.7	4.0	13.5	12.0	0.4	0	12.4	1.1	0	1.1	
2031	48	6606	6655	111.7	112.1	145.8	67.0	281.7	9.6	9.7	12.6	5.8	13.5	17.4	0.4	0	17.8	-4.3	13.5	9.2	13.5 ML at NRG at 2031
2036	81	6852	6933	116.4	117.0	152.2	69.8	294.3	10.1	10.1	13.2	6.0	13.5	18.1	0.4	0	18.5	-5.0	13.5	8.5	
Ultimate	81	7431	7512	126.1	126.7	164.8	75.6	318.7	10.9	11.0	14.2	6.5	13.5	19.6	0.4	0	20.0	-6.5	13.5	7.0	

NRG - With Power Plant Commercial Agreement (Power Plant - 2250.9 ET. Coms Agreement - MD = 8ML, AD = 5.5 ML, MinDay = 2.0 ML_

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage	
2014	48	1379	3679	87.6	88.0	124.3	37.5	240.2	7.6	7.6	10.7	3.2	13.5	9.7	0.4	0	10.2	3.3	0	3.3	
2016	48	1656	3955	92.3	92.7	130.3	40.3	251.8	8.0	8.0	11.3	3.5	13.5	10.4	0.4	0	10.9	2.6	0	2.6	
2021	48	1973	4272	97.6	98.0	137.3	43.5	265.2	8.4	8.5	11.9	3.8	13.5	11.3	0.4	0	11.7	1.8	0	1.8	
2026	48	2302	4601	103.1	103.5	144.4	46.8	279.1	8.9	8.9	12.5	4.0	13.5	12.1	0.4	0	12.6	0.9	0	0.9	
2031	48	4355	6655	137.6	138.0	189.2	67.5	365.6	11.9	11.9	16.4	5.8	13.5	17.5	0.4	0	17.9	-4.4	13.5	9.1	13.5 ML at NRG at 2031
2036	81	4601	6933	142.2	142.9	195.7	70.3	378.2	12.3	12.3	16.9	6.1	13.5	18.2	0.4	0	18.7	-5.2	13.5	8.3	
Ultimate	81	5180	7512	151.9	152.6	208.3	76.1	402.6	13.1	13.2	18.0	6.6	13.5	19.7	0.4	0	20.2	-6.7	13.5	6.8	

Existing Zone BC Area

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	1072	414	1486	24.9	33.9	45.0	15.0	92.6	2.2	2.9	3.9	1.3	4.9	3.9	0.4	0	4.3	0.6	0	0.6
2016	1072	444	1516	25.4	34.4	45.7	15.3	93.9	2.2	3.0	3.9	1.3	4.9	4.0	0.4	0	4.4	0.5	0	0.5
2021	1455	444	1899	31.9	44.1	58.5	19.1	120.8	2.8	3.8	5.1	1.7	4.9	5.0	0.4	0	5.4	-0.5	0	-0.5
2026	1775	444	2219	37.2	52.1	69.3	22.3	143.2	3.2	4.5	6.0	1.9	4.9	5.8	0.4	0	6.2	-1.3	0	-1.3
2031	2255	444	2699	45.3	64.2	85.4	27.2	176.9	3.9	5.5	7.4	2.3	4.9	7.0	0.4	0	7.5	-2.6	0	-2.6
2036	2553	444	2997	50.3	71.7	95.4	30.2	197.8	4.3	6.2	8.2	2.6	4.9	7.8	0.4	0	8.3	-3.4	0	-3.4
Ultimate	2553	444	2997	50.3	71.7	95.4	30.2	197.8	4.3	6.2	8.2	2.6	4.9	7.8	0.4	0	8.3	-3.4	0	-3.4

Zone BC Extension Area

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	1757	1433	3191	53.5	68.3	90.3	32.1	183.6	4.6	5.9	7.8	2.8	0	8.3	0.4	0	8.8	-8.8	20	11.2
2016	2025	1471	3496	58.7	75.7	100.1	35.2	204.0	5.1	6.5	8.6	3.0	0	9.1	0.4	0	9.6	-9.6	20	10.4
2021	2848	1555	4403	73.9	97.8	129.5	44.3	265.3	6.4	8.4	11.2	3.8	0	11.5	0.4	0	11.9	-11.9	20	8.1
2026	3053	1577	4630	77.7	103.3	136.9	46.6	280.6	6.7	8.9	11.8	4.0	0	12.1	0.4	0	12.5	-12.5	20	7.5
2031	3156	1583	4739	79.5	106.0	140.5	47.7	288.1	6.9	9.2	12.1	4.1	0	12.4	0.4	0	12.8	-12.8	20	7.2
2036	3650	1617	5267	88.4	119.0	157.8	53.0	324.2	7.6	10.3	13.6	4.6	0	13.7	0.4	0	14.2	-14.2	20	5.8
Ultimate	4414	1699	6112	102.6	139.6	185.2	61.5	381.2	8.9	12.1	16.0	5.3	0	16.0	0.4	0	16.4	-16.4	20	3.6

Combined Future Zone BC

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage	
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	4.9	12.2	0.4	0	12.6	-7.7	20	12.3	20 ML at Patterson 2 at 2014
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	4.9	13.1	0.4	0	13.5	-8.6	20	11.4	
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	4.9	16.4	0.4	0	16.9	-12.0	20	8.0	
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	4.9	17.9	0.4	0	18.3	-13.4	20	6.6	
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	4.9	19.4	0.4	0	19.8	-14.9	20	5.1	
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	4.9	21.6	0.4	0	22.0	-17.1	20	2.9	
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	4.9	23.8	0.4	0	24.2	-19.3	20	0.7	

Kirkwood high level

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0
2016	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0
2021	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0
2026	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1.3	1.3
2031	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1.3	1.3
2036	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	1.3	1.3
Ultimate	752	21.9	774	13.0	19.3	25.7	7.8	53.7	1.1	1.7	2.2	0.7	0	2.2	0.1	0	2.3	-2.3	1.3	-1.0

Clinton Reservoir - indicative supply extent

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current Storage	Operational Storage requirement (ML)	FF storage Requirement (ML)	Contingency Storage Requirements for downstream gravity fed reservoirs (ML)	Total Storage Requirement (ML)	Storage excess /deficiency (ML) on current storage	Proposed Storage (ML)	Storage excess /deficiency (ML) on proposed storage
2014	2563	356	2919	49.0	70.5	93.8	29.4	194.8	4.2	6.1	8.1	2.5	13.2	7.6	0.4	0	8.0	5.2	0	5.2
2016	2671	356	3027	50.8	73.2	97.4	30.5	202.3	4.4	6.3	8.4	2.6	13.2	7.9	0.4	0	8.3	4.9	0	4.9
2021	2678	410	3087	51.8	74.3	98.8	31.1	205.1	4.5	6.4	8.5	2.7	13.2	8.1	0.4	0	8.5	4.7	0	4.7
2026	2955	410	3365	56.5	81.3	108.1	33.9	224.6	4.9	7.0	9.3	2.9	13.2	8.8	0.4	0	9.2	4.0	0	4.0
2031	3120	410	3530	59.2	85.4	113.7	35.5	236.1	5.1	7.4	9.8	3.1	13.2	9.2	0.4	0	9.6	3.6	0	3.6
2036	3286	410	3696	62.0	89.6	119.2	37.2	247.8	5.4	7.7	10.3	3.2	13.2	9.6	0.4	0	10.1	3.1	0	3.1
Ultimate	3567	410	3977	66.7	96.7	128.7	40.0	267.5	5.8	8.4	11.1	3.5	13.2	10.4	0.4	0	10.8	2.4	0	2.4

Ultimate Zones Storage Assessment

Kirkwood Low - indicative supply extent

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	Kirkwood High Level Zone (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage
2014	1418	7	1425	23.9	35.8	47.7	14.3	99.8	2.1	3.1	4.1	1.2	0	3.7	0.4	0	4.2	-4.2	11	6.8
2016	1964	72	2035	34.2	50.6	67.5	20.5	140.8	3.0	4.4	5.8	1.8	0	5.3	0.4	0	5.7	-5.7	11	5.3
2021	1964	72	2035	34.2	50.6	67.5	20.5	140.8	3.0	4.4	5.8	1.8	0	5.3	0.4	0	5.7	-5.7	11	5.3
2026	2475	72	2546	42.7	63.5	84.6	25.6	176.6	3.7	5.5	7.3	2.2	0	6.6	0.4	0	7.1	-7.1	11	3.9
2031	3314	72	3386	56.8	84.6	112.8	34.1	235.5	4.9	7.3	9.7	2.9	0	8.8	0.4	0	9.3	-9.3	11	1.7
2036	3551	72	3623	60.8	90.6	120.8	36.5	252.1	5.3	7.8	10.4	3.2	0	9.5	0.4	0	9.9	-9.9	11	1.1
Ultimate	4399	158	4557	76.5	113.4	151.1	45.9	315.2	6.6	9.8	13.1	4.0	0	11.9	0.4	0.7	13.0	-13.0	11	-2.0

South Gladstone - indicative supply extent

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	downstream gravity fed reservoirs (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage
2014	2601	1012	3613	60.6	82.5	109.4	36.4	225.1	5.2	7.1	9.5	3.1	9.0	9.4	0.4	0.5	10.4	-1.4	0	-1.4
2016	2783	1029	3812	64.0	87.3	115.9	38.4	238.6	5.5	7.5	10.0	3.3	9.0	9.9	0.4	0.7	11.1	-2.1	0	-2.1
2021	3020	1193	4214	70.7	96.1	127.4	42.4	262.1	6.1	8.3	11.0	3.7	9.0	11.0	0.4	0.7	12.2	-3.2	0	-3.2
2026	3020	1216	4237	71.1	96.4	127.9	42.7	263.1	6.1	8.3	11.1	3.7	9.0	11.1	0.4	0.9	12.4	-3.4	0	-3.4
2031	3020	1216	4237	71.1	96.4	127.9	42.7	263.1	6.1	8.3	11.1	3.7	9.0	11.1	0.4	1.2	12.7	-3.7	0	-3.7
2036	3050	1306	4356	73.1	98.7	130.9	43.9	269.0	6.3	8.5	11.3	3.8	9.0	11.4	0.4	1.3	13.1	-4.1	0	-4.1
Ultimate	4568	1533	6101	102.4	140.7	186.8	61.4	385.0	8.8	12.2	16.1	5.3	9.0	15.9	0.4	1.6	18.0	-9.0	9	0.0

Round Hill - indicative supply extent

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	downstream gravity fed reservoirs (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage
2014	3610	1096	4706	79.0	109.3	145.1	47.4	299.4	6.8	9.4	12.5	4.1	11.8	12.3	0.4	2.1	14.8	-3.0	0	-3.0
2016	3666	1096	4762	79.9	110.7	147.0	47.9	303.3	6.9	9.6	12.7	4.1	11.8	12.4	0.4	2.2	15.0	-3.2	0	-3.2
2021	3666	1126	4792	80.4	111.2	147.6	48.3	304.6	6.9	9.6	12.8	4.2	11.8	12.5	0.4	2.7	15.6	-3.8	0	-3.8
2026	4080	1427	5508	92.4	126.7	168.1	55.5	346.4	8.0	10.9	14.5	4.8	11.8	14.4	0.4	2.9	17.7	-5.9	0	-5.9
2031	4152	1576	5727	96.1	131.0	173.7	57.7	357.6	8.3	11.3	15.0	5.0	11.8	14.9	0.4	3.6	19.0	-7.2	9.1	1.9
2036	4341	1586	5927	99.5	135.9	180.3	59.7	371.3	8.6	11.7	15.6	5.2	11.8	15.5	0.4	3.9	19.8	-8.0	9.1	1.1
Ultimate	4598	1586	6184	103.8	142.4	188.9	62.3	389.4	9.0	12.3	16.3	5.4	11.8	16.1	0.4	4.3	20.9	-9.1	9.1	0.0

Zone D Combined

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)	
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	downstream gravity fed reservoirs (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage	
2014	10192	2470	12662	212.5	298.0	396.0	127.5	819.0	18.4	25.7	34.2	11.0	34.0	33.0	1.7	2.6	37.3	-3.3	11.0	7.7	11 ML at Kirkwood Road 2014
2016	11083	2553	13636	228.8	321.8	427.7	137.3	885.0	19.8	27.8	37.0	11.9	34.0	35.6	1.7	2.9	40.2	-6.2	11.0	4.8	
2021	11327	2801	14128	237.1	332.2	441.3	142.3	912.6	20.5	28.7	38.1	12.3	34.0	36.9	1.7	3.4	42.0	-8.0	11.0	3.0	
2026	12531	3125	15656	262.7	367.9	488.8	157.6	1010.7	22.7	31.8	42.2	13.6	34.0	40.9	1.7	3.8	46.4	-12.4	11.0	-1.4	
2031	13606	3273	16880	283.3	397.5	528.1	170.0	1092.4	24.5	34.3	45.6	14.7	34.0	44.1	1.7	4.8	50.6	-16.6	20.1	3.5	9.1 ML at Round Hill at 2031
2036	14229	3373	17602	295.4	414.8	551.2	177.2	1140.2	25.5	35.8	47.6	15.3	34.0	45.9	1.7	5.2	52.9	-18.9	20.1	1.2	
Ultimate	17132	3687	20819	349.4	493.2	655.5	209.6	1357.2	30.2	42.6	56.6	18.1	34.0	54.3	1.7	6.7	62.7	-28.7	29.1	0.4	9 ML at South Gladstone at Ult

Zone A - Fisher Street and Radar Hill

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	downstream gravity fed reservoirs (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage
2014	401	574	974	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2016	401	574	974	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2021	401	574	974	16.4	19.7	26.0	9.8	52.3	1.4	1.7	2.2	0.8	4.6	2.5	0.4	0	3.0	1.6	0	1.6
2026	601	605	1207	20.3	25.3	33.4	12.2	67.7	1.7	2.2	2.9	1.0	4.6	3.1	0.4	0	3.6	1.0	0	1.0
2031	629	628	1257	21.1	26.4	34.8	12.7	70.6	1.8	2.3	3.0	1.1	4.6	3.3	0.4	0	3.7	0.9	0	0.9
2036	685	680	1365	22.9	28.7	37.8	13.7	76.7	2.0	2.5	3.3	1.2	4.6	3.6	0.4	0	4.0	0.6	0	0.6
Ultimate	814	710	1524	25.6	32.4	42.8	15.3	87.0	2.2	2.8	3.7	1.3	4.6	4.0	0.4	0	4.4	0.2	0	0.2

Ferris Hill

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)	
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	downstream gravity fed reservoirs (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage	
2014	1428	1389	2817	47.3	59.3	78.2	28.4	158.7	4.1	5.1	6.8	2.5	8.7	7.4	0.4	0	7.8	0.9	0	0.9	
2016	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6	
2021	1550	1389	2939	49.3	62.3	82.3	29.6	167.3	4.3	5.4	7.1	2.6	8.7	7.7	0.4	0	8.1	0.6	0	0.6	
2026	1663	1392	3055	51.3	65.2	86.2	30.8	175.3	4.4	5.6	7.4	2.7	8.7	8.0	0.4	0	8.4	0.3	0	0.3	
2031	1826	1425	3250	54.5	69.9	92.4	32.7	188.1	4.7	6.0	8.0	2.8	8.7	8.5	0.4	0	8.9	-0.2	2	1.8	2 ML at Ferris Hill at 2031
2036	2019	1559	3578	60.0	77.0	101.8	36.0	207.3	5.2	6.7	8.8	3.1	8.7	9.3	0.4	0	9.8	-1.1	2	0.9	
Ultimate	2258	1583	3841	64.5	83.4	110.3	38.7	225.1	5.6	7.2	9.5	3.3	8.7	10.0	0.4	0	10.5	-1.8	2	0.2	

TOTAL - Gladstone

				Demand (L/s)					Demand (ML/d)					Operational Storage	FF storage Requirement	Contingency Storage Requirements for	Total Storage	Storage excess /deficiency		Storage excess /deficiency (ML)
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current Storage	requirement (ML)	(ML)	downstream gravity fed reservoirs (ML)	Requirement (ML)	(ML) on current storage	Proposed Storage (ML)	on proposed storage
2014	14898	9911	24810	416.4	541.4	716.3	249.8	1462.6	36.0	46.8	61.9	21.6	65.7	64.8	3.5	2.6	70.8	-5.1	31.0	25.9
2016	16179	10337	26516	445.0	580.8	768.6	267.0	1570.4	38.4	50.2	66.4	23.1	65.7	69.2	3.5	2.9	75.6	-9.9	31.0	21.1
2021	17629	10986	28616	480.2	628.2	831.4	288.1	1699.5	41.5	54.3	71.8	24.9	65.7	74.7	3.5	3.4	81.5	-15.8	31.0	15.2
2026	19672	11697	31369	526.4	691.5	915.5	315.9	1872.7	45.5	59.7	79.1	27.3	65.7	81.9	3.5	3.8	89.2	-23.5	32.3	8.8
2031	21520	13959	35480	595.4	776.0	1026.9	357.3	2097.7	51.4	67.0	88.7	30.9	65.7	92.6	3.5	4.8	100.9	-35.2	56.9	21.7
2036	23217	14525	37743	633.4	828.2	1096.2	380.0	2240.6	54.7	71.6	94.7	32.8	65.7	98.5	3.5	5.2	107.2	-41.5	56.9	15.4
Ultimate	28004	15575	43580	731.4	966.4	1279.8	438.8	2620.6	63.2	83.5	110.6	37.9	65.7	113.9	3.6	6.7	124.2	-58.5	65.9	7.4

Appendix E Pump Station Capacity Assessment

High Lift station (included requirement for maximum pumped flow to TBBW and Calliope)

				Demand (L/s)					Demand (ML/d)															
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current duty flow capcacity (L/s)	Duty flow requirement (L/s)	excess / deficiency (L/s)	Proposed PS capacity (L/s)	excess / deficiency (L/s)		Static HGL lift (m)	Diameter of suppy main (mm)		Friction Headloss (m)	Head gain requirement (m)	Power (kW)
Existing	12334	5713	18047	302.9	406.4	538.6	181.7	1105.9	26.2	35.1	46.5	15.7	600.0	695.6	-95.6	600.0	-95.6							
2014	10807	6470	17277	289.9	380.6	503.9	174.0	1030.6	25.1	32.9	43.5	15.0	600.0	664.7	-64.7	900.0	235.3							
2016	11750	6842	18593	312.0	410.6	543.7	187.2	1112.5	27.0	35.5	47.0	16.2	600.0	820.8	-220.8	900.0	79.2							
2021	12236	7424	19661	330.0	432.6	572.7	198.0	1171.1	28.5	37.4	49.5	17.1	600.0	872.2	-272.2	900.0	27.8							
2026	13545	8082	21627	363.0	476.6	631.0	217.8	1290.6	31.4	41.2	54.5	18.8	600.0	924.9	-324.9	1200.0	275.1							
2031	14737	10285	25022	419.9	543.6	719.0	252.0	1467.1	36.3	47.0	62.1	21.8	600.0	1113.3	-513.3	1200.0	86.7							
2036	15550	10638	26188	439.5	570.0	754.0	263.7	1539.0	38.0	49.2	65.1	22.8	600.0	1145.0	-545.0	1200.0	55.0							
Ultimate	18607	11546	30153	506.0	662.2	876.4	303.6	1791.6	43.7	57.2	75.7	26.2	600.0	1564.6	-964.6	1600.0	35.4							

Low Lift Station

				Demand (L/s)					Demand (ML/d)															
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current duty flow capcacity (L/s)	Duty flow requirement (L/s)	excess / deficiency (L/s)	Proposed PS capacity (L/s)	excess / deficiency (L/s)		Static HGL lift (m)	Diameter of suppy main (mm)		Friction Headloss (m)	Head gain requirement (m)	Power (kW)
Existing	2564	4016	6580	110.4	131.9	173.7	66.3	349.0	9.5	11.4	15.0	5.7	157.7	158.3	-0.6	157.7	-0.6							
2014	1829	1963	3792	63.6	79.0	104.2	38.2	211.0	5.5	6.8	9.0	3.3	157.7	94.8	62.9	157.7	62.9							
2016	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	157.7	98.5	59.2	157.7	59.2							
2021	1951	1963	3913	65.7	82.0	108.3	39.4	219.5	5.7	7.1	9.4	3.4	157.7	98.5	59.2	157.7	59.2							
2026	2265	1997	4262	71.5	90.5	119.6	42.9	243.0	6.2	7.8	10.3	3.7	157.7	108.6	49.1	157.7	49.1							
2031	2454	2053	4507	75.6	96.2	127.2	45.4	258.6	6.5	8.3	11.0	3.9	157.7	115.5	42.2	157.7	42.2							
2036	2704	2238	4943	83.0	105.6	139.6	49.8	284.0	7.2	9.1	12.1	4.3	157.7	126.8	30.9	157.7	30.9							
Ultimate	3072	2294	5365	90.0	115.8	153.1	54.0	312.1	7.8	10.0	13.2	4.7	157.7	139.0	18.7	157.7	18.7							

Auckland Creek WPS

				Demand (L/s)					Demand (ML/d)															
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current duty flow capcacity (L/s)	Duty flow requirement (L/s)	excess / deficiency (L/s)	Proposed PS capacity (L/s)	excess / deficiency (L/s)		Static HGL lift (m)	Diameter of suppy main (mm)		Friction Headloss (m)	Head gain requirement (m)	Power (kW)
Existing	5130	795	5925	99.4	142.5	189.5	59.7	393.3	8.6	12.3	16.4	5.2	130	171.0	-41.0	130	-41.0							
2014	2563	356	2919	49.0	70.5	93.8	29.4	194.8	4.2	6.1	8.1	2.5	130	84.6	45.4	130	45.4							
2016	2671	356	3027	50.8	73.2	97.4	30.5	202.3	4.4	6.3	8.4	2.6	130	87.8	42.2	130	42.2							
2021	2678	410	3087	51.8	74.3	98.8	31.1	205.1	4.5	6.4	8.5	2.7	130	89.1	40.9	130	40.9							
2026	2955	410	3365	56.5	81.3	108.1	33.9	224.6	4.9	7.0	9.3	2.9	130	97.5	32.5	130	32.5							
2031	3120	410	3530	59.2	85.4	113.7	35.5	236.1	5.1	7.4	9.8	3.1	130	102.5	27.5	130	27.5							
2036	3286	410	3696	62.0	89.6	119.2	37.2	247.8	5.4	7.7	10.3	3.2	130	107.5	22.5	130	22.5							
Ultimate	3567	410	3977	66.7	96.7	128.7	40.0	267.5	5.8	8.4	11.1	3.5	130	116.0	14.0	130	14.0							

Kirkwood Road WPS - future

				Demand (L/s)					Demand (ML/d)																
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current duty flow capcacity (L/s)	Duty flow requirement (L/s)	excess / deficiency (L/s)	Proposed PS capacity (L/s)	excess / deficiency (L/s)		Static HGL lift (m)	Diameter of suppy main (mm)	Length of supply main (m)	Friction Headloss (m)	Head gain requirement (m)	Power (kW)	
Existing	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0								
2014	1418	7	1425	23.9	35.8	47.7	14.3	99.8	2.1	3.1	4.1	1.2	0	43.0	-43.0	80	37.0		32.0	375.0	950.0	1.6	33.6	37.6	
2016	1964	72	2035	34.2	50.6	67.5	20.5	140.8	3.0	4.4	5.8	1.8	0	60.8	-60.8	80	19.2		32.0	375.0	950.0	1.6	33.6	37.6	
2021	1964	72	2035	34.2	50.6	67.5	20.5	140.8	3.0	4.4	5.8	1.8	0	60.8	-60.8	80	19.2		32.0	375.0	950.0	1.6	33.6	37.6	
2026	2475	72	2546	42.7	63.5	84.6	25.6	176.6	3.7	5.5	7.3	2.2	0	76.2	-76.2	80	3.8		32.0	375.0	950.0	1.6	33.6	37.6	
2031	3314	72	3386	56.8	84.6	112.8	34.1	235.5	4.9	7.3	9.7	2.9	0	101.6	-101.6	160	58.4		32.0	375.0	950.0	5.7	37.7	84.5	Increase pump station capacity to Ultimate sizing
2036	3551	72	3623	60.8	90.6	120.8	36.5	252.1	5.3	7.8	10.4	3.2	0	108.7	-108.7	160	51.3		32.0	375.0	950.0	5.7	37.7	84.5	
Ultimate	4399	158	4557	76.5	113.4	151.1	45.9	315.2	6.6	9.8	13.1	4.0	0	136.1	-136.1	160	23.9		32.0	375.0	950.0	5.7	37.7	84.5	

Kirkwood Road High - future

				Demand (L/s)					Demand (ML/d)															
Planning Horizon	Total Res ET	Non Res ET	Total ET	AD	MDMM	MD	Min Day	MH	AD	MDMM	MD	Min Day	Current duty flow capcacity (L/s)	Duty flow requirement (L/s)	excess / deficiency (L/s)	Proposed PS capacity (L/s)	excess / deficiency (L/s)		Static HGL lift (m)	Diameter of suppy main (mm)	Length of supply main (m)	Friction Headloss (m)	Head gain requirement (m)	Power (kW)
Existing	0		0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0							
2014	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0		20.0	200.0	650.0	0.0		
2016	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0		20.0	200.0	650.0	0.0		
2021	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0		20.0	200.0	650.0	0.0		
2026	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0		20.0	200.0	650.0	0.0		
2031	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0		20.0	200.0	650.0	0.0		
2036	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0		20.0	200.0	650.0	0.0		
Ultimate	752	21.9	774	13.0	19.3	25.7	7.8	53.7	1.1	1.7	2.2	0.7	0	46.3	-46.3	50	3.7		20.0	250.0	650.0	3.3	23.3	16.3

Patterson 2 future WPS

Planning Horizon	Total Res ET	Non Res ET	Total ET	Demand (L/s) AD	MDMM	MD	Min Day	MH	Demand (ML/d) AD	MDMM	MD	Min Day	Current duty flow capcacity (L/s)	Duty flow requirement (L/s)	excess / deficiency (L/S)	Proposed PS capacity (L/s)	excess / deficiency (L/S)		Static HGL lift (m)	Diameter of suppy main (mm)	Length of supply main (m)	Friction Headloss (m)	Head gain requirement (m)	Power (kW)
Existing	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	0.0	0	0.0							
2014	2829	1848	4677	78.5	102.2	135.3	47.1	276.3	6.8	8.8	11.7	4.1	0	122.7	-122.7	205	82.3		38.0	450.0	1500.0	5.9	43.9	125.9
2016	3097	1915	5012	84.1	110.1	145.7	50.5	297.9	7.3	9.5	12.6	4.4	0	132.1	-132.1	205	72.9		38.0	450.0	1500.0	5.9	43.9	125.9
2021	4303	1999	6302	105.8	141.9	188.0	63.5	386.1	9.1	12.3	16.2	5.5	0	170.2	-170.2	205	34.8		38.0	450.0	1500.0	5.9	43.9	125.9
2026	4828	2021	6849	114.9	155.5	206.2	69.0	423.8	9.9	13.4	17.8	6.0	0	186.6	-186.6	205	18.4		38.0	450.0	1500.0	5.9	43.9	125.9
2031	5411	2027	7438	124.8	170.2	225.9	74.9	465.0	10.8	14.7	19.5	6.5	0	204.3	-204.3	205	0.7		38.0	450.0	1500.0	5.9	43.9	125.9
2036	6203	2061	8265	138.7	190.8	253.2	83.2	522.0	12.0	16.5	21.9	7.2	0	228.9	-228.9	260	31.1		38.0	450.0	1500.0	9.1	47.1	171.5
Ultimate	6967	2143	9110	152.9	211.3	280.6	91.7	579.0	13.2	18.3	24.2	7.9	0	253.6	-253.6	260	6.4		38.0	450.0	1500.0	9.1	47.1	171.5

Appendix F Proposed Infrastructure Schedules

Table F1: Gladstone Water Supply Augmentations and Costing

ID	LGIP or IPP	Planning Horizon	Water Supply Scheme	Water Supply Zone	Upgrade Type	Diameter (mm)	Length (m)	Address	Commentary	ET Trigger and Commentary	Geology	Landuse (Rural/Urban)	Unit Rate ($/m)	Item Cost Estimate ($)	Contingency	Cost Estimate including contingency (%)
WRM_D_061	IPP	2014	Gladstone	Zone D	Reticulation	200	90	Easment between Wivenhoe Close and Ben Lexcen Court	Zone D internal reticulation network connection. Resolves low presure in Ben Lexcen Court	Required at 2014 for resolvinf local maximum hour and fire flow losses resulting in pressure failure.	Clay	Urban	495.06	$ 50,000	0%	$ 50,000
WRM_D_081	IPP	2014	Gladstone	Zone D	Reticulation	200	230	Philip Street	proposed for resolution of low pressure in Marian Close	Proposed to resolve local existing low pressures and reduce head losses. 2014	Clay	Urban	495.06	$ 120,000	0%	$ 120,000
WRM_D_062	IPP	2021	Gladstone	Zone D	Reticulation	200	130	Eungella Parade, Clinton	Upgrade to service develompent of LotPLan 25SP206873	Upgrade to service develompent of LotPLan 25SP206873 at 2021	Clay	Urban	495.06	$ 70,000	0%	$ 70,000
WRM_BC_086	IPP	2036	Gladstone	Zone BC	Reticulation	200	200	Paterson Street	Zone BC Internal Trunk Connection	Proposed to resolve local low pressures at 2036	Clay	Urban	495.06	$ 100,000	0%	$ 100,000
WRM_D_063	IPP	2036	Gladstone	Zone D	Reticulation	150	170	Kirkwood Road to Karamea Close	new connection to internal trunk main	Local upgrade to resolve pressures in local area falling below 25 m in 2036	Clay	Urban	341.88	$ 60,000	0%	$ 60,000
WTM_D_022	IPP	2040	Gladstone	Zone D	Trunk	300	10	Kirkwood Road development land	Kirkwood Road HLZ reservoir supply main, supply upstream of Kirkwood Road HLZ WPS	Required 1st lot (1 ET) in Kirkwood Road HLZ. Expected at Ultimate	Clay	Greenfield	578.31	$ 10,000	0%	$ 10,000
WTM_D_025	IPP	2040	Gladstone	Zone D	Trunk	250	30	Kirkwood Road development land	Kirkwood Road HLZ reservoir supply main, rising main to Kirkwood Road HLZ reservoir	Required 1st lot (1 ET) in Kirkwood Road HLZ. Expected at Ultimate	Clay	Greenfield	495.06	$ 20,000	0%	$ 20,000
WTM_D_077	IPP	2040	Gladstone	Zone D	Trunk	300	30	South Gladstone resevoir site	South Gladstone 2 reservoir outlet main	Required with construcution of the South Gladstone 2 reservoir (9 ML) at Ultimate to resolve storage deficiencies. Combined Zone D ET > 20000 ET	Clay	Urban	658.23	$ 20,000	0%	$ 20,000
WRM_D_031	IPP	2040	Gladstone	Zone D	Reticulation	150	100	Eucalyptus Place	Kirkwood Road High Level extension to existing serviced properties in Eucalyptus Drive	Construct when Kirkwood Road HLZ extends to the north east toward Eucalyptus Drive.	Clay	Urban	341.88	$ 40,000	0%	$ 40,000
WTM_D_072	IPP	2040	Gladstone	Zone D	Trunk	300	70	Glen Eden	Internal trunk main for supply to future growth	Network trunk main for supply to development in Glen Eden at Ultimate. Combined Zone D ET > 18000 ET	Clay	Urban	658.23	$ 50,000	0%	$ 50,000
WTM_D_029	IPP	2040	Gladstone	Zone D	Trunk	200	130	Col Brown Avenue, Clinton	Upgrade of a 100 mm diameter section of main currently experiencing excessive head loss resulting in local pressure failures.	Required at Ultimate. Linked to Ultimate development size in Lot/Plan 25SP206873 & 25SP206873. Combined ET > 260 ET	Clay	Urban	495.06	$ 70,000	0%	$ 70,000
WTM_D_023	IPP	2040	Gladstone	Zone D	Trunk	300	140	Kirkwood Road development land	Kirkwood Road HLZ reservoir supply main, supply upstream of Kirkwood Road HLZ WPS	Required 1st lot (1 ET) in Kirkwood Road HLZ. Expected at Ultimate	Clay	Greenfield	578.31	$ 90,000	0%	$ 90,000
WTM_D_027	IPP	2040	Gladstone	Zone D	Trunk	300	190	Kirkwood Road development land	Kirkwood Road HLZ reservoir supply main, supply upstream of Kirkwood Road HLZ WPS	Required 1st lot (1 ET) in Kirkwood Road HLZ. Expected at Ultimate	Clay	Greenfield	578.31	$ 110,000	0%	$ 110,000
WTM_D_024	IPP	2040	Gladstone	Zone D	Trunk	300	230	Kirkwood Road development land	Kirkwood Road HLZ reservoir supply main, supply upstream of Kirkwood Road HLZ WPS	Required 1st lot (1 ET) in Kirkwood Road HLZ. Expected at Ultimate	Clay	Greenfield	578.31	$ 140,000	0%	$ 140,000
WTM_D_073	IPP	2040	Gladstone	Zone D	Trunk	200	490	Glen Eden	Internal trunk main for supply to future growth	Network trunk main for supply to development in Glen Eden at Ultimate. Combined Zone D ET > 18000 ET	Clay	Urban	495.06	$ 250,000	0%	$ 250,000
WTM_D_071	IPP	2040	Gladstone	Zone D	Trunk	300	400	Glen Eden	Internal trunk main for supply to future growth	Network trunk main for supply to development in Glen Eden at Ultimate. Combined Zone D ET > 18000 ET	Clay	Urban	658.23	$ 270,000	0%	$ 270,000
WTM_D_074	IPP	2040	Gladstone	Zone D	Trunk	300	400	Glen Eden	Internal trunk main for supply to future growth	Network trunk main for supply to development in Glen Eden at Ultimate. Combined Zone D ET > 18000 ET	Clay	Urban	658.23	$ 270,000	0%	$ 270,000
WTM_D_026	IPP	2040	Gladstone	Zone D	Trunk	250	610	Kirkwood Road development land	Kirkwood Road HLZ reservoir supply main, rising main to Kirkwood Road HLZ reservoir	Required 1st lot (1 ET) in Kirkwood Road HLZ. Expected at Ultimate	Clay	Greenfield	495.06	$ 310,000	0%	$ 310,000
WTM_D_070	IPP	2040	Gladstone	Zone D	Trunk	300	460	Glen Eden	Internal trunk main for supply to future growth	Network trunk main for supply to development in Glen Eden at Ultimate. Combined Zone D ET > 18000 ET	Clay	Urban	658.23	$ 310,000	0%	$ 310,000
WTM_A_045	LGIP	2014	Gladstone	Zone A	Trunk	300	30	166 Glenlyon Road	Fisher Street Resevoir to Zone A connection	Required at the timing of rezone of the Fisher Street WSZ to the NRG WSZ, such that the Fisher Street resevoir then supports Radar Hill and Ferris Hill reservoirs in supply to Zone A. An existing requirement. Current Fisher Street WSZ ET > 881	Clay	Urban	658.23	$ 20,000	0%	$ 20,000
WTM_A_089	LGIP	2014	Gladstone	Zone A	Trunk	375	700	Glenlyon Road	Replacement of 300 mm diameter main in Glenlyon road with a 375 mm diameter main as the inlet to Fisher Street, Radar Hill and Ferris Hill reservoirs	Required upon commissioning with the construction of the Paterson 2 reservoir	Clay	Urban	821.4	$ 580,000	0%	$ 580,000
WTM_BC_046	LGIP	2014	Gladstone	Zone BC	Trunk	300	40	William St and Glenlyon St Gladstone Central	Zone BC trunk main connection to facilitate supply into the CBD area	Required at the timing of the Zone BC extension for zone setup and establishment Zone BC ET > 1877 ET	Clay	Urban	658.23	$ 30,000	0%	$ 30,000
WTM_BC_048	LGIP	2014	Gladstone	Zone BC	Trunk	300	60	Hanson Road and Yaroon Street	Zone BC Internal Trunk Connection	Required at the timing of the Zone BC extension for zone setup and establishment Zone BC ET > 1877 ET	Clay	Urban	658.23	$ 40,000	0%	$ 40,000
WRM_BC_083	LGIP	2014	Gladstone	Zone BC	Trunk	200	110	Yaroon Street	Zone BC Internal Trunk Connection	Required at the timing of the Zone BC extension for zone setup and establishment. Zone BC ET > 1877 ET	Clay	Urban	495.06	$ 60,000	0%	$ 60,000
WTM_BC_094	LGIP	2014	Gladstone	Zone BC	Trunk	200	230	Paterson Street	New Inlet main to the Paterson Street reservoir	Required upon construction of the Glenlyon Road reservoir and the increase in the extent of Zone BC	Clay	Urban	495.06	$ 120,000	0%	$ 120,000
WTM_BC_047	LGIP	2014	Gladstone	Zone BC	Trunk	300	220	William Street, Gladstone Central	Zone BC internal trunk main, to facilitate supply into the CBD area	Required at the timing of the Zone BC extension for zone setup and establishment Zone BC ET > 1877 ET	Clay	Urban	658.23	$ 150,000	0%	$ 150,000
WTM_BC_043	LGIP	2014	Gladstone	Zone BC	Trunk	450	160	New Zone BC Reservoir Site - Glenlyon Road	Glenlyon Road reservoir outlet	Required with construction of Glenlyon Road resevoir to resolve existing storage deficiencies in Zone BC and Low Lift WSZs. An existing requirement. Zone BC WSZ ET > 1877 ET	Clay	Urban	986.79	$ 160,000	0%	$ 160,000

Table F1: Gladstone Water Supply Augmentations and Costing

ID	LGIP or IPP	Planning Horizon	Water Supply Scheme	Water Supply Zone	Upgrade Type	Diameter (mm)	Length (m)	Address	Commentary	ET Trigger and Commentary	Geology	Landuse (Rural/Urban)	Unit Rate ($/m)	Item Cost Estimate ($)	Contingency	Cost Estimate including contingency (%)
WTM_BC_049	LGIP	2014	Gladstone	Zone BC	Trunk	300	410	Yaroon Street	Zone BC Internal Trunk Connection	Required at the timing of the Zone BC extension for zone setup and establishment Zone BC ET > 1877 ET	Clay	Urban	658.23	$ 270,000	0%	$ 270,000
WTM_BC_058	LGIP	2014	Gladstone	Zone BC	Trunk	375	450	Breslin Street and Glenlyon Street	Connection from new Glenlyon Road reservoir to internal Zone BC network	Required at the timing of the Glenlyon Road reservoir for zone setup and establishment. Zone BC ET > 1877 ET	Clay	Urban	821.4	$ 370,000	0%	$ 370,000
WTM_BC_044	LGIP	2014	Gladstone	Zone BC	Trunk	450	500	151 Glenlyon Street	Glenlyon Road reservoir trunk main connection	Required at the timing of the Zone BC extension for zone setup and establishment. Zone BC WSZ ET > 1877 ET	Clay	Urban	986.79	$ 500,000	0%	$ 500,000
WTM_BC_093	LGIP	2014	Gladstone	Zone BC	Trunk	375	870	Round Hill reservoir to Glenlyon Road reservoir	Inlet main to the proposed Glenlyon Road reservoir from the Round Hill reservoir	Required upon construction of the Glenlyon Road reservoir	Clay	Urban	821.4	$ 720,000	0%	$ 720,000
WTM_D_051	LGIP	2014	Gladstone	Zone D	Trunk	200	20	2 Ballantine Street	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13027 ET	Clay	Urban	495.06	$ 10,000	0%	$ 10,000
WTM_D_053	LGIP	2014	Gladstone	Zone D	Trunk	200	20	Shaw Street, New Aukland	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13000 ET	Clay	Urban	495.06	$ 10,000	0%	$ 10,000
WTM_D_052	LGIP	2014	Gladstone	Zone D	Trunk	300	30	20 Ballantine Street	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13027 ET	Clay	Urban	658.23	$ 20,000	0%	$ 20,000
WTM_D_050	LGIP	2014	Gladstone	Zone D	Trunk	200	50	Shaw Street, New Aukland	Clinton Reservoir dedicated supply works	An existing requirement for combining Zone D and Clinton WSZs and to enable to supply of the proposed Kirkwood Road reservoir into the Zone D/Clinton WSZ. Combined Zone D ET > 13027 ET	Clay	Urban	495.06	$ 30,000	0%	$ 30,000
WTM_D_055	LGIP	2014	Gladstone	Zone D	Trunk	500	30	Lot 319 CL 40130 Haddock Drive	Kirkwood Low reservoir outlet	Required with construcution of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	1184.37	$ 40,000	0%	$ 40,000
WTM_D_028	LGIP	2014	Gladstone	Zone D	Trunk	500	60	Lot 319 CL 40130 Haddock Drive	Kirkwood Low reservoir outlet	Required with construcution of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	1184.37	$ 80,000	0%	$ 80,000
WTM_D_033	LGIP	2014	Gladstone	Zone D	Trunk	375	90	Haddock Drive	Kirkwood Low Reservoir Inlet	Required with construcution of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	821.4	$ 80,000	0%	$ 80,000
WTM_D_019	LGIP	2014	Gladstone	Zone D	Trunk	500	540	Kirkwood Road	Internal trunk main for connection of the Kirkwood low reservoir to the Zone D water supply network	Required with construcution of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	1184.37	$ 640,000	0%	$ 640,000
WTM_D_020	LGIP	2014	Gladstone	Zone D	Trunk	500	550	Kirkwood Road	Internal trunk main for connection of the Kirkwood low reservoir to the Zone D water supply network	Required with construcution of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	1184.37	$ 660,000	0%	$ 660,000
WTM_D_030	LGIP	2014	Gladstone	Zone D	Trunk	375	880	Haddock Drive	Kirkwood Low Reservoir Inlet	Required with construcution of the Kirkwood Road reservoir to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	821.4	$ 730,000	0%	$ 730,000
WTM_D_018	LGIP	2014	Gladstone	Zone D	Trunk	450	780	Kirkwood Road	Internal trunk main for connection of the Kirkwood low reservoir to the Zone D water supply network	Required with construcution of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	986.79	$ 770,000	0%	$ 770,000
WTM_D_054	LGIP	2014	Gladstone	Zone D	Trunk	500	770	Kirkwood Road	Kirkwood Low reservoir outlet	Required with construcution of the Kirkwood Road reservoir (11 ML) to resolve current storage deficiencies. Combined Zone D ET > 13000 ET	Clay	Urban	1184.37	$ 920,000	0%	$ 920,000
WTM_D_059	LGIP	2014	Gladstone	Zone D	Trunk	500	1320	Clinton resevoir to J Hickey Avenue	Clinton resevoir outlet to replace dedicated inlet main	Required as a replacement for the current inlet/outlet main to Clinton resevoir once made a dedicated supply. Combined Zone D WSZ ET > 13000 ET	Clay	Urban	1184.37	$ 1,570,000	0%	$ 1,570,000
WTM_F_092	LGIP	2014	Gladstone	Zone F	Trunk	300	830	Paterson Street	New Supply Main to Zone F	New supply main to NRG currently committed to construction and driven by road works at Philip Street and Dawson Highway intersection	Clay	Urban	658.23	$ 550,000	0%	$ 550,000
WTM_F_091	LGIP	2014	Gladstone	Zone F	Trunk	375	860	Round Hill reservoir to Paterson Street	New Supply Main to Zone F and Paterson St Reservoir	New supply main to NRG and Paterson St reservoirs, required at supply to the NRG zone from Round Hill via Paterson Street (see WTM_F_092)	Clay	Urban	821.4	$ 710,000	0%	$ 710,000
WTM_A_085	LGIP	2026	Gladstone	Zone A	Trunk	300	20	Corner of Tank Street and Auckland Street	Zone A rezoning establishment	Required for the segmentation of Ferris Hill and Zone A WSZs. Proposed at 2026 before storage requirements become critical due to different bottom water levels. Combined Zone ET > 4250 ET	Clay	Urban	658.23	$ 20,000	0%	$ 20,000
WTM_D_060	LGIP	2026	Gladstone	Zone D	Trunk	375	440	Chapman Drive	Extension of Clinton resevoir outlet to replace dedicated inlet main	Required in 2021 as a extension of the Clinton reservoir outlet main. Connects outlet main to the 300 mm diameter main in Harvey Road facilitating supply from Clinton reservoir to the south. Combined Zone D WSZ ET > 14000 ET	Clay	Urban	821.4	$ 370,000	0%	$ 370,000

Table F1: Gladstone Water Supply Augmentations and Costing

ID	LGIP or IPP	Planning Horizon	Water Supply Scheme	Water Supply Zone	Upgrade Type	Diameter (mm)	Length (m)	Address	Commentary	ET Trigger and Commentary	Geology	Landuse (Rural/Urban)	Unit Rate ($/m)	Item Cost Estimate ($)	Contingency	Cost Estimate including contingency (%)
WTM_G_084	LGIP	2026	Gladstone	Zone G	Trunk	300	10	Corner of Herbert Street and Auckland Street	Ferris Hill interconnnection for rezone establishment	Required for the segmentation of Ferris Hill and Zone A WSZs. Proposed at 2026 before storage requirements become critical due to different bottom water levels. Combined Zone ET > 4250 ET	Clay	Urban	658.23	$ 10,000	0%	$ 10,000
WTM_D_038	LGIP	2031	Gladstone	Zone D	Trunk	450	20	Round Hill reservoir site	Round Hill 2 pipework	Required with construction of Round Hill 2 resevoir (7.2 ML) to resolve 2031 storage deficiencies in Zone D. Combined Zone D ET > 17241 ET	Clay	Urban	986.79	$ 20,000	0%	$ 20,000
WTM_D_039	LGIP	2031	Gladstone	Zone D	Trunk	450	30	Round Hill reservoir site	Round Hill 2 pipework	Required with construction of Round Hill 2 resevoir (7.2 ML) to resolve 2031 storage deficiencies in Zone D. Combined Zone D ET > 17241 ET	Clay	Urban	986.79	$ 30,000	0%	$ 30,000
WTM_D_088	LGIP	2031	Gladstone	Zone D	Trunk	200	220	Boonderee Place to Penda Avenue	Zone D internal connection for low pressure Goodnight Place	Proposed to resolve local low pressures first appearing at the 2031 planning horizon	Clay	Urban	495.06	$ 110,000	0%	$ 110,000
WTM_D_087	LGIP	2031	Gladstone	Zone D	Trunk	300	390	Harvey road vacant land	Internal Zone D Interconnnection for low pressures Brindabella Parade and to facilitate supply from the Clinton reservoir into this area.	Proposed to resolve local low pressures first appearing at the 2031 planning horizon	Clay	Urban	658.23	$ 260,000	0%	$ 260,000
WTM_D_034	LGIP	2031	Gladstone	Zone D	Trunk	450	880	Glenlyon Road	Augmentation of 375 mm diameter supply to Calliope and Kirkwood Road Low	Required at the timing of the pump station upgrade at Kirkwood Road Low WPS (2031) to maintain HGL to the suction side of pump station and maintain HGL in supply to Calliope. Approximate ET in Zone D ~ 16880 ET	Clay	Urban	986.79	$ 870,000	0%	$ 870,000
WTM_D_021	LGIP	2031	Gladstone	Zone D	Trunk	450	3100	Glenlyon Road to Haddock Drive	Augmentation of 375 mm diameter supply to Calliope and Kirkwood Road Low Level Supply	Required at the timing of the pump station upgrade at Kirkwood Road Low WPS (2031) to maintain HGL to the suction side of pump station and maintain HGL in supply to Calliope. Approximate ET in Zone D ~ 16880 ET	Clay	Urban	986.79	$ 3,060,000	0%	$ 3,060,000
WTM_F_040	LGIP	2031	Gladstone	Zone F	Trunk	450	50	NRG reservoir Site	New reservoir pipework	Required with construction of NRG 2 resevoir (7.0 ML) to resolve 2031 storage deficiencies in extended NRG WSZ. Combined Zone D ET > 5172 ET	Clay	Urban	986.79	$ 50,000	0%	$ 50,000
WTM_F_041	LGIP	2031	Gladstone	Zone F	Trunk	300	80	NRG Reservoir Site	New reservoir pipework	Required with construction of NRG 2 resevoir (7.0 ML) to resolve 2031 storage deficiencies in extended NRG WSZ. Combined Zone D ET > 5127 ET	Clay	Urban	658.23	$ 60,000	0%	$ 60,000
WTM_G_035	LGIP	2031	Gladstone	Zone G	Trunk	500	50	Ferris Hill reservoir site	Ferris Hill No. 2 Pipework	Required with construction of Ferris Hill reservoir 2 proposed for 2031. Ferris Hill ET > 3100 ET.	Clay	Urban	1184.37	$ 60,000	0%	$ 60,000
WTM_G_032	LGIP	2031	Gladstone	Zone G	Trunk	600	70	Ferris Hill reservoir site	Ferris Hill No. 2 Pipework	Required with construction of Ferris Hill reservoir 2 proposed for 2031. Ferris Hill ET > 3100 ET.	Clay	Urban	1398.6	$ 100,000	0%	$ 100,000

Table F2: Gladstone Fire Flow Augmentation and Costing Table

ID New	LGIP or IPP	Planning Horizon	Water Supply Scheme	Water Supply Zone	Upgrade Type	Diameter (mm)	Length (m)	Address	Commentary	ET Trigger and Commentary	Geology	Landuse (Rural/Urban)	Unit Rate ($/m)	Item Cost Estimate ($)	Contingency	Cost Estimate including contingency (%)
WRM_D_FF_321	IPP	2014	Gladstone	Zone D	FF	150	230	South Trees Drive	FF upgrade - South Trees Drive industrial area	Fire flow 2014	Clay	Urban	341.88	$ 80,000	0%	$ 80,000
WRM_D_FF_323	IPP	2014	Gladstone	Zone D	FF	150	190	South Trees Drive	FF upgrade - South Trees Drive industrial area	Fire flow 2014	Clay	Urban	341.88	$ 70,000	0%	$ 70,000
WRM_D_FF_324	IPP	2014	Gladstone	Zone D	FF	150	550	South Trees Drive	FF upgrade - South Trees Drive industrial area	Fire flow 2014	Clay	Urban	341.88	$ 190,000	0%	$ 190,000
WRM_D_FF_325	IPP	2014	Gladstone	Zone D	FF	200	670	Unnamed Road Glen Eden	FF upgrade - South Trees Drive industrial area	Fire flow 2014	Clay	Urban	495.06	$ 340,000	0%	$ 340,000
WRM_D_FF_326	IPP	2014	Gladstone	Zone D	FF	150	180	Boys Road	FF upgrade - South Trees Drive industrial area	Fire flow 2014	Clay	Urban	341.88	$ 70,000	0%	$ 70,000
WRM_D_FF_327	IPP	2014	Gladstone	Zone D	FF	150	470	Gladstone Benaraby Road	FF upgrade - Gladstone Benarby Road Industrial Demand	Fire flow 2014	Clay	Urban	341.88	$ 170,000	0%	$ 170,000
WRM_D_FF_328	IPP	2014	Gladstone	Zone D	FF	150	300	Soppa Street	FF upgrade - Soppa Street single 100 mm dia	Fire flow 2014	Clay	Urban	341.88	$ 110,000	0%	$ 110,000
WRM_D_FF_329	IPP	2014	Gladstone	Zone D	FF	150	360	Ganley Street and Hixon Street	FF upgrade - Ganley Street and Hixon Street industrial area	Fire flow 2014	Clay	Urban	341.88	$ 130,000	0%	$ 130,000
WRM_D_FF_330	IPP	2014	Gladstone	Zone D	FF	150	270	Philip Street to Windward Passage	FF upgrade - for failure in Windward Passage	Fire flow 2014	Clay	Urban	341.88	$ 100,000	0%	$ 100,000
WRM_D_FF_333	IPP	2016	Gladstone	Zone D	FF	100	270	Archer Street	FF upgrade for Neluna Rise failures	Fire flow 2016	Clay	Urban	246.42	$ 70,000	0%	$ 70,000
WRM_D_FF_335	IPP	2014	Gladstone	Zone D	FF	150	260	Oxley Drive	FF upgrade for failures in vicinity of Koppabella Close, Solonika Court & Adelaide Street	Fire flow 2014	Clay	Urban	341.88	$ 90,000	0%	$ 90,000
WRM_G_FF_301	IPP	2014	Gladstone	Zone G	FF	150	190	Sanctuary Place	FF upgrade for failures in Sanctuary Place vicinity	Fire flow 2014	Clay	Urban	341.88	$ 70,000	0%	$ 70,000
WRM_G_FF_302	IPP	2014	Gladstone	Zone G	FF	150	240	Lyons Street to Dawson Highway	FF upgrade for Lyons Street	Fire flow 2014	Clay	Urban	341.88	$ 90,000	0%	$ 90,000
WRM_G_FF_303	IPP	2014	Gladstone	Zone G	FF	150	260	Young Street	FF upgrade - to industrial customer in Young Street	Fire flow 2014	Clay	Urban	341.88	$ 90,000	0%	$ 90,000
WRM_F_FF_307	IPP	2014	Gladstone	Zone F	FF	150	70	Rollo Street to Hanson Road	FF upgrade for properties in Rollo Street	Fire flow 2014	Clay	Urban	341.88	$ 30,000	0%	$ 30,000
WRM_F_FF_308	IPP	2014	Gladstone	Zone F	FF	150	170	Hilliard Street	FF upgrade for Hilliard Street	Fire flow 2014	Clay	Urban	341.88	$ 60,000	0%	$ 60,000
WRM_F_FF_309	IPP	2014	Gladstone	Zone F	FF	150	340	Rooksby Street	FF upgrade Rooksby Street	Fire flow 2014	Clay	Urban	341.88	$ 120,000	0%	$ 120,000
WRM_BC_FF_316	IPP	2014	Gladstone	Zone BC	FF	150	110	30 Dawson Road	FF upgrade - to hydrant at end of school connection	Fire flow 2014	Clay	Urban	341.88	$ 40,000	0%	$ 40,000
WRM_A_FF_320	IPP	2014	Gladstone	Zone A	FF	150	450	West Gladstone	FF upgrade to Industrial Demand	Fire flow 2014	Clay	Urban	341.88	$ 160,000	0%	$ 160,000
WRM_BC_FF_317	IPP	2021	Gladstone	Zone BC	FF	100	80	151 Glenlyon Street - Higgins Street to Fisher Street	FF upgrade for properties in Higgins Street	Fire flow 2021	Clay	Urban	246.42	$ 20,000	0%	$ 20,000
WRM_G_FF_304	IPP	2014	Gladstone	Zone G	FF	150	160	Off Lane off of Herbert Street	FF upgrade for properties in Off Lane	Fire flow 2014	Clay	Urban	341.88	$ 60,000	0%	$ 60,000
WRM_BC_FF_318	IPP	2016	Gladstone	Zone BC	FF	100	190	Stewart Street to Wenitong Street	FF upgrade for failures in Wenitong Street	Fire flow 2016	Clay	Urban	246.42	$ 50,000	0%	$ 50,000
WRM_D_FF_338	IPP	2016	Gladstone	Zone D	FF	150	170	Warren Street	FF upgrade for commercial FF in Warren Street	Fire flow 2016	Clay	Urban	341.88	$ 60,000	0%	$ 60,000
WRM_G_FF_305	IPP	2016	Gladstone	Zone G	FF	150	130	Yaralla Street	FF upgrade for properties in Yaralla Street	Fire flow 2016	Clay	Urban	341.88	$ 50,000	0%	$ 50,000
WRM_G_FF_306	IPP	2021	Gladstone	Zone G	FF	150	270	McLintock Street	FF upgrade for hydrant at supply to McLintock Street Industrial Customer	Fire flow 2021	Clay	Urban	341.88	$ 100,000	0%	$ 100,000
WRM_A_FF_319	IPP	2036	Gladstone	Zone A	FF	150	110	Central Lane	FF upgrade for at northern end of Central Lane	Fire flow 2036	Clay	Urban	341.88	$ 40,000	0%	$ 40,000

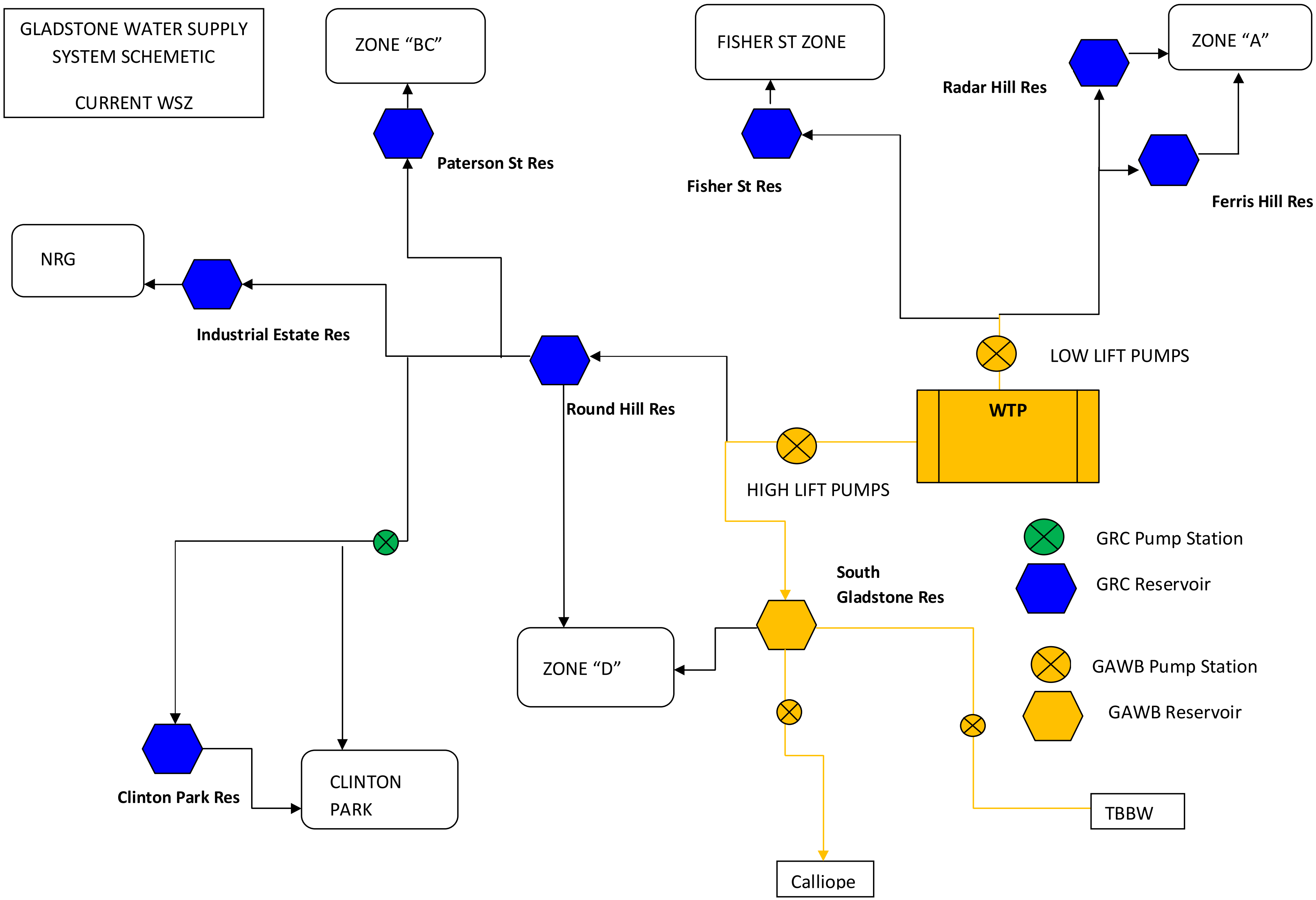
Table F3 : Gladstone Reservoir Augmentation and Costing Table

ID	Planning Horizon	LGIP or IPP	Water Supply Scheme	Water Supply Zone	Upgrade Type	Owner	Volume (ML)	TWL (m)	Address	Commentary	ET Trigger and Commentary	Hard Rock Uplift	Item Cost Estimate ($)	Contingency ($)	Cost Estimate including contingency (%)
WRS_D_201	2040	IPP	Gladstone	Zone D	Trunk	GAWB	9	91.4	South Gladstone Resevoir site	South Gladstone Reservoir 2 (9.0 ML)	Proposed in Ultimate to provide additional storage to Zone D. Combined Zone D ET > 20000 ET	1	$ 2,760,000	$ -	$ 2,760,000
WRS_D_200	2014	LGIP	Gladstone	Zone D	Trunk	GRC	11	91.4	Lot 319 CL 40130 Haddock Drive	Kirkwood Low Resevoir (11 ML)	Proposed to resolve storage deficiencies within the Clinton WSZ along with the merging of the Zone D and Clinton WSZs into a single zone. Storage deficiencies currently exist. Reservoir is proposed in the short term (2014). Combined Zone D ET > 13000 ET	1	$ 2,970,000	$ -	$ 2,970,000
WRS_G_203	2031	LGIP	Gladstone	Zone G	Trunk	GRC	2	61.3	Ferris Hill reservoir site	Ferris Hill No. 2 Reservoir (2.0 ML)	Proposed second reservoir at Ferris Hill to resolve storage deficiencies first experienced at 2031. Ferris Hill ET > 3100 ET	1	$ 1,020,000	$ -	$ 1,020,000
WRS_BC_202	2014	LGIP	Gladstone	Zone BC	Trunk	GRC	20	80.3	Glenlyon Street resevoir site	Glenlyon Road Reservoir - new Zone BC storage (20 ML)	Proposed second resevoir for zone BC. Facilitates the extension of Zone BC WSZ to accommodate part of the Zone A WSZ and remove storage pressure from Zone A. Deficiencies currently exist (2014). Zone BC ET > 1800 ET.	1	$ 4,698,227	$ -	$ 4,700,000
WRS_D_206	2031	LGIP	Gladstone	Zone D	Trunk	GRC	9.1	91.4	Round Hill reservoir site	Round Hill 2 (7.2 ML)	Proposed in 2031 to provide additional storage to Zone D. Combined Zone D ET > 17200 ET	1	$ 2,760,000	$ -	$ 2,760,000
WRS_F_204	2031	LGIP	Gladstone	Zone F	Trunk	GRC	13.5	51.8	NRG resevoir site	New NRG WSZ reservoir (13.5 ML)	Proposed in 2031 to provided additional storage to the extended NRG WSZ. Combined NRG Zone ET > 5100 ET	1	$ 3,615,472	$ -	$ 3,620,000
WRS_D_207	2040	IPP	Gladstone	Zone D	Trunk	GRC	2.3	105	Proposed Kirkwood high level reservoir site	Proposed new reservoir to service future elevated development south of Kirwood (2.3 ML)	Required upon development within the elevated area south of Kirkwood Road unable to be serviced by Zone D. Expected timing is Ultimate based on the development sequencing adopted in this study	1	$ 1,111,448	$ -	$ 1,120,000

Table F4 : Gladstone Pump Station Augmentation and Costing Table

ID	Planning Horizon	Water Supply Scheme	LGIP or IPP	Water Supply Zone	Upgrade Type	Owner	Duty Flow (L/s)	Duty Head (m)	Power (kW)	Address	Commentary	ET Trigger and Commentary	Item Cost Estimate ($)	Contingency ($)	Cost Estimate including contingency (%)
WPS_D_104	2040	Gladstone	IPP	Zone D	Trunk	GRC	50	25	17.5	Kirkwood Road	Kirkwood high	Required first lot (1 ET) in Kirkwood Road	$ 150,000	$ -	$ 150,000
WPS_D_101	2014	Gladstone	GAWB	Zone D	Trunk	GAWB	900	60	756.3	Gladstone WTP high lift pump station	WTP new high lift pump	Upgrade proposed for the 2014 planning horizon. High Lift zones + Calliope and TBBW		$ -	$ -
WPS_D_101a	2026	Gladstone	GAWB	Zone D	Trunk	GAWB	1050	60	1008.4	Gladstone WTP high lift pump station	WTP new high lift pump	Upgrade proposed for the 2026 planning horizon. High Lift zones + Calliope and TBBW		$ -	$ -
WPS_D_101b	2036	Gladstone	GAWB	Zone D	Trunk	GAWB	1250	60	1344.5	Gladstone WTP high lift pump station	WTP new high lift pump	Upgrade proposed for the Ultimate planning horizon. High Lift zones + Calliope and TBBW		$ -	$ -
WPS_D_102	2014	Gladstone	LGIP	Zone D	Trunk	GRC	80	35	39.2	Kirkwood Road WPS - Haddock Drive	New WPS Kirkwood Road	Required at the time of the Kirkwood Low level resevoir. Combined Zone D ET > 13000	$ 330,000	$ -	$ 330,000
WPS_D_102a	2031	Gladstone	LGIP	Zone D	Trunk	GRC	160	40	89.6	Kirkwood Road WPS - Haddock Drive	New WPS Kirkwood Road -	Requried at 2031. Combined Zone D ET > 32000 ET	$ 630,000	$ -	$ 630,000

Appendix G Existing Network Schematic


GLADSTONE WATER SUPPLY
SYSTEM SCHEMETIC
CURRENT WSZ
ZONE “BC”
FISHER ST ZONE
ZONE “A”
Radar Hill Res
Paterson St Res
Fisher St Res
Ferris Hill Res
NRG
Industrial Estate Res
LOW LIFT PUMPS
Round Hill Res
WTP
HIGH LIFT PUMPS
GRC Pump Station
South
Gladstone Res
GRC Reservoir
ZONE “D”
GAWB Pump Station
GAWB Reservoir
CLINTON
PARK
Clinton Park Res
TBBW
Calliope