WIDE BAY water
CORPORATION

2015 | Fraser Coast Water Supply Strategy

August 2015

Wide Bay Water Corporation

29-31 Ellengowan Street
Urangan QLD 4655
Telephone: 1300 79 49 29
Facsimile: (07) 4125 5118
Email: wbw@widebaywater.qld.gov.au

Document Control					
Revision	Author	Reviewer	Approved for Issue		
			Name	Signature	Date
2.0	J Mann	T Dean			

ABBREVIATIONS/DEFINITIONS

ACH	Aluminium Chlorohydrate – A coagulant used in water treatment
AD	Average Day (Water Demand)
ADWG	Australian Drinking Water Guidelines – Australian standard for the safe and aesthetic limits for drinking water parameters including physical and biological limits.
Alum	Aluminium Sulphate – A coagulant used in water treatment
BAC	Biologically Activated Carbon
BWL	Bottom Water Level (Reservoirs)
CBD	Central Business District
CPP	Critical Pressure Point
CW	Clear Water
CWS	Clear Water Storage
DAF	Dissolved Air Floatation – A method of water and wastewater treatment
DBP	Disinfection By Product
DCP	Development Control Plan
DEWS	Department of Energy and Water Supply. Formerly DERM. Publish a “Planning Guidelines for Water Supply and Sewerage” which relates to all levels of infrastructure except source.
DFP	Direct Filtration Plant
DMA	Demand Management Area
DN	Diameter (nominal) usually referring to a pipe size.
DOC	Dissolved organic carbon.
ED	Equivalent Dwelling – A measure to quantify loading of individual properties. Typically a 3 bedroom house is considered as 1 ED.
FF	Firefighting – This is a driver for infrastructure upgrades. It is the quantity of water available in the water supply system for the provision of fire services by mobile fire trucks and fixed booster points, sprinkler systems and hydrants.
GAC	Granular Activated Carbon
GIS	Geographical Information System
HB	Hervey Bay township
HGL	Hydraulic Grade Line
kL	kilolitres
L/s	Litres per Second
m	metres
MB	Maryborough township
MD	Maximum Day
MDMM	Mean Day Maximum Month – is a term used in the DEWS guidelines used to calculate transmission pump capacity and reservoir capacity.
ML	megalitres

ML/d	Megalitres per day
NHMRC	National Health and Medical Research Council
Non potable	Water that is not suitable for drinking because it does not meet ADWG.
OESR	Office of Economic and Statistical Research. Formerly the Planning Information and Forecasting Unit (PIFU).
PAC	Powdered activated carbon
PD	Peak Day
PH	Peak Hour
PIA	Priority Infrastructure Area
Potable	Water that is suitable for drinking. Typically has been treated and chlorinated.
PRV	Pressure Reducing Valve
Residual Pressure	That part of total pressure that is not used to overcome friction or gravity while forcing water through pipes, fittings, fire hoses and adaptors.
SCI	Statement of Corporate Intent
SOS	Standards of Service – This is a driver for infrastructure upgrades. This is the service level that is dictated by development guidelines, WSAA and DEWS guidelines, legislation or WBWC's customer charter.
TDS	Total Dissolved Solids
THM	Trihalomethane's - disinfection by-product formed by the reaction between chlorine and organics in water supply systems. ADWG limit this parameter at 0.25mg/L.
TIA	Tiaro township
TWL	Top Water Level
VOC	Volatile Organic Compound
VSD	Variable Speed Drive – A controller mounted to pumps to enable pressure and/or flow control.
WBWC	Wide Bay Water Corporation – Water utility serving the Fraser Coast in Queensland.
WQ	Water Quality – This is a driver for infrastructure upgrades. It can include water age as well as chlorine levels or other contaminants.
WSAA	Water Services of Australia Services – The peak industry body that supports the Australian Urban Water Industry and publisher of National Codes for the urban water industry.
WTP	Water Treatment Plant – For treating raw water to a quality suitable for drinking.

EXECUTIVE SUMMARY

Wide Bay Water Corporation (WBWC) owns, operates and maintains the water supply networks on the Fraser Coast.

Population growth increases demand on the water supply system. Capital expenditure on water infrastructure is required as demand reaches the capacity of the existing system. This report focuses on the provision of water infrastructure to accommodate anticipated growth to the year 2031 with some key source and treatment infrastructure identified to 2046.

This water strategy examines:

- the volume of source water supplies required to meet projected demands,
- treatment capacity and future augmentation required to meet projected future demands,
- pipe, pump and reservoir capacity to meet the projected future demands.
- quality issues, most notable being disinfection and disinfection by-products.

To undertake the investigation and determine augmentation requirements, extended period simulation water models were updated and analysed using WaterGems computer software. Simulation scenarios were developed using these hydraulic models to examine the impact of forecast water demands to 2031. These models identify network failures under each demand scenario. They also verify that proposed augmentation will meet the required standards of service.

The source and treatment components of the strategy were assessed and analysed using the aggregate water demand growth of all areas of each network.

Growth in the Fraser Coast

The projected growth in the Fraser Coast region is presented in the table below. It is separated into the three unconnected water supply networks of Hervey Bay, Maryborough and Tiaro.

Table 0-1: Projected Water Equivalent Dwellings (ED's)

Year	2016	2021	2026	2031
Hervey Bay	36,630	40,800	45,420	51,390
Maryborough	13,483	13,988	14,514	15,059
Tiaro	345	378	412	445
Total	**50,458**	**55,166**	**60,346**	**66,894**

Findings of the Report

Some of the significant findings of the report are;

- The water consumption per ED in Hervey Bay has increased from 590L/ED/day in 2010 to 630L/ED/day in 2015. This is a 7% increase since the last major review of the water strategies. This demand increase has a wide impact on the Hervey Bay water network from source to pipeline and has brought forward timing of water treatment upgrades at Burgowan.

- Maryborough's water consumption remains consistent at 680L/ED/day, 8% higher than Hervey Bay.

- Source augmentation will be required in 2046 based on current demand forecasts. Potential options for increasing source capacity include Fraser Island water supply, Burnett River water supply, indirect potable reuse and additional allocation from the Mary River. Up to the time of source augmentation it is anticipated that there will be increased frequency of Level 2 water restrictions particularly from the Burrum River supply. Demand Management, water saving devices and reflective pricing of water can all defer the need for source augmentation.

- Burgowan WTP requires additional capacity to meet water demand in 2028. Previously this upgrade was planned after the 2031 planning horizon but the increased demand on the system due to higher per unit consumption indicates the additional treatment capacity will be required sooner than previously expected. The increase in capacity is estimated to cost between $25 to $35m. Maintaining and upgrading Howard WTP could defer this expenditure (at a cost of $12m) although the Hervey Bay THM report has previously determined that upgrading Howard WTP is not a viable or preferred option.

- In order to provide broader security for the Fraser Coast, a water grid is proposed. This consists of a pipeline link between Hervey Bay and Maryborough and would allow treated water to be pumped from one system to the other and vice versa. The estimated cost of this link between Hervey Bay and Maryborough is $26m and has been programed for 2021.

- The aging pipe network in Maryborough continues to be replaced on a priority basis or in conjunction with road reconstruction works. The condition of the cast iron pipes are systematically assessed and replaced as required. There is higher expenditure in the first four (4) years due to these replacements in Maryborough. These assets have exceeded their identified nominal asset life (>80 years) and their level of deterioration is causing reduced performance and increased failure rates. Normally replacement of assets due to their condition is included in an Asset Management Plan. It has been included in this Strategy Plan to identify the level of capital expenditure required over the next 4 years.

- The Water Quality Assessment carried out as part of this Water Strategy Report identified that the installation of additional chlorine booster sites may decrease the overall chlorine dosing in the

Fraser Coast. Not only does this reduce the cost of chlorine being used, it also potentially reduces the formation of disinfection by-products such as THM's.

Capital Expenditure Programme

The report identifies the cost of augmentation works to meet future growth conditions. The total capital expenditure to 2031 is $127m. The major investments (>$500k) are outlined in Table 0-2.

Table 0-2: Major Projects >$500k to 2031

Type	Year	Strategy ID	Project	Cost ($000's)
Reservoir				
	2018	W282	River Heads: Land purchase for reservoir site	615
	2026	W284	Toogoom Reservoir upgrade 1.5Ml	800
	2031	W207	Ghost Hill No. 1 Reservoir upgrade	3,062
	2031	W281	2 Mile Reservoir reinstatement	591
Reservoir Total				**5,068**
Treatment				
	2016	W290	Burgowan WTP Ozone/ BAC treatment upgrade	2,626
	2018	W907	Teddington WTP Lime/CO2 stabilisation	800
	2019	W285	Burgowan WTP: Additional treatment capacity for recycled water (provisional)	5,500
	2020	W906	Teddington WTP - Ozone/BAC process (provisional)	2,700
	2027	W905	Burgowan WTP construction of additional treatment trains	30,000
Treatment Total				**41,626**
Water Main				
	2016 2017	W87	River Heads Rd - Booral Booster pump station to River Heads Reservoir	2,178
	2016	W49	Drury Lane - Urraween Rd to Pialba Burrum Heads Rd	1,962
	2018	W91	Sempfs Rd - between Ansons Rd and Sawmill Rd	740
	2018	W38	Esplanade, Urangan - Boundary Rd and Moolyyir Rd	665
	2020	W178	Doolong South Rd to River Heads Rd	2,850
	2021	W179	Interconnection between Hervey Bay and Maryborough water networks and two pump stations	30,923
	2025	W179	River Heads Rd - River Heads Reservoir to Rd 549	631
	2026	W701	Bayridge to Parklands - Sandy View Dr to Doolong Sth Rd	1,451
	2026	W207	Christensen St - between Hanover Dr and Jacobsen Outlook	686
	2030	W119	Walkers Pt Rd, Granville - Range St to Beaver Rock Rd.	944
	2029	W122	Cardigan St – between Range St and Cambridge St	561
	2027	W115	Alternate supply to Granville - Mary River crossing	1,080
	2030	W9	Hornes Rd - dedicated main to Dundowran zone	1,812
	2031	W84	Boundary Rd - Denman's Camp Rd to Elizabeth St	3,929
Water Main Total				**50,412**
Water Pump Station				
	2016	W206	Madsen Rd pump station construction (Urraween Reservoir)	1,505
	2021	W99	Burgowan Clear Water pump station capacity upgrade	600
	2031	W294	Urraween pump station upgrade	700
Water Pump Station Total				**2,805**
Total				**99,911**

Other capital projects less than $500k are totalised in Table 0-3 below.

Table 0-3: Projects <$500k to 2031 grouped by Project Type

Project Type	Cost ($000's)
Boundary Valve	20
DMA	85
Treatment	1,593
Water Main	23,073
Water PRV	220
Water Pump Station	1,600
Total	**26,591**

Additionally some projects have been identified between 2032 and 2046. The cost of these projects are estimated at $113m and, in large, is made up of an additional water source supply being required by 2046.

It should be noted that this report and the projected capital expenditure does not include operational projects, recurring projects or asset replacement projects (apart from the replacement of cast iron pipes in Maryborough).

Operation Expenditure Program

Throughout the course of In order to meet the objectives of the Water Supply Strategy, some additional planning studies have been identified and are listed in Table 0-4.

Table 0-4: OPEX Planning and Investigative Project Identified in the Strategy

Year	Planning/Investigative Study	Cost ($000's)
2016	Investigate Losses in Maryborough and Tiaro	5
2016	Planning Report - Urraween Water Supply Concept	60
2016	Investigate Viability of Reduced Firefighting Requirements	5
2016	Investigate the Burgowan Clear Water Pump Performance	10
2016	Investigate the Viability of a New Reservoir at Booral	15
2016	Investigate Disinfection Works at Burgowan WTP Gas vs Liquid	15
2016	Investigate and Recommend Chlorine Dosing Regime Over Summer Period	25
2016	Investigation Tiaro WTP - Options Study For Reducing Hardness Of Source Water	20
2016	Planning Report - NOM/DOC Removal Assessment of Options	50
2017	Investigate Viability of Decommissioning Howard WTP	100
2017	Planning Report - River Heads Water Supply Concept	60
2017	Planning Report - Maryborough Water Supply Concept	60
2017	Investigate DMA's For Firefighting And Security Of Supply	10
2017	Planning Report - River Heads Reservoir Options	30
2017	Investigate THM Removal At Tinana Zone	15
2018	Investigate Future Water Sources & Viability Of Fraser Island	95
2018	Investigate Demand Management Initiatives for the Fraser Coast	60
2018	Tiaro - Investigate Water Quality Improvements - Alkalinity	25
2019	Planning Report - Takura Water Supply Concept	60
2019	Planning Report - DMA Improvements	20
2023	Planning Report for Expansion of Burgowan WTP	200
	Grand Total	**940**

Infrastructure Charges

An estimate of infrastructure charges to the 2031 timeframe across the entire Fraser Coast has been developed to allow comparison between projected costs and the amount recouped from developer charges.

The infrastructure cost over the period was restricted to projects that are considered headwork's and are either;

- growth projects,
- required to meet firefighting requirements,
- required for reliability or standards of service,
- benefit multiple land owners (generally pipelines over DN150),
- water quality projects,

Asset replacement projects have been excluded from any calculation whether they satisfy the above criteria or not.

Based on a residential and non-residential ED growth of 16,500ED (to 2031) and a capital expenditure of $109m, the cost to provide water infrastructure to meet projected demands is estimated at $6,640/ED.

State Government currently caps developer charges in Queensland under the State Planning Regulatory Provisions (SPRP) at a maximum total charge of $28,000 for dwellings. Determining charges for non-residential development is more complex and based on floor area.

Currently the proportion of developer charges allocated to water infrastructure is 7% (source: FCRC Management Policy - Table 1). This equates to approximately $1,596/ED using the current charge of $22,800 for a residential lot.

Recommendations

The following recommendations are made with respect to the report:

1. That the WBWC Board adopts the Fraser Coast Water Supply Strategy Report 2015 as the basis for partial development of a Capital Works Programme for the period to 2031 with major projects identified to 2046.

2. That the WBWC Board notes the required expenditure of $127m for capital investment and $940k for investigations to the year 2031.

3. That this Water Supply Strategy report be reviewed every five years, as a minimum, to address any changes to water demand, population growth rates and development sequencing.

Table of Contents

APPENDICES

Volume 1

Appendix 1 – Capital Works Program

Appendix 2 – Water Infrastructure Plans

Appendix 3 – Structure Plans

Volume 2

Appendix 4 – Treatment

Appendix 5 – Water Reticulation

Appendix 6 – Water Quality

Appendix 7 – Unit Cost Rates

LIST OF FIGURES

LIST OF TABLES

This page is intentionally blank

1. INTRODUCTION

The Wide Bay Water Corporation's (WBWC) capital expenditure program is, in large, driven by the outcomes and recommendations of strategic planning for water supplies.

The methodology for arriving at a final strategy is both technical and complex. It involves the establishment of an infrastructure baseline and determination of current capacity and demands. Demand models are produced to examine the impact of predicted demand increases on the water supply system.

This water strategy examines:

- source water supplies into the future
- treatment capacity and future augmentation require to meet health and regulatory requirements
- pipe, pump and reservoir requirements
- options to determine the most efficient, cost effective solutions that provide long term benefits to WBWC.

Previous water supply strategies have been undertaken separately for Hervey Bay, Maryborough and Tiaro. This strategy has been prepared for the entire Fraser Coast water supply region.

1.1. Study Area

The study area is consistent with the previous supply infrastructure planning reports and incorporates all the reticulated water supply networks located within the Fraser Coast Council area including Hervey Bay, Maryborough, Toogoom, Burrum Heads, Howard, River Heads, Booral, Torbanlea, Granville, Tinana and Tiaro. Figure 1-1 shows the extent of the study area.

Additionally, it includes areas outside of the current priority infrastructure area (PIA) identified by FCRC as land use structure plan areas.

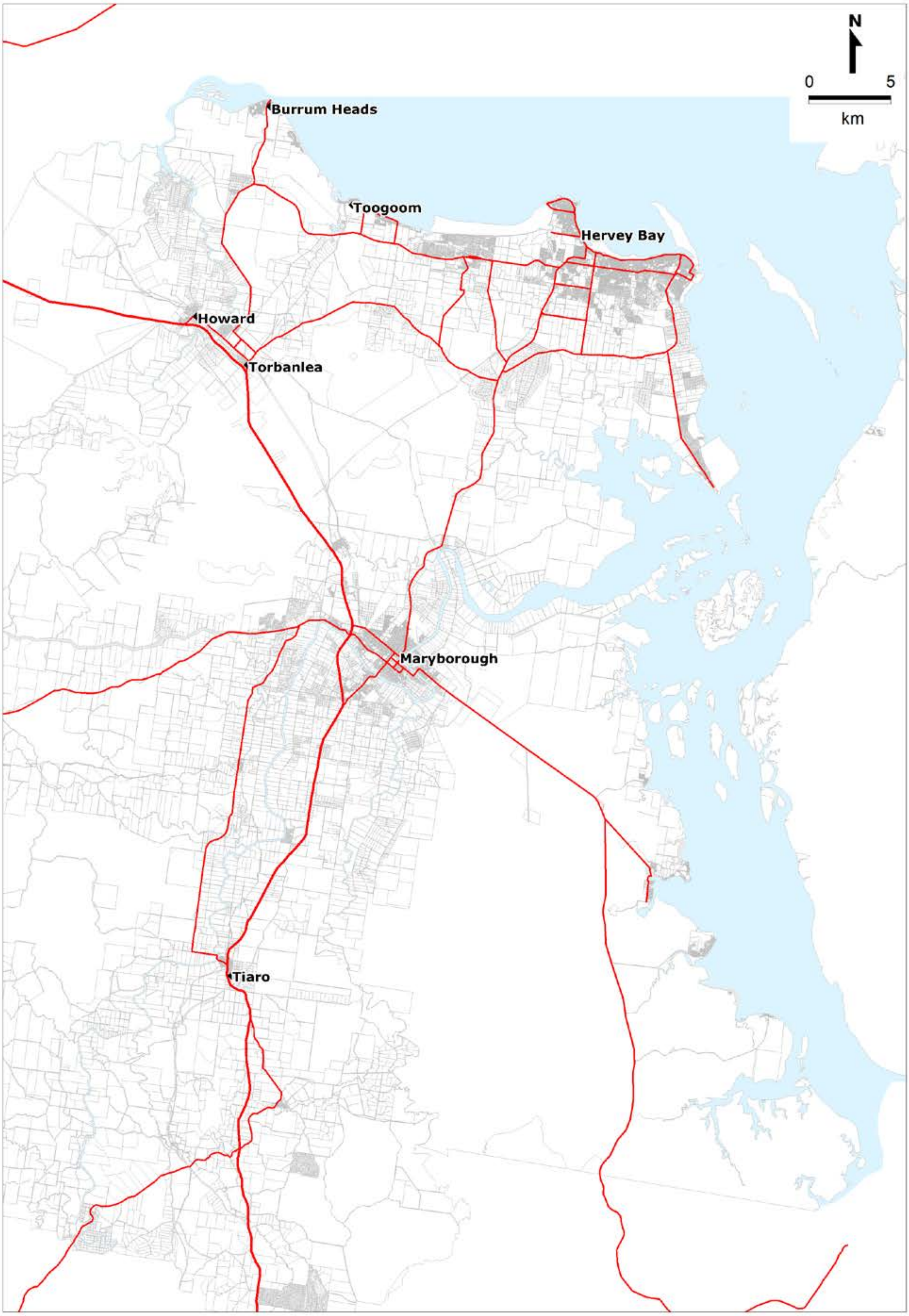


Figure 1-1: Map Depicting Study Area

2. OBJECTIVES

2.1. Water Supply Strategy Objectives

The objectives of the water supply strategy are to;

- Provide infrastructure that meets the increasing demand on the water supply system to 2031 and up to 2046 for major infrastructure.
- Provide water of a quality that meets the Australian Drinking Water Guidelines for health parameters. In the longer term the water supply should also meet the Australian Drinking Water Guidelines for aesthetic parameters.
- Provide water supply security to meet projected demands and provide a sustainable resource to the public.
- Provide operationally flexible infrastructure with the future water network in mind so that each asset may be used for the full term of its nominal life.

2.2. Aim of the Study

The aim of the investigation is to review existing and projected demand projections to enable the development of a strategic water infrastructure plan and associated capital works program to the year 2031.

Consistent with the work required to achieve these aims, a population model and detailed water network hydraulic models have been prepared. These models allow WBWC to periodically undertake system analyses on the water supply system to verify and amend the 20 year works program as necessary.

This Water Supply Strategy's main objective is to determine the existing water system's capacity to meet projected water demand forecasts and to identify when and where augmentation and further infrastructure is required to satisfactorily cater for these increased demands to the year 2031.

The key tasks in this report are to:

- Determine the projected demands to 2031 based on population projections that are consistent with Office of Economic and Statistical Research (OESR) projections;
- Identify the capacity of the existing raw water sources and determine the most appropriate future source options to meet future demands;
- Identify the capacity of the existing water treatment plants and any augmentation requirements to meet future demands;
- Identify the additional water supply infrastructure required and the timing for implementation to maintain the current Standards of Service (SOS) to WBWC customers;

- Identify and recommend a preferred strategy from the options proposed for water supply infrastructure planning up to 2031 with major infrastructure up to 2046.

2.3. Methodology

The key tasks in the methodology used in the study are as follows:

- Build a population model, which is capable of determining existing equivalent dwelling (ED) population and predicting future populations for nominated development or planning horizons;
- Develop calibrated water network models for the existing water supply system and for each of the 5 year planning horizons to the year 2031;
- Review the performance of the existing water supply scheme and identify areas which currently do not provide the adopted Standards of Service to consumers;
- Assess likely future renewal works for water infrastructure;
- Produce a capital works program to the year 2031 based on the results of the hydraulic modelling and engineering assessments.

2.4. Standards of Service

The Statement of Corporate Intent (SCI) is an agreement between the shareholders and the Board. Its purpose is to enhance accountability for performance and provide the business with certainty as to the shareholder expectations of financial performance. The main requirements from the Statement of Corporate Intent that affect the preparation of this report are as follows:

- The number of permissible hours of water discontinuity – maximum 5 hours;
- 99% of all premises will have water pressure of 20 metres or greater for 90% of the year;
- All premises will have a flow available of 20L/min or greater for 90% of the year;
- Water at the point of delivery will meet National Health and Medical Research Council (NHMRC) Health Guidelines for Australian Drinking Water 99% of the time;
- The quality of water at the point of delivery is to meet NHMRC aesthetic guidelines 95% of the time;
- Drinking Water quality complaints – Odour and Taste will be less than 5 per 1000 connections per year.

WBWC also aims to satisfy the following standards of service contained within the Department of Energy and Water Supply (DEWS) publication: “Planning Guidelines for Water Supply and Sewerage” and the Water and Sewerage Association of Australia (WSAA) codes. However it is noted that both of these guidelines are considered best practice and therefore are not mandatory minimum standards. The general requirements of these guidelines are that the;

- maximum residual pressure should not exceed 80 metres
- reticulation network shall aim to provide a fire flow in residential areas during the peak demand period of 15L/s while maintaining a minimum residual pressure of 12 metres, and
- reticulation network shall aim to provide a fire flow in commercial areas during the peak demand period of 30L/s while maintaining a minimum residual pressure of 12 metres.

3. EXISTING WATER SYSTEMS

There are three separate water supply systems in the Fraser Coast Region;

- Hervey Bay Water Supply system;
- Maryborough Water Supply system; and
- Tiaro Water Supply system.

3.1. System Overviews

3.1.1. Hervey Bay System Overview

WBWC's existing raw water supply is based on the Burrum River where three storages have been constructed (Burrum No.1 and Burrum No.2 Weirs and Lake Lenthall), and two relatively small dams on the headwaters of Beelbi Creek, near the Burgowan Water Treatment Plant (WTP) known as Cassava 1 and Cassava 2. WBWC own and operate all of these storages.

Water from the Burrum River system supplies the Burgowan WTP while the Cassava Dams supplement supply to Burgowan WTP when required. Two raw water mains (DN600 and DN375) and a pumping station, transfer water from the Burrum River to the Burgowan WTP and/or the Cassava Dams.

The Howard WTP is also supplied from the Burrum River via a DN450 raw water main. The Howard WTP is currently a standby treatment plant and is only used when demand exceeds the capacity of the Burgowan WTP or if operational reasons require it. The "Hervey Bay Disinfection By-Product" report by WBWC (2011) recommended that the all future water for Hervey Bay be supplied from the two existing treatment trains at the Burgowan WTP with no upgrades to the Howard WTP.

Most of the treated water from the Howard WTP and the Burgowan WTP is transferred to the Takura reservoirs, which includes Takura Reservoir No.1 (1ML) and Takura Reservoir No.2 (9ML). Uneven turnover of water in these reservoirs occurs because the reservoirs are constructed at different levels. As a result Takura No.1 is currently out of service because it has the highest detention time due to the uneven turnover and consequently has experienced water quality issues.

From Takura, water gravitates to the 32ML Urraween Reservoir and from there it is pumped up to the Ghost Hill Reservoirs. Hervey Bay City and River Heads are supplied from the Ghost Hill No.1 (4.5ML) Reservoir. Ghost Hill No.2 Reservoir (6.7ML) supplies the higher ridge area of Kawungan and the Nikenbah Ridge (Summit Ridge and Bayridge housing developments).

Treated water from the Burgowan WTP and the Howard WTP also supply the townships of Howard, Torbanlea, Toogoom, Burrum Heads and Dundowran.

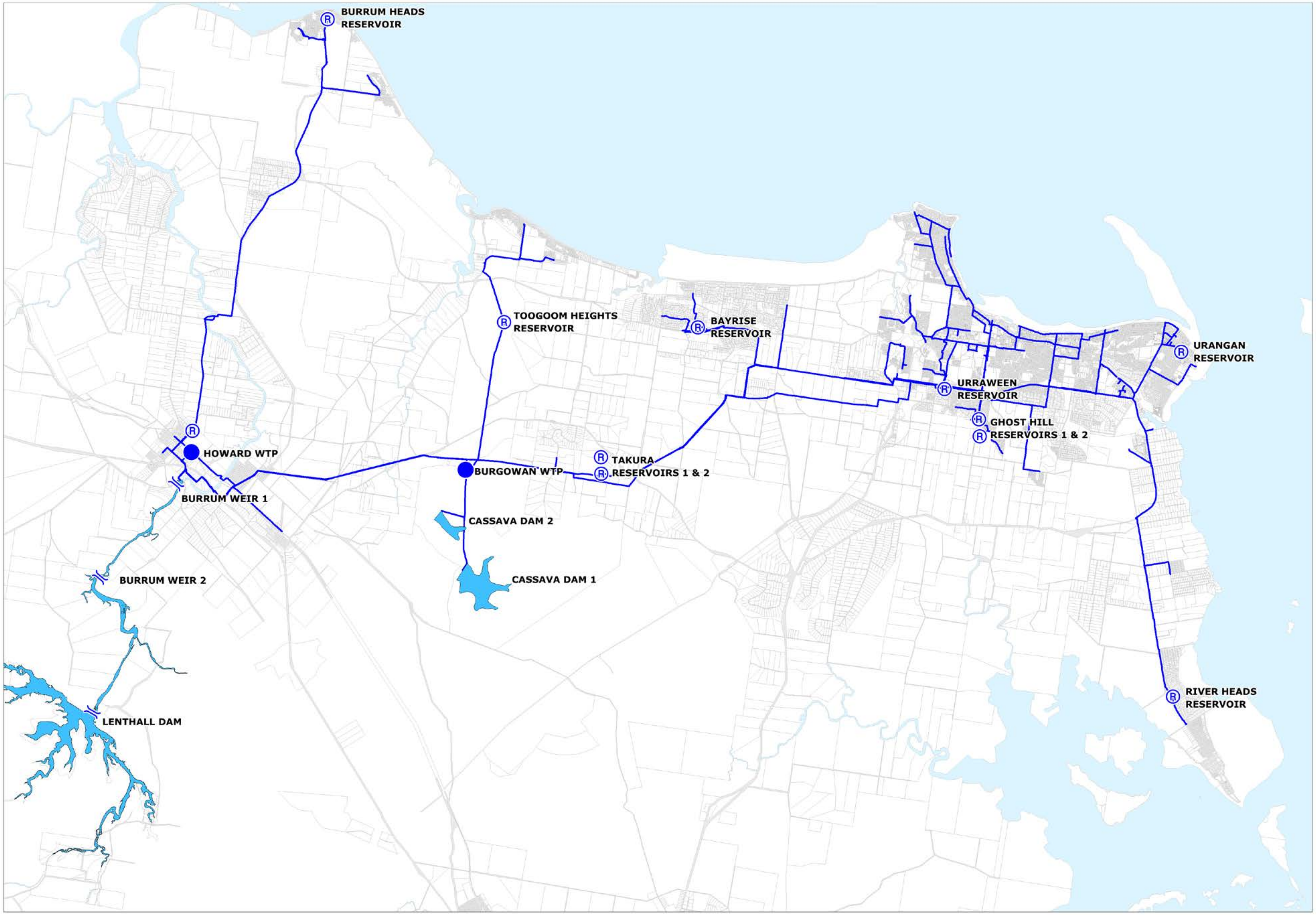


Figure 3-1: Hervey Bay Water System Overview

3.1.2. Maryborough System Overview

Maryborough's existing raw water supply is sourced from Tinana Creek, a tributary of the Mary River, on which two storages have been constructed; Teddington and Tallegalla Weirs.

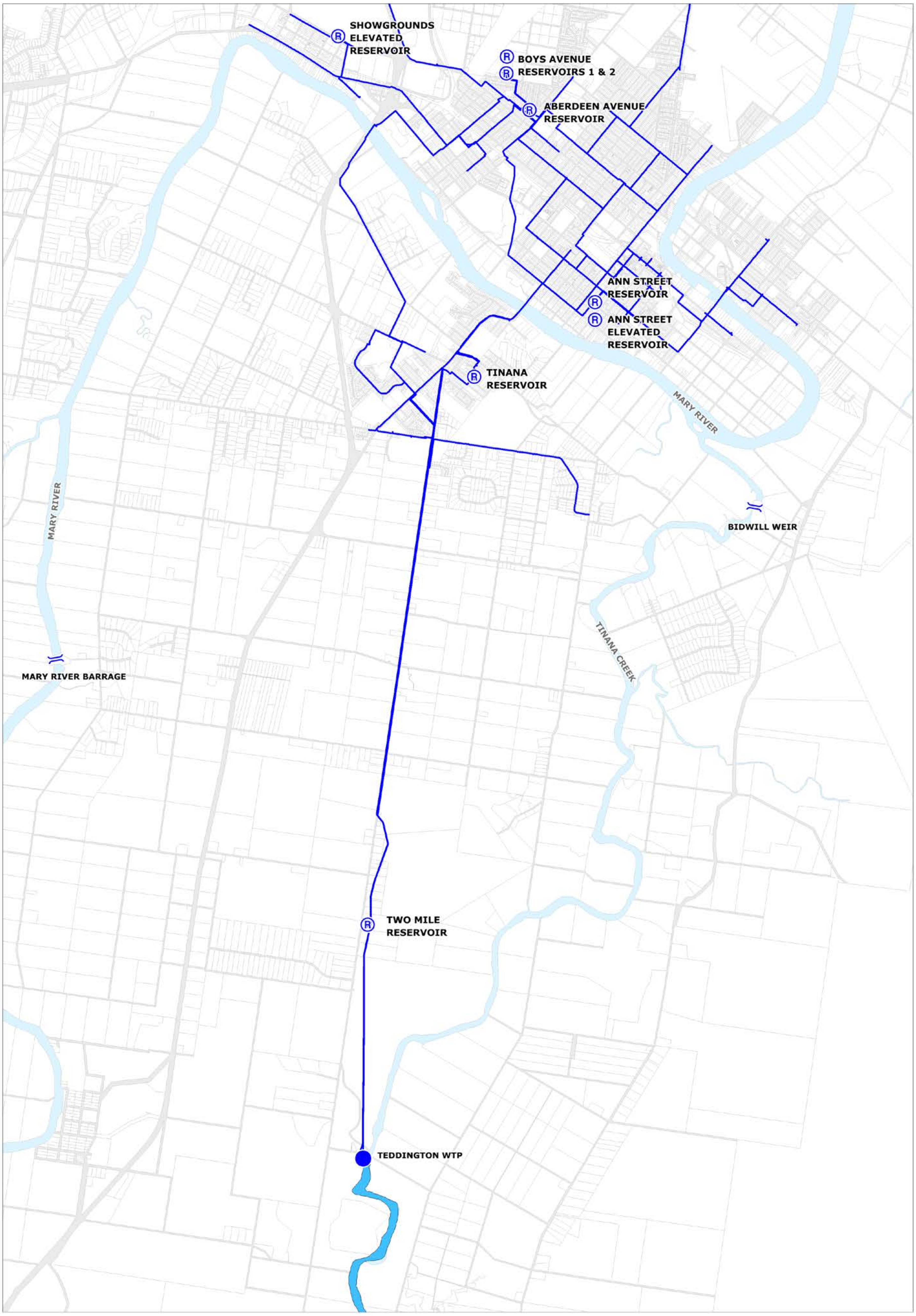
Teddington Weir is located approximately 16km south of Maryborough. Teddington and Tallegalla Weirs are owned and operated by WBWC.

Raw water is extracted from Teddington Weir and is treated at the Teddington WTP located adjacent to the weir. Raw water can also be transferred from the Mary River using Sunwater's network of pipelines and channels.

The treated water is transferred from Teddington WTP via two DN525 transmission mains to Two Mile Reservoir (4.5ML), where it is distributed via a DN600 to Boys Ave Reservoirs (10ML and 9ML) and a DN525 to supply Tinana.

While most of the customers are supplied through reticulation pipework, there are a number of customers along Teddington Rd that are connected directly to transmission mains. Parts of the water reticulation system in Maryborough date back to the early 1930's.

Records indicate that water supply to the city from Teddington commenced as early as 1881, albeit untreated water only.



* Bidwill Weir is also commonly known as Tinana Barrage and is owned and operated by Sunwater as part of the Lower Mary irrigation scheme.

Figure 3-2: Maryborough Water System Overview

3.1.3. Tiaro System Overview

Raw water is sourced from the Mary River using submersible pumps which transfer water to the Tiaro WTP through a DN100 main. The DN100 main was replaced in 2014.

The treatment plant consists of a DAF over filter plant (DAFF). From the treatment plant, water is pumped to the onsite ground level storage (1.25ML). Treated water is pumped directly into the reticulation system. This main also fills a 100kL elevated reservoir on Forgan Tce. This reservoir provides storage and consistent pressure to the reticulation network.

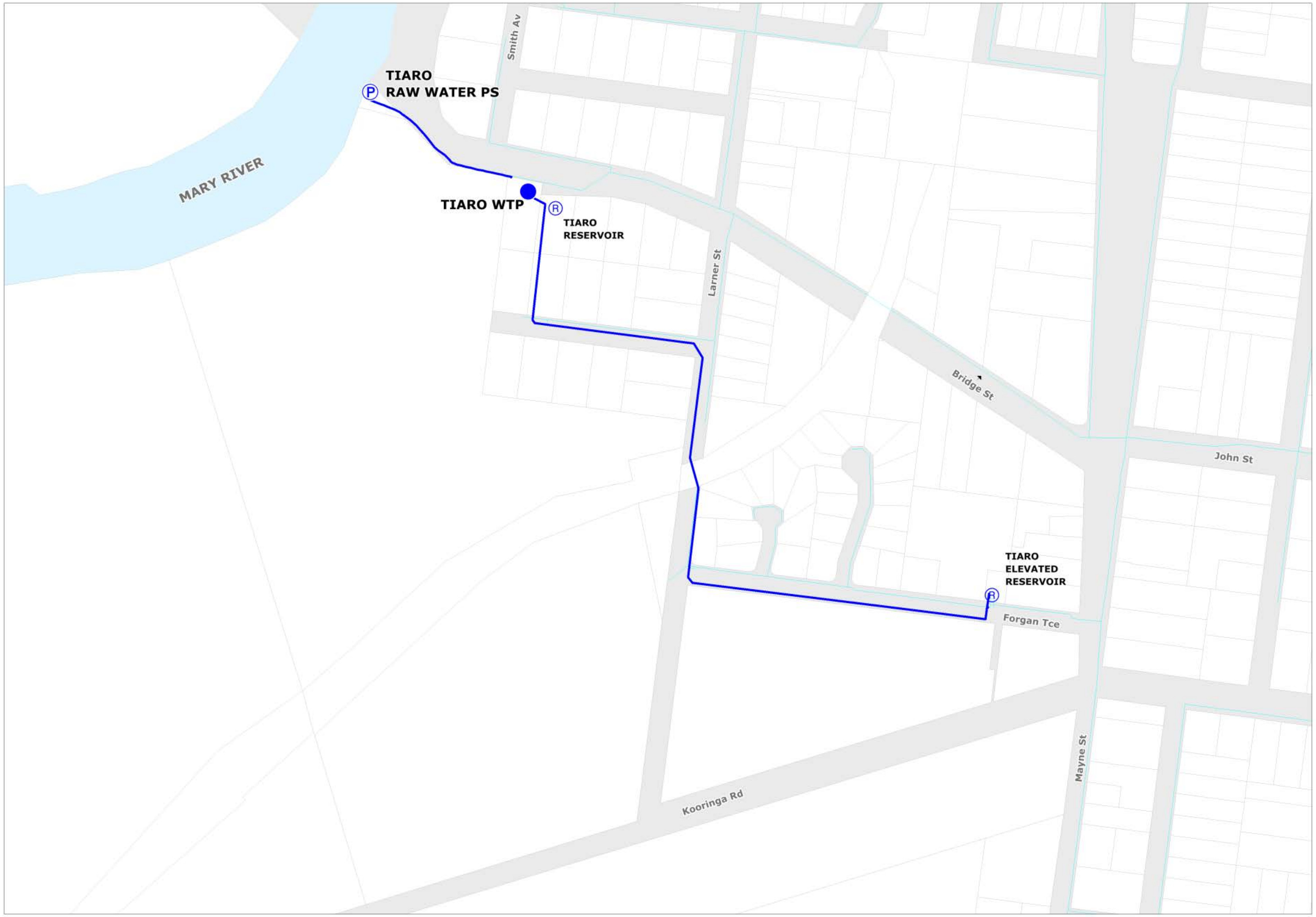


Figure 3-3: Tiaro Water System Overview

3.2. Sources

3.2.1. Hervey Bay Overview

The Wide Bay Water Supply Scheme (Mary Basin ROP, Attachment 4) has a high priority allocation of 14,020ML/annum and an allocation of 453ML/annum medium priority water (of which 12ML is allocated to WBWC, the remainder is to private irrigators) from the Burrum River. WBWC has an additional allocation reserve of 3,080ML/annum associated with the raising of Lake Lenthall which is available to WBWC through application to the Department Natural Resources and Mines (DNRM).

High priority allocation ensures that water is available above all medium priority allocations. A volume of high priority water is maintained in the water supply system after calculated evaporative and transmission losses are taken into account. The remaining available water (if any) is then shared amongst the medium priority users.

3.2.2. Burrum No.1 Dam

Burrum No.1 Dam is located on the Burrum River, approximately 30km from Hervey Bay and 2km upstream of the town of Howard. The dam is a low height straight concrete gravity weir with earth and concrete wing wall abutments. The concrete spillway section is 111m long and is 5m high. The dam statistics are given in the following table.

The dam was constructed in 1948-1952 to supply water to the towns of Howard, Torbanlea and Hervey Bay. A pump station was installed on the left abutment of the dam.

The spillway has operated many times, with recent floods up to 10.72m of overflow depth recorded (27th January 2013). The weir drowns (tailwater control) at approximately 4m of overflow (RL8).

Access to the left abutment of the dam and pump station is via Lower Thomas St, Howard. Access to the right abutment is via Old Coach Rd road reserve.

Table 3-1: Burrum No. 1 Dam Details

Name of Dam:	Burrum No.1
Owner:	Wide Bay Water Corporation
Designed:	GHD
Constructed:	1948 to 1952
Year of Completion:	1952
River:	Burrum AMTD 23.1km
Nearest Town:	Howard
Purpose:	Water Supply
Type:	Straight concrete overflow weir
Height:	5m
Length:	111m
Gross Capacity of Reservoir:	1,715ML (source: Mary Basin ROP)
Catchment Area:	670sq. km (including upstream storages)
Surface Area at FSL:	unknown
Probable Maximum Flood Inflow Peak:	6,450m^3/s (from Lenthall's Dam)
Type of Spillway:	Concrete Gravity Weir, Concrete flip bucket
Spillway Capacity:	to wing wall 110m^3/s, drowned flow at approx. 600m^3/s
Freeboard above FSL:	0.67m to wing wall
Hazard Rating (DNR):	Low to significant
Incremental Flood Consequence Category (ANCOLD 1997 Draft):	Low
Spillway Crest Level	4.87m AHD (source: Mary Basin ROP)
Dam Crest Level:	5.33m AHD
Minimum Operating Volume:	638ML (source: Mary Basin ROP)

3.2.3. Burrum No.2 Dam

Burrum No.2 Dam is located on the Burrum River, approximately 30km from Hervey Bay and 6km upstream of the town of Howard. The dam is a low height straight concrete gravity weir with earth and concrete wing wall abutments. The concrete spillway section is 104m long and is 10m high. The dam statistics are given in the following table.

The dam was designed in 1947-48 and was constructed in 1968-1970 to augment the existing water supply to the towns of Howard, Torbanlea and Hervey Bay.

The spillway has operated many times.

Access to both abutments is through private property.

Table 3-2: Burrum No.2 Dam Details

Name of Dam:	Burrum No.2
Owner:	Wide Bay Water Corporation
Designed:	GHD
Constructed:	1968-1970
Year of Completion:	1970
River:	Burrum AMTD 28.2km
Nearest Town:	Howard
Purpose:	Water Supply
Type:	Straight concrete overflow weir
Height:	10m
Length:	105m
Gross Capacity of Reservoir:	2,242ML (source: Mary Basin ROP)
Catchment Area:	between 500-670 sq. km (including upstream storages)
Surface Area at FSL:	unknown
Probable Maximum Flood Inflow Peak:	6,450m^3/s (from Lenthall's Dam)
Type of Spillway:	Concrete Gravity Weir, Concrete flip bucket
Spillway Capacity:	to wing wall 650m^3/s, drowned flow at approx. 4,600m^3/s
Freeboard above FSL:	2.1m to wing wall
Hazard Rating (DNR):	Low
Incremental Flood Consequence Category (ANCOLD 1997 Draft):	Low
Spillway Crest Level	10.97 m AHD (source: Mary Basin ROP)
Dam Crest Level:	13.2 m AHD
Minimum Operating Volume:	220ML (source: Mary Basin ROP)
Minimum Operating Level:	3.05 m AHD (source: Mary Basin ROP)

3.2.4. Lake Lenthall

Lake Lenthall is located on the Burrum River approximately 10km south west of Howard near Hervey Bay, Queensland.

The dam was constructed in the period February 1983 to June 1984. The outlet and diversion were completed in July 1983. The construction of the spillway was completed in December 1983, and the embankment was constructed in the period August 1983 to June 1984.

In 2006, the full supply level was raised by 2m resulting in an increase in the storage capacity from 17,256ML at RL 24.0m to approximately 28,411ML at RL 26.0m.

The raising involved the installation of five crest gates, comprising four 14.8m wide gates and one 9.8m wide gate. The upstream water load on the gates is transferred to piers constructed to 0.5m above the raised full supply level of RL 26.0m.

The dam originally comprised a zoned earth fill embankment, approximately 29m maximum height (crest elevation at RL 34.0m) with a crest length of about 350m. The upstream face was sloped at 3H: 1V and the downstream face at 2H: 1V with a 5m wide berm at RL 21.0m and a 15m wide berm at RL 13.5m.

The dam crest was raised to RL 34.6m in the 2006 upgrade, which included clearing the downstream berms of vegetation and topsoil that has eroded from the upper slopes. The trees and bushes were removed off the embankment and topsoil and grass was replaced on the downstream slope.

The spillway on the right bank abutment comprises a curved gravity ogee section with anchors and a concrete lined chute. The ogee section is 7m high with a crest length of 75m. The concrete lined spillway chute is 75m wide at the ogee section, tapering down to a 46m width at the energy dissipater.

The outlet works comprise a multilevel draw off intake tower, two 1,050mm ID outlet pipes encased in concrete under the dam and a downstream valve house. The multilevel draw offs lead to two vertical 800mm diameter pipes connected to the two outlet pipes under the dam. The intake tower operates as a dry well with the top of the tower walls at RL 34.0m. The left hand side 1,050mm ID outlet pipe is blanked off and the right hand side one is connected to a 500mm diameter cone valve within a baffled dissipater.

Table 3-3: Lake Lenthall Details

Name of Dam:	Lake Lenthall (or Burrum No.3 Dam)
Owner:	Wide Bay Water Corporation
Designed:	GHD
Constructed:	February 1983 to June 1984
Year of Completion:	Stage 1: 1984, Raising: 2007
River:	Burrum, 34.2 AMTD
Nearest Town:	Howard
Property Description	Lot 21, Plan SP 134986 Parish: Warrah County: Lennox
Location of Dam	Latitude: 25 24' Longitude: 152 32'
Purpose:	Water Supply Storage
Type:	Zoned earth fill dam with concrete gravity spillway
Maximum Height:	29.60m Main Dam (above lowest d/s toe at RL 5.0m
Dam Crest Length:	350m for Main Dam
Gross Capacity of Reservoir:	28,411ML
Catchment Area:	518 sq. km
Surface Area at FSL:	7.2km^2
Probable Maximum Flood Inflow Peak:	
Type of Spillway:	Gated overflow spillway with an ogee crest and post tensioned anchors, and concrete lined chute
Spillway Crest Level	RL 24.00m with over the crest gates have been installed, raising FSL to RL 26.00m
Spillway Crest Length	75.3m at crest, tapering to 46m at energy dissipater
Spillway Capacity:	5,670m3/s (with no gate failure)
Control Description	5 No Flow gates Crest Gates (4 x 14.8 m and 1 x 9.8m) Gate Arrangement Gate 1 (right hand flank of Spillway), Gate 2 (next to Gate 1), Gate 3 (next to Gate 2, in the centre), Gate 4 (next to Gate 3) and Gate 5 (next to Gate 4 in the left hand flank of Spillway in the embankment dam side)
Sequence of Gate Opening	3, 2, 4, 5, 1
Energy Dissipation Method	Type II USBR stilling basin
Freeboard above FSL:	
Hazard Rating (DNR):	
Full Supply Level	RL 26.00m[1]
Dam Crest Level:	RL 34.60m
Minimum Operating Level:	not known
Outlet Description	The outlet works comprises a dry intake tower with multilevel intakes, twin 1,050mm ID steel pipes and a downstream valve chamber

1 All heights (RL) are to "Burrum No.3" datum. For AHD 0.18m will have to be added.

As can be seen in Figure 3-4 the dam level is highly sensitive to rainfall events.

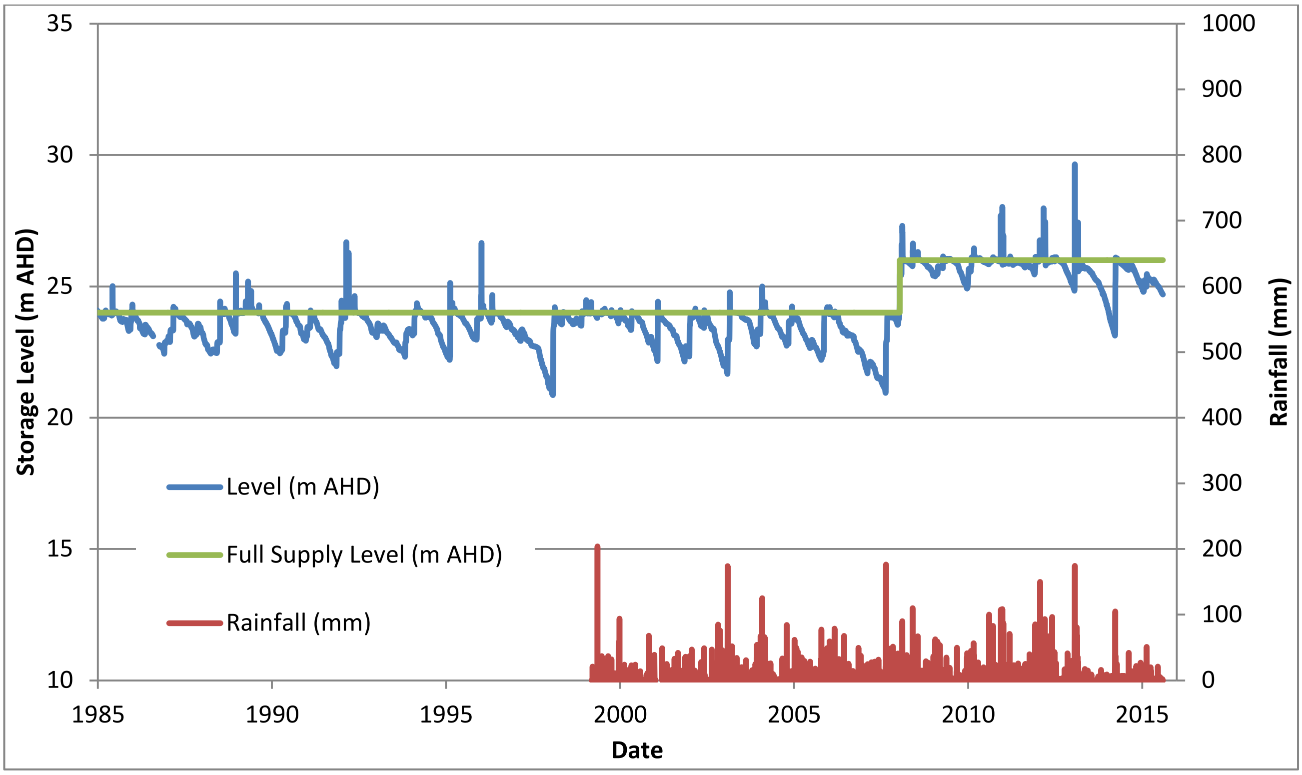


Figure 3-4: Lake Lenthall Historical Rainfall and Volume

If there are no recharge events then there is approximately two years of storage available at existing demand provided that the drought management plan is implemented.

Based on the FSL volume and the FSL surface area, the average depth of the dam is 3.9m and therefore fairly shallow. Using the average evaporation data and the calculated surface area of the dam the average evaporation over the past four years was determined to be 31ML/day.

3.2.5. Cassava Dams

Cassava No.1 and Cassava No.2 Dams are located to the south of the Burgowan WTP. The Dams are at the headwater of the Beelbi Creek catchment. The Dams are used to provide some storage for raw water transferred from Burrum No.1 weir prior to being treated at the Burgowan WTP. Water can be pumped from either dam to the WTP. The following tables provide details for each of the dams.

The Dams have relatively small catchments and therefore recharging of the dams from runoff alone does not provide a sufficient yield to consider the storages as a separate source.

Table 3-4: Cassava No.1 Dam Details

Name of Dam:	Cassava No.1 Dam (Site No.3)
Owner:	Wide Bay Water Corporation
Designed:	Queensland Water Resources Commission
Constructed:	
Year of Completion:	
River:	Beelbi Creek
Nearest Town:	Torbanlea
Property Description	
	Lot 199 Churchill Mine Rd
	Burgowan
Location of Dam	Approximately 3.4km south of Burgowan Water Treatment Plant
Purpose:	Water Supply
Type:	Gully Dam clay core earth embankment
Maximum Height:	7.1m (EL 24.9m)
Dam Crest Length:	525m
Gross Capacity of Reservoir:	2,187.4ML
Catchment Area:	851Ha
Surface Area at FSL:	105.4Ha
Probable Maximum Flood Inflow Peak:	
Type of Spillway:	Rock pitched Bywash + Drop Inlet Spillway
Spillway Crest Level	23.5m Drop Inlet, EL 23.6m Bywash
Spillway Crest Length	115m
Spillway Capacity:	423m^3/s
Sequence of Gate Opening	n/a
Energy Dissipation Method	
Freeboard above FSL:	1.5m
Hazard Rating (DNR):	
Full Supply Level	EL 23.5m
Dam Crest Level:	EL 24.9
Minimum Operating Level:	EL 19.5
Outlet Description	

Table 3-5: Cassava No.2 Dam Details

Name of Dam:	Cassava No.2 Dam (Site No.4)
Owner:	Wide Bay Water Corporation
Designed:	Queensland Water Resources Commission Design Drawing dated 26 August 1979
Constructed:	
Year of Completion:	
River:	Beelbi Creek
Nearest Town:	Torbanlea
Property Description	
	Lot 199 Churchill Mine Rd
	Burgowan
Location of Dam	Approximately 1.7km south-south-west of Burgowan Water Treatment Plant
Purpose:	Water Supply
Type:	Gully Dam clay core earth embankment
Maximum Height:	
Dam Crest Length:	357m
Gross Capacity of Reservoir:	426.5ML
Catchment Area:	243Ha
Surface Area at FSL:	35.11Ha (estimated from and estimated FSL shoreline)
Probable Maximum Flood Inflow Peak:	
Type of Spillway:	Drop Inlet + Bywash
Spillway Crest Level	EL18.0m Drop Inlet, EL18.1m Bywash
Spillway Crest Length	Bywash 40m
Spillway Capacity:	
Control Description	
Sequence of Gate Opening	
Energy Dissipation Method	
Freeboard above FSL:	1.3m
Hazard Rating (DNR):	
Full Supply Level:	EL 18m
Dam Crest Level:	EL 19.3
Minimum Operating Level:	
Outlet Description	

3.2.5.1. Notable issues with Cassava Dams

The water quality from these dams is known to be low in alkalinity.

Cassava No.1 has an average depth of 2.1m (based on the FSL surface area and the FSL volume). Cassava No.2 has an average depth of 1.2m (based on the FSL surface area and the FSL volume). The shallow nature of these dams makes them more susceptible to losses through evaporation when compared with a deeper dam of the same capacity.

3.2.6. Mary River and Tinana Creek

Teddington Weir is located on Tinana Creek approximately 13km south of Maryborough and 12km northeast of Tiaro. The current weir is a concrete structure built around the 1950's with outlet works feeding the Teddington WTP on the left bank looking downstream. On the right bank a fish way was constructed. A review of the weir structure by GHD (2013) indicated the weir to be in good condition.

WBWC has an annual high priority allocation of 6,819ML to draw raw water from Teddington Weir. An additional high priority allocation of 1,000ML/annum is also available from Teddington Weir. Teddington Weir has a historical no failure yield of 4,120ML. The Resource Operating Licence for the Mary River provides for the transfer of an additional 1,360ML/annum of high priority water allocation from the Mary River although historically, bulk water transfers have only been necessary to meet irrigation demand and not for the supply of town water.

Total annual demand has reduced significantly since 2002 due in part to the water restrictions and also the introduction of water meters on all residential properties which commenced in the same year.

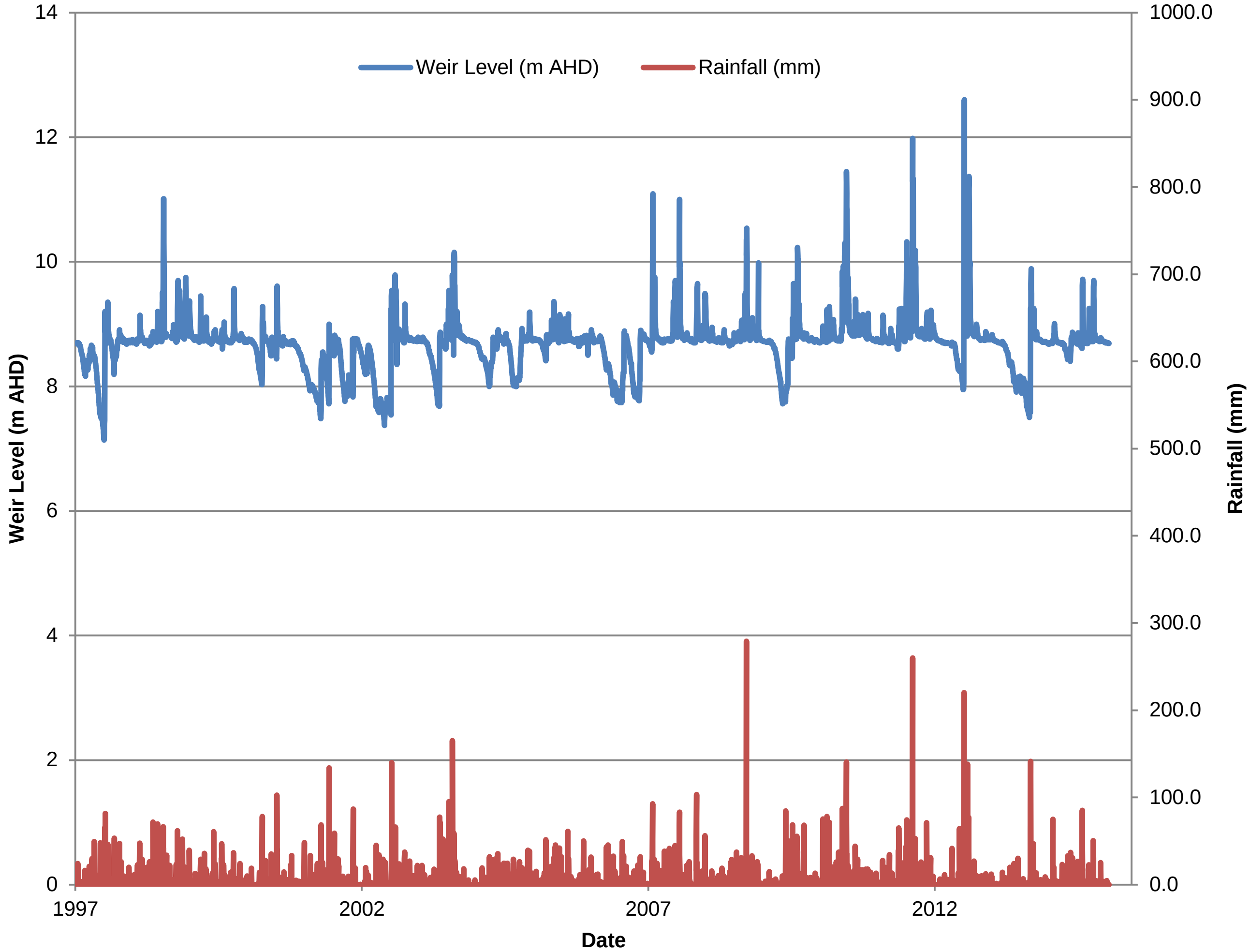


Figure 3-5: Teddington Weir Historical Level and Volume

Table 3-6 provides details of the weir storage.

Table 3-6: Teddington Weir Details

Name of Dam:	Teddington Weir
Owner:	Wide Bay Water Corporation
Designed:	Raising: WJ Reinholds & Partners (circa 1970)
Constructed:	Original: circa 1950's
Year of Completion:	Raising: circa 1970's
River:	Tinana Creek AMTD 15.8km
Nearest Town:	Tiaro
Property Description	
	Adjacent to Teddington WTP
Location of Dam	Lat 25^{o}39' long 152^{o}40'
Purpose:	Water Supply
Type:	Concrete Gravity
Maximum Height:	
Dam Crest Length:	90m
Gross Capacity of Reservoir:	3,710ML (source: Mary Basin ROP)
Catchment Area:	1,269km^2
Surface Area at FSL:	
Probable Maximum Flood Inflow Peak:	
Type of Spillway:	Central ungated ogee-crested overflow spillway with a width of 50.7m
Spillway Crest Level	8.66 m AHD
Spillway Crest Length	50.7
Spillway Capacity:	zero discharge at FSL
Control Description	
Energy Dissipation Method	
Freeboard above FSL:	0 m
Hazard Rating (DNR):	
Full Supply Level	8.66 m AHD
Dam Crest Level:	9.27 m AHD
Minimum Operating Level:	2.99 m AHD (source: Mary Basin ROP) Foundation level is 0.89 m AHD

3.2.6.1. Notable Issues with the Tinana Creek and Mary River

Water quality and quantity issues in the Lower Mary River Area are increasingly being addressed in a more catchment-wide regional basis involving the major stakeholders.

The introduction of announced allocations specified in licences will dictate the percentage of allocation allowed in any particular year. This announced allocation is calculated using a formula and takes into account factors including usable volume available, high priority demands, environmental release requirements and losses.

The allocation of water is divided into two categories being:

- high priority users including WBWC's water use for public water supplies.
- medium priority users including water use for irrigation purposes. Access to lower priority allocation is restricted or suspended when certain predetermined weir level triggers occur.

Two storages located at the Mary River Barrage upstream of Maryborough and on Tinana Creek downstream of the Teddington Weir are used principally for irrigation. These storages are owned and operated by SunWater Ltd and are part of the Lower Mary River Water Supply Scheme. The scheme supplies water to farmers within the Maryborough area and those rural areas within the former Shires of Woocoo and Tiaro. Under the scheme, water is transferred via open channel and pipeline from the pondage at the Mary River Barrage to the Tinana Creek Barrage for delivery to farmers in the Walkers Point, Bidwill and the Maryborough areas.

In 1993 a pipeline was constructed to transfer Mary River water directly to Teddington Weir via the Owanyilla channel to augment irrigation allocations from Teddington Weir and to increase the reliability of the then Maryborough City Council's raw water source. This transfer pipe discharges approximately 300m upstream from the Teddington Weir.

Cyanobacteria (blue-green algae) and its attendant water quality and health problems are a significant consideration in the management of urban water supplies. There are concerns over potential threats to the town water supply from cyanobacterial blooms and impacts on the water quality of Teddington Weir by potential transfers of algal laden waters from the Mary River. Minimisation of this threat is achieved through the constant monitoring of water quality during transfers from the Mary River (through the Owanyilla Channel) to Teddington Weir (Tinana Creek).

The water quality differs significantly between the Tinana Creek catchment and the Mary River catchment. Table 3-7 summarises the commonly analysed water quality parameters including turbidity, alkalinity, colour, PH, manganese and iron. For the purposes of this comparison samples were used from the Teddington Weir on Tinana Creek and at Tiaro intake for the Mary River.

Table 3-7: Comparison between Tinana Creek and Mary River Water Quality (2012 – 2015)

		Average	Min - Max	10^{th} - 90^{th} Percentile
Turbidity (NTU)	Mary River	20	3-410	5-42
	Tinana Creek	11	1-280	2-18
Alkalinity (as $CaCO_3$)	Mary River	92	25-145	55-132
	Tinana Creek	19	4-106	7-28
Colour	Mary River	167	6-2233	51-331
	Tinana Creek	235	4-1600	54-385
PH	Mary River	7.70	6.50-8.83	7.30-8.00
	Tinana Creek	6.33	1.00-8.00	5.80-6.70
Manganese (mg/L)	Mary River	0.101	0.002-0.942	0.015-0.257
	Tinana Creek	0.167	0.003-0.880	0.067-0.303
Iron (mg/L)	Mary River	0.285	0.011-2.140	0.060-0.630
	Tinana Creek	1.344	0.060-3.860	0.400-1.980

The main differences in water quality between the Mary River and Tinana Creek waters are that the Mary River has:

- alkalinity levels are higher in the Mary River catchment;
- apparent and true colour is lower in the Mary River catchment;
- higher hardness associated with higher levels of calcium and magnesium in the Mary River catchment;
- higher pH in the Mary River catchment and
- lower iron and manganese in the Mary River catchment.

The biodiversity of the Teddington Weir pool is expected to change with the introduction of Mary River water. Changes that can be expected are an increased level of algae in the weir pool due to increased levels of alkalinity and reduced levels of colour. This is likely to result in higher levels of transmittance of UV light in the water body and produce conditions favourable for algal production.

The prevalence of water weed in the catchments contributes to the high level of organic matter within the Tinana Creek. Periodically work is undertaken to remove blankets of hyacinth and salvinia weeds from the water storage. This removal is undertaken in order to minimise the levels of decomposing organic material requiring removal during the water treatment process.

Officers of the former Maryborough City Council had developed operating rules for the Teddington Weir based on releases from Tallegalla Weir (Hunter Water Australia) and the implementation of staged water restrictions. Council developed operating rules in 1998 for water transfers from the Mary River to

Teddington Weir based on cyanobacteria levels in the Mary River. A blue-green algae (*Cyanobacteria*) contingency plan was also developed for Teddington Weir which was adopted by Maryborough Council. Now WBWC uses the Drinking Water Quality Management Plan (2014) to control risks associated with the outbreak of *Cyanobacteria*.

Another significant issue with the Teddington storage is the incidence of higher than desirable levels of iron and manganese in the water which ultimately results in water discolouration problems in Maryborough. An artificial destratification system was installed in the Teddington Weir pool in 1995 to reduce peaks of iron and manganese in the raw water. This system was to provide lower, more consistent levels of iron and manganese although problems still occur occasionally with stratification and its effectiveness needs to be verified.

As part of a review of water discolouration problems the former Maryborough City Council reviewed the performance of the destratification system. The review concluded that:

- the installed diffuser arrangement did not address the issue of protecting the intake structure from drawing un-aerated water;
- the diffuser holes appear larger and too close together to develop mixing;
- the air flow rate is in the appropriate range; and
- the destratification system requires modification.

The works done to date have not addressed the high levels of Dissolved Organic Carbon (DOC) which leads to the formation of THM's.

3.3. Raw Water Supply Infrastructure

3.3.1. Burrum Weir Raw Water Transfer

Raw water is supplied from Burrum Weir to Burgowan WTP and Howard WTP.

Raw water is transferred to Burgowan from a dry well through DN600 and DN375 transmission mains. The pumping system (using the DN600 has the capability of 20ML/day with one pump and approximately 25ML/day when both pumps are in operation.

Raw water can also be transferred to Howard WTP through a wet well pump station with a 1.3km DN450 water transmission main. The pumping system is capable of 18ML/day with one pump and approximately 22ML/day with two pumps in operation.

3.3.2. Cassava Raw Water Transfer

Raw water is also available from Cassava Dams. These dams supply raw water directly to Burgowan WTP for treatment.

Raw water is transferred from Cassava Dam No.2 via a dedicated pump and a 1km DN200 transmission main. Likewise raw water from Cassava Dam No.1 is transferred via a dedicated pump and a 2km DN450 transmission main. Both these mains join into a 1.6km DN450 transmission main to the Burgowan WTP.

3.3.3. Teddington Weir Raw Water Transfer

Raw water is supplied from the Teddington Weir directly into the Teddington WTP. The infrastructure used to transfer water from the Teddington Weir intake structure to the Teddington WTP includes an intake tower which draws water through two submersed pipes to a wet well containing two pumps. This wet well pump station transfers water from the wet well though a short length of DN450 transmission main into the Teddington WTP.

The exact duty of the pump station is unknown but it is has the capacity to supply up to 15ML/day if required.

There is a current project being delivered that replaces the existing intake structure, pump well, pumping units, and delivery pipework to the treatment plant.

3.3.4. Tiaro Raw Water Transfer

Raw water is sourced from the Mary River and transferred to the Tiaro WTP through two intake pumps located in the Mary River. These pump into separate DN100 mains which connect in a manifold and transfer water to the Tiaro WTP through a 160m DN100 main.

This raw water system has the capacity to deliver 0.8ML/day with a single pump operating and approximately 1.2ML/day with both pumps operating.

3.4. Treatment

3.4.1. Howard Water Treatment Plant

The Howard WTP is a conventional plant consisting of a chemical flash mixer, flocculation, reactivator, circular clarifier and dual media pressure filters. Disinfection is achieved by the addition of chlorine gas.

The plant was built and commissioned in 1964 with a capacity of 115 litres per second, approximately 10ML/day. Plant capacity was increased in 1982 to a maximum hydraulic rate of 250L/s but the secure capacity[1] was considered to be 18ML/day.

Further augmentations were undertaken between 1999 (chemical dosing upgrades) and 2003 (backwash recovery) to meet the new standards for drinking water quality and improve the plant efficiency and reliability. This work comprised renovation of the filters, upgrading of the chemical dosing system and a new switch board. In 2004 a variable speed drive was installed on No.1 clear water pump.

The flow diagram for the treatment plant is shown in Figure 3-6.

The water quality at Howard WTP does not meet current water quality standards. The main issues are that:

- The water produced is low in calcium.
- The treatment plant does not minimise the production of Trihalomethane's (THM's).
- High turbidity in final filtered water from the addition of lime for pH correction.
- Taste and odour are not addressed at this plant.
- Algal toxins are not removed.

In addition to the water quality issues the capacity of the plant is not sufficient to produce sufficient water to sustain Hervey Bay's MDMM without assistance from the Burgowan WTP.

The cost of upgrading this plant to address these issues was not deemed viable compared to the option of upgrade works at the Burgowan WTP and using Burgowan's two treatment trains to supply treated water to serve the Hervey Bay area (WBWC, 2011).

The water treatment plant at Howard is now a standby treatment plant and will only be used when major maintenance is being undertaken at the Burgowan WTP or if demand on the system exceeds the capacity of the Burgowan WTP. Since the capacity upgrade at the Burgowan WTP, the need for the Howard WTP has further reduced.

[1] Note secure capacity is defined as the reliable plant performance treating average raw water quality and an allowance for loss of production due to down-time for backwashing, plant breakdowns and reduced raw water pumping efficiency.

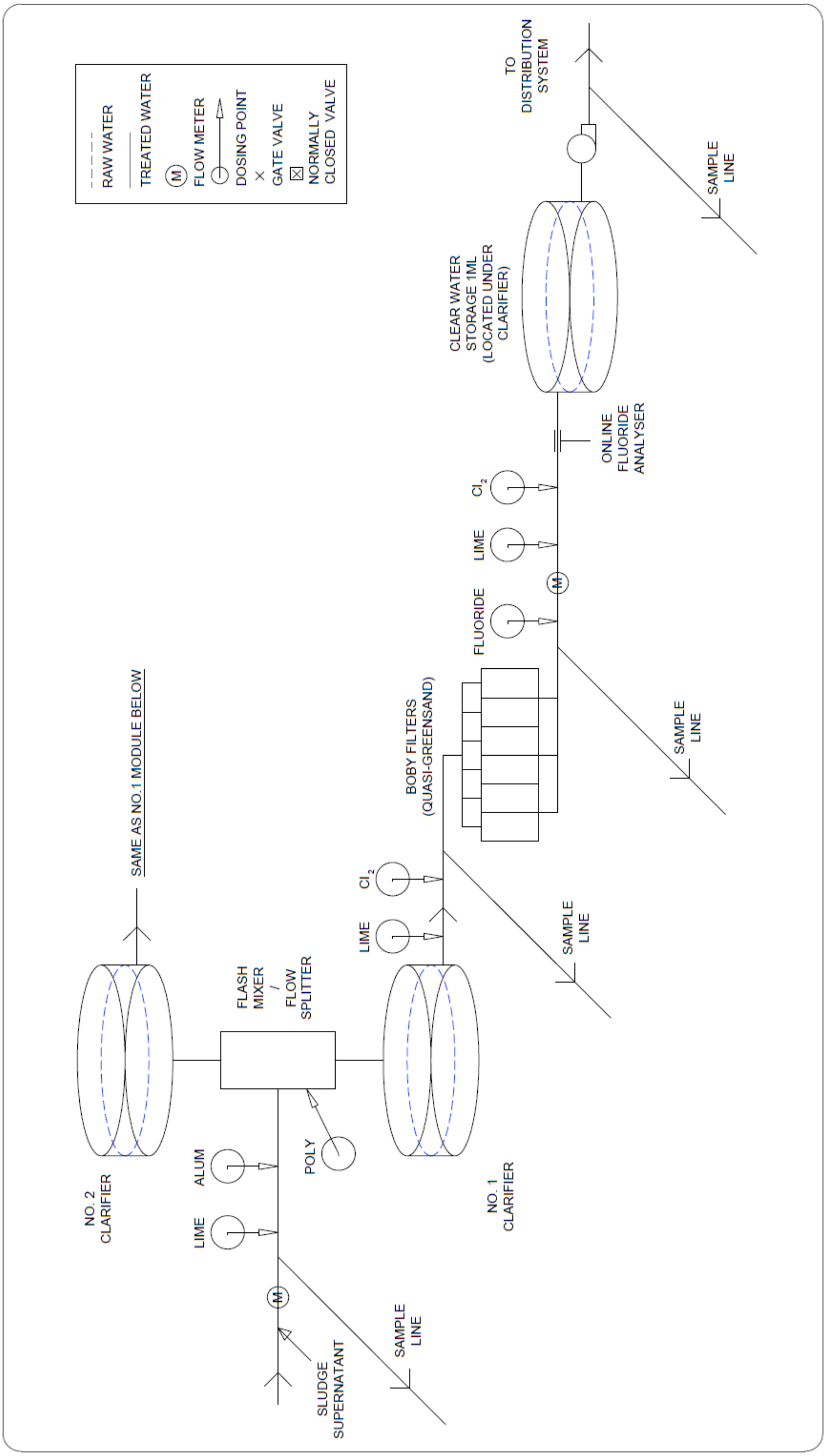


Figure 3-6: Howard Water Treatment Plant Flow Diagram

Figure 3-7 shows the Howard WTP usage and production trends over the years from 2009 to 2015. When Howard WTP is used it operates at near its full treatment capacity of 18ML/day. Its extended usage at the end of 2014 was due to the instillation and commissioning of the Actiflo module at the Burgowan WTP.

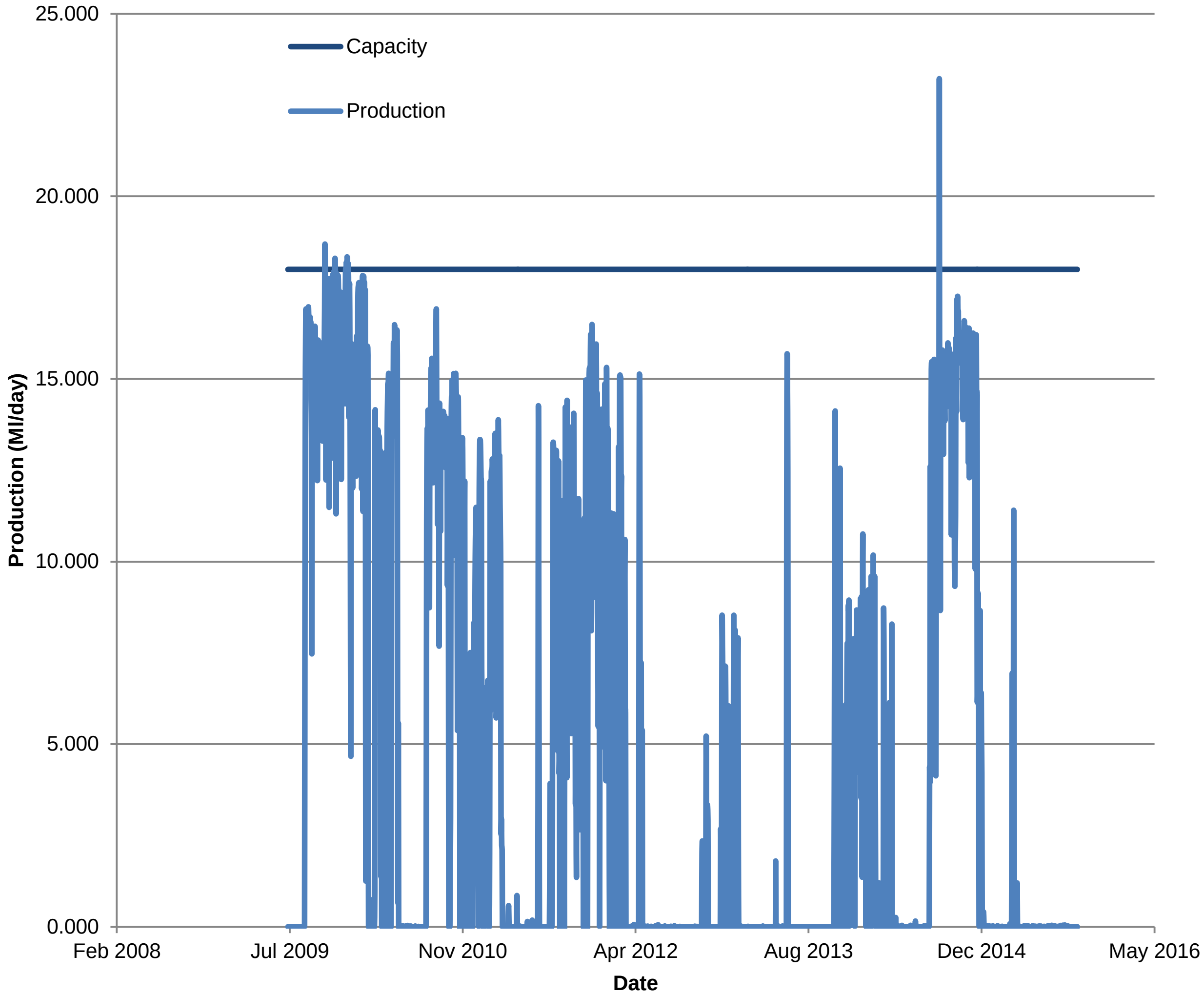


Figure 3-7: Treated Water Production Howard WTP

3.4.2. Burgowan Water Treatment Plant

There are two separate treatment processes at the Burgowan WTP;

- Dynasand - capable of producing approximately 11ML/day
- Ozone/BAC - capable of producing approximately 30ML/day

Figure 3-8 shows the production of water from the Burgowan WTP over the period 2009 to 2015. There is a significant period during the end of 2014, when the plant production was minimal. This coincides with the installation of the Actiflo module with Howard WTP used extensively while the Actiflo system was commissioned.

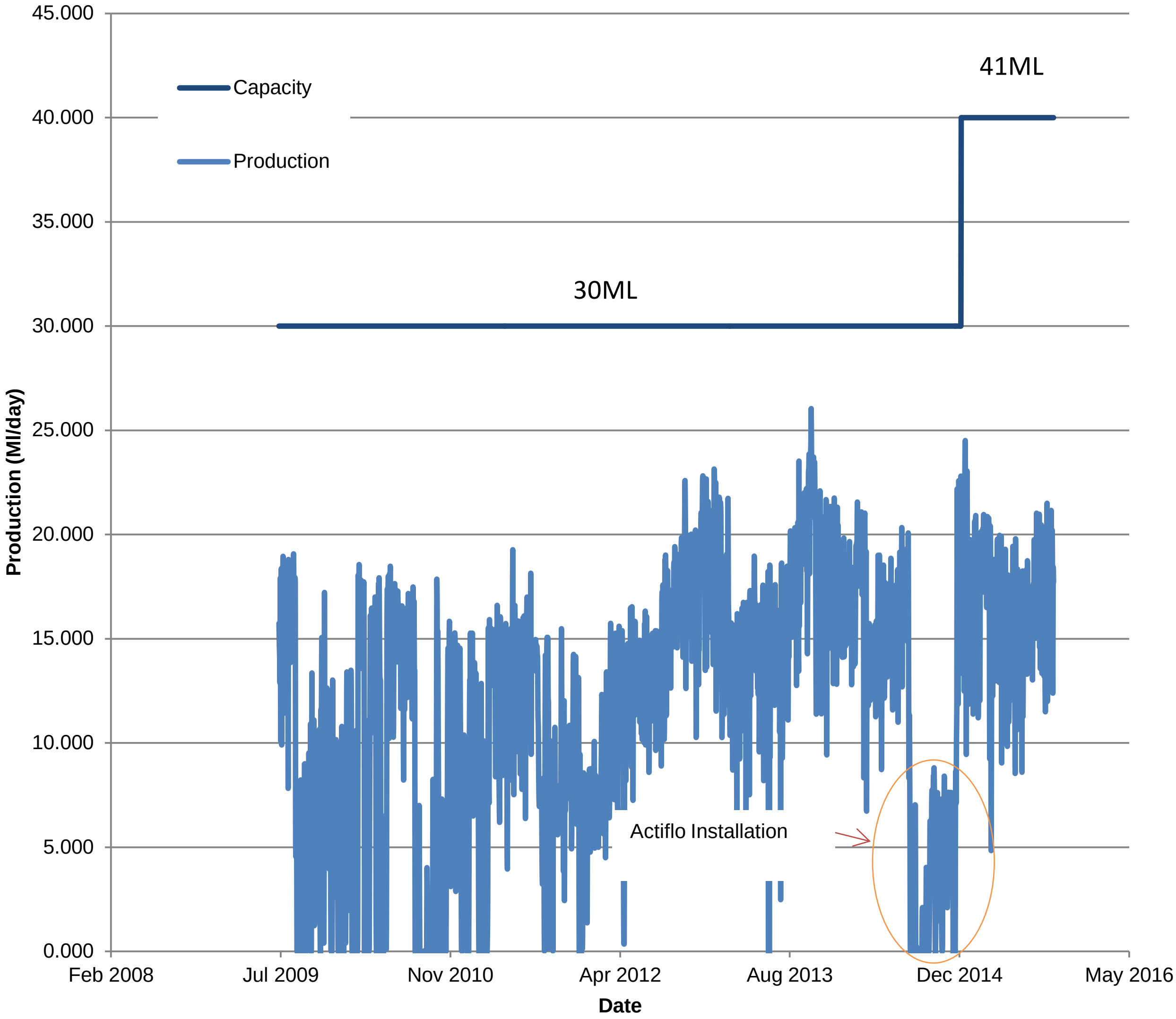


Figure 3-8: Treated Water Production Burgowan WTP

3.4.2.1. Dynasand Filtration Train

A continuous backwashing Dynasand direct filtration train was constructed and commissioned in 1991. With all eight filter cells in operation the plant has a maximum hydraulic capacity of 11ML/day.

The plant can achieve suitable output water quality at variable flow rates of 45, 90 and 140 litres per second depending on demand. The raw water quality also impacts on this plants ability to achieve suitable output water quality at the higher flowrates.

Soluble manganese can be removed through oxidation by dosing chlorine however this can lead to unacceptably high THM production rates. Dosing of chlorine for the purposes of manganese oxidation has not been used for some time as the preferred raw water source for the DFP is Cassava as it is typically low in dissolved iron and manganese.

These filters have in general performed well but their capability is particularly affected by changes in raw water quality, especially colour. High raw water colour (greater than - 150 Pt Co units) requires an increase in the coagulant dose rate producing excess floc that the backwash process cannot process. Under these conditions the plant flow rate has to be reduced to 45L/s and if the colour exceeds 250 Pt Co units the plant has to be shut down. In effect, the plant can only reliably treat water from the Cassava dams. Its "secure" capacity is therefore the safe Cassava dam yield which is estimated to be 1,000ML/annum plus low manganese and low coloured water pumped from the Burrum River when conditions are suitable.

These problems can be attributed to a lack of polymer dosing. The plant was first commissioned in 1993 and the chemical dosing system design included a liquid polymer batching and dosing system. For undocumented reasons, a polymer dosing system was installed but not commissioned. In the ensuing years it had been rendered inoperable as components were removed to replace failed components on other systems.

The use of polymers strengthens and improves attachment forces of floc particles within the filter. The added strength enables the floc to resist higher shear forces when filter rates are increased. This in turn results in minimising or eliminating turbidity increases at higher filtration rates. Filter aids are generally high molecular weight non-ionic polymers. The use of filter aids is particularly important with respect to direct filtration plants as they typically experience higher solids loading rates compared to filters with upstream clarification.

Works are being undertaken to facilitate prefiltration dosing of polymer (as a filtration aid). These works include the installation of a new powder polymer batching system as well as a dosing system.

Backwash sludge was initially thickened using a Lamella separator and dried on sand drying beds. The construction of two sludge dewatering lagoons at the site for the Ozone/BAC plant has allowed the sludge from the Dynasand plant to be dried in these lagoons.

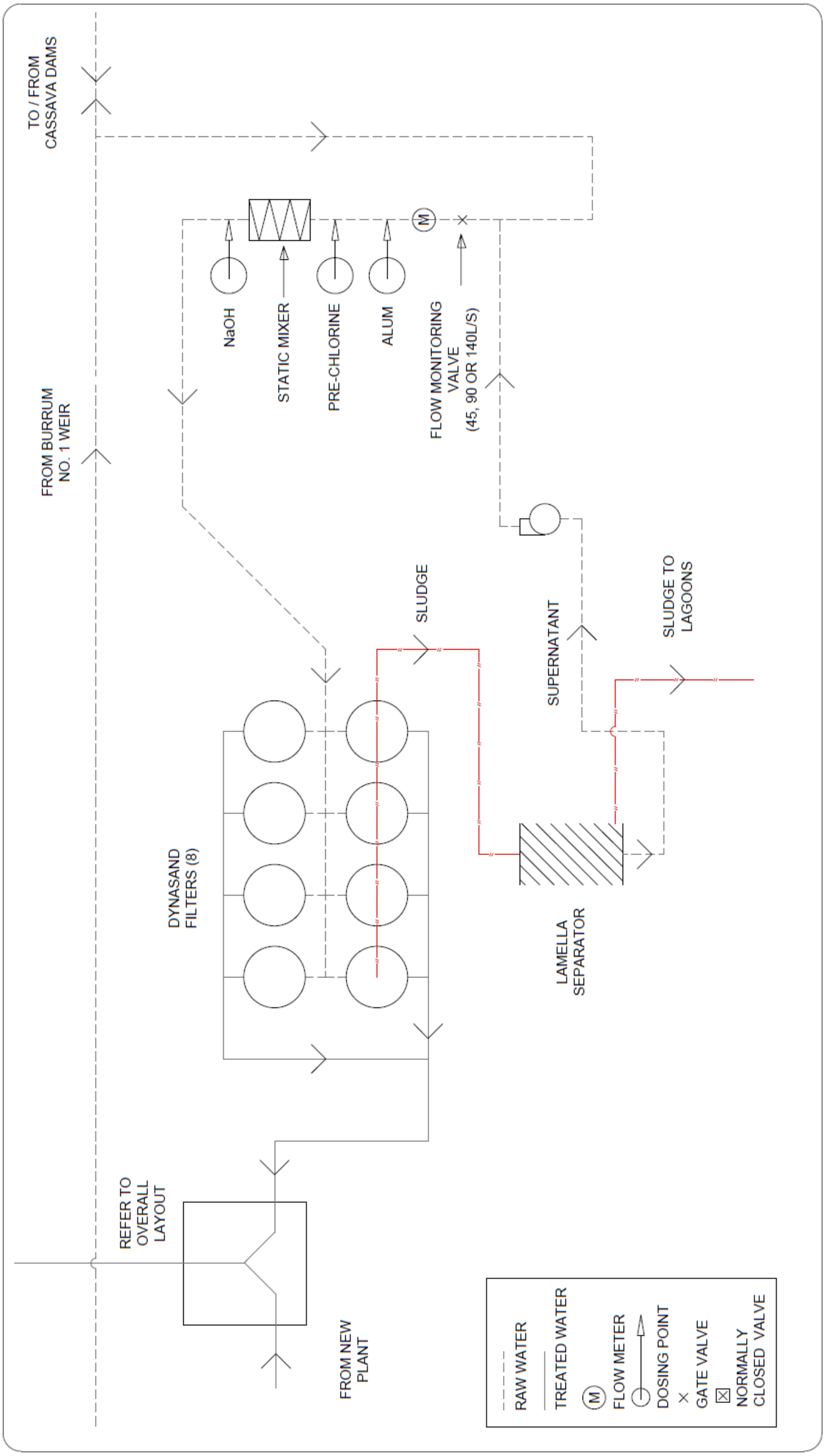


Figure 3-9: Burgowan Water Treatment Plant - TEMA

3.4.2.2. Ozone/BAC Train

Commissioning of the Ozone/BAC treatment train was completed in 2006 with a design capacity of 20ML/day. During commissioning it was determined that the up-flow clarifiers required more frequent backwashing than originally anticipated at design stage. Additionally high raw water colour resulted in reduced filter run times between backwashing which reduced the plant capacity to 15ML/day.

The high volumes of backwash water also impacted on the effectiveness of the sludge lagoons. Based on 18 months operation, it was determined that one lagoon was required for each 1,800ML of water treated. Therefore, a lagoon would fill every 120 days and would need to be dried out and emptied within four months whilst the second lagoon was filling. This imposed a further constraint on plant throughput as drying time is typically six months.

An Actiflo module was installed in 2014 to reduce solids loading on the upflow clarifier and the plant is now deemed to have a design capacity of 30ML/day. The robust treatment process can treat raw water from different sources and variable quality characteristics, removing a wide range of contaminants.

The process train now comprises:

- The inlet works including raw water pipe manifold and valves and a compartmentalised mixing chamber where chemicals are added sequentially,
- An Actiflo microsand ballasted clarification process,
- Up-flow buoyant media clarifiers to remove flocs entraining colour and turbidity from the coagulated water,
- Ozone contact tank for ozonation of the clarified water (turbidity < 0.3NTU) to oxidise dissolved organic carbon, taste compounds and any algal toxins,
- Biological activated carbon filters to remove readily biodegradable bi-products and residual floc particles,
- Disinfection and final water pH correction with sodium hypochlorite and sodium hydroxide respectively,
- Dewatering lagoons to dewater sludge generated from the clarifier and filter backwash with the supernatant water recycled back to the plant inlet.

The upgrade to the process has already seen a marked improvement to the water quality and a significant reduction in backwashing requirements, meaning that the plant is expected to now have a design capacity of 30ML/day and backwashing has been reduced to every 18 hours.

The process flow diagram is shown in Figure 3-9.

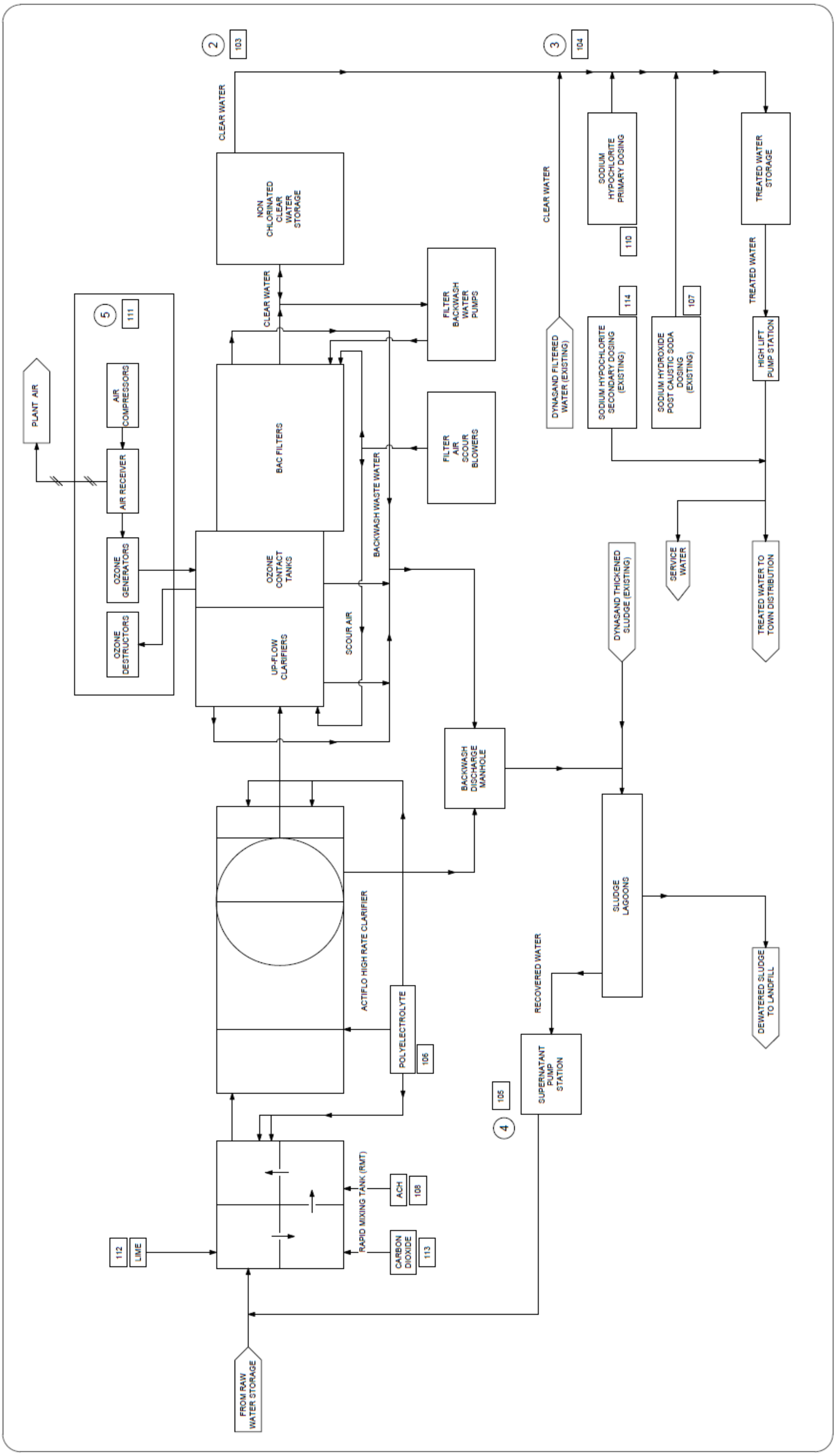


Figure 3-10: Burgowan Ozone/BAC Process Treatment Chart

3.4.3. Teddington

The Teddington WTP is understood to have been constructed in the early 1970's and is located at Teddington Weir. The plant consists of two identical conventional treatment process trains providing aeration, coagulation, clarification, filtration, pH correction and disinfection. Raw water supply to the plant is pumped from the weir via one of two available pumping configurations depending on which process stream is to be used. The plant is hydraulically capable of treating 460L/s which is equivalent to 36ML/day for a 22 hour operating day, however treated water demand has historically reached only a maximum of approximately 22ML/day prior to 2008 and there are significant issues with treated water quality at higher production rates. Operators at Teddington indicate that the nominal capacity without adversely affecting water quality is approximately 20ML/day.

In October 2002, Maryborough City Council (MCC) engaged Hunter Water Australia (HWA) to perform a review of its Teddington WTP chemical dosing regime to determine where the treatment process could be improved in terms of treated water quality, plant operability and operating costs. The main issues of concern were the costs and OH&S issues associated with the use of both hydrated lime and aluminium sulphate (alum) that were both delivered to the plant dry in 25kg bags. In 2011 the alum system was replaced with a bulk aluminium chlorohydrate (liquid ACH) system which resulted in marginal improvements in alkalinity levels in the product water. In 2013 the bagged lime system was replaced with bulk lime storage and dosing system. This has eliminated manual handling, improved process control and reduced chemical costs.

Raw water is initially dosed with lime and then ACH is added upstream of the aerator. The dosed water is then fed to a reactivator type clarification process where a coagulant aid polymer is added to improve settling. The clarified water is chlorinated to oxidise residual iron and manganese which is removed during the filtration process. The two boby™ pressure filter units each consisting of eight filters contain sand that is coated with potassium permanganate in order to assist in the removal of the oxidised iron and manganese. The filtered water is chlorinated before flowing into either of two clear water storage tanks on site prior to being pumped into the distribution system.

The plant has provision for PAC dosing which has typically been used during blue green algae blooms.

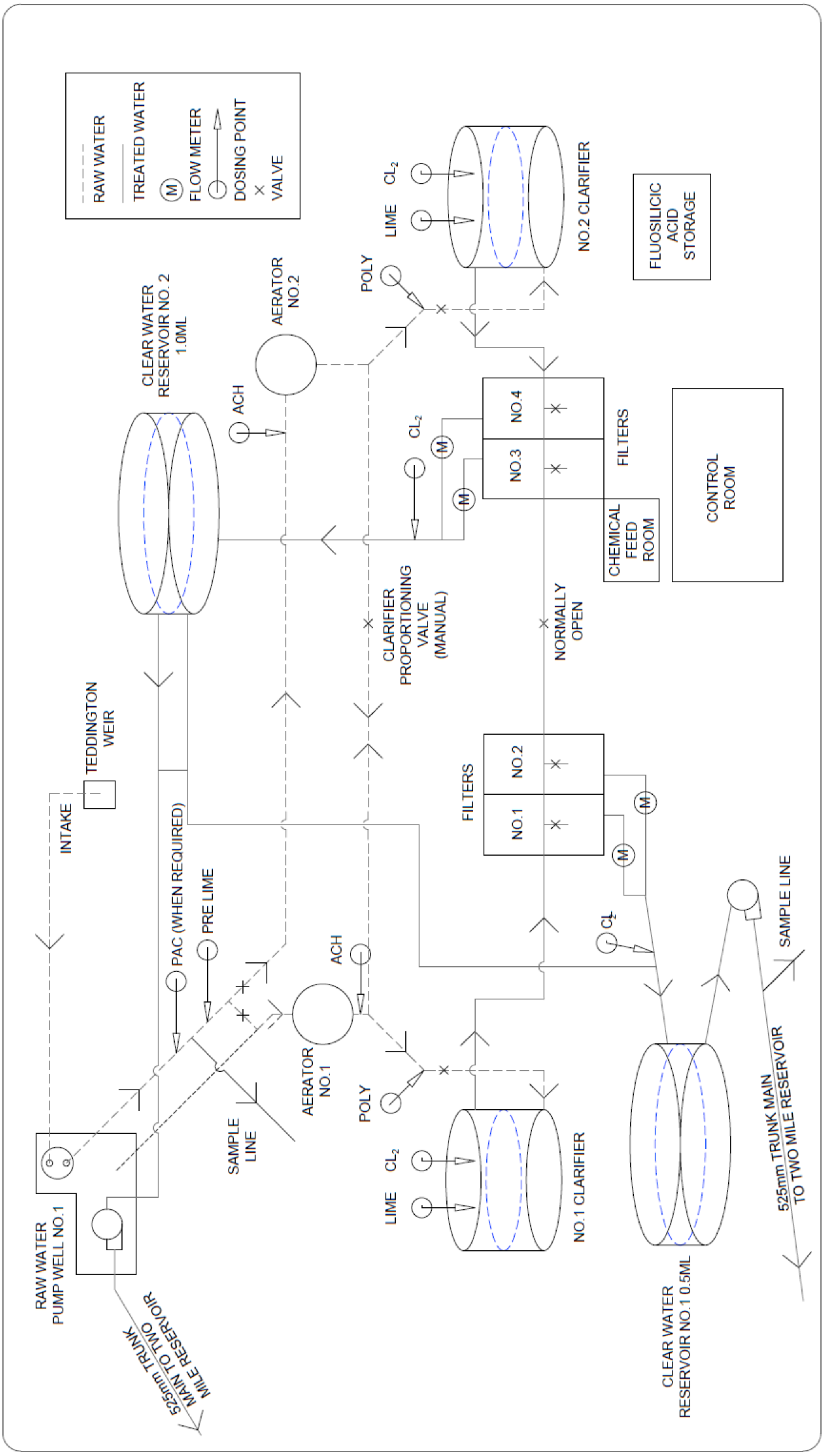


Figure 3-11: Teddington Water Treatment Plant - Flow Diagram

WBWC determined that further improvement in water quality from the plant could be achieved through optimisation of the existing processes. New control systems have been installed to assist in achieving this outcome.

In the longer term, additional processes may also be required to meet higher water quality standards and increased production rates.

Subsequent to the introduction of water meters and consumption based charges in Maryborough, water consumption has dropped significantly. The treated water production, between 2008 and 2010, ranges between 5 and 15ML/day. Figure 3-12 details the recent production rates from the Teddington WTP.

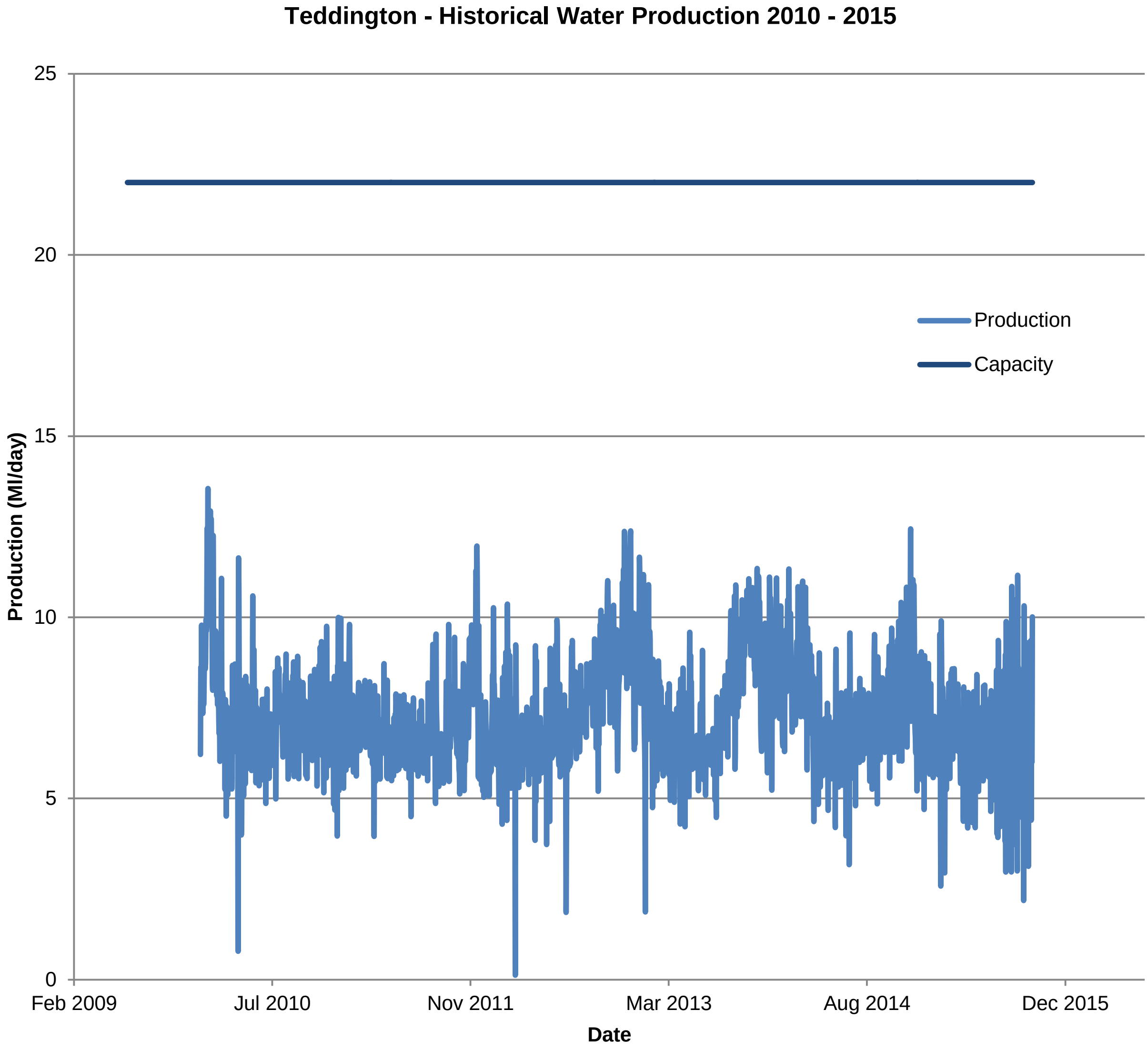


Figure 3-12: Treated Water Production 2010 – 2015 Teddington WTP

3.4.4. Tiaro WTP

Tiaro draws water from the Mary River upstream of the barrage. Water is pumped to the dissolved air floatation over filter (DAFF) plant before being stored in a 1.25ML ground level storage. From here clear water pumps transfer the water to the reticulation system.

The DAFF plant was commissioned in August 2001. It can produce 1ML of treated water per day to supply the township of Tiaro.

Chemical dosing is used to assist in floc formation during the dissolved air floatation (DAF) process. To optimise floc formation pH correction is undertaken. The floc mat formed in the DAF process is removed to the sludge trough by a mechanical sludge roller, where it is then pumped to sludge drying beds.

After water in the DAF has been through the filter media it is disinfected and the pH is corrected again before being transferred to the 1.25ML clear water storage.

Figure 3-13 illustrates the treatment process at the Tiaro WTP.

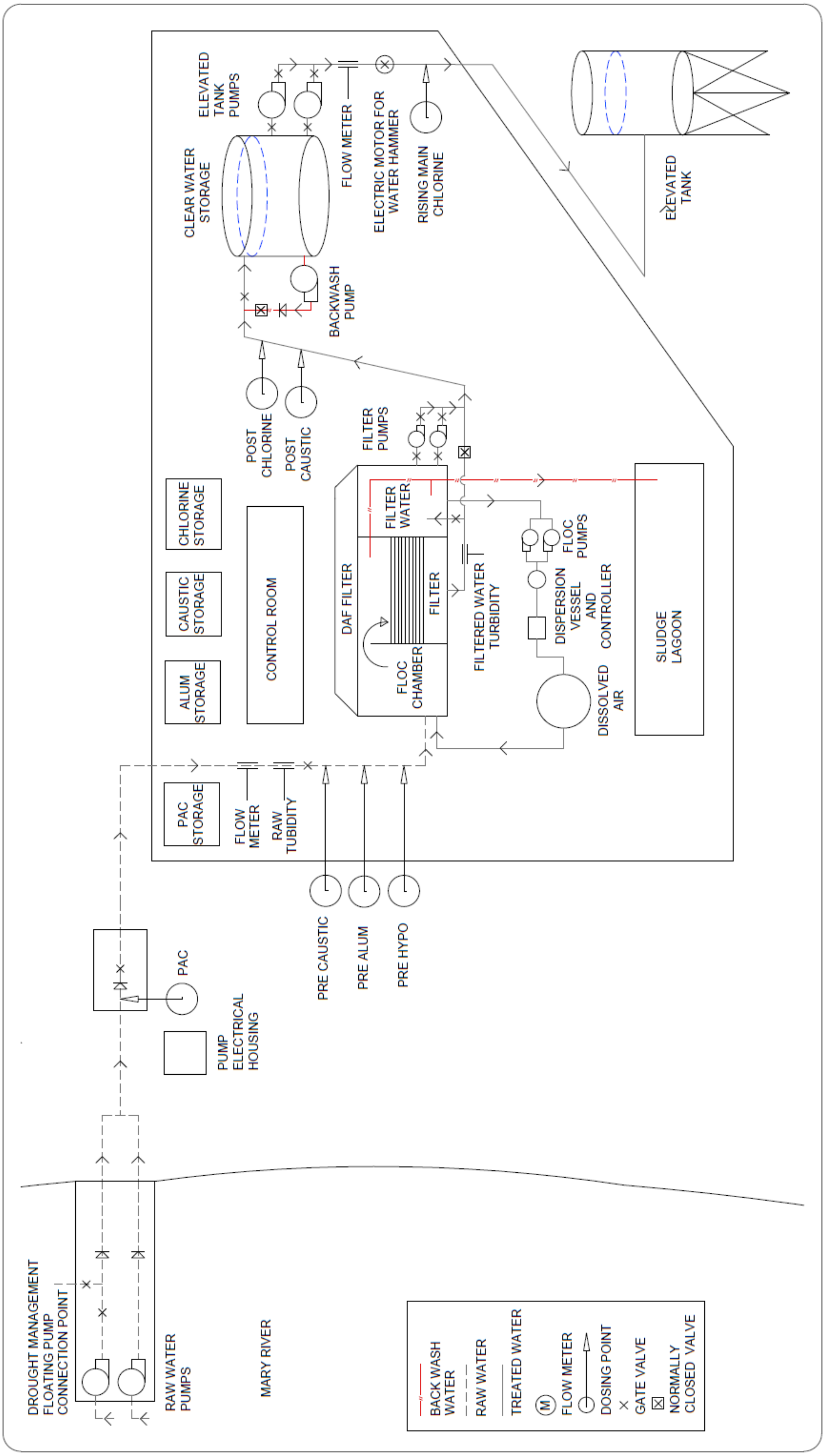


Figure 3-13: Tiaro Water Treatment Plant Flow Diagram

Figure 3-14 shows the clear water production at the Tiaro WTP from 2009 to 2015. It can be seen from the graph that the treatment plant capacity (7,000kL/week) is significantly greater than the current system demands and therefore there is ample capacity for growth in Tiaro.

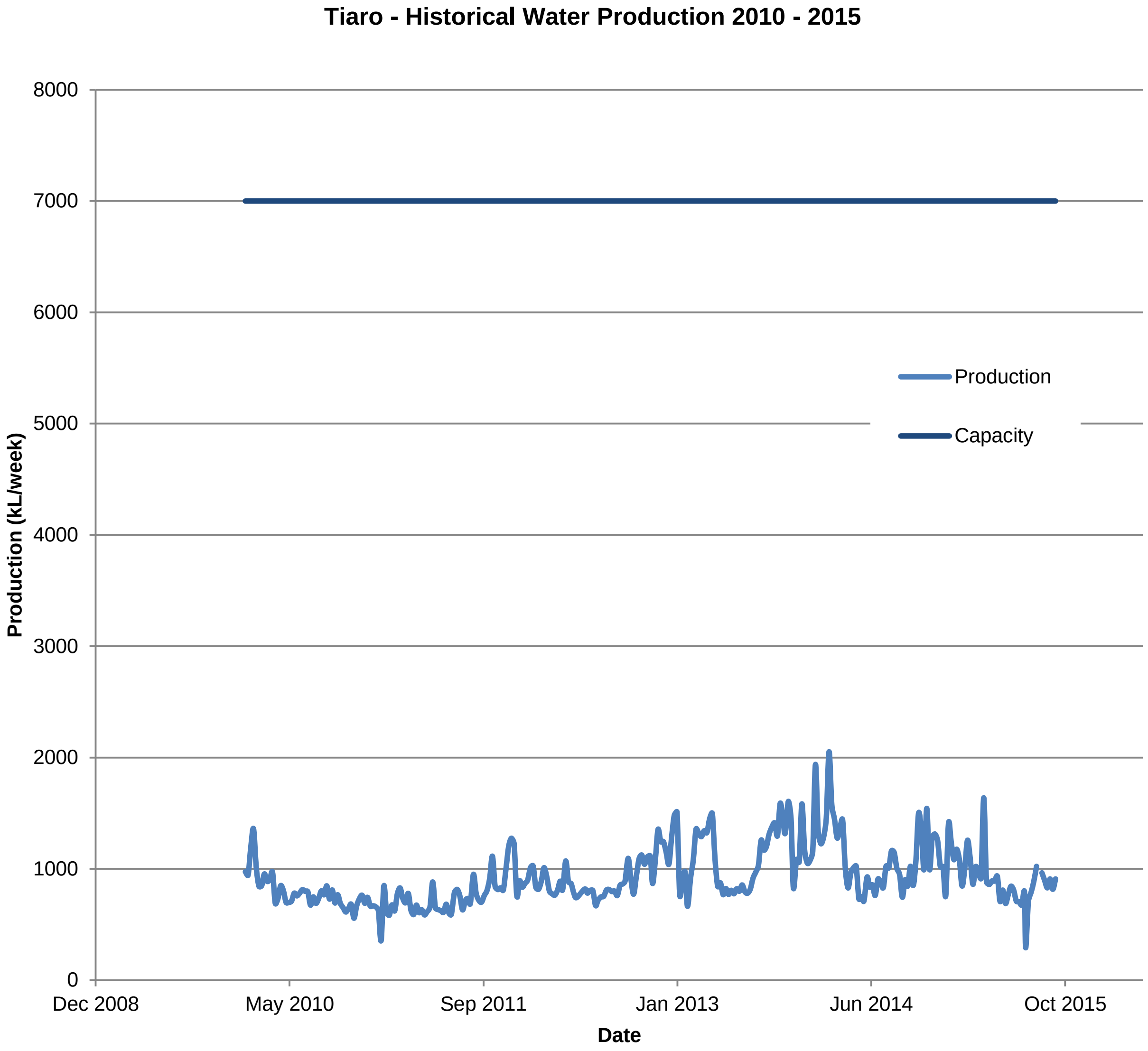


Figure 3-14: Treated Water Production Tiaro WTP

3.5. Bulk Water Supply

The treated bulk water supply system is defined as the infrastructure from the source to the distribution network including some ground level reservoirs. It generally consists of pump stations, large diameter mains (>300mm) and ground level and elevated reservoirs. Generally this infrastructure provides MDMM capacity.

3.5.1. Bulk Water Supply – Hervey Bay

The bulk supply in the Hervey Bay system consists of the following assets:

- Howard WTP, clear water storage and pumping station
- Burgowan WTP (2 process trains), clear water storage (20ML) and pumping station
- Bulk treated water delivery main (DN450), from to Burgowan WTP
- Bulk treated water delivery main (DN450 and DN600), from Burgowan to the Takura Reservoirs
- Takura Reservoir No.1 and No.2 – volume of 1.0ML and 9.0ML respectively
- Bulk treated water delivery main (DN450 and DN500) from Takura Reservoir to Cooks Rd
- Bulk treated water delivery main (DN600) from Cooks Rd to Urraween Reservoir
- Urraween Reservoir and Urraween Pumping Station
- Treated water delivery mains (DN500 and DN450) from Urraween Reservoir to Ghost Hill Reservoirs.

These and other trunk distribution mains are shown in Figure 3-15.

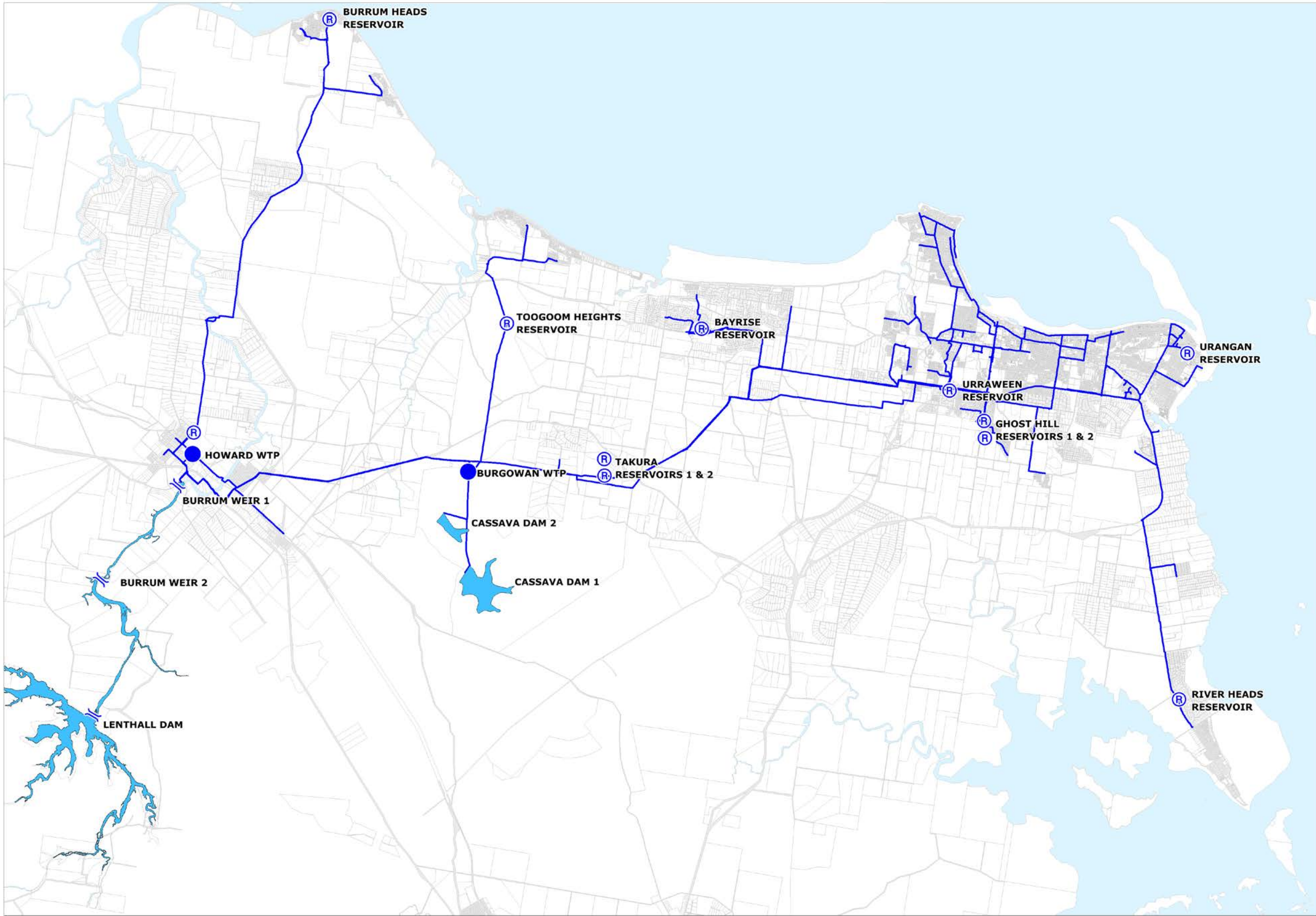


Figure 3-15: Hervey Bay Headwork's Infrastructure

3.5.2. Bulk Water Supply – Maryborough

The treated bulk water supply in the Maryborough system consists of the following assets:

- Teddington WTP, clear water storage and raw and treated water pumping stations.
- Bulk treated water delivery mains 2 x DN525 to Two Mile Reservoir.
- Two Mile facility consisting of an operational 4.5ML reservoir and a decommissioned 4.5ML reservoir.
- The DN525 and DN600 water mains to the town reservoirs at Boys Ave.
- Boys Avenue Reservoirs (9ML and 10ML).

These and other trunk distribution mains are shown in Figure 3-16.

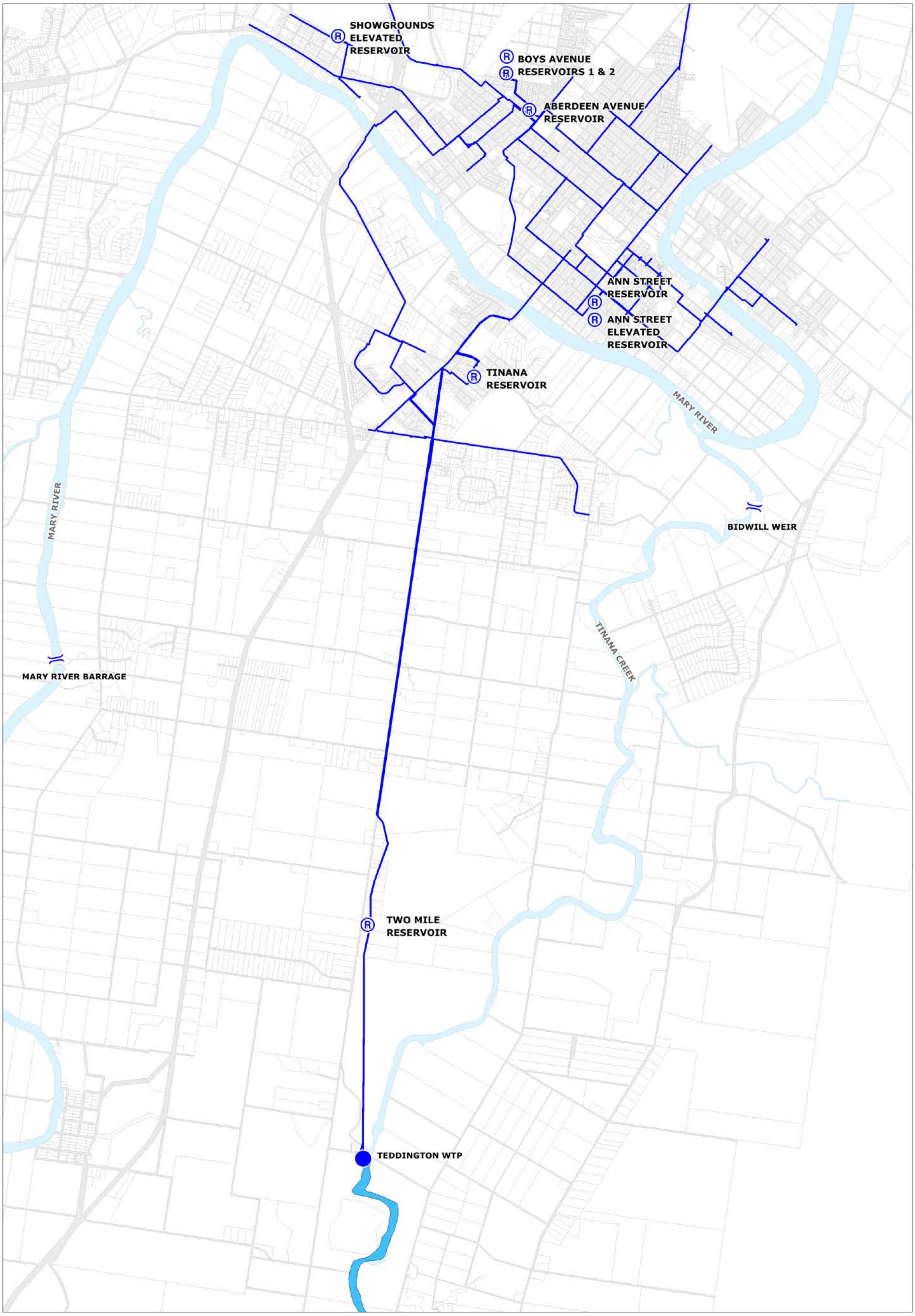


Figure 3-16: Maryborough Headwork's Infrastructure

3.5.3. Bulk Water Supply – Tiaro

The treated bulk water supply in the Tiaro system consists of the following assets:

- Tiaro WTP, clear water storage and raw and treated water pumping stations.
- Bulk treated water delivery main (DN200) to the Forgan Tce Elevated Reservoir.

3.6. Water Distribution System

3.6.1. General Network layout

In this report, the distribution system has been defined as that infrastructure that delivers water from the bulk supply assets to the individual water districts. These assets are typically required to deliver the maximum hour demands throughout the system. However, in some cases they also provide flow to the various service reservoirs located within a number of the water districts.

3.6.1.1. Hervey Bay Network

In Hervey Bay, the Urraween pumping station and Ghost Hill No.1 and No.2 Reservoirs service the Hervey Bay communities of Point Vernon, Pialba, Scarness, Torquay and Urangan. The Urraween pumping station pumps directly to the Ghost Hill Reservoirs via existing DN450 and DN500 water mains. A pump station was constructed at Ghost Hill No.2 Reservoir site to supply to a high elevation area along the Ghost Hill ridge. From the Ghost Hill No.1 Reservoir water gravitates through a DN750 main to Urraween Rd at which point, Point Vernon and Pialba are supplied via a new DN600 distribution main, while Scarness, Torquay and Urangan are serviced via the DN600, DN450 and DN300 distribution mains.

River Heads and Booral are also supplied from these distribution mains on Boundary Road. To ensure standards of service are satisfied during peak demand periods, the pressure is boosted by the Booral Pump Station. A high level and low level zone has been established at River Heads to assist in demand management. The low lying areas use the existing 1ML River Heads Reservoir to provide its pressure while the high zone relies on the River Heads pumping station. The High Zone Pump Station draws water from the River Heads Reservoir.

The Takura Reservoirs directly service the districts of Dundowran, Bayrise and Craignish via DN375 and DN250 distribution mains. The Dundowran pumping station was originally constructed only to provide pumped flows during peak periods. Growth in the system has meant that this pump station is now used to provide pressure and flow for the majority of the Dundowran area. It also provides water supply to the Bayrise Estate Reservoir which supplies the lower lying areas including part of the Dundowran Beach area.

The Burgowan Clear water pumps provide water to Burrum Heads by back feeding down the DN450. The Burrum Heads community is supplied via a DN300 / DN150 distribution main. The DN150 supply main to Burrum Heads from the Toogoom system has been closed at Beelbi Creek but is available to provide an emergency supply if required. This main is seldom used and is known to have reliability and water quality issues if it were to be utilised. It is also questionable if the main would have sufficient capacity to maintain adequate levels of service in a situation where it was the sole supply.

The Burgowan WTP also provides water to the Toogoom community. Water is pumped from Burgowan to the Takura Heights (Toogoom) Reservoir via a DN150 main. Water can also gravitate from the Takura Reservoirs to the Toogoom Heights Reservoir. In recent years, during peak demand periods, the Toogoom Bush Pump Station has been used to pump water into the Takura Heights (Toogoom) Reservoir. A DN300 diameter distribution water main runs from the reservoir into the township. A pressure reducing valve, located on Toogoom Road is used to set the hydraulic grade for Toogoom as most of the land within the district has an elevation significantly lower than the Takura Heights (Toogoom) Reservoir.

3.6.1.2. Maryborough Network

Boys Ave No.1 and No.2 Reservoirs have capacities of 9.1ML and 10ML respectively. They supply water to Maryborough West, Bell Hilltop, Newtown Central, CBD and Granville.

Maryborough West is supplied from the High Zone Pump Station located at Aberdeen Ave. Water is pumped directly into the reticulation system while concurrently supplying water to a 1ML elevated reservoir at the Showgrounds via a DN525 water main and to a 0.45ML elevated reservoir located on the Aberdeen Ave. In the past there were issues with water hammer through the reticulation system as the pumps turned on and off. This was rectified through the installation of variable speed drives on the pumps in this pump station.

The Newtown Central, CBD and Granville area are supplied from the Low Zone Pump Station located at Aberdeen Ave. From here the water is pumped directly into the system while concurrently supplying water to the Low Zone Elevated Reservoir (0.45ML) located at Aberdeen Ave. The elevated reservoir provides the reticulation system with consistent pressure and some limited storage. The Ann St Elevated Reservoir (0.45ML) is also supplied from the Low Zone Pump Station through a network of pipelines.

Tinana is supplied directly off the DN525 from Two Mile Reservoir. The area is supplied from a pump station located on Nathan St. The Tinana Elevated Reservoir is supplied from this pump station and provides 0.45ML of storage for the Tinana area. It also provides consistent pressures to the area.

3.6.1.3. Tiaro Network

Water is pumped from the clear water storage reservoir (1.25ML) at the Tiaro WTP to the elevated reservoir in Forgan Tce via a DN200 trunk main (821m in length). From the elevated reservoir water is provided directly into the reticulation system. The operation of the pumps is determined by the level in the elevated reservoir. This elevated storage (100kL) provides limited storage to the township under emergency conditions and provides consistent pressures into the reticulation system.

3.6.2. Pump Stations

The Fraser Coast has 23 water pump stations which deliver water at a required level of service. Six of these pump stations are used to convey raw water to their respective treatment plants with 17 pump stations used to transfer water throughout the water supply network. The existing pump stations are presented in Table 3-8 below.

Table 3-8: Fraser Coast Water Pump Stations

System	Pump Station No.	PS Name
HB	WPS1318	Burrum Weir (New) raw water PS
HB	WPS1300	Burrum Weir (Orig) raw water PS
HB	WPS1200	Cassava No.1 raw water PS
HB	WPS1400	Cassava No.2 raw water PS
HB	5225	Burgowan Clear Water PS
HB	WPS0300	Toogoom Bush PS
HB	WPS0200	Toogoom Rd PS
HB	WPS0100	Burrum Heads Standpipe PS
HB	WPS0400	Dundowran PS
HB	WPS0500	Urraween No.1 PS
HB	WPS0600	Ghost Hill Res No.2 HLZ PS
HB	WPS0700	Ghost Hill No.1 PS
HB	WPS1600	Parklands Estate
HB	WPS0900	Booral PS
HB	WPS1000	River Heads HLZ PS
MB	50003	Teddington Raw Water PS
MB	50011	Teddington Clear Water PS
MB	WPS5100	Tinana Water PS
MB	WPS5300	High Zone PS
MB	WPS5400	Low Zone PS
MB	WPS5200	Ann St PS
TIA	WPS4100	Tiaro Raw Water PS
TIA	40005	Tiaro Clear Water PS

For a complete list of pump stations including location plans, pump information, duty points and descriptions are located in Appendix 5J.

3.6.3. Ground Level Reservoirs

Treated water from the Burgowan WTP is pumped to the Takura Reservoirs. Treated water from the Howard WTP is pumped to Takura Reservoirs and also to Burrum Heads and the elevated storage in Howard. When the Howard WTP is not operating both Howard and Burrum Heads can be supplied directly from Takura Reservoir.

Takura Reservoir distributes water to Urraween Reservoir through gravity trunk mains and also to Takura Heights and Bayrise Reservoirs with assistance from booster pumping. Ghost Hill High and Ghost Hill Low are supplied by pumping from Urraween Reservoir. The pumps at Urraween Reservoir also supply water directly into the reticulation system at Main St and are required to meet the maximum hour demand. The River Heads Reservoir is supplied from the Ghost Hill Reservoirs with a pump station on Booral Road to boost the supply. There are also a number of properties supplied directly from the trunk mains although no further connections are permitted.

For the purposes of this report, Maryborough can be dissected into three parts delineated by the natural water courses of the Mary River and Tinana Creek.

The Maryborough portion is the area bound by the Mary River to the south and east and is the greatest. It is also the location of three of the largest ground level reservoirs, being Boys Ave Reservoirs No.1 and No.2 and the Ann St Reservoir, which have a combined storage volume of 23.6ML. The Ann St Reservoir is currently out of service. A ground level reservoir at Aberdeen Ave has been decommissioned (2013).

Ann St Reservoir is currently out of service. It relies on the Ann St Pump Station to distribute water into the reticulation system. This pump station has not been operated since it was commissioned and it is understood that noise complaints may have been received in relation to the pump station which resulted in the decision to discontinue its use.

The area bound by the Mary River to the north and Tinana Creek to the east is the Tinana portion. This area is supplied directly from Two Mile Reservoir which is fed from the existing DN525 / DN600 trunk mains. Two Mile Reservoir has a storage capacity of 4.5ML.

The area bound by the Mary River to the west and south is Granville and relies on supply from Maryborough via a single water main across the Mary River. The Granville zone does not have a dedicated reservoir located within its boundaries.

The existing ground level reservoirs are detailed in Table 3-9.

Table 3-9: Ground Level Reservoir

System	***Reservoir***	***Construction Year***	***Storage Volume (ML)***	***Top Water Level (mAHD)***	***Bottom Water Level (mAHD)***
HB	Bayrise Reservoir	1993	0.33	61	57
HB	Burgowan Clear Water Reservoir	1991	20.7	25	18.62
HB	Ghost Hill Reservoir No.1	1953	4.5	67.5	63.75
HB	Ghost Hill Reservoir No.2	Circa 1970's	6.7	80.8	71.66
HB	River Heads Reservoir	1992	1	56*	52*
HB	Takura Reservoir No.1	1953	1	95.48	88.4
HB	Takura Reservoir No.2	1985	9	95.48	87.06
HB	Toogoom Heights Reservoir	1972	0.68	76.43	72.93
HB	Urraween Reservoir	1991	35.4	32.5	27
MB	Two Mile Reservoir	1951	4.5	48.35	42.07
MB	Ann St Reservoir	1968	4.5	30.3	24.05
MB	Boys Ave Reservoir No. 1	1969	9.1	30.52	24.57
MB	Boys Ave Reservoir No. 2	1983	10	30.8	24.8
TIA	Tiaro Clear Water Reservoir	2001	1.25	33*	29*

*Estimated values

3.6.4. Elevated Reservoirs

The Hervey Bay system has just the one operational elevated reservoir which is the Howard Reservoir. Other existing elevated reservoirs at Urangan and Burrum Heads have been decommissioned because they do not provide sufficient head pressure to meet minimum service level requirements. Because these reservoirs are relatively high they are now used for the purposes of housing telecommunications aerials.

Maryborough has five elevated reservoirs which provide limited storage to the Maryborough water supply system. The elevated reservoirs are;

- Showgrounds, High Zone and Low Zone Elevated Reservoirs which are all supplied from the Boys Ave No.1 and No.2 Reservoirs;
- Ann St Elevated Reservoir which is supplied from the Ann St Reservoir; and
- Tinana Elevated Reservoir which is supplied from the Two Mile Reservoir.

The Showgrounds Elevated Reservoir, while being the largest elevated reservoir in Maryborough, is located on the periphery of the town and therefore has limited benefit until there is further growth in that area.

The Granville Elevated Reservoir was decommissioned and demolished in November 2010. While the capacity of this reservoir was only 50kL, it provided a small amount of security of supply to the Granville area. Currently there is no security of supply to Granville and the only supply is via a DN450 bridge crossing at the Mary River.

Tiaro has a single elevated reservoir which supplies the town. It is a relatively small elevated tower but provides a limited amount of gravity storage for emergencies.

Table 3-10 outlines the reservoir details for each of the elevated reservoirs in the Fraser Coast.

Table 3-10: Elevated Reservoirs

System	*Elevated Reservoir*	*Construction Year*	*Storage Volume (ML)*	*Top Water Level (mAHD)*	*Bottom Water Level (mAHD)*
HB	Howard	1953	0.68	52.12	43.6
MB	Low Zone	1970	0.45	50.60	43.74
MB	High Zone	1971	0.45	57.00	50.14
MB	Anne St	1970	0.45	49.10	42.24
MB	Showgrounds	1991	1.00	61.00	53.00
MB	Tinana	1981	0.5	62.00	54.78
TIA	Tiaro	1999	0.1	72.7*	69.2*

*Estimated values

3.7. Reticulation Network

There is over 1,000km of water main located in the Fraser Coast region. The pipes age from installations in the early 1900's through to 2015.

The reticulation system mainly comprises DN100, DN150 and DN200 water mains to which the majority of service connections are made. These mains are required to provide both peak hour demands and firefighting flows.

Hervey Bay has approximately 750km of DN100 and larger water mains. Maryborough has approximately 270km of DN100 and larger water mains. Tiaro in contrast has just 10km of DN100 and larger water mains. Tabulated data on pipe lengths by diameter, material type and system can be found in Appendix 5A.

The majority of the Hervey Bay Water supply system has network mains able to meet all design parameters. However, there are areas in the south west of the township of Howard where minimum service levels are not met under maximum hour demands. There are also some deficiencies in Toogoom due to the coastal strip development and long single feed mains (up to 2.5km) which service residential customers. These single feed mains have high head losses and are of concern in terms of maintaining security of supply and level of service.

The more elevated areas at Ghost Hill, Craignish, Dundowran and East Booral are serviced by booster pumps and this method of supply will need to continue due to their elevation relative to the storages.

Without boosters most of these areas will still receive water in most situations although it will be well below required volumes and pressures.

3.7.1. District Metered Areas/Demand Management Areas (DMA)

DMA's were introduced to assist with demand management and leak detection. They generally consist of a small demand area (typically around 1,000ED) and are usually supplied by a single controlled point. Generally the DMA's are isolated from one another by the installation of boundary valves which can be manually opened in times of emergency.

Even though most of the PRV's are flow modulated and pass more water when demands increase system losses can be significant in areas where there is a large demand (such as a fire flow) and unidirectional flow. In these situations pressures within the DMA can drop substantially and flows are adversely affected.

Similarly DMA's can be a problem if there is a failure of the supply main into the DMA (no alternative feed). DMA's are usually metered and in some cases PRV's are installed to help demand management in the area.

The 34 existing DMA's in the Fraser Coast are presented in Table 3-11.

Table 3-11: Fraser Coast DMA's

Hervey Bay	Hervey Bay Surrounds	Maryborough
Booral East	Burrum Heads	Maryborough CBD
Booral to River Heads Trunk	Dundowran High	Granville
Booral Trunk	Dundowran Low	Bell Hilltop
DCP2	Dundowran Bayrise	Maryborough West
Eli Waters	Dundowran PRV	Tinana
Ghost Hill High	Howard	Newtown Central
Ghost Hill Low	Howard to Takura Trunk	
Kawungan		
Lower Mountain Road		
Pialba		
Point Vernon		
River Heads High		
River Heads Low		
Scarness High		
Scarness Low		
Torquay High		
Torquay Low		
Urangan High		
Urangan Low		
Urangan Industrial		
Wondunna		

4. WATER DEMAND PROJECTIONS

In order to determine the future demands, the following methodology was used;

- Determine the losses per Equivalent Dwelling (ED) in the networks,
- Determine the demand per ED in the networks,
- Determine areas of growth and sequencing,
- Establish ED projections,
- Establish Demand Projections.

4.1. Existing Equivalent Dwellings

The existing ED's are estimated in the following table. They are generally classified as residential or non-residential demand.

Table 4-1: Estimated 2015 ED's Fraser Coast

	Total Residential	Total Non-Residential	Total
Hervey Bay	29,070	6,938	36,008
Maryborough	10,452	2,914	13,367
Tiaro			338
Total	**39,522**	**9,853**	**49,712**

4.2. Demand Considerations

4.2.1. System Losses

The losses in a system are defined as water which is produced for consumption but generates no income. It can take the form of accounted for water which includes such things as filling of mains for operational purposes and unaccounted for water which includes theft, leakage etc.

A brief assessment of water losses was undertaken as part of this report. It compared the water produced at Teddington and Burgowan WTP against the water that was billed to customers over a two year period (November 2012 to February 2015). The results concluded that Hervey Bay has losses of 10%, while Maryborough has losses of 19% and Tiaro has losses of 29%.

Table 4-2: Water Losses for period Nov 2012 to Feb 2015

	Hervey Bay	Maryborough	Tiaro
Billed consumption from meters (ML)	13,582	5,410	102
WTP recorded consumption (ML)	15,155	6,642	144
Losses (ML)	1,574	1,232	41
Losses %	10%	19%	29%
L/connection/day*	57	109	125

* based on average water consumption for residential lots over the period July 2012 to June 2015 as shown in Table 4-3.

Liemberger (2005) indicates that for developed countries with system pressures of 40m, that losses of less than 100L/connection/day are excellent. The QLD state benchmarking for 2012/13 carried out by QLDWater (2013), reports that the state water service providers median losses is approximately 95L/connection/day.

4.2.2. Demand Allocation

Demand allocation is dependent on the number of equivalent dwellings (ED's) either existing or permitted under the planning scheme on a particular site. Over the planning period the amount of residential and non-residential development will increase.

The Wide Bay Burnett Regional Plan (2011) has forecast that the demand per person (L/person/day) will increase due to higher living standards and a higher incidence of the use of dishwashers and swimming pools.

An assessment of water use based on billing data supports this view in Hervey Bay where the average water consumption per ED has increased by approximately 7%, Maryborough experienced very little change although it should be noted that their average usage is still higher than the usage in Hervey Bay.

Table 4-3: Average Residential Consumption in Billing Period

Location	C2 12.13	C3 12.13	C1 13.14	C2 13.14	C3 13.14	C1 14.15	C2 14.15	Average	losses	L/connection/day	adopted consumption (L/ED/day)
HB	589	616	407	670	663	498	566	573	10%	57	630
MB	693	508	442	704	620	500	564	576	19%	109	680
TIA	450	327	348	493	503	409	506	434	29%	125	560

Notes:

1. All zero meter readings were excluded from the analysis

2. Only property types of residences and home units were used in the derivation of these figures.

3. Losses were added to calculate the adopted consumption (10% for Hervey Bay, 19% for Maryborough and 29% for Tiaro)

The number persons/dwelling was obtained from the Australian Bureau of Statistics Census data from 2011 which indicated a population density of 2.4 persons/dwelling in Hervey Bay and Maryborough and this figure is adopted in this study.

RECOMMENDATION: Further investigation is carried out in 2016 to determine the causes of losses in Tiaro and Maryborough water systems at a cost of $5k.

4.3. Proposed Development Areas

The growth areas are largely dictated by developers and influenced by the Planning Scheme. The Planning Scheme indicates what development can occur within town areas through zoning plans. It further explores future development areas through the establishment of Land Use Structure Plans.

Within the next 20 years the Planning Scheme for Hervey Bay provides for the foreshore of Urangan, Pialba, Scarness and Torquay to evolve into High and Medium Density development areas due to the proximity of facilities and beach access. Industrial areas in Pialba, Lower Mountain Road and the Airport Industrial Estate will also develop steadily to meet the increasing demand for services from residential growth and major commercial nodes are planned to develop at the Pialba precinct and Urangan.

The planning scheme for Maryborough allows for expansion of residential areas in Tinana and Granville, and some infill in Maryborough Central. Growth in non-residential development has been provided for in the North Maryborough area.

Detailed information on the planning scheme is available on the Fraser Coast Regional Council website but the major development areas are briefly described in the following pages.

More detailed plans of each area can be found in Appendix 3.

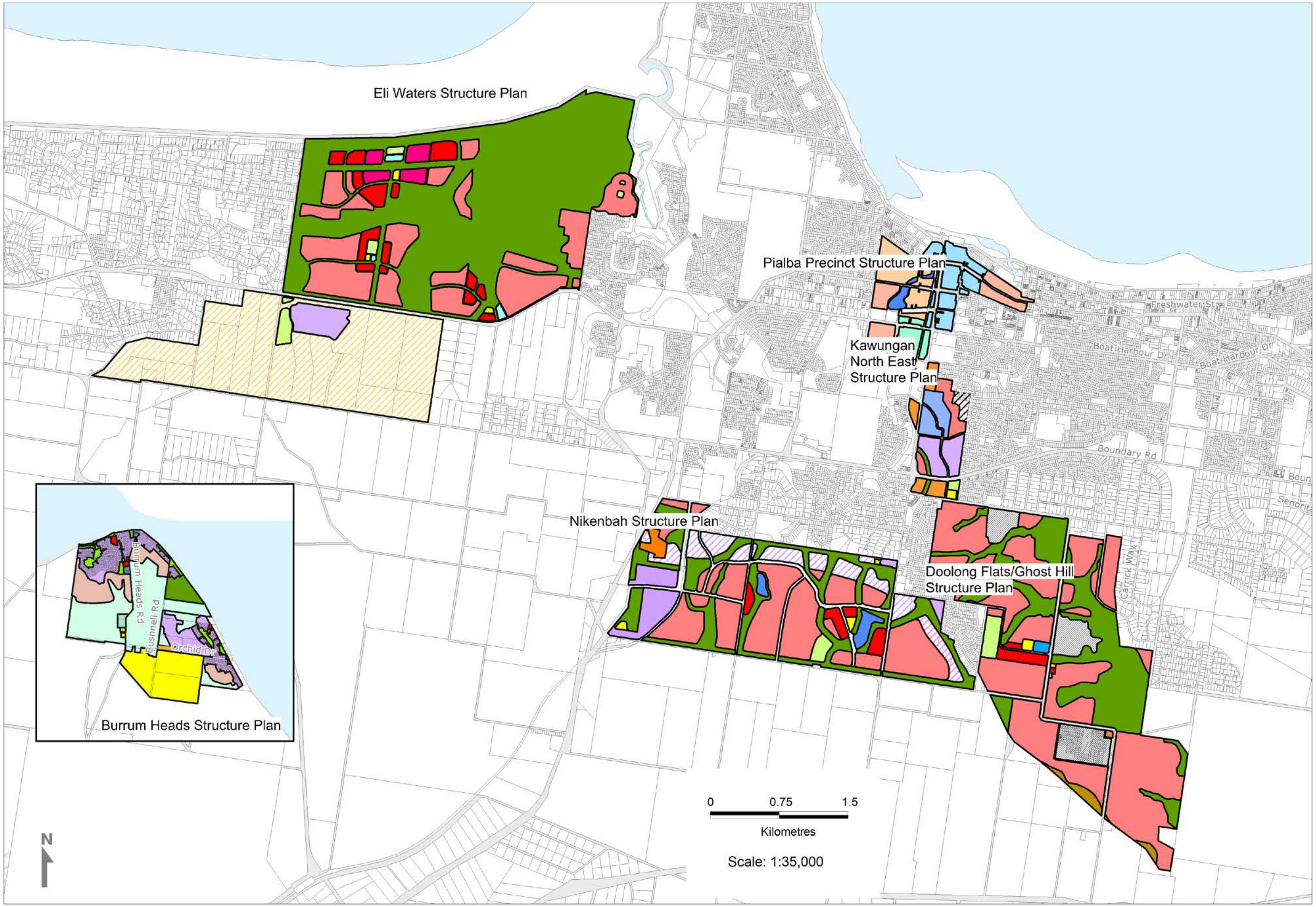


Figure 4-1: Hervey Bay Development Plan Overview

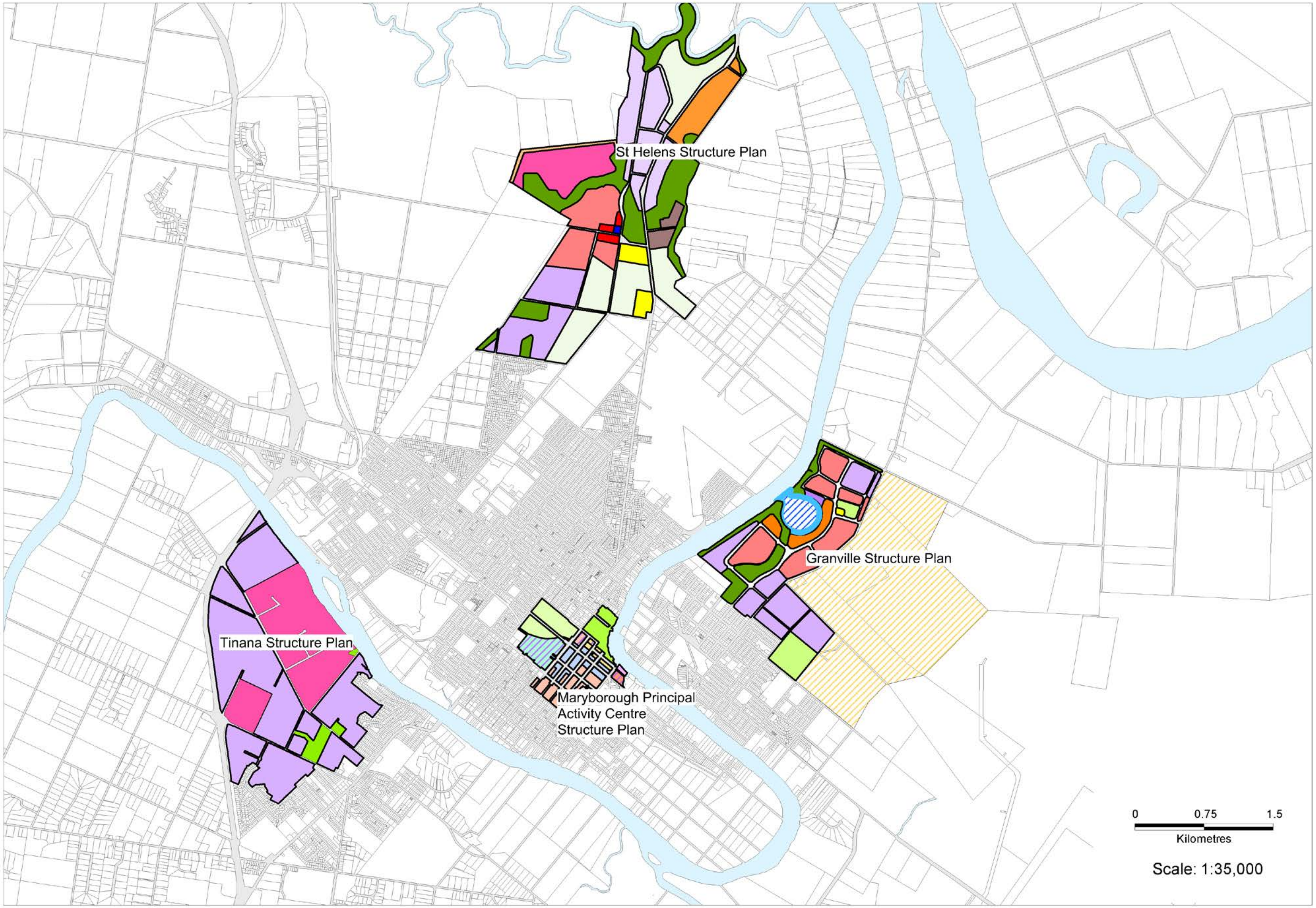


Figure 4-2: Maryborough Development Plan Overview

HB – Nikenbah

This predominantly greenfield site is located on the southern side of the ridge. The area is approximately 445Ha in size and bound by the Ghost Hill ridgeline and existing residential subdivision in the north and east; Chapel Rd and Maggs Hill Rd in the south, and; the road reserves of Aalborg Rd North, Maryborough-Hervey Bay Rd and Scrub Hill Rd in the west.

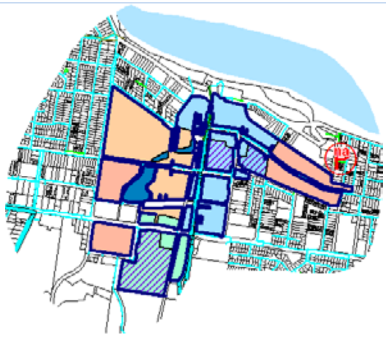
The area is proposed for predominantly residential development with some industrial development along the Maryborough-Hervey Bay Rd. It has a potential yield of approximately 4,000ED. A sports precinct has been proposed for the area to the south of the Nikenbah structure plan and the development of this precinct would encourage growth in this area.

HB - Eli Waters

Eli Waters is located in the predominantly greenfield area between the coastal foreshore of Dundowran Beach in the north, the emerging Eli Waters residential community in the east; Lower Mountain Rd in the south; and Ansons Rd, Carls Rd and Karraschs Rd in the west. There is a large area of land to the south of Pialba – Burrum Heads Rd classed as "further investigation" area in the Fraser Coast Planning Scheme. This area has been excluded from any analysis in this strategy. It is estimated that the potential ED yield for the remaining area is approximately 3,980. This is made up of mixed density residential and medium density residential with some tourist precincts and associated commercial land use.

HB - Pialba Precinct

The Pialba Precinct is located around the existing Pialba commercial area in Hervey Bay. This is an already established area and hence the development in this area is by way of densification and higher use of existing facilities. The estimated ED yield is approximately 4,500. This is approximately 3,500ED above the current estimated ED for the area.

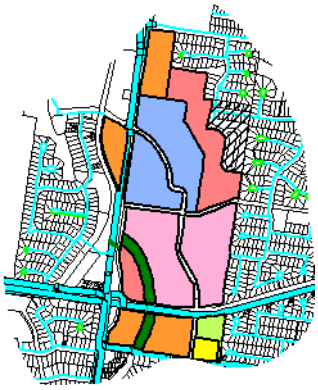


HB – Doolong Flats/ Ghost Hill

This predominantly greenfield area consists of approximately 528Ha of undeveloped land stretching between Doolong Rd, Doolong South Rd, the Ghost Hill ridgeline and the existing Kawungan development to the west. The estimated ED yield is approximately 5,130, consisting mainly of residential areas, with a small commercial centre.

HB – Kawungan North East

This predominantly greenfield area consists of approximately 67.2Ha of undeveloped land stretching between McLiver St, existing development in the east, Main St in the west and Urraween Rd in the south. The estimated ED yield is approximately 1,830ED, consisting mainly of residential areas, with a commercial centre to the south. The area is proposed for large commercial development buffered by residential areas.



Burrum Heads

There is potential for growth in Burrum Heads and significant interest from developers on further development in the area. It is estimated that there could be up to an additional 1,520ED developed in the area. This land is made up of mostly residential areas.

HB - Infill development

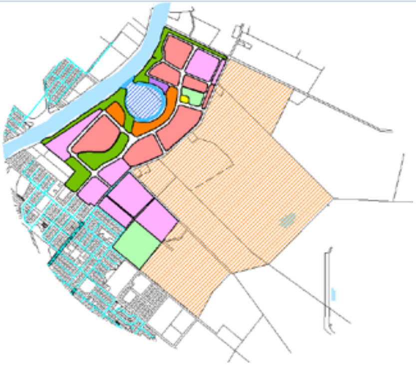
Infill development is expected to continue throughout the Hervey Bay area and includes increased densification by redevelopment as well as through subdivision. It is estimated that infill development could account for approximately 20% of growth in the area.

MB - Tinana

Tinana has one of the highest potential for growth in Maryborough. While some of the areas are below the Q100 flood level there is suitable land for development located to the west of Gympie Rd and east of Bruce Highway. Most of the area is zoned residential. There is potentially about 5,310ED at full yield, although this is not likely to be realised because significant fill would be required to achieve a minimum level to meet flood level requirements.

MB - Granville

Proposals for Granville Harbour development indicate that the initial component of the site could accommodate 2,600ED. While this development is in preliminary stages it is included in this strategy for completeness. It is proposed for a major marina area, surrounded by residential and commercial land.



MB - St Helens

St Helens has recently had several large development proposals. Hibiscus Gardens is one such development and is located at the north eastern part of St Helens. There is the potential for approximately 3,320 ED's to be developed in this area and would be mostly residential development in the south and large industrial areas to the north.

MB – Maryborough Principal Activity Centre

This area is predominantly the Maryborough CBD and includes densification and significant open space and community purposes. There is a large emphasis on heritage and maintaining its historical and cultural features.

MB – Infill

Infill development is expected to continue throughout the Maryborough area and includes increased densification by redevelopment as well as through subdivision. It is estimated that infill development could account for approximately 20% of growth in the area.

TIA - Tiaro

Tiaro is predominantly residential with commercial areas bordering the Bruce Highway. Most of the development potential in Tiaro is infill and it is expected that there could be some development through these commercial areas. It is, however, estimated that the take up rate of redevelopment/ development will be slow.

The development is assumed to occur in sequence shown in Table 4-4. Often this can change depending on the developer, other commitments, economic viability and even political reasons. The sequencing was formulated through discussions with the development and planning sections of the FCRC, who have also indicated that development sequencing is developer driven.

The assumptions made are consistent with the growth forecast for the Fraser Coast. The actual location of that growth may have an impact on infrastructure delivery and timing. It will be necessary to review the development sequencing on a regular basis with the view of updating the capital expenditure timings.

Table 4-4: Development Area Potential ED Yields

Development Area	2011	2016	2021	2026	2031	2036	2041	2046	2051	Ultimate
Nikenbah					324	2006	3688	5370	5370	5370
Eli Waters			718	1365	2601	3058	3515	3973	3973	3973
Pialba Precinct	120	265	330	500	530	600	650	700	800	4446
Doolong Flats/Ghost Hill	200	615	983	1601	2827	3597	4377	5130	5130	5130
Kawungan NE		136	212	453	984	1264	1544	1829	1829	1829
Burrum Heads	60	136	197	303	441	801	1161	1515	1515	1515
Tinana	20	202	425	679	903	2353	3803	5310	5310	5310
Granville				850	1700	2654	2654	2654	2654	2654
St Helens				500	1000	1500	2000	2500	3000	3317
Principal Activity Centre (CBD)						186	372	560	560	1253
Tiaro	5	60	120	280	440	468	468	468	468	468

4.4. Future ED Demand

The estimated consumption for future demand in Hervey Bay (including Burrum Heads, Toogoom, Howard and Torbanlea) has risen 7% to 630L/ED/day (up from 590L/ED/day) inclusive of losses.

OESR growth forecasts indicate that the Hervey Bay region will grow at approximately 2.4% per annum which is consistent with the OESR Medium Series Growth Projections. This growth forecast has been used throughout this report.

Total ED projections for each of the five year design horizons from the year 2011 to the year 2031 are detailed in Table 4-4. Total ED's are also included for 2031-2066.

Table 4-5: Hervey Bay Design Equivalent Dwelling (ED) Projections

Year	Total Residential	Total Non-Residential	Total
	ED	ED	ED
2011	27,134	6,387	33,521
2016	29,554	7,076	36,630
2021	32,931	7,869	40,800
2026	36,700	8,719	45,420
2031	41,759	9,631	51,390
2036	45,431	10,478	55,909
2041	49,427	11,399	60,826
2046	53,773	12,402	66,175
2051	58,502	13,492	71,994
2056	63,646	14,679	78,325
2061	69,243	15,970	85,212
2066	75,331	17,374	92,705

Table 4-6: Hervey Bay Estimated Daily Water Requirements

Year	Average Day	Mean Day Maximum Month	Peak Day
	(ML/D)	(ML/D)	(ML/D)
2011	21.1	27.5	33.8
2016	23.1	30.0	36.9
2021	25.7	33.4	41.1
2026	28.6	37.2	45.8
2031	32.4	42.1	51.8
2036	35.2	45.8	56.4
2041	38.3	49.8	61.3
2046	41.7	54.2	66.7
2051	45.4	59.0	72.6
2056	49.3	64.1	79.0
2061	53.7	69.8	85.9
2066	58.4	75.9	93.4

The consumption per ED in Maryborough remains constant at 680L/ED/day inclusive of system losses.

OESR growth forecasts indicate that Maryborough will continue to grow at 0.8% per annum which is consistent with previous OESR Medium Series Growth Projections. This growth forecast has been used throughout this report.

Total ED projections for each of the five year design horizons from the year 2011 to the year 2031 are detailed below. Also included are the total ED figures for 2013-2066.

Table 4-7: Maryborough Equivalent Dwelling (ED) Projections

Year	Total Residential	Total Non-Residential	Total
	ED	ED	ED
2011	10,061	2,844	12,906
2016	10,550	2,932	13,483
2021	10,979	3,010	13,988
2026	11,425	3,088	14,514
2031	11,890	3,169	15,059
2036	12,423	3,311	15,734
2041	12,927	3,446	16,373
2046	13,453	3,586	17,039
2051	14,000	3,731	17,731
2056	14,569	3,883	18,452
2061	15,161	4,041	19,202
2066	15,778	4,205	19,983

Table 4-8: Maryborough Projected Daily Water Demands

Year	Average Day	Mean Day Maximum Month	Peak Day
	(ML/D)	(ML/D)	(ML/D)
2011	8.8	11.4	14.0
2016	9.2	12.0	14.7
2021	9.5	12.4	15.2
2026	9.9	12.9	15.8
2031	10.2	13.3	16.4
2036	10.7	13.9	17.1
2041	11.1	14.5	17.8
2046	11.6	15.1	18.5
2051	12.1	15.7	19.3
2056	12.5	16.3	20.1
2061	13.1	17.0	20.9
2066	13.6	17.7	21.7

Tiaro water usage per ED is lower than previous strategy at 560L/ED/day (down from 680L/ED/day). The forecasts to 2031 are shown in the following tables.

Table 4-9: Tiaro Equivalent Dwelling (ED) Projections

Year	Total ED
2011	308
2016	345
2021	378
2026	412
2031	445

Table 4-10: Tiaro Projected Daily Water Demands

Year	Average Day (ML/D)	Mean Day Maximum Month (ML/D)	Peak Day (ML/D)
2011	0.21	0.27	0.34
2016	0.23	0.31	0.38
2021	0.26	0.33	0.41
2026	0.28	0.36	0.45
2031	0.30	0.39	0.48

4.5. Vacancy Rates

The vacancy rates over Hervey Bay and Maryborough are currently 11.8% (2011 census data). For the purposes of modelling it is assumed that all of the available detached residential dwellings are fully occupied. For hotels and caravan parks, actual water consumption, based on two years of data, is used to more accurately reflect occupancy rates.

4.6. Demand Types

For modelling purposes demand types have been simplified into two categories, residential and non-residential:

- Residential demand encompasses all residential development including low, medium and high density residential development;
- Non-residential development includes commercial, industrial, educational, sporting, recreation and health related premises.

Although it is recognised that non-residential demand patterns can vary greatly, no differentiation for these variations has been considered in the modelled results in this report.

4.7. Peaking Factors

Peaking factors for the Average Day (AD), Mean Day Maximum Month (MDMM), Peak Day (PD) and Peak Hour (PH) were derived from an analysis of water production and consumption data.

A report by Cardno (2009) which was based on water production data prior to 2005 indicated that the PD and the MDMM factors should be 1.9 and 1.4 respectively. A recent review of the water production figures indicates that the PD and MDMM factors are 1.6 and 1.3 respectively.

Average Day Demand is equal to the total consumption recorded for the year divided by the number of days in the year.

Average Day (AD) = 630 L/ED/D x No. of ED's for Hervey Bay

Average Day (AD) = 680 L/ED/D x No. of ED's for Maryborough and

Average Day (AD) = 560 L/ED/D x No. of ED's for Tiaro

Peak Day Demand is the demand expected to occur one day (usually in summer) every year. It is relevant to the Fraser Coast Water Service area and reflects data recorded through water meter readings/SCADA monitoring system as a ratio to Average Day (AD). It is calculated by multiplying Average Day by 1.6.

Peak Day (PD) = Average Day x 1.6 (Peaking Factor)

Mean Day Maximum Month Demand is the average demand expected to be experienced over the maximum month of the year. Mean day maximum month for domestic connections is calculated by multiplying average day demand by 1.3. This ratio is representative of the Fraser Coast water consumption data.

Mean Day Maximum Month (MDMM) = Average Day x 1.3 (Peaking Factor)

Peak Hour Demand is the peak rate of consumption in any hour of the day. It should be noted that for small numbers of dwellings (less than 100) the peak hour demand is likely to rise since there is less diversity of water usage. The maximum hour demand depends on the type of land use within a district.

Peak Hour (PH) = Peak Day x 2.25 (Residential Peaking Factor)

Peak Hour (PH) = Peak Day x 1.5 (Non Residential Peaking Factor)

Note that the peak hour factor relates to peak instantaneous flow and not peak day volumes.

4.8. Diurnal Profiles

Diurnal profiles take into account variations for demand over a day. They differ for different land uses. The residential diurnal profile represents water usage by a dwelling or unit over a typical 24 hour period. The non-residential profile, used for industrial and commercial areas, also represents water usage over a typical 24hr period. In the water network model, the profiles apply diurnal factors on an hourly basis to establish the demand at any given time.

As expected, the diurnal curves vary by geographical area depending on factors such as land usage, socio-economic level, allotment sizing, culture and local weather. Thus it can be seen that the diurnal curves for Hervey Bay and Maryborough differ.

The use of automated meter reading (AMR) on an hourly basis was used in the derivation of these diurnal patterns. The diurnal curves adopted for the investigation are illustrated in Figure 4-3.

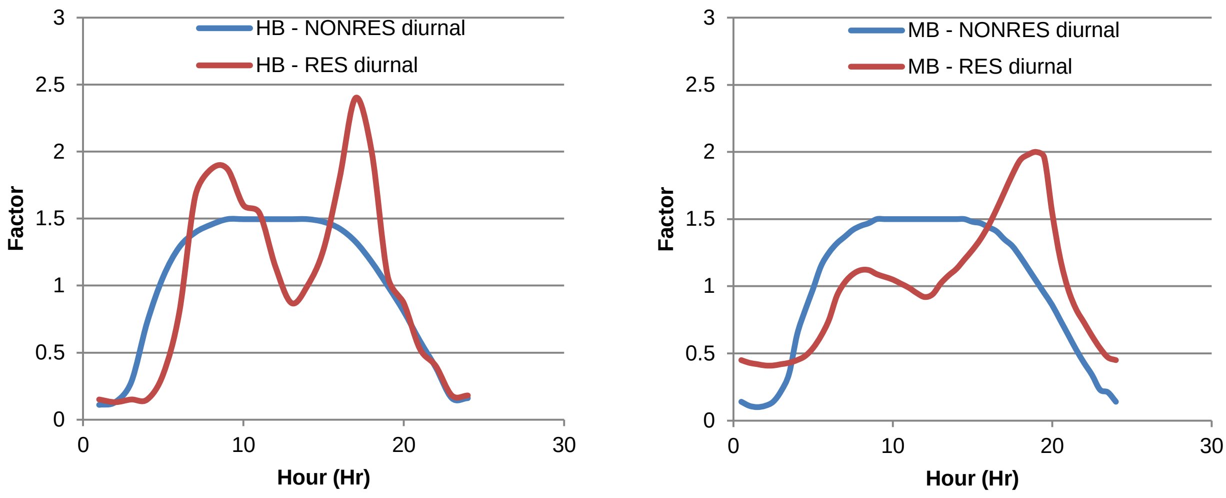


Figure 4-3: Hervey Bay and Maryborough Diurnal Curves

5. SYSTEM REVIEW AND ASSESSMENT

5.1. Raw Water Source

The Hervey Bay forecasted demands in Table 4-6 shows that the forecast average day demand will almost triple by 2066. The corresponding annual demand to 2066 are shown in Figure 5-1. The safe yield of Lake Lenthall is 14,020ML/annum. It can be seen that the forecasted demand will exceed the safe yield in 2046, at which time source augmentation will be required.

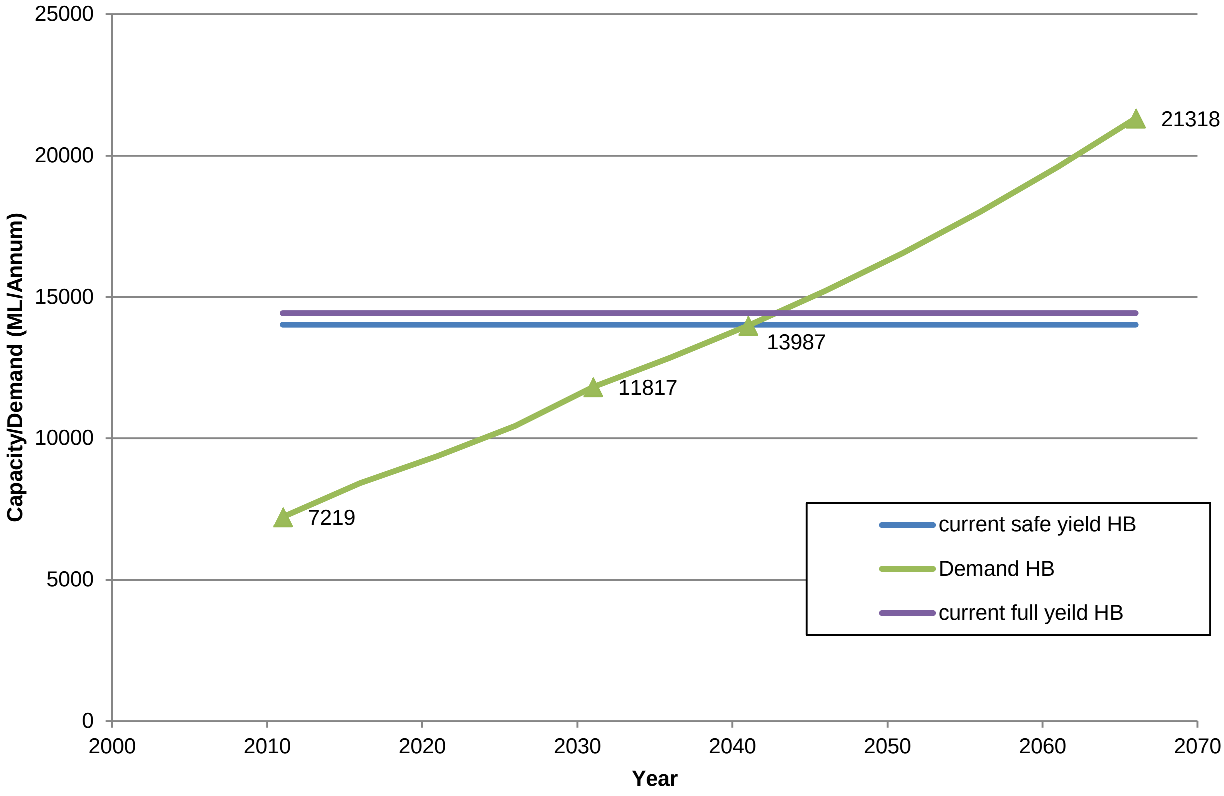


Figure 5-1: Hervey Bay Water Supply - Current Capacity and Projected Demand

The forecasted water demand for Maryborough in Figure 5-2 shows that augmentation at the growth rates assumed will be required at some time after 2066.

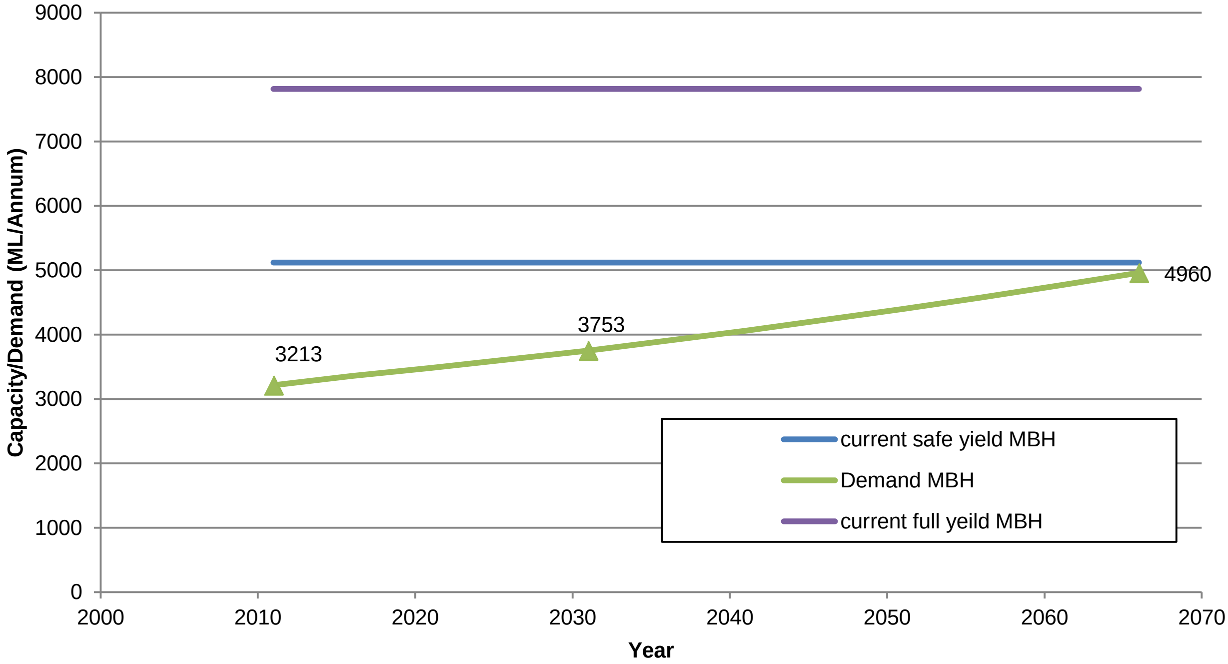


Figure 5-2: Maryborough Water Supply - Current Capacity and Projected Demands

A Regional Water Supply Security Assessment undertaken by DEWS (2014) investigated the likelihood of predetermined water levels being reached using stochastic modelling techniques with over 100 years of historical data. Two models were created to assess the adequacy of the current water supplies.

The Burrum River system catchment was used to assess the water supply for Hervey Bay. The modelling results are shown in Figure 5-3.

The Mary River Catchment model was used to assess the water supply for Maryborough. The modelling results are presented in Figure 5-4.

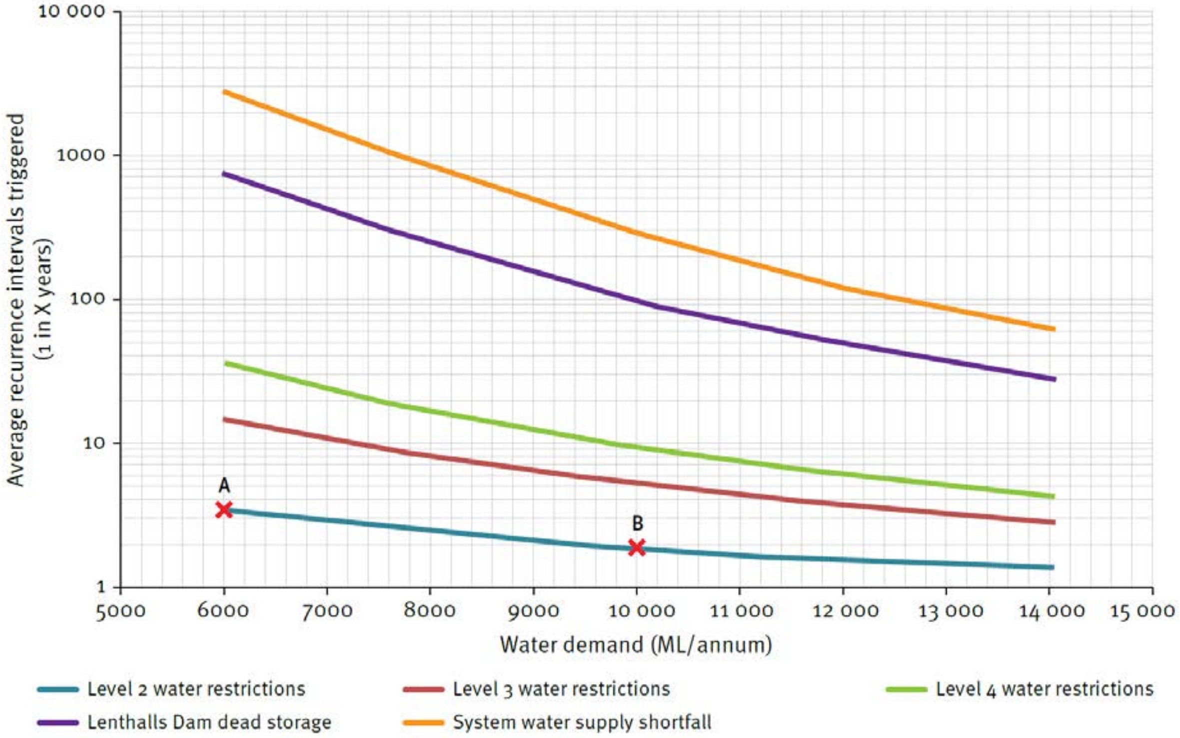


Figure 5-3: Hervey Bay frequency of water restrictions and supply shortfalls compared to annual demand

It can be seen that the average recurrence interval of reaching level 2 water restrictions in Hervey Bay are less than 1:3 (ie on average once every three years). As demand increases the frequency of the recurrence will increase, which indicates that the dam is approaching its maximum safe yield.

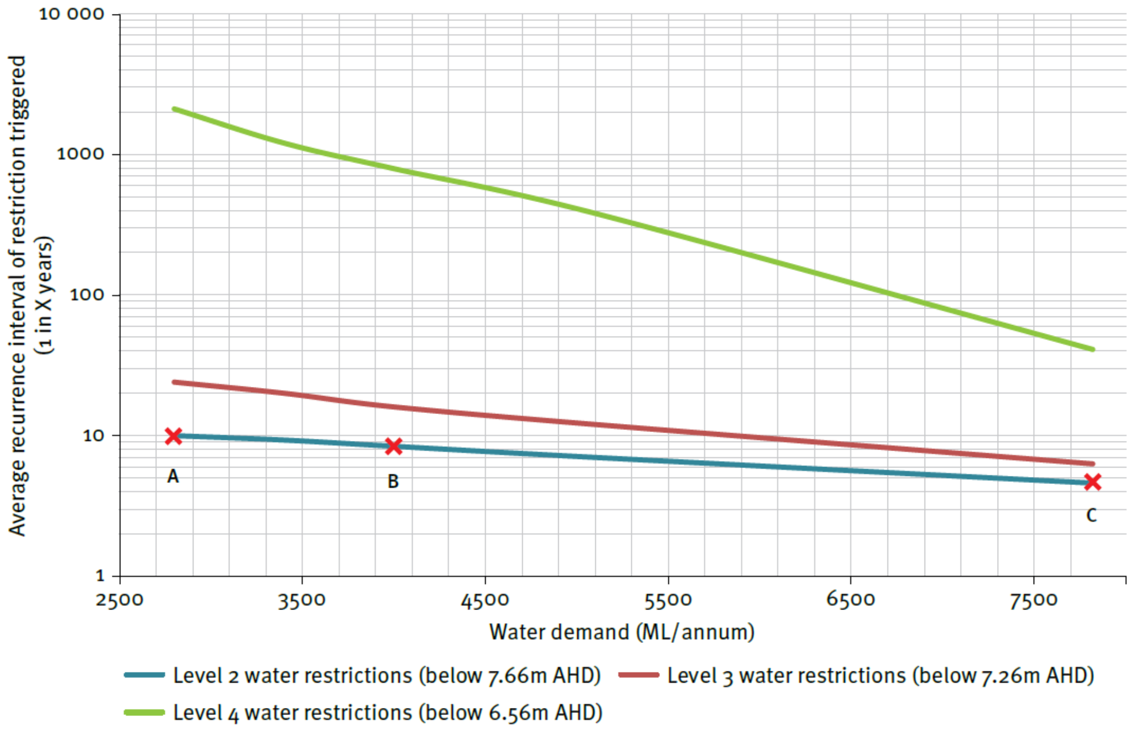


Figure 5-4: Maryborough frequency of water restrictions and supply shortfalls compared to annual demand

5.1.1. Future Source Options

Figure 5-1 shows the safe yield at Lake Lenthall being exceeded after 2046. Therefore an alternative water supply source will be required by that timeframe. Access to reliable water sources is fundamental in meeting the community's requirements for potable water. Various studies have been undertaken to assess options for future water supplies in the Fraser Coast and a report prepared by WBWC in 2014 summarised the future water source options for the Fraser Coast.

Various options are available to augment existing water supplies for both Maryborough and Hervey Bay. The five options discussed in this study are;

- Indirect Potable reuse;
- Fraser Island;
- Desalination;
- Burnett River (Paradise Dam); and
- Additional allocation from the Mary River.

In addition this report considered the advantages of interconnecting the Maryborough and Hervey Bay water networks.

Indirect Potable reuse – This option involves performing additional treatment to the wastewater produced at the existing WWTP's. A possible system involves the addition of reverse osmosis and advanced oxidation treatment processes at the Nikenbah WWTP. Water would then be transferred to Cassava Dam where it would then be used as a raw water source for the Burgowan WTP. This configuration would satisfy the seven barrier system as required by the Water Supply (Safety and Reliability) Act 2008. While not costed, a similar system may be achievable in Maryborough. Significant upgrades would be required to achieve the required level of treatment at the WWTP and WTP. There would also be the concern of integration with the existing water body at Teddington Weir in Maryborough.

Fraser Island – This option involves sourcing water from the Bogimbah Creek area either via a borefield or directly from the creek flow itself. Water would be transferred to the mainland through a sub marine pipeline. The JWP (1994) strategy report indicates that the scheme could extract up to 54ML/day from the aquifer without any detrimental effect. The subsequent report by JWP (2001) does dismiss Fraser Island as a viable option because of environmental constraints and possible community resistance. Water could be supplied to Maryborough in this option by the construction of a 32km dedicated water transmission main from Ghost Hill to Boys Avenue in Maryborough.

Desalination – is the process of removing dissolved solids from a saline water using thermal or membrane technology. Reverse osmosis is the current technology for desalination in Australia. A report by WBWC in 2009 identified several sites for the possible construction of desalination plants including River Heads, Booral, Dundowran and Burrum Heads. A pipeline from Hervey Bay to Maryborough would need to be constructed for Maryborough to have access to desalinated water.

Burnett River (Paradise Dam) – This option involves the construction of a new pipeline and associated pump station to transport raw water from the Burnett River to the Burrum Weir Pump Station.

Approximately 63km of pipeline is required and to source 22ML/day a DN600 main would be required. Purchase of an 8,000ML high priority allocation is $21m, with an ongoing current annual cost of $900k (Part A) and an additional $1.16/ML of water used (Part B). Water could be supplied to Maryborough by extending the main a further 12.5km to Burgowan for treatment before transfer to Maryborough through the Maryborough - Hervey Bay interconnection.

Mary River – This option involves the installation of a pipeline from the Mary River Barrage to the Burgowan WTP site (JWP, 2001). The previous report indicates a pump station and main would be required to realise this project. It also indicates that 6,000ML/annum allocation would be required by 2035. This was modified in the 2010 Water Supply Strategy to 8,000ML/annum to align with the revised 50 year projections. The allocation costs of the Mary River are unknown; however for the purposes of comparison, it has been assumed that it is comparable to the Paradise Dam scheme. There are also concerns over the availability of a further 8,000ML/annum of high priority water from this scheme and the ongoing reliability as a source.

The interconnection between the Maryborough and Hervey Bay networks – This interconnection between the townships of Maryborough and Hervey Bay does not provide any additional capacity to the system as such, it does however, allow the available water capacity to be managed across the region thereby improving security by ensuring more than one raw water source is available for the whole Fraser Coast water supply scheme.

A summary of the costs for the options outlined in this report are presented in Table 5-1.

Table 5-1: Summary of Option Costs

Option	***Cost ($m)***	***System Benefited***	***Capacity Increase (ML/day)***	***$/ML CAPEX***
Indirect Potable Reuse	47	HB	4.8	9.8m
Fraser Island	86	HB	56	1.5m
	36#	MB	56*	0.6#
Desalination	81.2	HB	20	4.1m
	8	MB	2.6	7.7m
Burnett River	91	HB	22	4.1m
	43#	MB	22*	1.9m#
Mary River	59.5	HB	22	1.8m
Interconnection of HB & MBH water networks	31	Both	0	n/a

* The capacity in this option is shared between Hervey Bay and Maryborough

Cost in addition to the Hervey Bay Option

Table 5-2: Summary of Options Advantages and Disadvantages

Option	*Advantages*	*Disadvantages*
Indirect Potable Reuse	– Does not rely on surface water storage which is susceptible to droughts – Higher class of use of resource to current irrigation – Can be used all year around as opposed to irrigation, therefore less storage required	– Public resistance to the scheme. A dual reticulation system might be an option. – A pipeline is required from Nikenbah WWTP to Cassava Dam – Cannot supply total volume required. Supplementary source only. – Potentially expensive OPEX – Some components may require a minimum base load and if not required for use need to be temporarily decommissioned.
Fraser Island	– Abundant water supply. – Relatively close to mainland Hervey Bay. – Low TDS and protected catchment.	– Environmentally sensitive and heritage listed area. – Submarine water pipeline crossing through Sandy Straits. – Potentially high in colour and potentially requiring additional treatment to stabilise the water.
Desalination	– Does not rely on favourable rainfall for supply. – Unlimited supply with production only limited by the size or number of plant and energy availability.	– Expensive CAPEX and OPEX – Disposal of waste brine may be difficult or problematic – Requires specialist training in operation – Requires relatively clean input water. – Desalination plants require a minimum base load and if not required for use need to be temporarily decommissioned.
Burnett River	– WBWC does not own infrastructure upstream of the point of connection. – Full benefit of high priority water – Surface water supply subjected to different micro climatic conditions to Burrum and Mary River catchments – High Priority allocation is available	– Expensive initial CAPEX outlay – Limited control over Part A and Part B costs.
Mary River	– Relatively cheap water compared to other options.	– Long term security may be an issue if there is competition for water source in the upstream catchment. – No much diversity in water supplies.
Interconnection between HB and MBH	– Allows better distribution of capacity. – Allows redirection of flow for drought or if specific treatment plant is out of service. – Provides a link between the two systems for any new source augmentation.	– Does not offer any additional capacity (only ability to distribute existing capacity) – Expensive OPEX pumping costs particularly in MBH -> HB direction

For future water sources, the previous water supply strategy document (WBWC, 2010) indicated that the Wide Bay Burnett Regional Plan preferred option is to install two small desalination plants; use purified recycled water and source water from the Burnett River and Mary River. This is essentially components from the options above used in combination as a solution. Desalination plants have very high OPEX and CAPEX costs per megalitre water supplied and purified recycled water would likely encounter significant public resistance. In contrast the Burnett River, Mary River and Fraser Island options are more economically viable on a capital cost per megalitre supplied basis.

The Fraser Island option would be the preferred option if it can be demonstrated that it is feasible and is socially, politically and environmentally acceptable. It would be difficult and cost prohibitive to stage the submarine component of this project, however there is scope for staging the borefield should staging of implementation be necessary.

Should the Fraser Island option not prove feasible, the Mary River or Burnett River options will provide a suitable water source solution into the future.

Although the Mary and the Burnett Basins are separated geographically and subject to their own micro climates, it is possible that a drought may affect both the Mary and Burnett systems simultaneously. As such these two options may be less favourable when compared with the less drought affected options of indirect potable reuse, groundwater and desalination.

Demand management and consumption reduction is another option which will defer the capital expenditure for a new source. This option has not been assessed in this strategy, however it is recommended that a demand management assessment for the Fraser Coast be undertaken as a separate study in Section 5.7.

Figure 5-5 demonstrates how the increasing demand on the Hervey Bay and Maryborough systems collectively can be met by the source augmentation, satisfying water demand beyond the next 50 years.

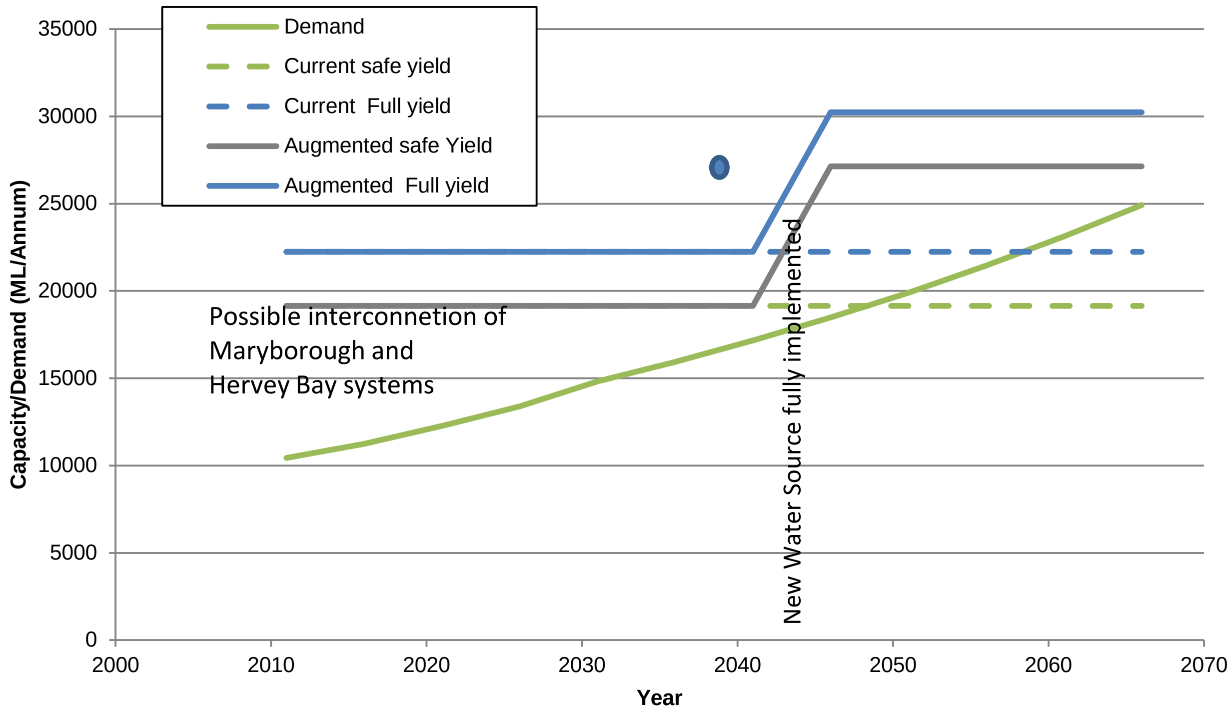


Figure 5-5: Water Source Augmentation

RECOMMENDATION: It is recommended that a planning study be undertaken to examine future water sources in more detail at a cost of $95k in 2018. As part of the study a preliminary feasibility study regarding sourcing water from Fraser Island to determine what approvals are required, the likelihood of receiving approvals, the estimated CAPEX and the ongoing OPEX be undertaken.

5.2. Drought Protection

A drought scenario would occur when the available water supply has fallen to a level at which unrestricted water use is not in the public interest. Drought Management Plans have been prepared for the Hervey Bay, Maryborough and Tiaro schemes as well as a Drought Management Implementation Plan which incorporates the wider Fraser Coast Region. Broadly these documents outline the action strategy for managing water supply under drought conditions and document historical drought management initiatives. The main focus of the plans are to implement water restrictions and thereby, decrease demand levels and extend the longevity of remaining supply capacity during times of limited or no rainfall. It clearly outlines triggers, activities and responsibilities associated with each restriction regime.

While the Drought Management Plans include action strategies for the short term management of water supply in drought conditions, it does not provide contingencies for the supply of additional water sources for the medium term. Some of the options proposed are:

- Interconnection between Maryborough and Hervey Bay, which does not in itself provide additional capacity but will allow best operational flexibility.
- Alternative source augmentation which under this strategy would be the move to Paradise Dam or alternatively Fraser Island.
- If drought continues then desalination options would be required.
- Indirect Potable Reuse could be considered as a drought management option although the quantities available are likely to be lower than required by the community. It also requires some further works to the Nikenbah WWTP and Burgowan WTP.

With the exception of smaller package desalination plants, the lead time on other options could be up to 15-20 years. For these contingencies to be effective in times of critical water shortage, designs and approvals need to be in place. It would therefore be necessary that designs, approvals and consultation for these options be undertaken, so that they are ready for immediate implementation when required. This would reduce the lead times associated with construction.

5.3. Water Treatment

To sustain demands in Hervey Bay over the planning horizon to 2031, it is necessary that there is the capacity to treat 42.1ML/day (MDMM) in Hervey Bay.

5.3.1. Howard Water Treatment Plant

Hervey Bay's water supply system consists of two treatment plants, one at Howard and the other at Burgowan. There are cost implications associated with the maintenance and operation of WTP's on decentralised sites. Factors such as land ownership costs, plant operator costs, treatment and maintenance costs security of supply, treatment quality and cost effectiveness must all be considered when assessing a centralised WTP approach.

If both the process trains at the Burgowan WTP were to fail, the Howard WTP is unable to provide sufficient water to meet MDMM for Hervey Bay. Power outages would be the most likely cause of such an occurrence. It would be expected that such a problem would be rectified within a day. In addition the water produced from the Howard WTP is unable to meet key quality parameters on a continual basis. The main issues are that:

- The current process does not allow stabilisation of the water to control both internal corrosion and deposition of scale.
- The water produced is low in calcium, meaning that it has the potential to leach calcium from cement linings on pipes and this can lead to high pH water. To rectify this would require the addition of calcium carbonate to the treatment process.

- The treatment plant does not minimise the production of Trihalomethane's (THM's). Removal of total organic carbon (TOC) can be done through process augmentations (e.g. MIEX or PAC) or extensive chlorination, detention and aeration to reduce THM's.
- The treatment plant can treat 18ML/day. The current MDMM is approximately 26ML and the 2031 MDMM demand projection is 42.1ML. Therefore the capacity of the existing plant is insufficient to meet total demand from the Hervey Bay area for any extended period of time.
- The final water is not filtered after the post filtration addition of lime for pH correction leading to suspended solids being deposited in pipelines.
- Taste and odour are not addressed at this plant. This would require some additional treatment modules to enable this capacity.
- The plant has no capacity to remove algal toxins.
- Expansion at the existing site is constrained by the amount of land available.

The cost of improving water quality to address these issues is estimated at $12m. These costs are presented in Table 5-3.

Table 5-3: Howard WTP Possible upgrades

Item	***Cost ($000's)***
Land Acquisition	500
RMT	1,000
Actiflo Module	1,500
Upflow Clarifier	1,000
Ozone	1,500
6 cell filter	4,000
Dosing systems	1,500
Pumps, blower, pipeline	1,000
Total	**12,000**

These are preliminary costs only and further work is required to determine more accurate costs associated with treatment upgrades at the Howard WTP. Note that these costs do not allow for any capacity increase above the current capacity of 20ML/day.

The option of retaining Howard WTP at an augmentation cost of $12m will defer capital expenditure for capacity upgrades at Burgowan WTP. Although this is not the preferred option as it decentralises the treatment capacity, it would provide a total of 59ML/day of treated water deferring the need for further treatment capacity until 2051.

RECOMMENDATION: It is recommended that a comprehensive study be undertaken to determine the viability of decommissioning this plant versus the advantages of maintaining it as a secondary treatment plant versus upgrading the plant instead of additional treatment capacity at Burgowan. It is estimated that this investigation will cost $100k and is to be undertaken in 2017.

5.3.2. Burgowan

The MDMM demand of the Hervey Bay system in the year 2031 is projected at 42.1ML. The recent augmentation to the TEMA plant at the Burgowan WTP provides treatment capacity of 11ML/day, while an upgrade to the Actiflo WTP in 2014 achieved an increase in treatment capacity to 30ML/day. Together the plant can produce a maximum of 41ML/day. From current projections it is indicated that this plant will have sufficient capacity until 2028.

An augmentation to the treatment plant of 40ML/d at 2028 will meet projected demands past 2066. Options for consideration in the provision of an additional 40ML/day treatment capacity are closely linked with the source option adopted.

As stated in Section 5.3.1, the total treatment capacity could be augmented by upgrading the treatment quality at the Howard WTP and maintaining that plant. This option needs to be thoroughly investigated against additional treatment capacity at Burgowan. If the Howard WTP (capacity 18ML/day) is a viable long term solution then this could defer the need for additional treatment capacity at Burgowan until 2051.

Figure 5-6 below demonstrates the likely timing of future augmentation requirements to meet projected demands. Should growth rates and/or consumption change significantly from the values assumed in the projections, these works will either need to be brought forward to meet increased demand, or deferred if the projected demands are not realised.

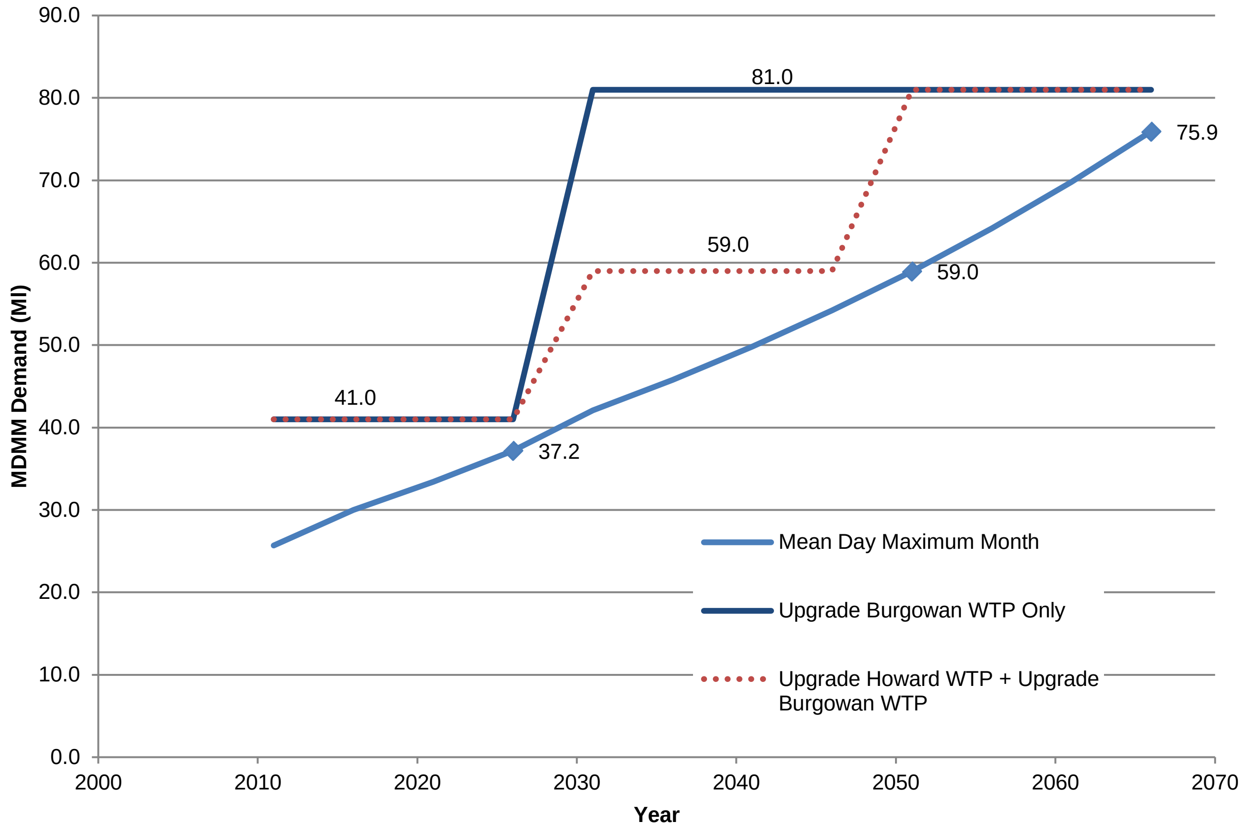


Figure 5-6: Burgowan WTP Treatment Capacity Forecast and Upgrades

Burgowan is unable to remove manganese high concentrations are present in the raw water. Options are currently being investigated to reduce manganese levels in the water supply and is discussed further in Section 5.6.5.5.

Additional capacity at the Burgowan WTP is WBWC's preferred option for meeting future treatment projections. However the decision to upgrade Burgowan WTP cannot be made until Howard WTP has been investigated further. For the purposes of this study it is assumed that the treatment capacity will be augmented at Burgowan WTP in lieu of upgrading Howard WTP.

The existing clear water pump station at Burgowan will require upgrading to meet demands post 2021.

Further details of this project can be obtained in Appendix 4.

RECOMMENDATION: Planning and concept design for upgrade to water treatment facility for a nominal increase of 40ML/day commence in 2023 to allow further treatment capacity to be realised by 2027 ($25-35m over five years).

5.3.3. Teddington Water Treatment Plant

The Maryborough MDMM is forecast to increase to 13.3ML/day in 2031. The nominal hydraulic capacity of the treatment plant at Teddington is 36ML/day. However, there are limitations on the plant production capacity due to deteriorating water quality at increased production rates. In order to produce 36ML/day at the required quality, significant upgrades will be required at the plant. These improvements are not required to meet the projected demand in Maryborough but need to be assessed as part of a regional approach to water supply. This is beyond the scope of this report and further investigation forms one of the recommendations. The operators of the plant indicate that the plant is capable of sustaining up to 20ML/day without significant deterioration of production water quality.

Figure 5-7 illustrates the projected water demand on this treatment plant and the current sustainable treatment capacity.

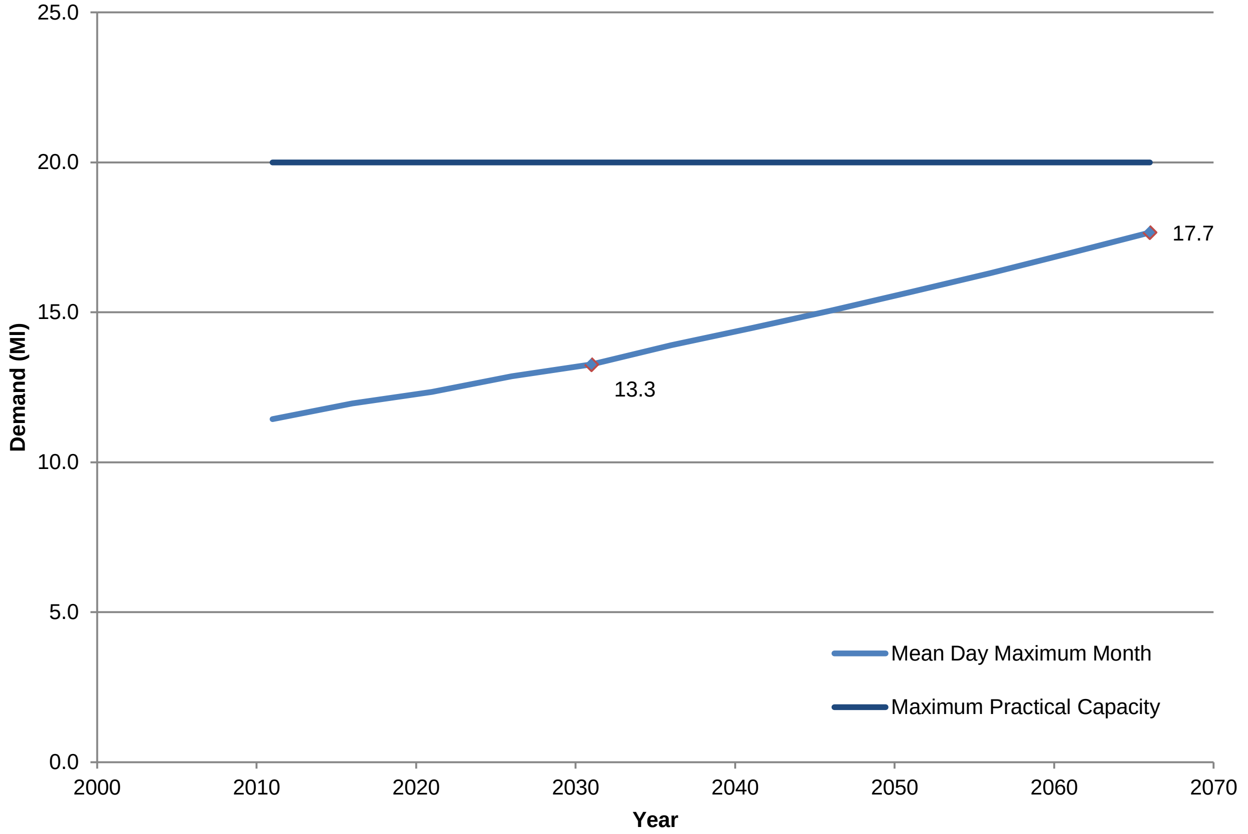


Figure 5-7: Teddington WTP Treatment Capacity Forecast

While no treatment capacity upgrades have been identified in this study, there are water quality and process efficiency improvement projects identified. Some of the significant projects are as follows:

- Raw water pipeline estimated at $206k with design to commence in 2016.
- Raw water pump station upgrade and inlet works at Teddington weir (current works).
- Potassium Permanganate trials and installation at $200k in 2017.
- Lime /CO2 dosing implementation for water stabilisation in 2018 at a cost of $800k.
- Additional treatment phases to improve water quality at $2.7m (should aeration and potassium permanganate not achieve desired results in THM reduction and iron/manganese reduction). This might include MIEX or Ozone/BAC.

Further details of these projects are included in Appendix 4.

RECOMMENDATION: Preliminary investigations for including Ozone/BAC or MIEX capability be undertaken.

5.3.4. Tiaro Water Treatment Plant

Tiaro's water supply is sourced from the Mary River and as such it exhibits different characteristics to the Teddington Weir water supply. Characteristically, the water in the Mary River has higher alkalinity (as $CaCO_3$) than water from Teddington Weir. At times, water sampling at Tiaro has indicated $CaCO_3$ levels above 200mg/L. According to the ADWG (2011) this indicates that there is likely to be some scaling of pipelines and fittings. It is proposed to investigate whether alkalinity is an issue in Tiaro and if so what treatment actions could be undertaken to reduce its alkalinity. It is estimated that this investigation could cost approximately $25k.

RECOMMENDATION: Investigate the impact of alkalinity on the Tiaro water supply system in 2018 at a cost of $25k.

5.4. Water Distribution

5.4.1. Fraser Coast Water Grid

The Maryborough and Hervey Bay systems operate as discrete networks from one another. Interconnecting the Maryborough and Hervey Bay networks will provide operational flexibility to better manage water availability during emergency periods such as droughts. It needs to be recognised that interconnecting the two systems does not provide additional water supply but will allow water to be transferred from Hervey Bay to Maryborough and vice versa.

As shown in Figure 5-8, the proposed scheme would include;

- a DN600 water main from the Burgowan WTP to the Boys Avenue Reservoirs.
- a transfer pump station at Boys Avenue to allow pumping to Burgowan.
- a transfer pump station at Burgowan to allow pumping to Boys Av Reservoir site.

The transfer of potable water between systems is the preferred operational method.

There may be times when raw water needs to be transferred from one system to the other. This could be achieved with some additional pipework modifications to allow raw water from Hervey Bay to be treated at Teddington WTP and likewise raw water from Teddington Weir could be treated at the Burgowan WTP.

Alternating between raw water and potable water transfer is not recommended as there is significant pipeline cleaning that would be required before being able to use the pipeline for potable purposes.

While raw water transfer can be achieved it is recommended that the normal mode of operation is to transfer treated potable water along this pipeline only.

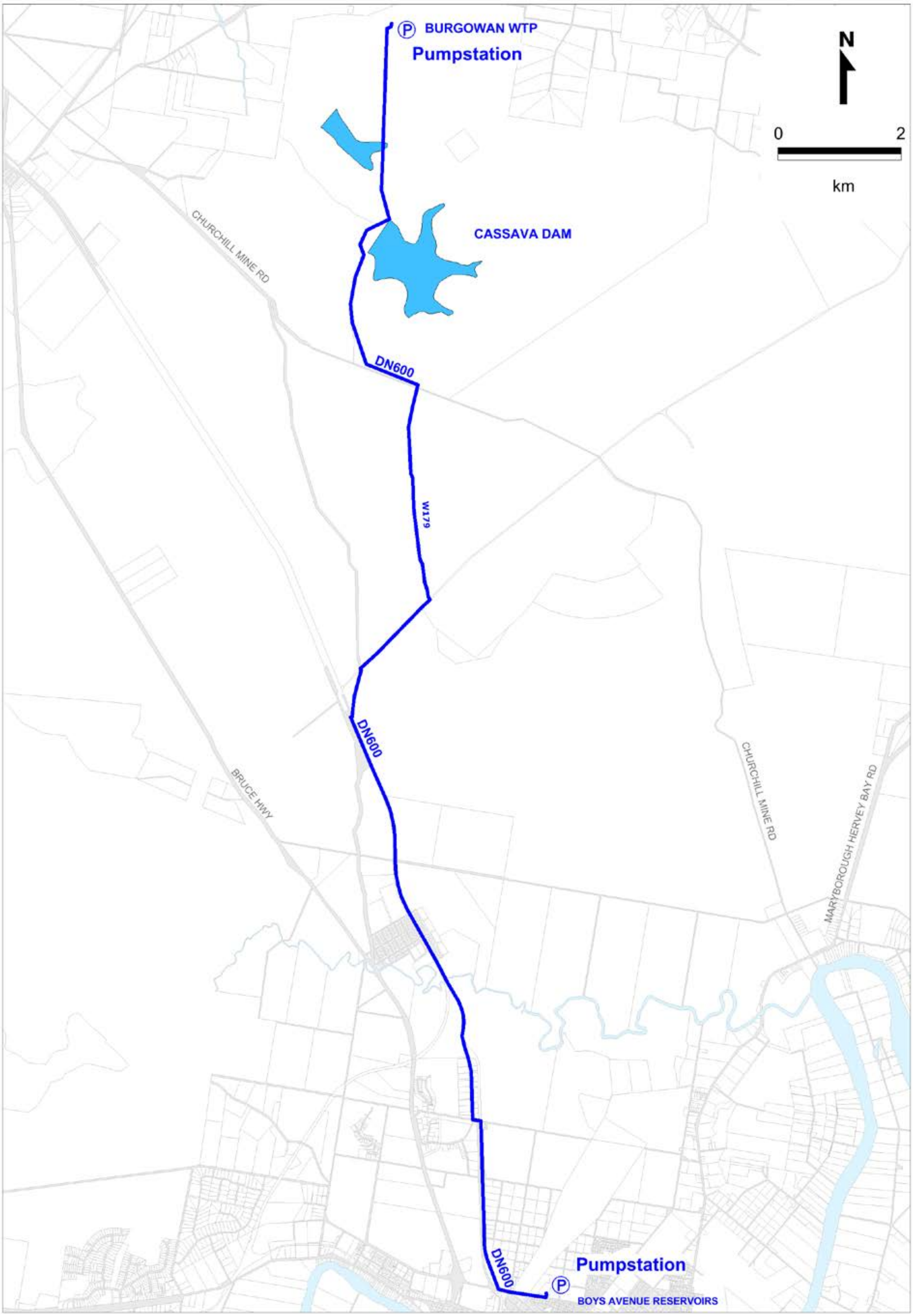


Figure 5-8: Hervey Bay to Maryborough Connection

Table 5-4: Cost Estimate for Water Grid

Item	Description	Size	Length/no	$/m: $/item	Total
Boys Ave to Burgowan		600	19129.6	1,087	$20,793,875
Allowance for Rock	20%		4782.4	1,745	$8,345,288
Pump Station	Boys Av to Burgowan 360L/s @ 62m approx 290kW		1	1,136,122	$1,136,122
	Burgowan to Boys Av 200L/s @ 39m approx 100kW		1	617,356	$617,356
	Power Supply		300	100	$30,000
Total			**23,912**		**$30,922,000**

The works are estimated to cost $31m and consists of approximately 24kms of DN600 water main and a pump station at each end of the pipeline.

RECOMMENDATION: Create an interconnection between the Hervey Bay and Maryborough networks in the year 2021 at a cost of $31m.

5.4.2. Takura Water Supply Concept

Raw water is treated at the Burgowan WTP and is transferred to the Hervey Bay region by the Burgowan Clear Water Pump Station. The required demand on the Burgowan clear storage is nearing the capacity of the current pump station. This is in part due to growth, but also largely due to the fact that Howard, Burrum Heads and Dundowran all draw water directly from this pump station, meaning that the pump station is subjected to the peak hour flows from these areas.

Even though the peak hour flows are partially buffered by the Takura Reservoirs, modelling shows that the configuration is not sustainable as demands increase into the future. Therefore it is proposed that the Takura Reservoirs be used to provide storage for the Burrum Heads, Dundowran and Howard areas which will buffer the peak hour flows and reduce the flow rates required from Burgowan Clear Water Pump Station to meet MDMM for these areas. The Takura reservoirs are sufficiently sized to meet the storage requirements of this area beyond the planning horizon (refer to Section 5.4.7).

Some pipework modifications will be required to facilitate this water supply concept including;

- a new section of DN375 main (2.7km) will be required to complete a dedicated feed from Takura Reservoirs to Dundowran Pump Station. It is estimated that this main would cost $1.3m
- the existing 450mm main from Howard to Takura reservoirs be dedicated to servicing the Howard and Burrum Heads areas.

This supply concept will allow dedication of the existing DN600 / DN500 transmission mains to transfer water from Burgowan to the Urraween Reservoir for distribution across the Hervey Bay area.

In addition there are other recommendations that arise from this water supply concept including;

- the reservoirs be cycled so that regular turnover of the water in the reservoirs occurs.

- the Takura reservoir complex is at a top water level of approximately AHD 95m. The strategy will require that pressure reducing valves (PRV's) be installed on the mains that supply properties directly from the Takura Reservoirs so that these customers and associated reticulation networks do not experience excessive pressures.

RECOMMENDATION: Adopt the Takura Water Supply Concept and undertake a detailed planning report at a cost of $60k in 2016.

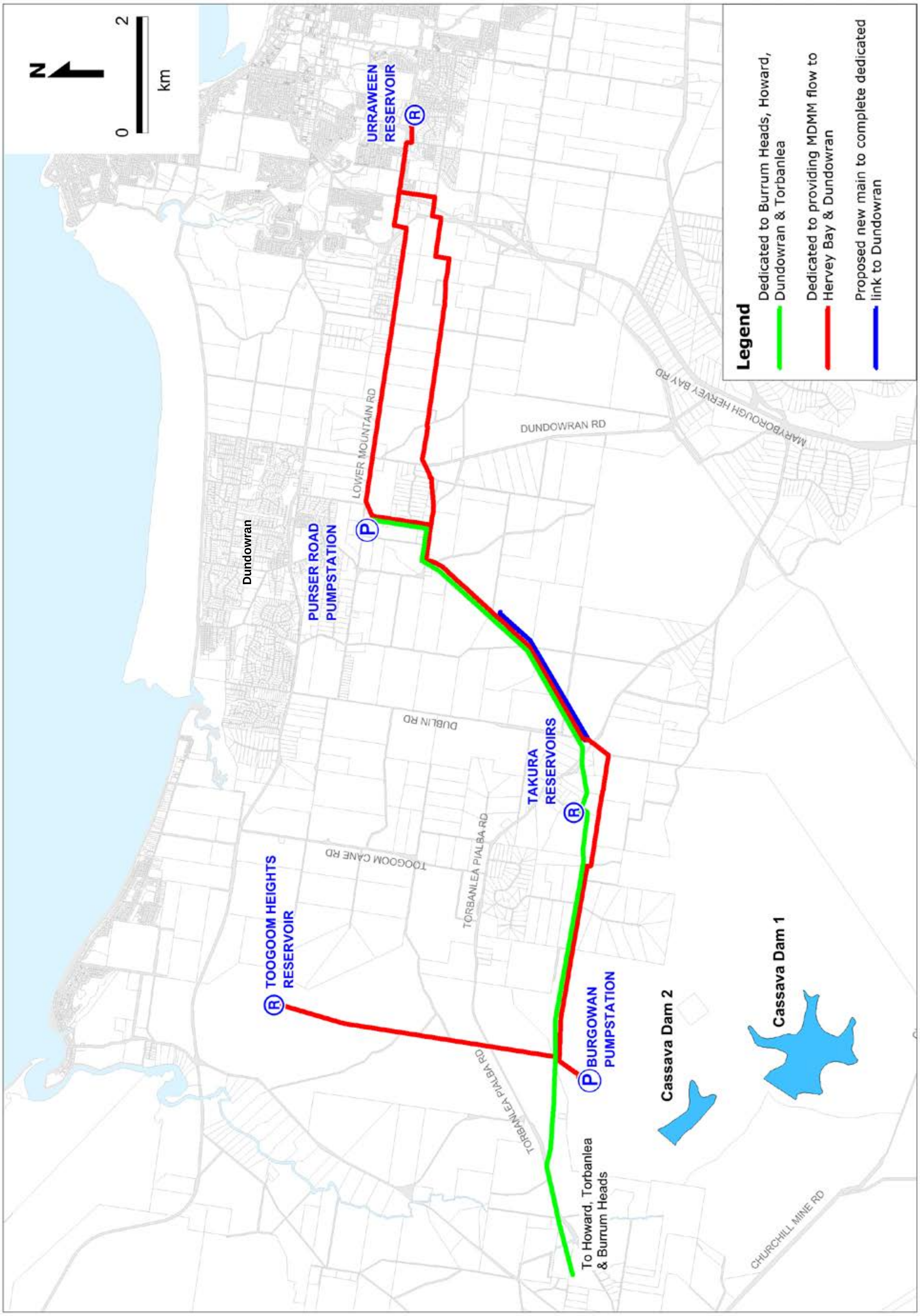


Figure 5-9: Takura Water Supply Concept

5.4.3. Urraween Zone Water Supply Concept

Demand projections to 2031 show that 23.2ML of storage will be required for the Hervey Bay and River Heads townships. There is currently a total of 46.6 ML of storage between Urraween and Ghost Hill Reservoirs, although the majority of this storage (35.4ML) is in the lower elevation Urraween Reservoir. This would suggest that from a system wide perspective, that additional storage is not required in the short term at Ghost Hill.

Consideration is however, required on the consequences of not providing additional storage at Ghost Hill in the short term.

The existing pump station at Urraween Reservoir currently supplies peak hour demands by delivering water directly into the distribution system at Main St. Flows are supplemented to a degree by the Ghost Hill No.1 and No.2 Reservoirs with TWL's of 67.5 and 80.8mAHD respectively.

The Urraween Pump Station provides sufficient pressure to fill the higher of these reservoirs but it does so at a reduced flowrate.

The construction of a large storage (20 ML) at the Ghost Hill No.1 site will enable the majority of Hervey Bay City to be supplied from this reservoir with only the high level zones (above RL 35) supplied from Ghost Hill No.2 Reservoir.

Pumping from Urraween Reservoir to a new 20ML storage will be at MDMM flow rates because the new reservoir will buffer the peak hour demands. This will reduce the energy required by the pumps. A significant energy reduction can be also achieved if pumping occurs directly from the Burgowan transmission mains. By using the head available in this pipeline, it is only necessary to provide pumps to boost the pressure from the available pressure to the required pressure. To facilitate this, a new pump station (Madsen Rd PS) is proposed at the Urraween Reservoir site and is currently being designed for construction.

Figure 5-10 shows the difference between the current system where water is pumped from Urraween reservoir to Ghost Hill No.1 reservoir and the proposed system where the Madsen Rd Pump Station pumps directly from the Burgowan mains. It can be seen that in the current system HGL is wasted when using the Urraween reservoir and as a consequence the Urraween Pump Station needs to pump at higher pressure to regain this lost HGL. In contrast the proposed system makes use of the existing HGL and consequently the required pump pressure to pump to Ghost Hill No.1 reservoir is significantly lowered.

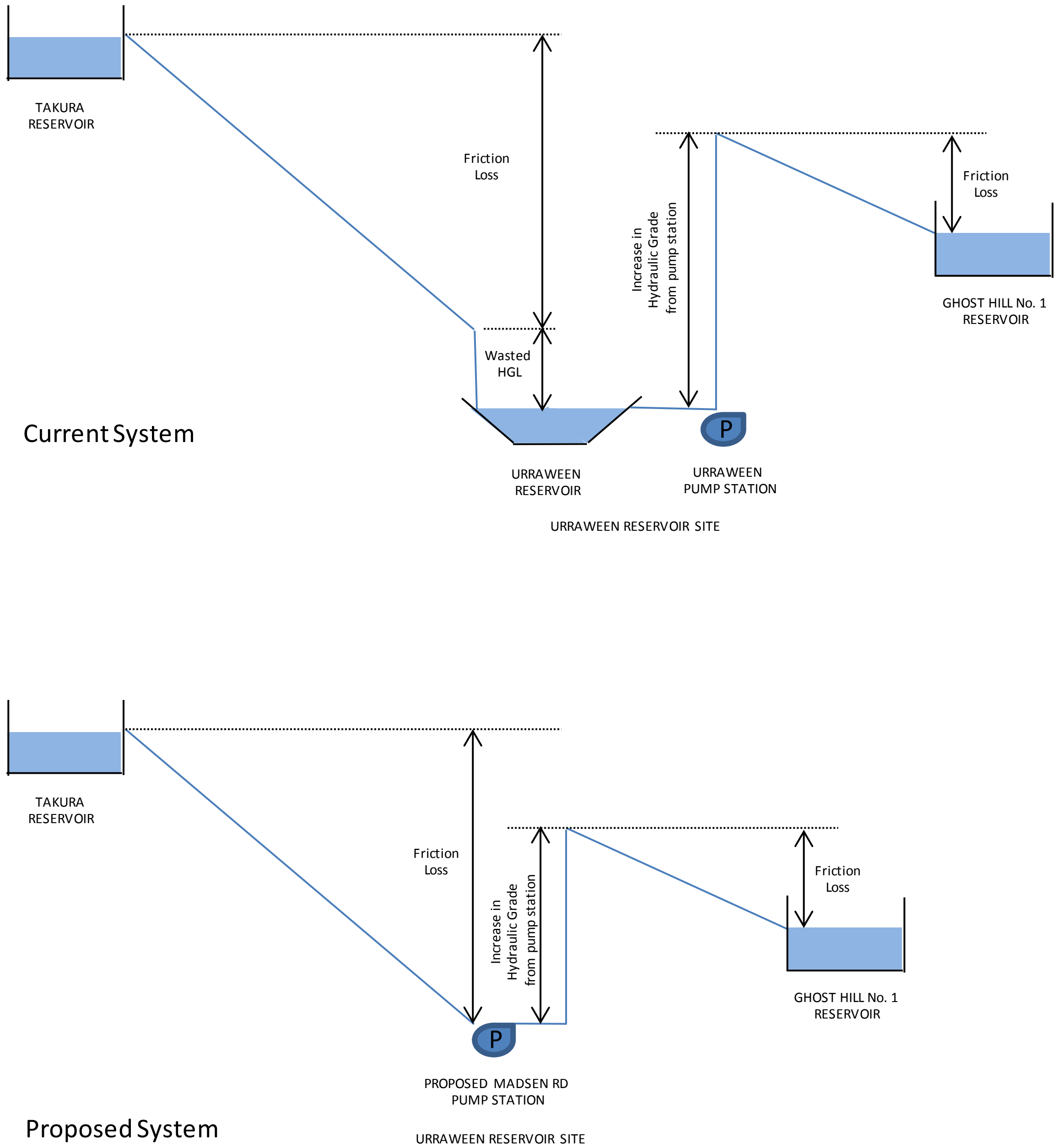


Figure 5-10: Current and Proposed HGL (NTS)

Without sufficient storage at Ghost Hill the flowrate from the Madsen Rd PS will need to be greater than MDMM because there will not be sufficient capacity in Ghost Hill Reservoir No.1 to buffer the peak hour flows. It is estimated that the flow rate required in 2031 to meet peak hour demand and using the reservoir to supplement flows will be 600L/s. At this time the reservoir will be fully utilised. Therefore additional storage at Ghost Hill No.1 will be required in 2031.

A 20 year NPV has been carried out to determine the extent of costs savings from reduced energy consumption. The two options were investigated.

- OPTION 1 - New pump station with reduced head and MDMM flow. This option also requires the addition of the Ghost Hill No.1 Reservoir upgrade to 20ML in 2031.

- OPTION 2 - Upgrade the existing pump station and continue to provide peak hour flows into the reticulation network with minimum buffering for the existing Ghost Hill No.1 Reservoir.

Option 1 was undertaken using 2031 MDMM figures as required under the DEWS (2014) guidelines for a pump station pumping to a reservoir. This would be the normal operating conditions. This option has a NPV of $8.2m.

Option 2 was undertaken using 2031 AD figures. This would be the normal operating conditions averaged across the year. This option has a NPV of $10.3m. The complete NPV analyses are available in Appendix 5.

Based on the data used, Option 1 is the preferred option, providing an average energy saving of approximately $300k/annum over Option 2. Based on these savings the payback period is approximately eight years.

The existing DN450 and DN500 trunk mains from Urraween Reservoir will be used to transfer water to the new 20ML storage (Ghost Hill Reservoir No.1). These mains have a capacity of approximately 700L/s which is sufficient to meet MMDM flow requirements in 2031. The existing DN750 main from Ghost Hill Reservoir No.1 will be used to distribute water to the township. This main has a capacity of approximately 1,000L/s.

It will be necessary to pump from the new 20ML storage to Ghost Hill Reservoir No.2 but this will be at MDMM pump rates.

Ghost Hill Reservoir No.2 will be dedicated to servicing the high level zones along the Kawungan Ridge and is more than adequate for this purpose. Ultimately this reservoir could be used to service the River Heads area. This option is detailed in the next section of the report.

RECOMMENDATION: Adopt the Urraween Water Supply Concept and undertake a detailed planning report at a cost of $60k in 2016.

5.4.4. River Heads Water Supply Concept

The River Heads area is currently serviced by the Ghost Hill Reservoir No.1 via a DN600 to Denman Camp Rd, a combination of DN450 / DN375 / DN300 along Boundary Road and a DN375 from Elizabeth St to the Hervey Bay Airport. From the end of the DN375 a 2.5km, DN150 main is used to supply the Booral Pump Station. The pump station boosts the pressure through approximately 6km of DN150 water main to the River Heads Reservoir.

This main has a history of multiple longitudinal fractures caused by the early PVC material use and insufficient bedding sand used in the installation of the main.

The current demand at River Heads is approximately 1,000ED. The demand is expected to increase to 1,600ED by the year 2031.

Previous versions of the strategy proposed an upgrade of the main along Booral Rd to meet future demands at River Heads. This strategy proposes to install a trunk main from Ghost Hill Reservoir No.2 Pump Station to the Booral Pump Station. Although this option requires greater infrastructure it will improve the pressures in the River Heads area, and remove the need for the Booral Pump Station. A DN300 main along the ridge line connecting to the inlet of the Boral Pump Station would need to be built to achieve desired outcomes.

A flow of approximately 35L/s (750kL/day) could be achieved by gravity from Ghost Hill No.2 Reservoir during a six hour low demand period each night. The remaining time supply to River Heads Reservoir will rely on pumping from Ghost Hill Reservoir No.2 Pump Station.

The existing Boral Pump Station could then be reserved for servicing an area of higher terrain in Boral East.

The project can be staged as follows;

- Stage 1 Construction of DN300 from Booral BPS to Doolong South Rd. In this stage the Booral BPS will still be required to pump water to River Heads Reservoir.
- Stage 2 Connection of the DN300 along the ridge. On completion of this stage the Booral BPS will no longer be required to pump to River Heads Reservoir.

Table 5-5: River Heads Water Supply Concept Costs

Main	Diameter	Length	Cost ($000's)
Stage 1			
Doolong South Rd to River Heads Rd	300	4,955	2,850
Stage 2			
Sandy View Dr to Doolong South Rd	300	2,525	1,451
From Samurai Dr to Sandy View Dr	300	324	186
TOTAL (Stage 1 and 2)			**4,487**

The project provides the following advantages over the previously adopted strategy:

- The previously identified DN300 along Booral Rd will no longer be required for the River Heads supply. There may be benefit in installing this main in the future to provide an alternative supply to Urangan on a security of supply basis.
- It will defer $4m of capital works by deferring the need to build a DN600 along Boundary Road for approximately five years at an expected saving of $200k/annum using a 5% interest rate.
- It will reduce the demand on the Urangan system and hence allow a further 1,000ED loading in the Urangan area before major upgrades are required.
- It will allow removal of two pump stations (Parklands Pump Station and Booral Pump Station which will be repurposed) at a net annual operational saving of approximately $50k.
- It facilitates development of a large area of land along the ridge in the Doolong South Rd area.

The disadvantages are that:

- It is a significant capital outlay.
- There may be land acquisition required for the pipeline installation
- Some modification to the operation of the existing DN300 ridgeline pipeline will be required.

In the longer term a reservoir can be built on the higher ground adjacent to the River Heads Rd providing distributed storage across the Hervey Bay. A potential reservoir site is available on the western side of River Heads Road. The Bottom Water level at this site is RL65 m AHD, making it slightly higher than Ghost Hill No.1 reservoir (63.75 m AHD), and 6m lower than Ghost Hill No.2 Reservoir (71.66 m AHD).

This means that during low flow periods (for 6hrs overnight), it is possible to achieve approximately 0.5ML of water by gravity from Ghost Hill No.2 Reservoir. The remainder of the time the Ghost Hill No.2 Pump Station needs to be engaged to fill the reservoir.

RECOMMENDATION: Adopt the River Head Supply Concept and undertake a detailed planning report at a cost of $60k in 2016.

RECOMMENDATION: Investigation is to be carried out to determine if a new reservoir is a viable option in 2017 at a cost of $30k.

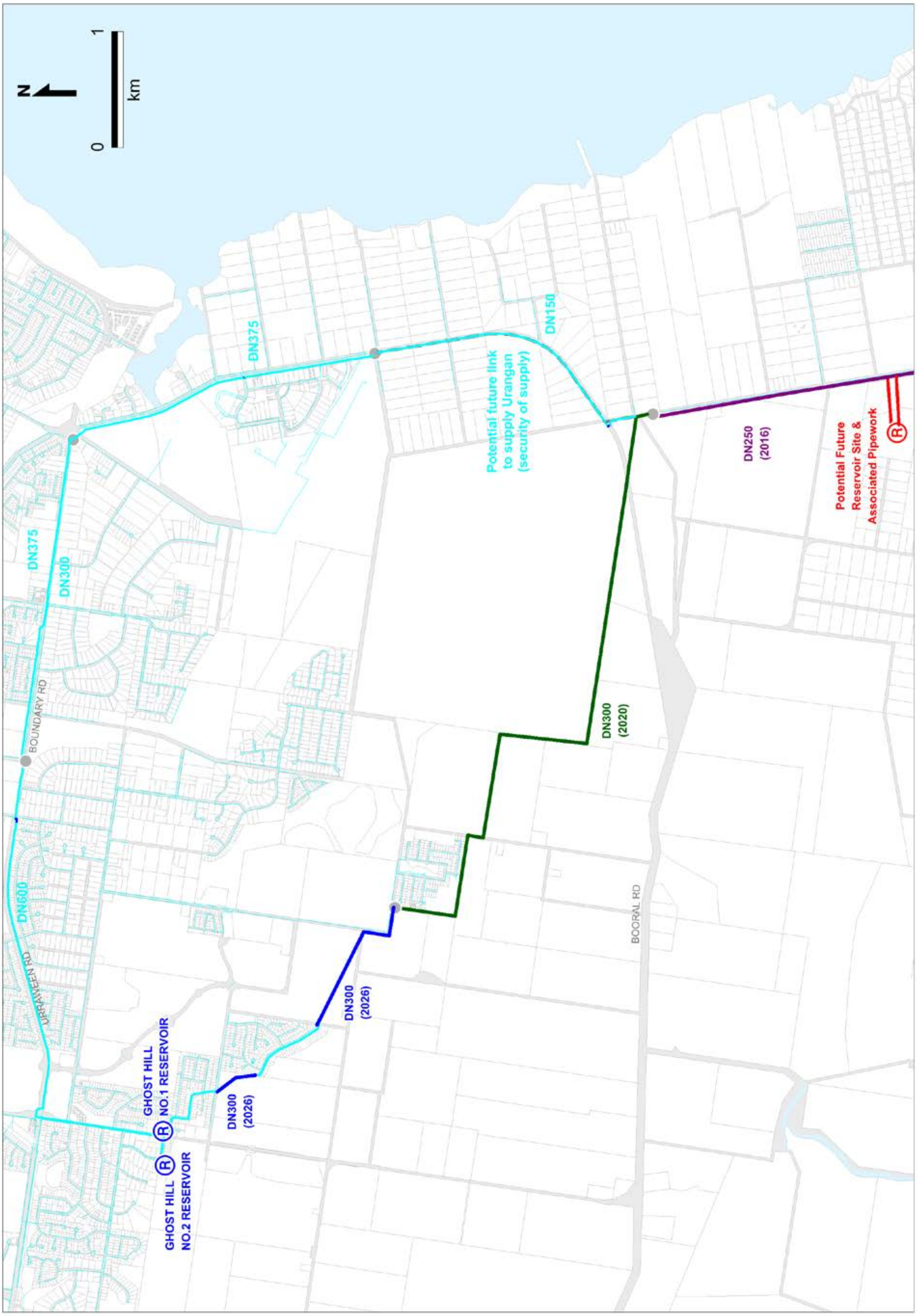


Figure 5-11: River Heads Water Supply Concept

5.4.5. Maryborough Water Supply Zone Concept

Water for the Maryborough township is supplied from Two Mile reservoir by a DN525 and a DN600 water main. These mains diverge at Tinana and the DN525 crosses the Mary River at the Lamington Bridge while the DN600 crosses at the Henry Palmer Bridge. The DN525 supplies Tinana (through the Nathan St Pump Station) and there is a connection for the Ann St Reservoir before it reaches Aberdeen Ave. The DN600 joins the DN525 at Aberdeen Ave and there are two DN600's that supply the Boys Ave Reservoirs.

Currently the Boys Ave Reservoirs supply all the water to the Maryborough township through the High Zone and Low Zone Pump Stations at Aberdeen Ave and their respective elevated reservoirs.

Growth areas identified by FCRC are in St Helens, Granville and within the Maryborough CBD. If development occurs in these areas then it will place a strain on the High and Low Zone Reservoirs and pump stations. It is proposed to recommission the Ann St Reservoir and pump station to accommodate some demand from the Low Zone DMA. Doing so will also create a new zone (Ann St Zone) which will provide a dedicated reservoir and pump station to facilitate growth in the CBD and Granville area. As stated in Section 3.6.3, this reservoir system (ground and elevated) has been out of service for a considerable period due to a number of issues most notable of which is leakage from the ground reservoir.

An assessment to reinstate the Ann St Reservoir was undertaken by Cardno in 2012. Some of the recommendations from their report have already been undertaken. The outstanding works include;

- installation of venting on the roof at a cost of approximately $70k.
- the inlet and outlet pipework sizes need to be increased to DN300 to cater for the projected demands. It is estimated that the pipework will cost approximately $50k and is currently being undertaken.
- the Ann St Pump Station is to be recommissioned. The pump station is located adjacent to residential areas and noise may be an issue. The existing pump station is also fixed speed pump station so installation of a variable speed drive will be required to reduce pressure transients in the network and allow the automatic adjustment of pump flow to match demand. The cost of upgrading the Ann St Pump Station is estimated at $81k.

In the longer term and as demand requires it, the operational 4ML reservoir at Two Mile would be dedicated to the Boys Ave Reservoirs while the unused reservoir at Two Mile is reinstated and dedicated to servicing the Ann St Reservoir and Tinana zone.

A structural assessment of the suitability of the unused reservoir at Two Mile was undertaken by Cardno in 2012. It was concluded that, based on the available information, the structure appeared to be suitable for recommissioning. If water proofing was required (although there was no indication of ingress from groundwater during the investigation, then this could be achieved through lining the interior of the reservoir. A roof structure was also required for this reservoir.

A cost estimate to recommission the unused Two Mile reservoir was prepared by Cardno in 2012 and identified five options for reinstatement of this reservoir. The options were:

- Colorbond Ultra roof alternative - $591k
- Aluminium Roof Alternative - $739k
- Colorbond Stainless Steel Roof Alternative - $798k
- Floating Membrane Roof Alternative - $318k
- Suspended Concrete Roof Alternative - $646k.

All options included reinstatement of the existing walls and floor using a water proof membrane. The preferred option is the colorbond roofing option at a cost of $591k. While this is not the lowest price option it does allow additional aeration to be installed in the reservoir to further release volatile THM's.

RECOMMENDATION: Adopt the Maryborough water supply concept and undertake a detailed planning report at a cost of $60k in 2016.

RECOMMENDATION: Continue to recommission the GL reservoir and pump station at the Ann St facility in 2017 at a cost of $70k and $81k respectively

RECOMMENDATION: Note reinstatement option for the reinstatement of Two Mile Reservoir in 2046 at a cost of $591k.

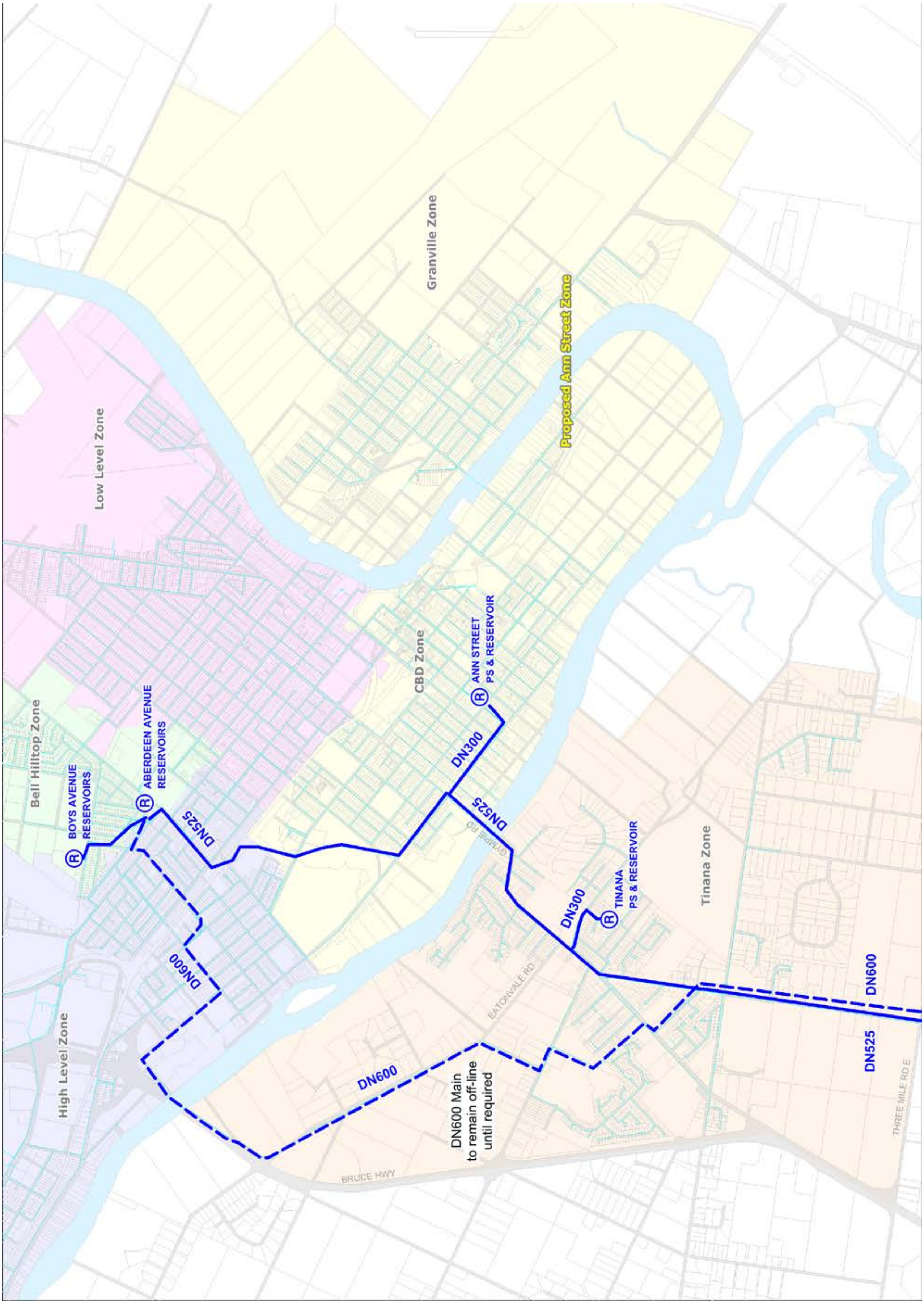


Figure 5-12: Maryborough Water Supply Concept

5.4.6. Pump Stations

A pump station assessment was carried out using modelling to determine when pump station capacity upgrades will be required. The pump stations that require future augmentation under this strategy are presented in Table 5-6 below.

Table 5-6: Pump Station Upgrades for Capacity

Area	PS Name	PS No.	Existing Current Duty	Future Required PS Duty	Year Required
HB	River Heads HLZ	WPS1000	5L/s@43m head	35L/s@34.4m head	2016
HB	Dundowran - Apex Close Future PS	n/a	n/a	17L/s@20m head	2016
HB	Madsen Rd PS	n/a	n/a	620L/s@53m head	2016
HB	Dundowran (Purser Rd)	WPS0400	50L/s@20m head	61L/s@48m head	2021
HB	Booral	WPS0900	13L/s@32m head	35L/s@40m head	2021
HB	Burgowan Clear Water PS	5225	517L/s@58.4m head	600L/s@75m head	2021
HB	Parklands Estate	WPS1600	2.8L/s@31.9m head	32.6L/s@ 13.6m head*	2026
HB	Ghost Hill No.1	WPS0700	not currently used	304 L/s @ 14m head	2031
MB	Ann St PS (was WPS4707)	WPS5200	Not currently used	155L/s@20.4m head	2021
MB	Granville Water Pump Station	n/a	n/a	20L/s@20m head	post 2031

* This pump station may no longer be required once the River Heads Concept Plan is implemented.

Refer to Appendix 5J for a full list of pump stations and other details.

5.4.6.1. Power Failure

A review of the critical pump stations in the Fraser Coast has revealed that the inoperability of most of these stations due to power interruptions will result in an inability to maintain minimum levels of service to the network they supply. The criticality of a pump station was determined by the system's ability to function without the pump station in operation while maintaining some water pressure to the affected houses (pressures above 5m residual). Consideration was given to the number of connections that were affected by a power outage and had less than 5m residual pressure at the connection point. Furthermore, where storage was available consideration was given to the amount of time available before connections were affected by the power outage. A risk matrix was developed as shown in Table 5-7.

Table 5-7: Risk Matrix Used to assess critical Pump Stations

Time to water shortage	Consequence (How many Connections affected)				
	Less than 10	10-100	100-1000	1000-5000	Greater than 5000
immediate	Medium-11	High-16	High-20	Extreme-23	Extreme-25
0-2hr	Medium-7	Medium-12	High-17	High-21	Extreme-24
2-8hr	Low-4	Medium-8	Medium-13	High-18	Extreme-22
8-24hr	Low-2	Low-5	Medium-9	Medium-14	High-19
Greater than 24hr	Low-1	Low-3	Medium-6	Medium-10	High-15

An assessment based on these criteria has been undertaken and the resulting risk rating has been tabulated in Table 5-8.

Table 5-8: Pump Station Generator Risk Assessment

System	PS Name	PS No.	Are pressures reduced below 5m (if yes how many properties)	how quickly will they be out of water (AD) assumes res is full	Risk	Comment
HB	Burrum Weir (New) raw water PS	WPS1318	Entire Town*	44	High-15	Generator not warranted in these location because there are 2 days (AD) storage available to rectify an outage and in the likelihood of an event extending beyond 2 days demand management strategies would be implemented to extend the available water supply
HB	Burrum Weir (Orig) raw water PS	WPS1300	Entire Town*	44	High-15	
HB	Cassava No.1 raw water PS	WPS1200	Entire Town*	44	High-15	
HB	Cassava No.2 raw water PS	WPS1400	Entire Town*	44	High-15	
HB	Burgowan Clear Water PS	5225	Entire Town*	44	High-15	
HB	Toogoom Bush PS	WPS0300	0	17.5hr	Low-2	
HB	Toogoom Rd PS	WPS0200	n/a	n/a	n/a	not is use
HB	Burrum Heads Standpipe PS	WPS0100	n/a	n/a	n/a	not is use
HB	Dundowran PS	WPS0400	229	immediately	High-20	
HB	Dundowran – Apex Close	n/a	n/a	n/a	n/a	Covered by Dundowran PS
HB	Urraween No 1 PS	WPS0500	1219	10.5	Medium-14	
HB	Madsen Rd PS	n/a	1219	10.5	Medium-14	
HB	Ghost Hill Res No.2 HLZ PS	WPS0600	129	immediately	High-20	
HB	Ghost Hill No 1 PS	WPS0700	n/a	n/a	n/a	Covered by GH#2
HB	Parklands Estate	WPS1600	3	>24	Low-1	
HB	Booral PS	WPS0900	84	immediately	High-16	
HB	River Heads HLZ PS	WPS1000	26	immediately	High-16	
MB	Teddington Raw Water PS	50003	Entire Town*	48hr	High-15	Generators are not warranted in this location because there are 3 days (AD) storage available to rectify an outage and in the likelihood of an event extending beyond this time demand management strategies would be implemented to extend the available water supply
MB	Teddington Clear Water PS	50011	Entire Town*	48hr	High-15	
MB	Tinana Water PS	WPS5100	127	6hr	Medium-13	serviced from 2 Mile
MB	High Zone PS	WPS5300	770	15.8hr	Medium-9	Serviced from Boys
MB	Low Zone PS	WPS5400	50	4.2hr	Medium-8	Serviced from Boys
MB	Ann Street PS	WPS5200	136	3.3hr	Medium-13	Serviced from Ann St
MB	Granville Water Pump Station	n/a	n/a	n/a	n/a	Covered by Ann St
TIA	Tiaro Raw Water PS	WPS4100	274	8hr	Medium-9	
TIA	Tiaro Clear Water PS	40005	274	8hr	Medium-9	

* No of connections affected will increase progressively as length of outage increases

The risk assessment process indicates that any risk rating of Low should be accepted and monitored. Risk ratings above this level should have a risk management plan developed. For the purposes of this this assessment, it was deemed appropriate that any risk rating greater than 10 should be considered for an onsite generator. With the risk ratings less than or equal to 10 the risk should be monitored and reassessed on a five yearly basis.

Table 5-9: Generator Requirements for Water Pump Stations

System	PS Name	PS No.	RISK	Generator (Y/N)	Generator Sizing (kW)	Cost ($000's)	Year	Comment
HB	Dundowran PS	WPS0400	High-20	Y	50	50	2016	
HB	Urraween No.1 PS	WPS0500	Medium-14	Y	555	200	2016	Madsen and Urraween Generator can be co-utilised
HB	Madsen Rd PS	n/a	Medium-14	n/a				
HB	Ghost Hill Res No.2 HLZ PS	WPS0600	High-20	Y	50	70	2016	
HB	Booral PS	WPS0900	High-16	Y	10.1	40	2016	
HB	River Heads HLZ PS	WPS1000	High-16	N	-	-	-	Only a small number of connections affected (26). The remaining
MB	Tinana Water PS	WPS5100	Medium-13	Y	30	40	2016	
MB	Ann St PS	WPS5200	Medium-13	Y	91	50	2018	

5.4.6.2. HB – Purser Rd (Dundowran) Pump Station

The Craignish/Dundowran area is separated into four separate DMA's

- Dundowran High
- Dundowran PRV
- Dundowran Bayrise
- Dundowran Low

The area is supplied through the Takura Reservoir system with a pump station at Pursers Rd boosting pressure to achieve level of service required in the elevated areas.

The pump station consists of two variable speed pumps. The pumps are controlled by a critical pressure point at Apex Close where the pumps maintain a minimum level of service for pressure. The Dundowran Bayrise DMA is supplied via the Bayrise reservoir from the Dundowran High Zone DMA network.

The Dundowran PRV DMA is also supplied from the Dundowran High Zone DMA network with a PRV to reduce pressures in the zone.

The Dundowran Low Zone is also supplied from the Dundowran High Zone DMA. Network modelling of the Dundowran system has indicated that the Dundowran Low Zone DMA can be supplied directly from the Takura Reservoir and will meet the minimum level of service required under this scenario. To facilitate this, a new main is required, bypassing the Purser Rd Pump Station and connecting directly into the Dundowran Low Zone. Without the installation of this main, the two pumps in the Purser Rd Pump Station will require upgrading in 2016.

In later planning period's substandard pressures are likely in the elevated areas of Dundowran, particularly in Apex Close. At this time the pumps will require a capacity upgrade in terms of both flow and pressure to meet peak hour demands and to maintain agreed level of service pressures in the more elevated areas. It is proposed to place a small local area booster pump in the Apex Close area to provide the additional head required and reduce the head in the remainder of the system by approximately 5m. This will be done by the introduction of a small variable speed pump station at High Point Rd.

These changes will increase the longevity of the Purser Rd Pump Station to 2021.

Table 5-10: Apex Close Pump Station Costing

Component	***Diameter (mm)***	***Cost***
Pipework	150	$60,000
Pump station	n/a	$110,000

RECOMMENDATION: Upgrade the Existing Dundowran (Purser Rd) Pump Station in 2021 at a cost of $300k.

RECOMMENDATION: Address the local area pressure issues at Apex Close with a small pressure pump and associated pipework in 2016 at a cost of $170k.

5.4.6.3. HB - River Heads High Zone Pump Station

The High Level Zone DMA in River Heads services 512 properties. It is supplied from a booster pump station at the River Heads Reservoir. There are three pumps located at the pump station and are controlled according to demand fluctuations throughout the day. Each pump delivers 5L/s at its design operating point, giving a total capacity of less than 12L/s at the existing pump station.

The existing demand is approximately 10L/s during peak hour flows. In addition 15L/s is required for firefighting purposes in residential areas. Therefore the existing pump station should be capable of providing 25L/s into the network. The projected future demand in 2031 is estimated at 35L/s. The existing pumps are insufficient to meet current and future demand, as required under the Planning Guidelines for Water Supply and Sewerage (DEWS, 2014). To meet these demands the pump station will require upgrading immediately.

Upgrades to the pumps are estimated at $30k. This site may also require an upgrade to the switchboard at an estimated cost of $60k.

This pump station has experienced several power outages due to overloading of the Ergon electrical network. Operations plan to install a generator at this location until the power outages are addressed by Ergon.

RECOMMENDATION: Upgrade the River Head High Zone Pump Station to meet growth in 2016 at a cost of $90k.

5.4.6.4. HB – Madsen Rd Pump Station

This pump station is a required component of the Urraween Water Supply Concept. The pump station is to be located at the Urraween reservoir site. Functionally the pump station should;

- Use suction pressure from the Burgowan transmission mains to boost water to Ghost Hill Reservoir No.1.
- Controls the flow rate through the pump station to maintain the upstream pressures, although this isn't critical if the Takura Water Supply concept is realised.
- Provide MDMM flows to the future 20ML Ghost Hill No.1 Reservoir.
- In high usage times, assist with providing peak hour flows with the assistance from Ghost Hill No.1 (4.5ML) until the 20ML reservoir is constructed in 2031. During this time water will need to be accessed from the Urraween reservoir.

This pump station is currently being designed for construction at an estimated cost of $1.5m.

The pump station and the Urraween Pump Station are critical components of the Hervey Bay water Supply system. They provide flows and pressures to fill the Ghost Hill reservoirs and are capable of providing water directly into the distribution network if required. Without these pump station there would be insufficient pressure and flows available to supply Hervey Bay and accessing water from the Urraween reservoir would not be possible.

RECOMMENDATION: Installation of back-up generator to this site up power generator in 2016 at $200k.

5.4.6.5. HB – Booral Pump Station

The Booral Pump Station located on River Heads Road near Booral Road and currently delivers water to the River Heads reservoir. It also supplies properties connected directly to the rising main in the elevated areas of east Booral.

The pump station will not be required once the River Heads water supply concept is realised, however the area of east Booral, containing 130 properties, will require boosted pressures to maintain domestic and fire flows. This pump station could be repurposed to meet that objective. Downsizing of the pumps and switchboard is estimated at $50,000 although the existing pumps (variable speed) could easily cater for this area indefinitely.

This area has elevations of between 25 m AHD and 52 m AHD. To provide adequate pressure to these properties requires a HGL at the booster pump station of 74 m AHD. The HGL at the pump station inlet averages 50 m AHD. Therefore the pump station will need to operate at all times. Reliance on the gravity HGL of 50 m AHD will mean that some of the network will be exposed to negative pressures in excess of 1 atmosphere, which could be detrimental to the pipeline. Therefore a back-up generator will be required at the Booral Pump Station site to maintain pressures to this area. A back-up generator is estimated at a cost $40k and will be required in 2016.

Should the River Heads water supply concept not be realised by 2026, then a pump station upgrade will be required at this pump station to account for growth. A capacity upgrade to 35L/s at 40m is required at an approximate cost of $90k.

RECOMMENDATION: Install a back-up power supply at Booral PS estimated at $40k.

5.4.6.6. HB – Burgowan Clear Water Pump Station

The Burgowan Clear Water Pump Station supplies treated water to the entire Hervey Bay network. It draws water from the Clear Water Reservoir at the Burgowan WTP and transfers water to Urraween, Takura, Toogoom and Howard Reservoirs. The Burgowan Clear Water Pump Station has a theoretical capacity of approximately 520L/s, however in practice flows of up to 400L/s are achievable. The pump station will reach capacity by 2021 at which time it will need upgrading.

To meet future demands in 2031 the Burgowan clear water pumps will need to pump 42.1ML/day in a 20 hour period. This means the flow rate required will be approximately 600L/s at a head of 70m and a power requirement of 520kW.

The existing pump station power requirements are approximately 300kW.

Previous upgrades at the Burgowan WTP site have been limited by Ergon Energy's network capacity and is expected that this may continue to be the case until such time as Ergon Energy has affected necessary network upgrades to increase available capacity. The limitation on the available power supply restricts the operation of the pump station to a single pump only. The power supply will need to be upgraded to allow dual pump operation.

RECOMMENDATION: Upgrade Burgowan Clear Water Pump Station to 600L/s in 2021 at a cost of $600k.

5.4.6.7. HB – Urraween Pump Station

The Urraween Pump Station transfers water from the Urraween Reservoir to both the Ghost Hill Reservoirs and directly into the reticulation system. Peak hour demands are met by both the Urraween Pump Station and Ghost Hill No.1 Reservoir.

As discussed in Section 5.4.3, the existing pump station does not take advantage of the available pressure from Burgowan Clear Water Pump Station and as a result, has less than optimal operational costs. The system is currently being reconfigured to minimise the usage of this pump station under normal operation. The proposed Madsen Rd Pump Station will be designed to take advantage of the available pressure from the Burgowan Clear Water Pump Station, but will not have the delivery head to pump from Urraween Reservoir to the Ghost Hill Reservoirs. Therefore the Urraween Pump Station will still be required to access water from the Urraween Reservoir and as such it is necessary to maintain this pump station in operation. It is envisaged that this pump station would be operated on a daily basis to assist with water turn over in the Urraween Reservoir.

At other times it will only be used as an emergency backup pump station and therefore no upgrade works are proposed for this pump station aside from normal maintenance. This pump station should be considered when sizing the backup power generator for the Urraween Reservoir site.

5.4.6.8. HB – Parklands Estate Pump Station

The Parkland Estate Pump Station is a small pump station located at Parklands Estate in Wondunna. This four pump pumping station increases the hydraulic grade line (HGL) to boost pressures in the higher elevated areas of the Parklands subdivision. To accommodate variations in flow and suction pressure, the pumps are fitted with variable speed drives. It is a localised pump station and if any upgrades are required they will be undertaken by the developers as a development requirement.

Once the River Heads Concept is realised, this pump station will no longer be required and this zone will be supplied from the Ghost Hill No.2 Reservoir.

5.4.6.9. HB – Ghost Hill No.1 Pump Station

This pump station is required to transfer water from the Ghost Hill No.1 Reservoir to the Ghost Hill No.2 Reservoir. The proposed changes as identified in the Urraween Water Supply Concept (Section 5.4.3) transfers water from Urraween/Madsen Rd Pump Stations to Ghost Hill No.1 Reservoir. Ghost Hill No.1 Pump Station will be critical in transferring water from the Ghost Hill No.1 site to Ghost Hill No.2 Reservoir.

An upgrade to the existing pump station will be required to meet demands in 2031 and could be incorporated with the new 20ML Ghost Hill No.1 Reservoir installation. The future pump station will require a flow rate of 304L/s to meet projected demands. It is estimated that a pump and switchboard upgrade is likely to cost $190k.

RECOMMENDATION: Install/upgrade Ghost Hill No.1 Pump Station in 2031 at a cost of $190k.

5.4.6.10. MB – Ann St Pump Station

The Ann St Pump Station is an essential component in the proposed Maryborough Water Supply Concept as outlined in Section 5.4.5. The pumps supply water directly to the reticulation and into the Ann St Elevated Reservoir (0.45ML). The elevated reservoir provides some back up storage and regulates pressures in the system.

This existing pump station consists of two pumps and each has an identical capacity of 115L/s at 31.6m. The existing pumps have the capacity to service the Maryborough CBD DMA and the Granville DMA until 2026. Prior to recommissioning this system, the pump station is required to undergo the following works:

- Housing and pipework modifications ($40k).

- Installation of noise dampening systems at the pump station to reduce the noise in a residential area ($10.8k).
- Installing variable speed drives to allow the pumps to match demands ($30K). At this time consideration could be given to decommissioning the Ann St Elevated Reservoir.
- Installation of a standby generator for increased reliability ($50k)

It is proposed that a building be placed over the pump station and the external walls clad with soundproofing membrane as to not disturb the adjacent residential area. It is also proposed that the starters controlling the pumps be replaced with variable speeds drives so that water hammer and fluctuations in pressure are reduced and that the pumps can match the demand even when the elevated tank is offline.

In addition a standby generator should be installed at this site as determined in Section 5.4.6.1. The estimated cost for the pump station upgrade and back-up power supply is $81k and $50k respectively.

After 2026 the pump station will no longer be able to meet the required demand. At this time it is required to upgrade the pump station to 155L/s @ 35m (90kW). This will require an upgrade to the switchboard and replacement of pumps at an estimated cost of $230k in 2026.

RECOMMENDATION: The Ann St Pump Station be recommissioned at a cost of $81k in 2018.

RECOMMENDATION: A permanent back-up power supply be installed at the Ann St Site at a cost of $50k in 2018.

RECOMMENDATION: A capacity upgrade occurs in 2026 to meet future demands at a cost of $230k for pump and switchboard upgrades.

5.4.6.11. MB – Granville Local Area Pump Station

There is a small area of Granville which is significantly more elevated than the surrounding areas. Modelling shows that after 2031 it will be difficult to maintain a satisfactory level of service (residual pressure) under fire fighting conditions for this area of Granville. Therefore it is proposed to install a booster pump station in the area to ensure minimum pressures are maintained during peak demand periods.

While the modelling shows that this isn't required immediately it is included in this strategy for the purposes of completeness. The likely timing for this is 2036 although this could be brought forward should development activity increase.

Figure 5-13 illustrates the extent of the Granville pressure zone and the proposed location of the booster pump station and associated pipework.

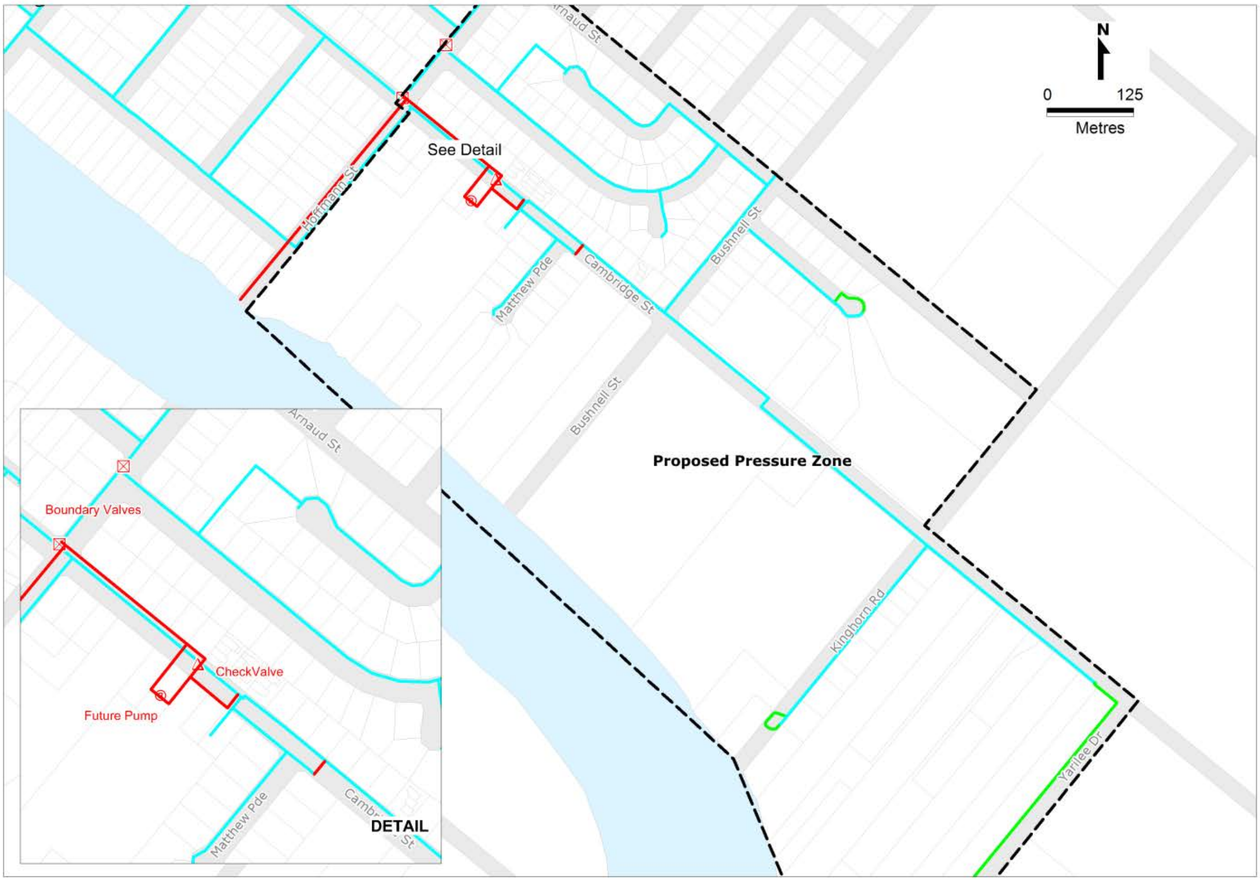


Figure 5-13: Granville Booster Pump Station Concept Layout

5.4.7. Ground Level Reservoirs

Reservoirs perform an important function in the water supply system. They provide security of supply and storage of water for emergencies, but they also provide necessary buffering within the system to reduce peak demands on trunk systems. They achieve this by providing capacity during peak times. This allows other trunk infrastructure such as pump stations to be sized to meet MDMM flows and not full PH flows.

An analysis of the required reservoir capacities for the projected demands in each reservoir zone is summarised in Table 5-11.

The table was calculated by applying the DEWS (2014) guidelines for the sizing of service reservoirs. The table indicates that there are current deficiencies in the storage provided at Takura Heights (supplying Toogoom), River Heads and Bayrise Estate Reservoirs.

Table 5-11: Ground level Reservoirs Capacity Assessment

	Reservoir	2011	2016	2021	2026	2031	2036	2041	2046	2051	2056	Existing Capacity
HB	Bayrise Estate Reservoir (Dundowran Beach)	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.3
HB	River Heads Reservoir	0.9	1.0	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1
HB	Takura No.1 and No.2 Reservoirs	4.0	4.5	4.9	5.2	5.5	5.9	6.4	6.9	7.5	8.1	10
HB	Takura Heights Reservoir (Toogoom)	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.5	1.6	1.7	0.7
HB	Ghost Hill No.2 Reservoir (GH2)	1.1	1.3	1.4	1.7	1.9	2.1	2.2	2.4	2.5	2.7	6.7
HB	*Town Supply (GH2, GH1, Urraween) excluded River Heads*	*14.7*	*15.6*	*17.4*	*19.4*	*22.0*	*24.0*	*26.0*	*28.3*	*30.7*	*33.4*	*46.6*
MB	Boys Ave No.1 and No.2 Reservoirs	4.5	4.6	4.7	4.7	4.7	4.9	5.1	5.3	5.5	5.7	19
MB	Ann St Reservoir	3.2	3.3	3.3	3.3	3.4	3.5	3.6	3.8	3.9	4.1	4.5
MB	Tinana Reservoir	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.2	2.3	2.4	4.5
TIA	Tiaro Reservoir	0.6	0.6	0.7	0.7	0.7						1.25

5.4.7.1. Ghost Hill/Urraween Reservoir

Ghost Hill No.1 and No.2 Reservoirs and Urraween Reservoir have been considered together as currently they collectively service the Hervey Bay area.

As discussed in Section 5.4.3, Ghost Hill No.1 Reservoir is undersized for the catchment is serves. If it is considered in conjunction with Urraween Reservoir it can provide sufficient storage for the zone up to 2031 at which time it will need to be upgraded.

The site at Ghost Hill No.1 has sufficient area to facilitate the construction of a 20ML reservoir, however this will necessitate the demolition of the existing reservoir. During construction of this new reservoir the Hervey Bay area will need to be supplied from Ghost Hill No.2 and Urraween Reservoirs. Construction of the new reservoir should also occur during low usage times (i.e. in May to September) to further reduce the impact on the water supply system.

The cost of a new 20ML reservoir is estimated at $3.06m.

To allow the current system assets to meet LOS requirements under maximum demands, the pumping arrangement at Urraween will require a generator to be available in the event of a failure of power supply.

RECOMMENDATION: New Ghost Hill No.1 Reservoir be constructed in 2031 at a cost of $3.06m

5.4.7.2. Burrum Heads

As the Howard WTP no longer operates continually, Burrum Heads is, for the majority of time, supplied from Takura Reservoir via approximately 32km of trunk mains.

At the time of writing this report, the population in Burrum Heads is approximately 2,600 with effectively no alternative means of supply. To improve the reliability of the system a DN400 PE main has been installed under the Burrum River in addition to the existing DN200 river crossing. However there is still a section of approximately 11km of water main feeding Burrum Heads and any repairs to this main would mean lengthy periods without water for Burrum Heads. It is estimated that repairs on this main could take up to 8 hours, which is above the maximum time for outages under WBWC's standards of service.

A short term emergency supply is available from Toogoom via approximately 10.5km of DN150 main although this is insufficient to meet other than short term supply interruptions. Modelling indicates that this main is capable of supplying 5L/s to the Burrum Heads area under peak day conditions. It should also be noted that this 1972 AC water main is in poor condition and has a history of breaks when attempts have been made to recommission this main. The main was built through tidal areas of Beelbi Creek and access to it is difficult in wet conditions. It is also not used regularly and therefore flushing and/or disinfection will be required prior to use. At present the pump station at Toogoom Rd feeding the DN150 main has been disconnected from the system.

RECOMMENDATION: Investigate the option of maintaining the DN150 link between Toogoom and Burrum Heads in operating condition and reinstating the pump station for use with this main.

5.4.7.3. Bayrise Estate Reservoir

Dundowran has insufficient storage for a community of approximately 3,500 people. The only storage is a small 300kL reservoir which services part of Dundowran Beach. It does not meet the storage requirements for Dundowran Beach let alone any greater area.

It is proposed that Dundowran use the storage capacity from Takura to meet its storage requirements as described in the Takura Water Supply Concept; however this would mean approximately 2.7km of suction main between the reservoir and the pump station. This would enable a dedicated main to Dundowran (Purser Rd) Pump Station without compromising the supply mains to Urraween Reservoir.

RECOMMENDATION: Construct a link main to feed Dundowran Pump Station from Takura Reservoir in 2030 at a cost of $1.8m.

5.4.7.4. Two Mile No.2 Reservoir

Tinana is separated from the Maryborough storage by the Mary River and relies on storage from Two Mile. While no upgrades are required in the foreseeable future additional storage is recommended to assist in the reduction of THM's by providing additional aeration to the incoming water from Teddington WTP. It is anticipated that this storage could be achieved by the reinstatement of the existing unused Two Mile Reservoir (currently not in service).

While this reservoir is structurally sound, there would be significant work required including lining, roofing and associated pipework before the reservoir could be reinstated. A report by Cardno (2012) indicates that a colour bond roof and repair of the reservoir would cost $591k. Additionally it is estimated that the cost for pipework and ancillary equipment will be approximately $100k.

RECOMMENDATION: Reinstate Two Mile No.2 Reservoir in 2031 at a cost of $700k.

5.4.7.5. Takura Heights (Toogoom) Reservoir

The Takura Height (Toogoom) Reservoir supplies the Toogoom township. The reservoir does not meet current storage requirements for the demands it services.

An additional 1ML reservoir or a 1.7ML replacement reservoir is proposed to be constructed at the existing reservoir site at a cost of $500k (or $700k for the 1.7ML reservoir). This will provide sufficient capacity to meet projected demands to 2056. It is proposed to carry out these works in 2022.

RECOMMENDATION: Install an additional 1ML of storage for Toogoom in 2022 at a cost of $500k.

5.4.7.6. River Heads Reservoir

The River Heads Reservoir provides the township of River Heads with storage of 1ML. With the projected growth in the River Heads area, this storage is expected to be insufficient by the year 2021. The proposed River Heads Water Supply Concept as outlined in Section 5.4.4 uses the Ghost Hill No.2 Reservoir to provide storage for River Heads until such time that dedicated storage for River Heads is constructed.

A site with an elevation of 65m on Lot 34 RP852843 has been identified as a suitable site for a future reservoir site to service River Heads. It is ideally located between River Heads and Ghost Hill No.2 Reservoir, is currently unoccupied and offers some of the highest elevated land in the River Head Booral area.

The construction of this reservoir is outside the planning horizon of this report. However securing the site and gaining appropriate planning approvals is a priority.

RECOMMENDATION: Purchase Part Lot 34 RP852843 for the purposes of a future water supply reservoir and obtain the necessary rezoning over the site at an estimated cost of $600k.

5.4.7.7. Ann St Reservoir

A report prepared by Cardno (2012) outlined various options for the recommissioning of the ground level reservoir at Ann St. The existing reservoir is assessed as structurally sound but some cracking along the joints would lead to the reservoir leaking. As such it is recommended that the structure be coated with a water proof membrane (Cardno, 2012). Work is currently being undertaken to repair these leaks and will be completed by 2015.

The intention is that the reservoir be recommissioned and, in conjunction with a major upgrade to the Ann St Pump Station, will allow the separation of the CBD and Granville Zones from the Newtown Central Zone.

The budget cost of this work was estimated to be $300,000 based on the leak proofing.

RECOMMENDATION: Reinstate Ann St Reservoir and in 2015 at a cost of $300k.

5.4.8. Elevated Reservoirs

The DEWS (2014) guidelines for the sizing of service reservoirs, has been used to calculate the projected elevated storage requirements and is tabulated in Table 5-12.

Table 5-12: Storage requirements for Elevated Reservoirs by Projected Planning Horizon

Reservoir	***Type***	***Storage Volume (ML)***	***Storage Required (ML)***				
			2011	**2016**	**2021**	**2026**	**2031**
Howard	Elevated	0.68	0.30	0.32	0.33	0.34	0.35
Low Zone	Elevated	0.45	0.80	0.81	0.81	0.81	0.82
High Zone	Elevated	0.45	Refer to Total Maryborough West				
Show Grounds	Elevated	1					
Total Maryborough West		1.45	0.74	0.75	0.76	0.76	0.76
Ann St	Elevated	0.45	0.89	0.90	0.91	0.91	0.92
Tinana	Elevated	0.5	0.61	0.63	0.65	0.67	0.70
Tiaro	Elevated	0.1	0.25	0.25	0.25	0.26	0.26

The shaded cells indicate the elevated reservoirs that do not meet the DEWS (2014) guidelines for sizing elevated reservoirs. The Guideline includes allowances for firefighting and/or emergency storage. Provision of additional elevated storage to meet the DEWS guidelines is deemed uneconomical and an alternative option has been investigated.

The elevated reservoirs in Maryborough have been sized to store firefighting flows only and make no allowance for a domestic or emergency storage component. These reservoirs “float” on the system, meaning that pump stations pump directly into the reticulation system and the elevated reservoirs serve to ensure constant pressures and a limited amount of storage. If a pump failure occurs, the reservoirs will generally provide less than a peak hour’s flow.

To meet firefighting and domestic demands, it is proposed that the firefighting capacity be included in the ground level reservoirs in each zone. When fire flows are required the existing pumps will ramp up and pump directly into the system to meet the required firefighting demand.

To facilitate this it is required that the pump stations be made reliable by:

- providing backup power supply to each of the critical pump stations by way of a standby generator set as determined in Section 5.4.6.1 (where not already provided), and
- providing standby pumps in all stations.

5.5. Water Reticulation

The water supply networks have been assessed using WaterGems water network modelling software. Models were created using known information from WBWC's Geographical Information System (GIS), it telemetry system and other pressure and flow data that is continuously monitored in the field.

Hydraulic network models were developed for each 5 year increment from 2016 through to 2031 taking into account:

- Average Water demand of 630L/ED/day for Hervey Bay and 680L/ED/day for Maryborough and Tiaro.
- Population growth as defined in ED projections section of this document consistent with OESR published growth rates for the townships.
- Peaking factors and diurnal profiles as defined in the Peaking Factors section of this document.
- Existing network operating parameters (pump start/stop, reservoir levels etc.)
- No failure scenario of 3 consecutive days of maximum day demand (i.e. Average day x 1.6).
- An allowance of 15L/s for residential and 30L/s for commercial fire flow at peak hour demand at each hydrant located in the water network.
- Residual pressures of 20m for domestic flows and 12m for firefighting.
- Residual pressures minimised but not exceeding 80m.

Modelling was carried out for the ultimate development anticipated by the planning scheme and for intermediate time steps in five year intervals to 2031. Growth rates used in the underlying demand model are consistent with those outlined in Section 4.3 and development sequencing has been determined through discussions with Fraser Coast Regional Council and modelled accordingly.

Modelling was undertaken for both a domestic and firefighting scenario for each five year interval. Where a pressure was below the minimum standard during any five year time step, additional pipeline/s were provided to that area. Generally low pressures were a result of pipelines with either high velocities or high head losses. In some cases pipelines were not the primary cause for the reduced pressure and in these cases alternative solutions were proposed for achieving the required service level outcome e.g. installation of a pump station. Where a pump station failed to meet the required demand or a reservoir was depleted of water, additional pumping capacity or storage was provided.

Fire flow of 30L/s was used in commercial, industrial and high residential zones. All other hydrants were simulated using residential fire flows of 15L/s. The modelling identified a number of hydrants that do not meet the desired standards. They were generally located on small diameter mains, dead end mains or in courts, or at DMA boundaries where flow is only available to the hydrant from one direction.

Failure of a hydrant does not indicate that water is not available from the hydrant; it means that the hydrant does not achieve the full fire flow required by the DEWS (2014) guidelines. Provision has been made within the capital works program to upgrade these mains where practical and economical. It should be noted that there is no legal requirement for WBWC to provide water for firefighting purposes nor does WBWC guarantee that water will be available from a hydrant at all times.

The results of the modelling are qualified to the extent that the condition of the network has been considered to be reasonable. There is insufficient pressure and flow data available to reach any conclusions about the internal condition of the network, however fittings that have been removed and assessed from the system indicate that the unlined fillings are causing the majority of the flow restrictions with some fittings tuberculated to the extent that no void is visible through the fitting. The pipes have been shown to have reasonable internal condition and most are cement lined. The external condition of the mains appears to have the largest impact on the condition of the main. It is not possible to assume internal pipe roughness values will account for the variations throughout the network due to the random nature of the restrictions. As more data becomes available and the problem fittings are replaced, the level of confidence in the model will be able to be improved.

Three main areas of the reticulation require attention;

- Firefighting standards are not achievable in some areas of the system.
- DMA's are generally discrete isolated sections of reticulation. Since many of the interconnections between zones are isolated, there are issues with maintaining fire flows through these areas. In general a strategy of creating a minimum of two feeds into a DMA reduces or eliminates this problem.

Refer to Appendix 2 for infrastructure plans showing the extent and locations of the infrastructure proposed in this strategy plan in five yearly intervals.

Any upgrades required were tabulated and cost estimates based on the WBWC standard unit rates in Appendix 7 were used to prepare the forward Capital Works Program. The unit rates used were derived from the 2015 asset revaluation project, which was undertaken by independent valuers and audited as part of the annual Queensland Audit Office (QAO).

5.5.1. Demand Management Areas (DMA's)

5.5.1.1. Alternate feeds into DMA's

The adoption of the DMA's has resulted in substantial reduction of unaccounted water within the system. It has also resulted in a number of dead end mains with supply from only one direction. While it would appear consideration has been given to minimising the number of dead end mains within the boundaries of the water districts, the reality is that these dead end mains are difficult to avoid. They lead to poor water quality and in some cases may limit the ability of the reticulation system to meet the adopted standards of service with respect to residual pressure during peak demand periods and the provision of fire flows.

The majority of these issues can be resolved by using a secondary metered inlet main or modulated pressure reducing valves (PRV's) to overcome any water pressure/flow/quality problems. The PRV's at the secondary inlets need to be set significantly lower than the main feed into the DMA otherwise there is the possibility that the PRV's will work against one another which can lead to erratic pressures and can cause premature failure of the PRV's. In practice it is prudent to exercise these PRV's so that they don't seize, therefore it was decided that these secondary feeds should operate during peak hour flows.

Existing PRV's operate under a range of controls which are designed to maintain required levels of service at the critical pressure point (CPP) within each DMA. Rather than monitoring pressures at remote CPP's and using telemetry to control the PRV's, PRV controls have been linked to downstream pressures close to the PRV for which a relationship has been developed with pressures experienced in the field at the CPP.

Providing a second feed into these DMA will improve water quality, firefighting capacity and will provide an automated security of supply.

Hervey Bay has a number of DMA's which could be combined to make a single DMA. Typically those DMA's on similar elevation could be combined to reduce the number of dead ends and improve flows and water quality.

RECOMMENDATION: Carry out project scoping to provide secondary feeds or combining DMA's at $20k in 2019.

5.5.1.2. Creation/Modification of DMA Boundaries

It is proposed that several DMA's be modified or created under this strategy. These include;

- Maryborough Network - Creation of the Bell Hilltop DMA/Zone at a cost of $25k in 2017 requiring the installation of a boundary valve and altitude valve controls. This DMA will be serviced by the existing High Zone Elevated Reservoir and will allow it to be better utilised.
- Maryborough Network - Creation of Ann St Zone at a cost of $60k starting in 2018. Note that this is specifically for the installation of 3 boundary valves at Lennox St, Cheapside and Ferry St. The installation of this DMA will allow water to be transferred from Two Mile directly to the Ann St facility without the need to pass through Boys Ave Reservoirs and the Low Zone DMA.
- Maryborough Network - Proposed modification to the boundary between CBD DMA and High Zone DMA at no cost in 2016. This modification is for the realignment of the boundary to incorporate a small residential pocket into the High Zone. Currently is it serviced from the Low Zone and suffers from inadequate pressures and fire flows.

Further details of these DMA modifications are provided in Appendix 5.

RECOMMENDATION: Create zone for Bell Hilltop DMA in 2017 at a cost of $25k.

RECOMMENDATION: Create zone boundary between CBD DMA and Low Zone DMA to create the Ann St Zone DMA in 2018 at a cost of $60k.

RECOMMENDATION: Modify DMA boundary between CBD DMA and High Zone DMA at no cost in 2016.

5.5.1.3. MB - Granville Security of Supply

The current demand in Granville is approximately 1,300ED. This will rise to 1,700ED by 2031 and potentially 3,400ED if the Marina Precinct is completed. Granville is isolated from the remainder of the Maryborough network by the Mary River. Granville is supplied by a single DN450 water main crossing the Mary River at the Granville Bridge (Tiger St/Odessa St). While the main across the river is located on the downstream side of the bridge, if flooded, the AC may be struck by floating debris. There have been previous proposals to replace this section of pipe with a more robust material such as steel.

There are no reservoirs in the Granville area. A 50kL elevated reservoir was decommissioned in 2010 because it was in poor condition. This elevated storage was well under the capacity required for the area that it serviced.

Several options were investigated to improve the security of supply to Granville including onsite storage reservoirs and alternative supply mains. The installation of reservoirs is not deemed feasible at a cost of $2m ($4m if an elevated tank is also provided).

An alternate supply main to Granville crossing the Mary River had previously been considered by Maryborough City Council and is a more economical option. The alternative feed across the Mary River would also provide security of supply should the DN450 feed be inoperable. The alternative feed should be a minimum of DN300 the sizing being dependent upon the future growth and development in Granville. It does, however, require that a main be installed along Kent St from Ajax St to Tiger St.

The estimated costs are presented in the table below;

Table 5-13: Granville DMA Water Supply Infrastructure – Option A2 – New Water Supply Main

Item	Description	Size DN (mm)	Unit Rate ($/m)	Length (m)	Year Proposed	Capital Cost ($000's)
1	DN300 bored main under Mary River Ajax St	DN300	3572	300	2029	1,080
2	DN300 Kent St from Tiger St to Ajax St	DN300	317	1360	2030	304
	Total					**1,384**

* includes a compensation factor of 1.15 for poor soil (High WT) in urban areas

RECOMMENDATION: Provide security of supply to Granville in 2030 at a cost of $1.4m.

5.5.2. Fire Capability Assessment

The sizing of reticulation mains is comprised of a domestic consumption component and a fire flow component. In pipelines serving less than 2,000ED the majority of the pipeline capacity is used for fire flows. It can be seen that the fire flow component will be the determining factor in sizing and hence the cost of a pipeline for many areas, particularly in smaller residential areas.

Firefighting availability is not required under the Water Supply Act nor is required under the WSAA code. WSAA (2011) stipulates:

"Unless otherwise required by a Water Agency's operating licence, the water supply system shall not be designed for a specific fire fight capability." – CL3.1.5

In contrast the CL6.3 of the "Planning Guidelines for Water Supply and Sewerage" published by DEWS (2014) indicates that;

> *While there are no legislative requirements for a water service provider in Queensland to provide a water supply for firefighting purposes, water service providers typically provide fire hydrants in road reserves for this purpose. These fire hydrants are maintained at standards set by the provider*.

This document also specifies the minimum firefighting provisions for water service provider networks (DEWS, 2014, CL6.6.2). These provisions are outlined in Table 5-14.

Table 5-14: DEWS (2014) Planning Guidelines for Water Supply and Sewerage Fire Flow Provisions

Zoning	Min Flow	Min Residual Pressure
Residential (low - med Density)	15L/s for 2hr duration	12m residual
Commercial and Industrial and High density residential	30L/s for 4hr duration	12m residual
Small Communities (less than 500 people)	7.5L/s for residential 15L/s for commercial	12m residual

WBWC adopts the DEWS (2014) guidelines for the design of water mains.

There are many areas in the water supply network that are remote and supplied by small mains with insufficient capacity to provide the required fire flows stipulated in the guidelines. In some cases the elevation of the terrain is a major contributing factor in the reduced ability to meet these firefighting requirements.

The cost of upgrading these mains to meet fire flow requirements is prohibitive. Therefore a reduction in the firefighting criteria is to be investigated for areas where normal fire flows cannot be achieved. The DEWS (2014) guidelines indicate that lower fire flow requirements can be used for rural areas if agreed with fire service.

DEWS (2014) suggests that firefighting provision should be agreed through a service level agreement, between the water utility and the local fire department.

RECOMMENDATION: An investigation is proposed into the viability of achieving lower criteria for fire flows in water supply areas through agreement with the fire service at $5k in 2016.

5.5.1. Replacement of Pipelines/Fittings

Normal maintenance and asset replacement is not part of this strategy, but the replacement program for Maryborough's cast iron pipes is included for completeness.

The program to replace pipes in Maryborough has approximately three years remaining (2016 through to 2019) at a cost of $7m. These costs form part of the 20 year capital expenditure program identified in this strategy.

It is expected that pipeline replacement will continue indefinitely as part of the ongoing asset lifecycle and such replacements are generally addressed through Asset Management Plans.

Further details on the current Maryborough pipeline replacement program can be found in Appendix 5.

RECOMMENDATION: The identified pipeline replacements for condition be undertaken over 2016-2020 at a cost of approximately $7m.

5.6. Water Quality

Chlorine is the most commonly used disinfectant in municipal water supplies. The primary purpose of chlorination as a disinfectant is for the deactivation of pathogens and bacteria in drinking water supplies.

Compared to other disinfection techniques, chlorination is relatively inexpensive and provides a chlorine residual in the network which is used to prevent recontamination of the water supply prior to reaching customers (EPA, 2011).

WBWC currently uses chlorination as its primary disinfectant at its WTP's. Disinfection usually occurs after the water treatment process and prior to storage in the clear water reservoirs. Typical dosing rates are 2mg/L to 3.5mg/L. With the exception of Tiaro, chlorine booster sites throughout the network are used to boost and maintain consistent residual chlorine levels throughout the water supply networks.

This section reports on the findings of the investigation into the effectiveness of the current disinfection regime where the hydraulic network model was used to simulate the current and proposed disinfection regime to determine the chlorine residuals in the networks to optimise chlorine dosing in Hervey Bay, Maryborough and Tiaro.

This section will also discuss options for the treatment of other water quality issues in the Fraser Coast water supply.

5.6.1. Water Quality Standards

The World Health Organisation (WHO) recommends that a minimum of 0.5mg/L residual chlorine (leaving the treatment plant) with a minimum 30 minute contact time be maintained through the distribution system prior to reaching customers. The Australian Drinking Water Guidelines (ADWG) prefers that levels of between 0.2-0.5mg/L of free chlorine be maintained through the distribution system.

ADWG indicates that provision of disinfection residuals throughout the distribution system assists in protection against contamination and limits biofilm growth but identifies that the production of disinfection by-products must be considered also.

ADWG indicate that THM levels should not exceed 0.25mg/L based on the health concerns associated with this disinfection by-product. The guidelines warn that reducing THM's is encouraged but must not compromise disinfection, as non-disinfected water potentially poses much greater and widespread health risks than THM's.

ADWG recommends a maximum limit for iron at 0.3mg/L for aesthetic reasons. They do not provide a health related limit for iron.

Manganese concentration is limited to 0.5mg/L for health reasons. For aesthetic reasons a manganese concentration limit of 0.1mg/L is recommended.

5.6.2. Disinfection by products

Chlorination, through reaction between free chlorine and organic matter, produces undesirable disinfection by-products (DBP's).

To date the major organochlorine by-products of concern have been four halogenated compounds, known collectively as the Trihalomethane's (THMs):

- bromoform (tribromomethane);
- dibromochloromethane;
- bromodichloromethane; and
- chloroform (trichloromethane).

The concentration of THM compounds produced by chlorination are a function of pH, temperature, free chlorine concentration, contact time, concentration and nature of oxidisable organic material in the water. In many situations where chlorine is used in distribution (rather than chloramination), the majority of THMs are formed in the distribution system (EPA, 2011).

Reducing THM's can be undertaken at the source by the reduction of organics in the source water. International trends show an increasingly stringent guideline level for THM's. The European Union generally allows a maximum of 0.1mg/L as does Canada, while in Norway it is 0.050mg/L. A similar trend could follow in Australia where the maximum acceptable THM levels are currently 0.25mg/L (ADWG, 2011). Where stringent guideline values are in place, there is a trend for water utilities to treat raw water to reduce DOC. A reduction in DOC will reduce chlorine demand in the water supply network.

Granulated activated carbon (GAC), nanofiltration, MIEX or ozone/BAC (DEWS, 2014) can be used for reducing or removing organics in raw water (DOC) however these measures are costly compared to minimising the formation of THM's through operational techniques such as reducing the amount of free chlorine in the system or reducing water detention times. Aeration has been proven to remove volatile THM's from the distribution system. The removal of formed THM's through aeration at reservoirs may provide a more economical solution to the removal of THM's.

5.6.3. Current Disinfection Strategy

5.6.3.1. Source Chlorination

WBWC currently chlorinates water to Hervey Bay at the Burgowan WTP prior to the clear water reservoir. Typically the dosing rates are between 2-3mg/L free chlorine.

Water supply to Maryborough is chlorinated at the Teddington WTP prior to the clear water reservoir. Typically the dosing rates at this plant are between 2-3.5mg/L free chlorine.

Tiaro water supply is chlorinated at the Tiaro WTP prior to the clear water reservoir.

The Teddington WTP also uses chlorine to oxidise iron and manganese prior to filtration which also increases the THM formation potential.

5.6.3.2. Booster Chlorination Sites

Chlorine boosters are used in the Hervey Bay and Maryborough water supply systems to boost and maintain levels of residual chlorine in the network. These are used so that residual chlorine levels can be consistently achieved across the network.

The locations of the chlorine booster sites are presented in Table 5-15.

Table 5-15: Fraser Coast Chlorine Booster Sites

Township	Site	Type	Average D/S Dosing Level Summer 2015	Average D/S Dosing Level Winter 2015
Hervey Bay	Belmont Park Re-chlorination Station	Flow paced	2	3
Hervey Bay	Booral Pump Station	Flow paced	3	2.5
Hervey Bay	Dundowran Pump Station	Flow paced	2.5	2.5
Hervey Bay	Howard ET	Flow paced	Data not available	3.5
Hervey Bay	Toogoom Bush Pump Station	Flow paced	Data not available	Data not available
Hervey Bay	Urraween Reservoir Site	Flow paced	2.4	2.5
Maryborough	High Zone PS	Set point	3	2
Maryborough	Low Zone PS	Set point	2.5	2
Maryborough	Showgrounds ET	Set point	1.6	1.5
Maryborough	Tinana Pump Station	Set point	2	1.5

One of the issues raised by operators of the flow based systems is that the analysers are unable to respond during low flow periods (e.g. overnight). This can lead to over or under dosing.

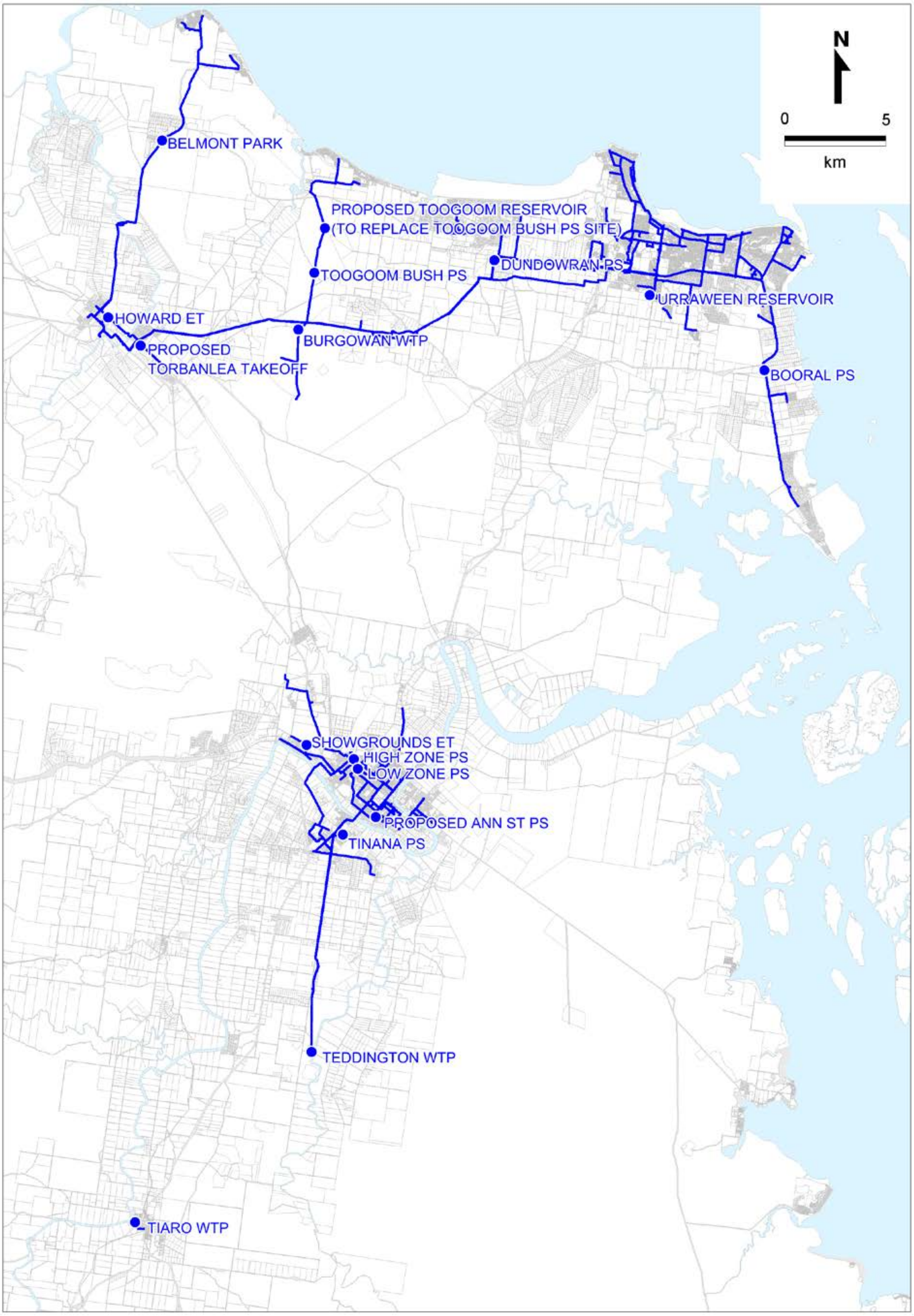


Figure 5-14: Location of Chlorine Dosing Sites

5.6.3.3. Monitoring Sites

Permanent chlorine monitoring sites have been established around the Fraser Coast water supply systems. Most of these monitoring sites serve primarily as a feedback loop for controlling the dosing equipment at their related chlorine booster site. These sites presented in Table 5-16 are all connected to the SCADA system and offer continuous monitoring of chlorine levels in the water supply systems.

Table 5-16: Fraser Coast Chlorine Monitoring Sites

Township	Site	Purpose	Typical Cl_2 Readings Summer 2015 (mg/L)	Typical Cl_2 Readings Winter 2015 (mg/L)
Hervey Bay	Booral Pump Station	Control of dosing at Booral Pump Station	2-3	1-2.5
Hervey Bay	Burrum Heads Standpipe Site	Monitoring	2	
Hervey Bay	Dundowran Pump Station	Control of dosing at Dundowran Pump Station	1.2	1-2.5
Hervey Bay	Tooth St	Monitoring	0.9	0.7
Hervey Bay	Takura Reservoir Facility	Monitoring	0.5-2.5	0.7-2.1
Hervey Bay	Toogoom Heights Reservoir	Control of dosing at Toogoom Pump Station	0.11	2-3.5
Hervey Bay	Inlet Urraween Reservoir Site	Monitoring	1.25	0.7-2
Hervey Bay	Outlet Urraween Reservoir Site	Control of dosing at Urraween Reservoir Site	2.4	2.5
Hervey Bay	Hervey Bay SPS02	Monitoring	0.16	No Data Available
Hervey Bay	Hervey Bay SPS05	Monitoring	0.9	1.7
Hervey Bay	Hervey Bay SPS09	Monitoring	1.2	2
Hervey Bay	Hervey Bay SPS61	Monitoring	No Data Available	1
Maryborough	Showgrounds ET	Control of dosing at Showgrounds ET	1.6	1.5
Maryborough	Tinana ET	Control of dosing at Tinana Pump Station	2	1.3-1.5
Maryborough	High Zone PS	Control of dosing at High Zone	0-3	0.5-2
Maryborough	Low Zone PS	Control of dosing at Low Zone	1.5-2.5	1.8-2.3
Maryborough	Boys Ave Res 1	Monitoring	1-1.2	1.1
Maryborough	Boys Ave Res 2	Monitoring	1.2	1.3

In addition to these continuously monitored sites, WBWC has a comprehensive monitoring program which involves chlorine residual monitoring throughout the water reticulation networks. Analysis at these sites is carried out manually with the use of a digital colorimeter. While the chlorine residuals are recorded, they are an instantaneous snapshot of the chlorine levels. Monitoring of sample sites are undertaken on a weekly interval.

RECOMMENDATION: Continuous sampling of chlorine levels should be installed at extremities of the Maryborough system and connect to SCADA. Allow for 6 sites @ $10k each.

5.6.3.4. Current Chlorination Philosophy

Currently WBWC endeavours to maintain 0.3mg/L of free chlorine at all parts of its distribution system. This philosophy has the impact of increasing chlorine levels at other points in the system to achieve the 0.3mg/L residual in the outer extremities.

A compromised approach might be to lower the chlorine levels and implement a flushing regime in the problematic areas.

Illustrative Case Study 1 – Existing Operation – Urraween Chlorine Booster

Figure 5-15: Case Study Locality Plan

During summer periods Burgowan WTP maintains up to 3mg/L leaving the plant, although this varies greatly depending on operator discretion. The chlorine is boosted at Urraween and a residual is monitored at various sites at the extremities of the reticulation system. One such monitoring site is at the intersection of Guard St and the Esplanade in Urangan. The following graph demonstrates the chlorine levels at these locations of a typical 3 day period. It can be seen that the residual chlorine levels at the intersection of Guard St and the Esplanade are maintained above 1mg/L under current chlorinating regime.

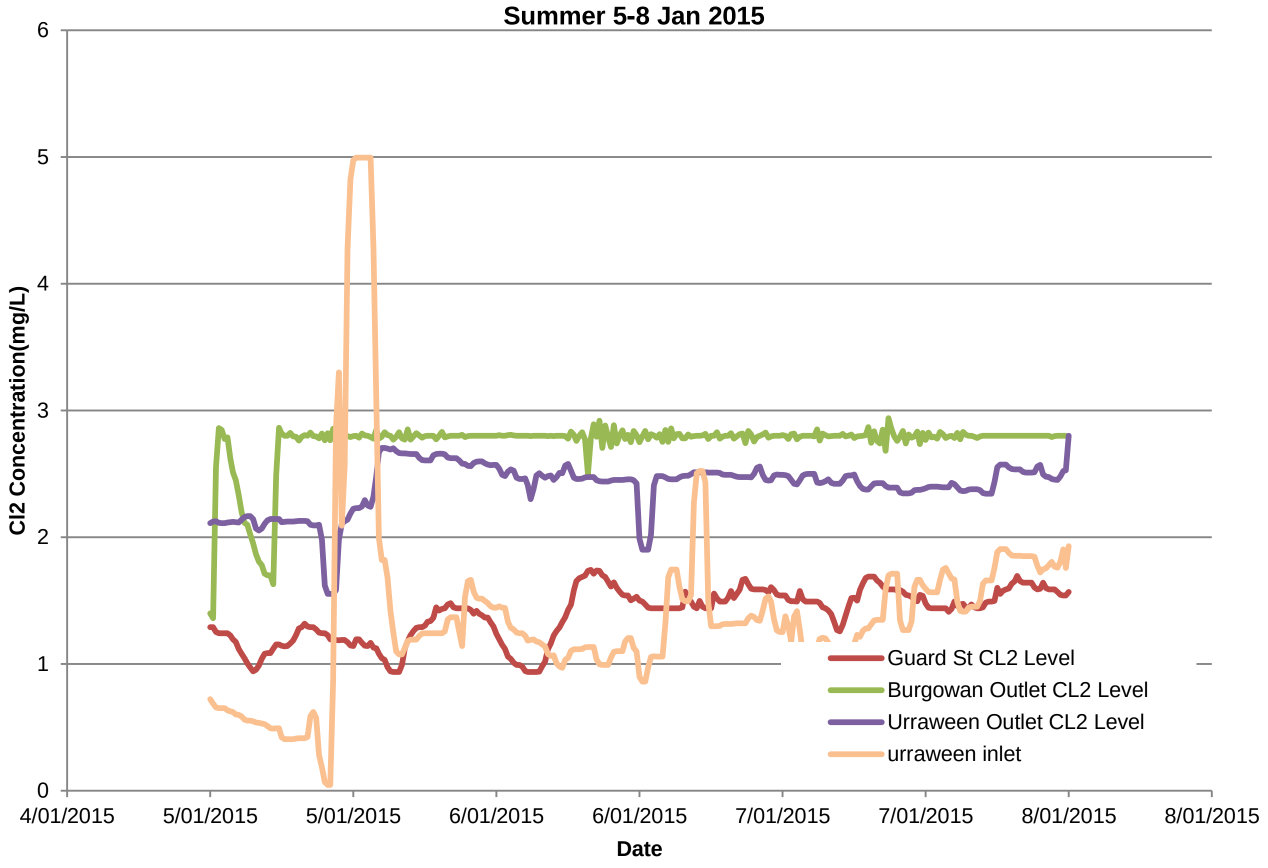


Figure 5-16: Case Study Chlorine Levels Summer Period

For the same scenario during the winter period the typical chlorine levels are as follows Burgowan was dosed slightly less at approximately 2.5mg/L, which is maintained by boosting at Urraween, and showing the levels at Guard St rarely falling below 2mg/L.

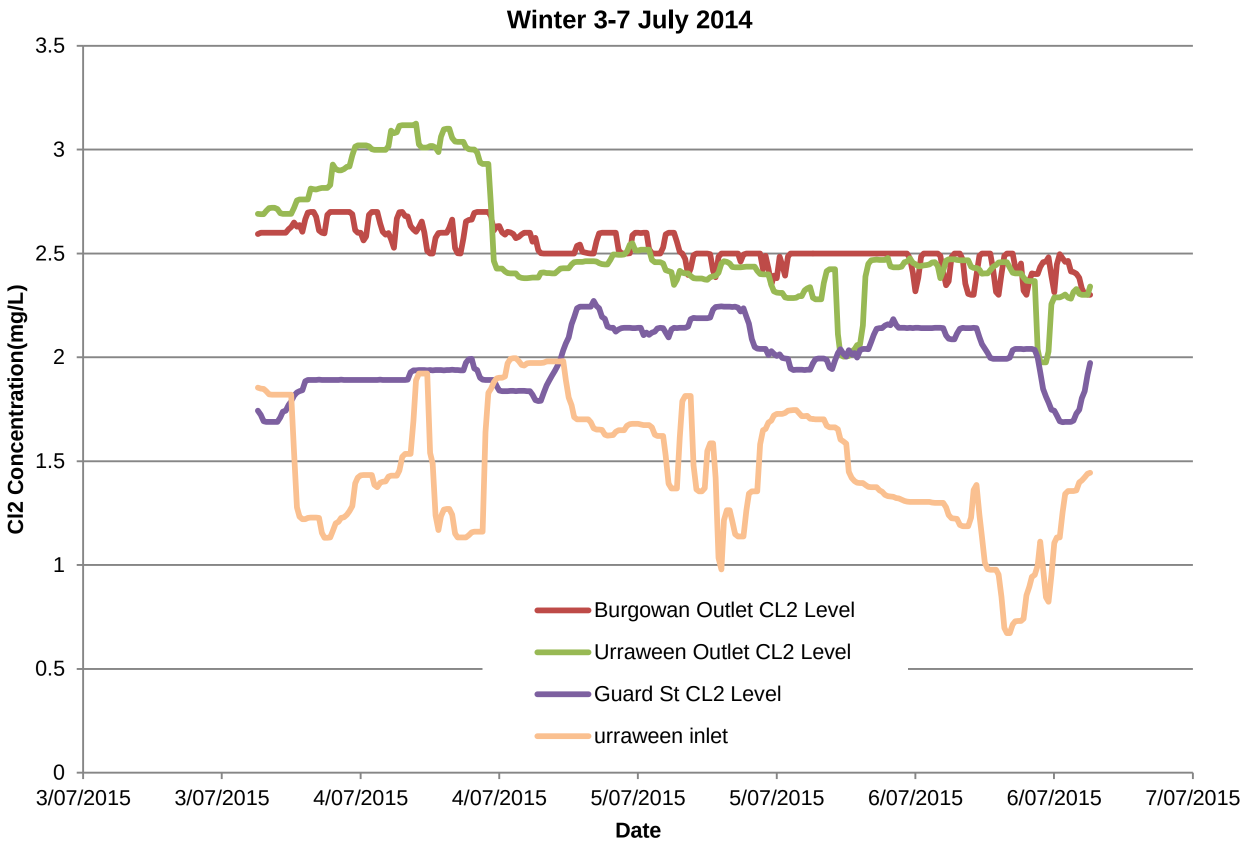


Figure 5-17: Case Study Chlorine Levels Winter Period

Clearly the residuals being achieved are higher than they need to be in this location, particularly in the winter period.

As discussed earlier, the ADWG recommend chlorine residuals of between 0.2mg/L and 0.5mg/L after completion of water treatment. Although not specifically required; if we endeavour to maintain a residual chlorine level of 0.3mg/L in the Urangan system then presumably the chlorine level from Urraween could be reduced to approximately 1.5mg/L instead of the 2.5mg/L it is maintaining.

There are 3 other SCADA monitoring sites; Zephyr St in Scarness, Esplanade at the tip of Point Vernon and Tooth St on the primary feed into Point Vernon. While Zephyr and Tooth St display similar chlorine readings to Urangan, it is understood that Point Vernon (which already shows readings around 0.05mg/L) would suffer if this is were to occur and may even have no residual chlorine. Increasing the entire system's chlorine level and promoting the formation of THM's for this one part of the system is not viable solution. The installation of another booster might provide an acceptable solution whilst minimising the chlorine levels across the town as a whole.

Modelling of the chlorine residuals in the system can confirm that reducing the set points will still achieve adequate residuals across the vast majority of the system. The primary areas of concern are at Boral and Point Vernon.

It is observed that the chlorine decay is higher in the summer to the winter period. This is likely to be a result of higher temperatures and higher biological activity.

5.6.4. Water Quality Model

5.6.4.1. Hydraulic Model Verification and Calibration

A reliable water quality model relies on a calibrated hydraulic model. WBWC uses Bentley Water Gems for modelling hydraulic and water quality aspects of the water supply networks.

The hydraulic water network models for Hervey Bay and Maryborough were calibrated against known flow rates and pressure data. It is imperative that the hydraulic model represents the water network accurately to ensure reliable water quality modelling.

After the models were hydraulically calibrated they could be used as the basis for water age and chlorine modelling. Refer to Appendix 6A for calibration results.

Some anomalies occurred in hydraulic calibration and are included below for reference;

- The calibration of the Boys Avenue Reservoirs did not achieve the rapid measured drops in reservoir levels that were measured on the calibration day. Attempts were made to reduce the flow from Two Mile to Boys Ave, however this was insufficient to replicate exactly what occurs in the field.
- Poor data was obtained from the Granville bulk flow meter. It is suspected that the meter was faulty. Data was used from previous periods to enable calibration.
- Guard St chlorine levels in excess of 2mg/L were not able to be simulated in the chlorine model despite reducing wall and bulk coefficients to near zero.

5.6.4.2. Water Quality Model Development and Calibration

Before the water quality model calibration could commence previously used chlorine decay rates were reviewed and additional testing was carried out in the field and in the laboratory. The samples were collected and analysed in June 2015 so the decay rates may not be representative of all times of the year.

Water Gems – Derivation of Chlorine Decay Coefficients

Montgomery Watson undertook a Water Quality Strategy for Hervey Bay in 1999 from an engagement date of 22 March 1999 to the completion of the report in October 1999. It is reasonable to assume that the water quality testing undertaken by Montgomery Watson (1999) would have occurred around the same time of year as the water quality testing in this study, therefore the results obtained for wall and bulk coefficients should be comparable.

While the report includes figures for bulk and wall coefficients there were no figures able to be sourced for Maryborough. Therefore experimentation in accordance with Appendix 6C was undertaken. The aim was to compare the results of experimentation with the previously used figures in the Montgomery Watson (1999) report to verify their validity and to obtain data for the Maryborough system.

Bulk Water Coefficient

The bulk water coefficient describes the decay of chlorine by the reaction of chlorine with the water itself.

The bulk water coefficient was derived through laboratory analysis (refer to Appendix 6C for full methodology). When using raw water samples, the experiments showed that there were faster rates of reaction at the start of the experiment and a slower rate of reaction as the chlorine contact time increased. This is attributable to a larger concentration of chlorine and organics at the start of the experiment. Post chlorination samples were also taken where the initial high rate of decay was not as prevalent and accordingly the rate of decay was found to be less.

Because first order modelling of bulk water assumed the same rate of decay throughout the system and is independent of the amount of organics in the system, the post chlorinated samples were deemed to better represent the actual field situation for decay for the transmission system. The analysis concluded that bulk water coefficients of 0.869day^{-1} and 0.808day^{-1} for Maryborough and Hervey Bay respectively adequately represented the chlorine decay rate in the transmission system.

Montgomery Watson (1999) performed a similar experiment on the Hervey Bay water supply and concluded bulk coefficients of between 1.008day^{-1} and 1.354day^{-1} once factored up to the correct units. When these figures are compared to the results obtained in this study they differ somewhat. This difference might be explained because more organics are removed from the source water through ozonation at the Burgowan WTP when compared with the older Howard WTP which would have been predominantly used when the Montgomery Watson report was prepared.

Upon identifying that the reaction rate in the bulk water reduced the longer the contact time a further analysis was carried out using water in the reticulation system to determine the bulk water decay which would be apparent in the reticulation pipework. Since the reticulation pipework makes up a large proportion of the water network, it was deemed appropriate that a separate bulk decay rate be assigned to the reticulation system.

The analysis yielded vastly different decay rates, as expected, and was used for modelling the reticulation system. The analysis concluded a bulk decay coefficient of 0.14day^{-1} for the reticulation system.

The adopted bulk coefficients are presented in Table 5-17.

Table 5-17: Adopted Bulk Coefficients

	3/6/15	**29/6/15**	**Montgomery Watson (1999) for Comparison**
Location	**k_b (day^{-1})**	**k_b (day^{-1})**	
Teddington WTP	0.869	-	n/a
Burgowan WTP	0.808	-	1.008 – 1.354
Reticulation	-	0.14	n/a

Wall Coefficient

The wall coefficients were also determined by experimentation. The wall coefficients represent the decay of chlorine as a result of reactions between chlorine and the biofilm clinging to pipe walls. Where flowrates are small the biomass is expected to be larger and hence the same can be expected of chlorine decay in these pipes.

Locations were chosen around Hervey Bay and Maryborough of varying sizes and material types. The experiment methodology and results are attached in Appendix 6C. The results are summarised in Table 5-18 below and are categorised on an area basis.

These figures compare reasonably well in most areas to the Montgomery Watson (1999) water quality report figures. The report by Montgomery Watson (1999) attributed changes to wall coefficients being dependant on location.

Table 5-18: Adopted Wall Coefficients

	June 2015	Montgomery Watson (1999) figures for comparison
Location	**K_w (m/day)**	**K_w (m/day)**
Hervey Bay	0.1596 - 0.4501	0.168
Lower Mountain Rd	1.1632	1.2 (Urraween)
River Heads	0.0447	2.016
Toogoom	0.0001	1.92
Point Vernon	0.2886	0.24
Maryborough	0.0248 - 0.1016	n/a
Tinana	0.21	n/a

While some areas correlate well and show little change from the previous study, Toogoom and River Heads show a significant difference. It is interesting to note that the majority of the pipes in Toogoom have been installed or were replaced after 1999 with materials such as PVC which is known to have smoother walls and less adherence of biofilms. River Heads has a small amount of new pipework installed after 1999, but most of the pipework in this area was built in the 1990's. Here it is more likely that a large increase in demand as lots have become occupied with houses coupled with small pipe diameters as the most likely reason for the significantly lower wall coefficients obtained in this study.

Calibration of the Water Quality Model

The Water Quality model for Hervey Bay was calibrated against existing known chlorine data for the calibration date on the 24th March 2015. In the calibration model all booster chlorinators were set to replicate the recorded doses during that day.

The 27th of April represented the best data set for Maryborough and also coincided with the average day demand. A similar methodology was used to calibrate the Maryborough Model.

All available water quality and hydraulic trend data was assessed for adequacy and the models were calibrated to best fit these measured readings. The calibration charts comparing the measured and the modelled results of calibration are included in Appendix 6B.

During the course of the study it was determined that the periods of high demand provides the highest chlorine usage. This might be explained through higher water temperature and increased biological activity. None the less the data collected and analysed was during average usage periods and therefore it can be assumed that the findings in this report are valid for average day demands.

Some follow up study is recommended to determine the operational and set point targets for the summer period when the temperatures are higher. This would require similar bulk and wall coefficients to be determined.

RECOMMENDATION: Water Quality Modelling parameters be established for the higher demand periods of the year.

5.6.5. Water Quality Improvement Strategy

5.6.5.1. Water Age Analysis

Water Age Analysis was undertaken in the first instance to gain an understanding of where water quality might be an issue in the water supply system. Dead ends produced the highest modelled water age areas. Other areas with high detention times such as large diameter mains or reservoirs also increased water age substantially. Water age can also indicate of the amount of chlorine consumption in a system and will identify areas within networks where lower levels of chlorine might be expected.

Figure 5-18, Figure 5-19 and Figure 5-20 show the water age analysis for the Hervey Bay System.

As expected the oldest water age occurs at the extremities of the network and where there are reservoirs to increase the detention times in the system. Toogoom has relatively low water age despite having a reservoir. This can be explained because the Toogoom reservoir is undersized for the area it services and therefore the detention time in the reservoir is low.

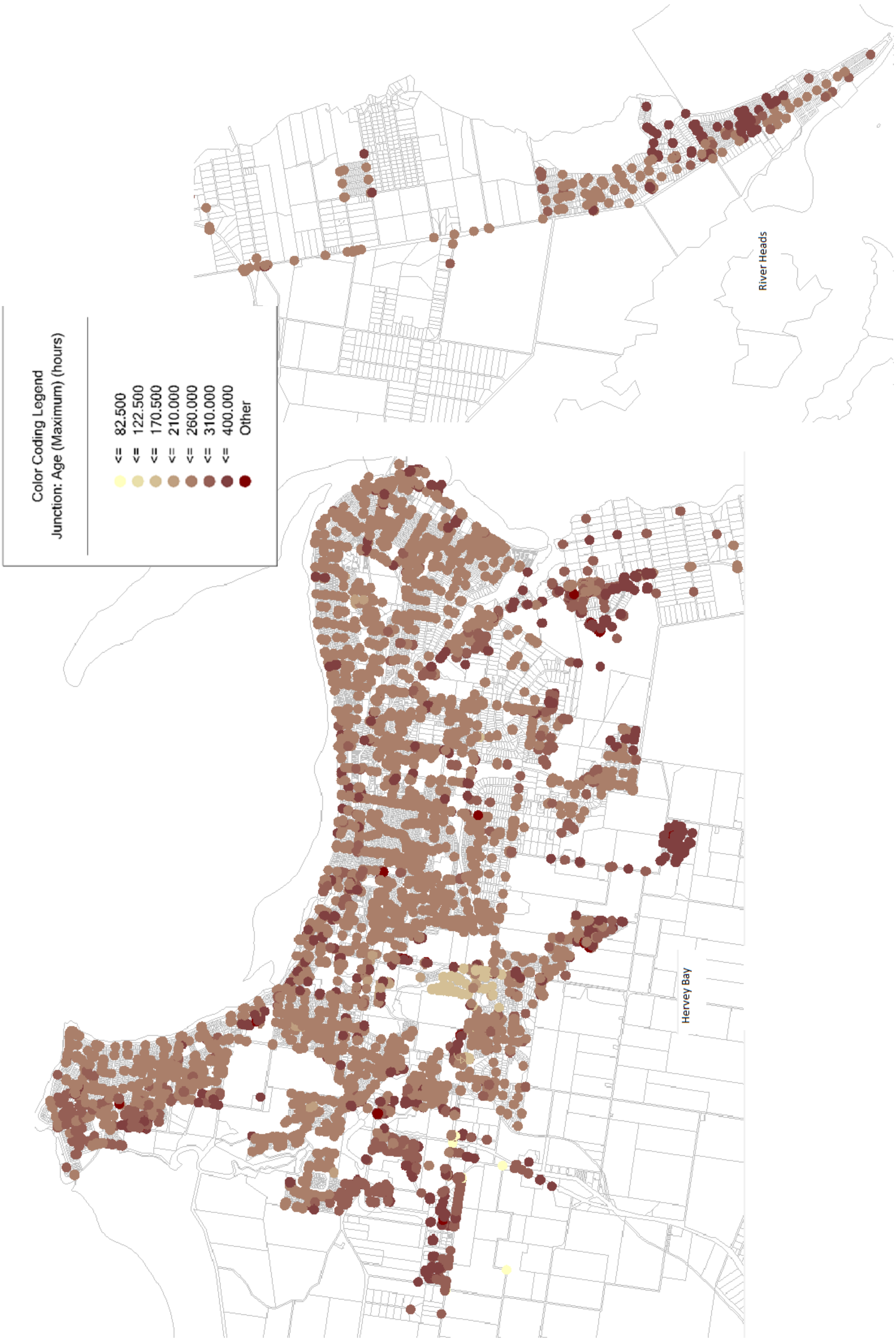


Figure 5-18: Hervey Bay and River Heads Water Age

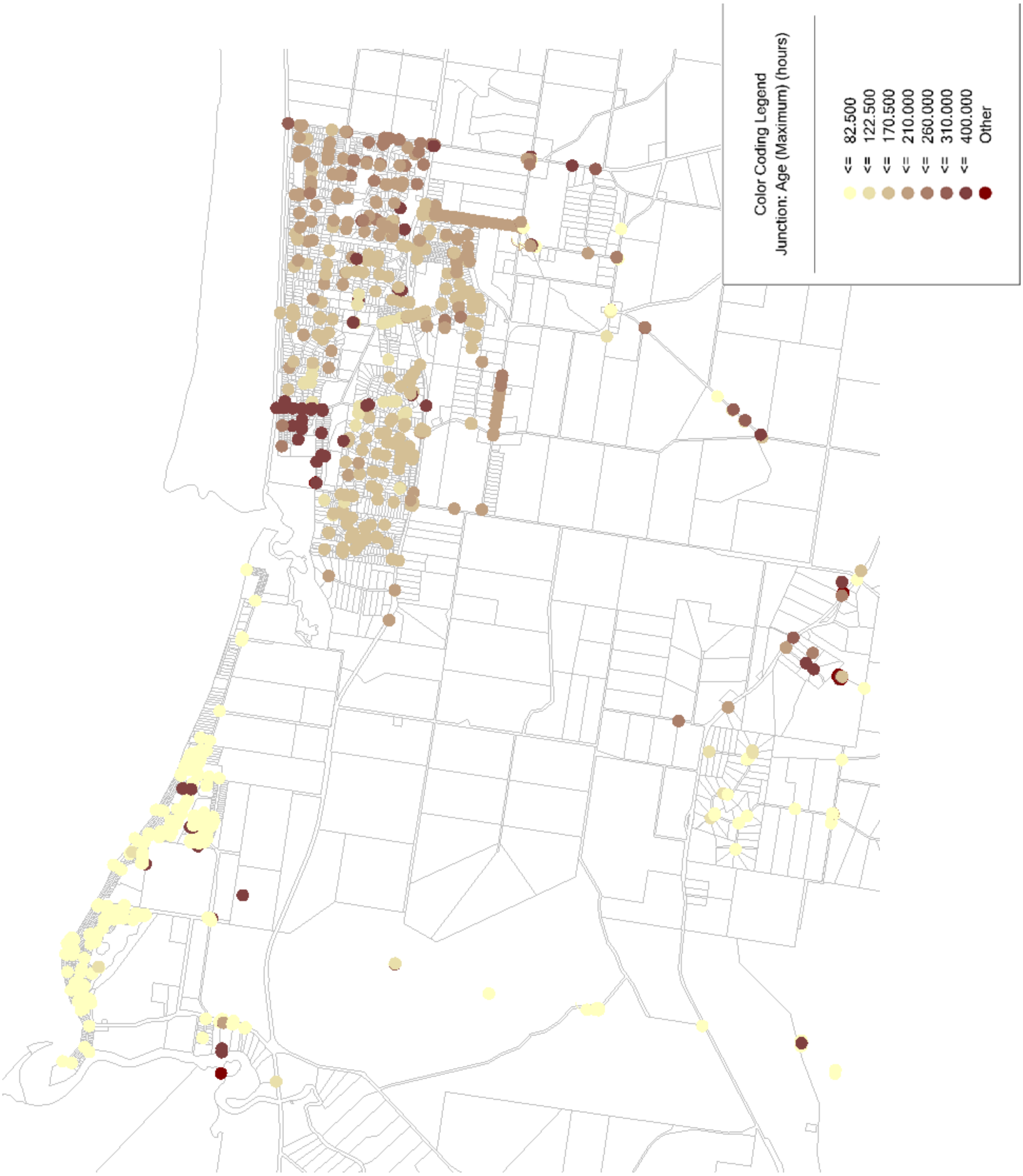


Figure 5-19: Toogoom and Dundowran Water Age

Figure 5-20: Burrum Heads, Howard and Torbanlea Water Age

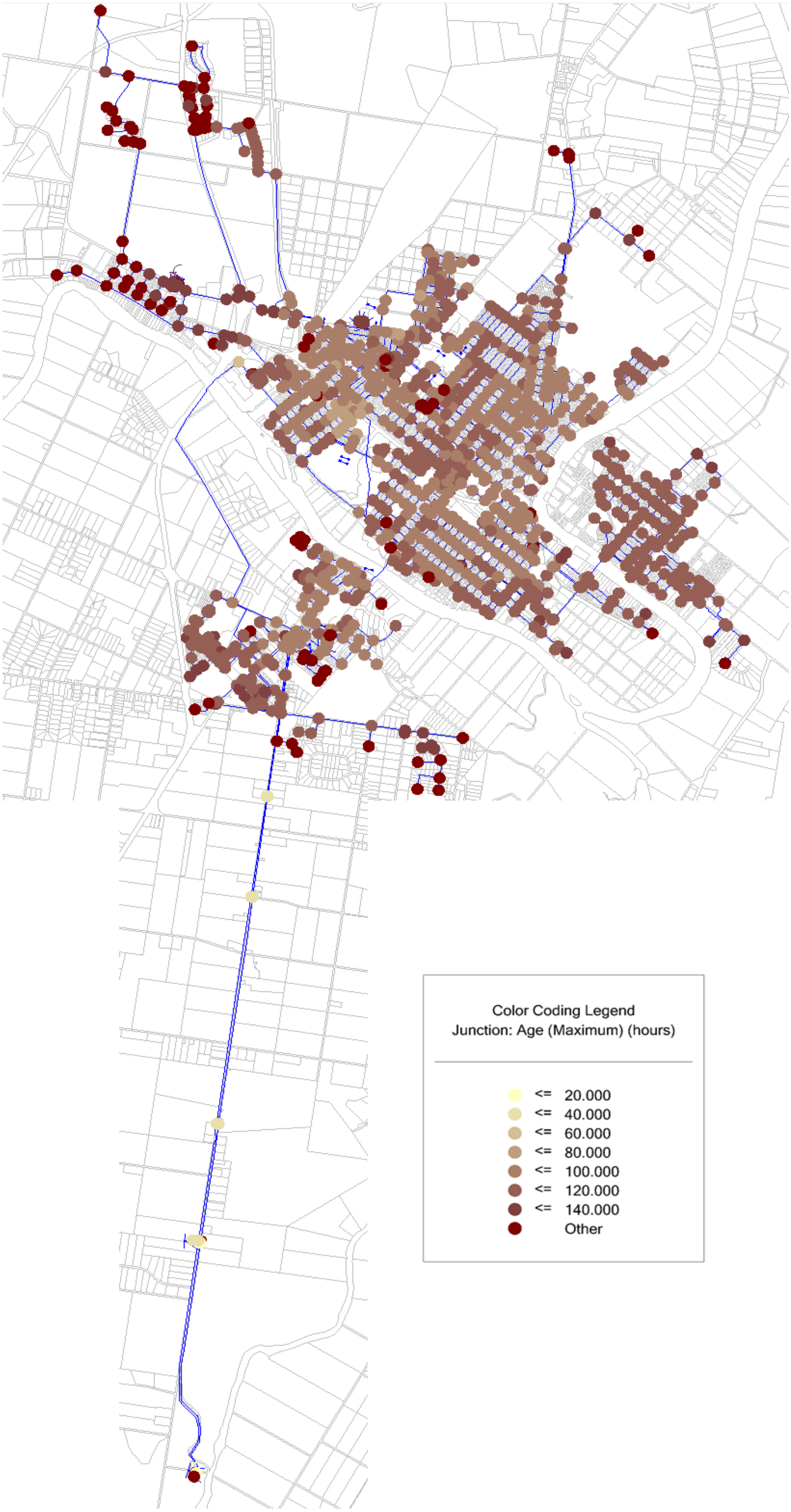


Figure 5-21: Maryborough Water Age

The water age analysis in Maryborough shows that the oldest water age can be expected at the extremities of the system. Of particular note is the western most part of Maryborough and the South eastern part of Tinana. Both of these locations are at the extremity of the system. Overall, the system averages a water age of between 80 and 100 hours during an average day. This can be partially explained by the fact that Maryborough has a large volume of reservoir storage which contributes to water age. Maryborough also has relatively large pipe sizes for the demand required. Water travels more slowly through these pipes and increases the water age.

It can also be seen that there is increased water age along the boundaries between zones. This is because dead ends were formed when the boundaries were created.

5.6.5.2. Proposed System Chlorination Strategy

Modelled Chlorine Levels

The Hervey Bay modelled chlorine levels are included in Figure 5-22, Figure 5-23 and Figure 5-24. They show the modelled chlorine residual levels at current dosing regime for an average day.

Some areas of concern include;

- High residual chlorine levels around Urangan, Scarness, Torquay, Toogoom and Howard.
- Low chlorine residual levels in Torbanlea and Point Vernon, Eli Waters and parts of Dundowran, Burrum Heads and River Heads.

The areas of high residual chlorine levels generally coincide with the locations of the chlorine boosters. The areas of low residual chlorine levels generally coincide with the extremities of the system.

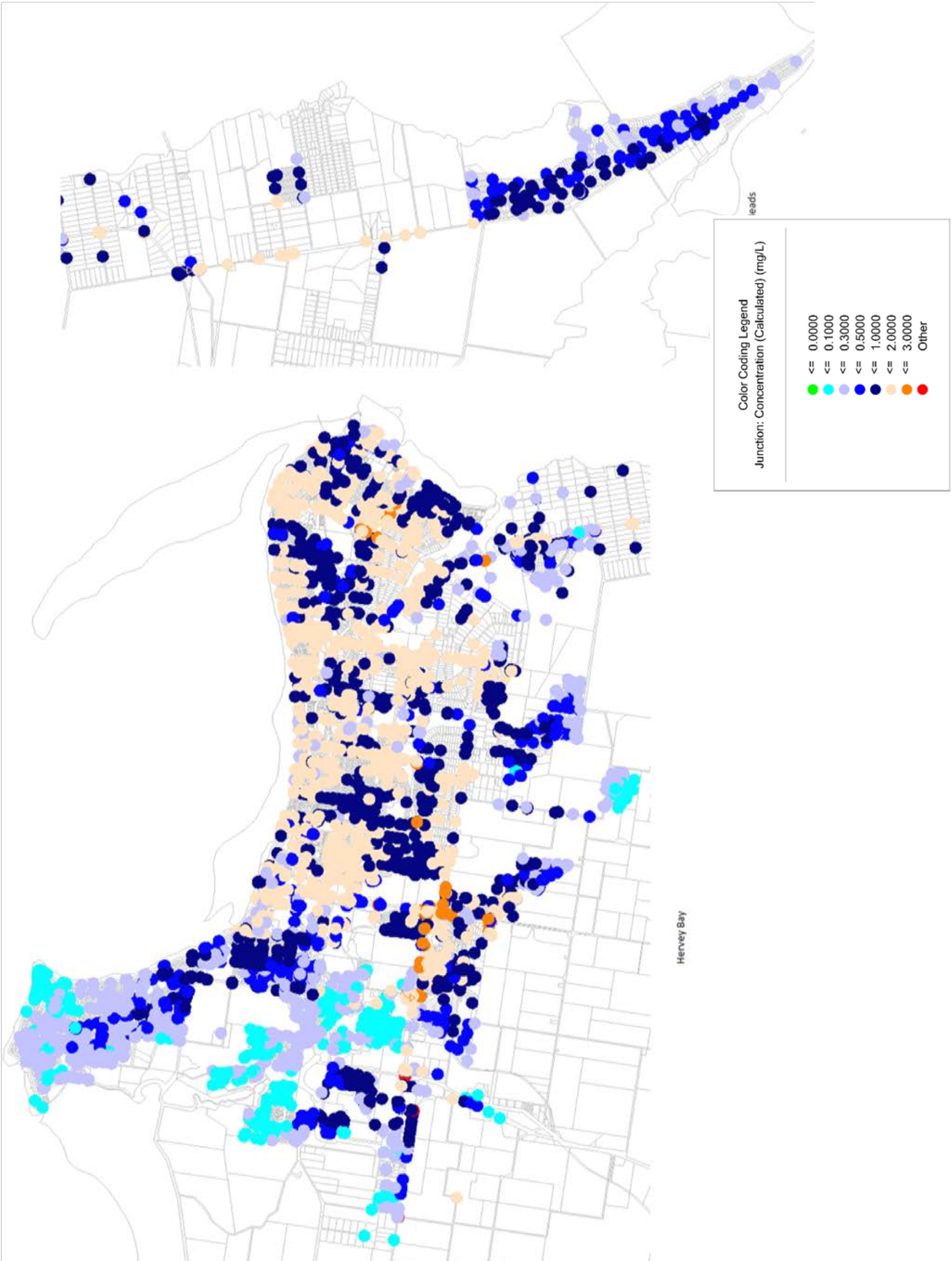


Figure 5-22: Hervey Bay and River Heads Modelled Cl_2 Levels at Current Dosing Regime

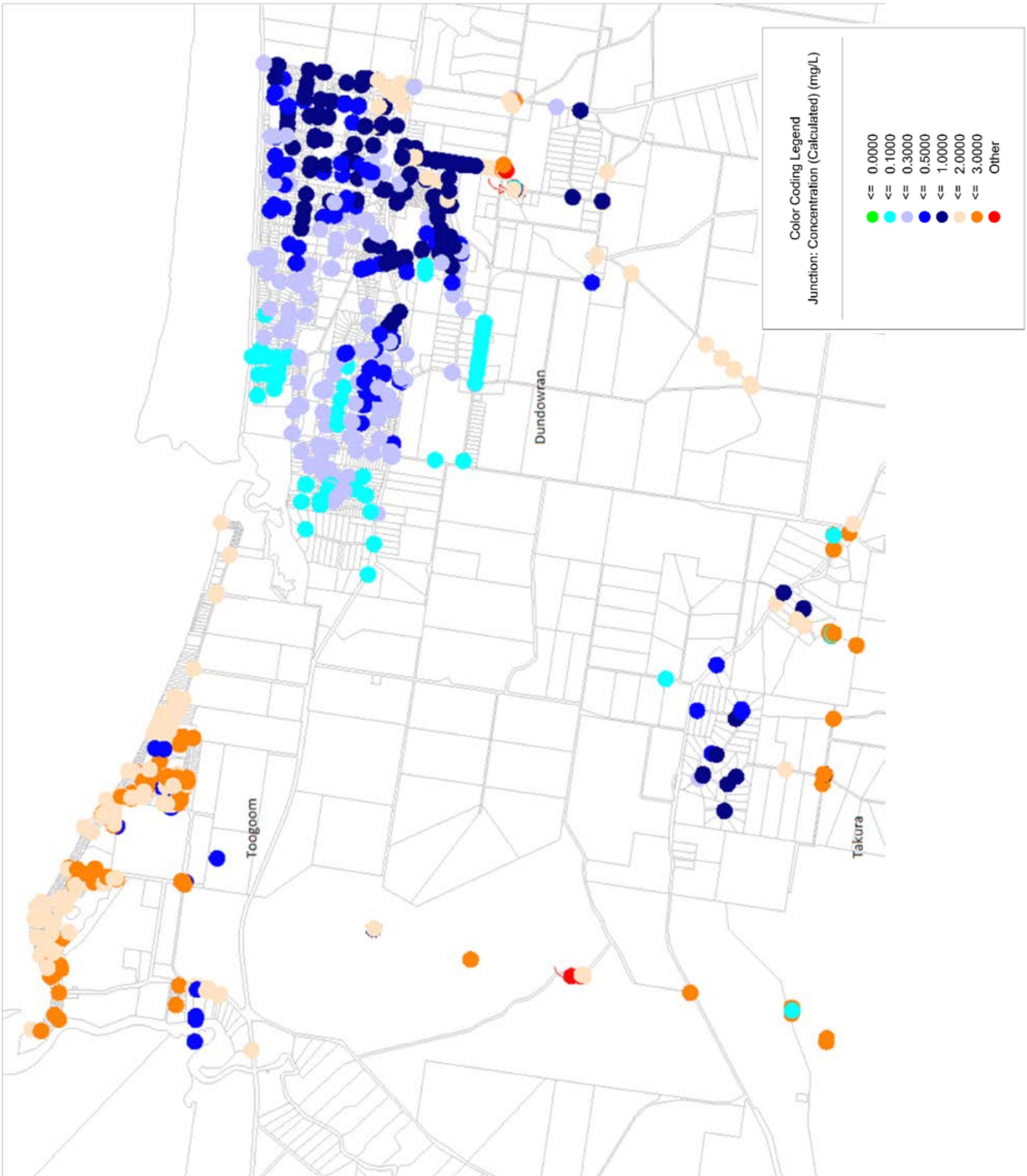


Figure 5-23: Dundowran and Toogoom Modelled Cl_2 Levels at Current Dosing Regime

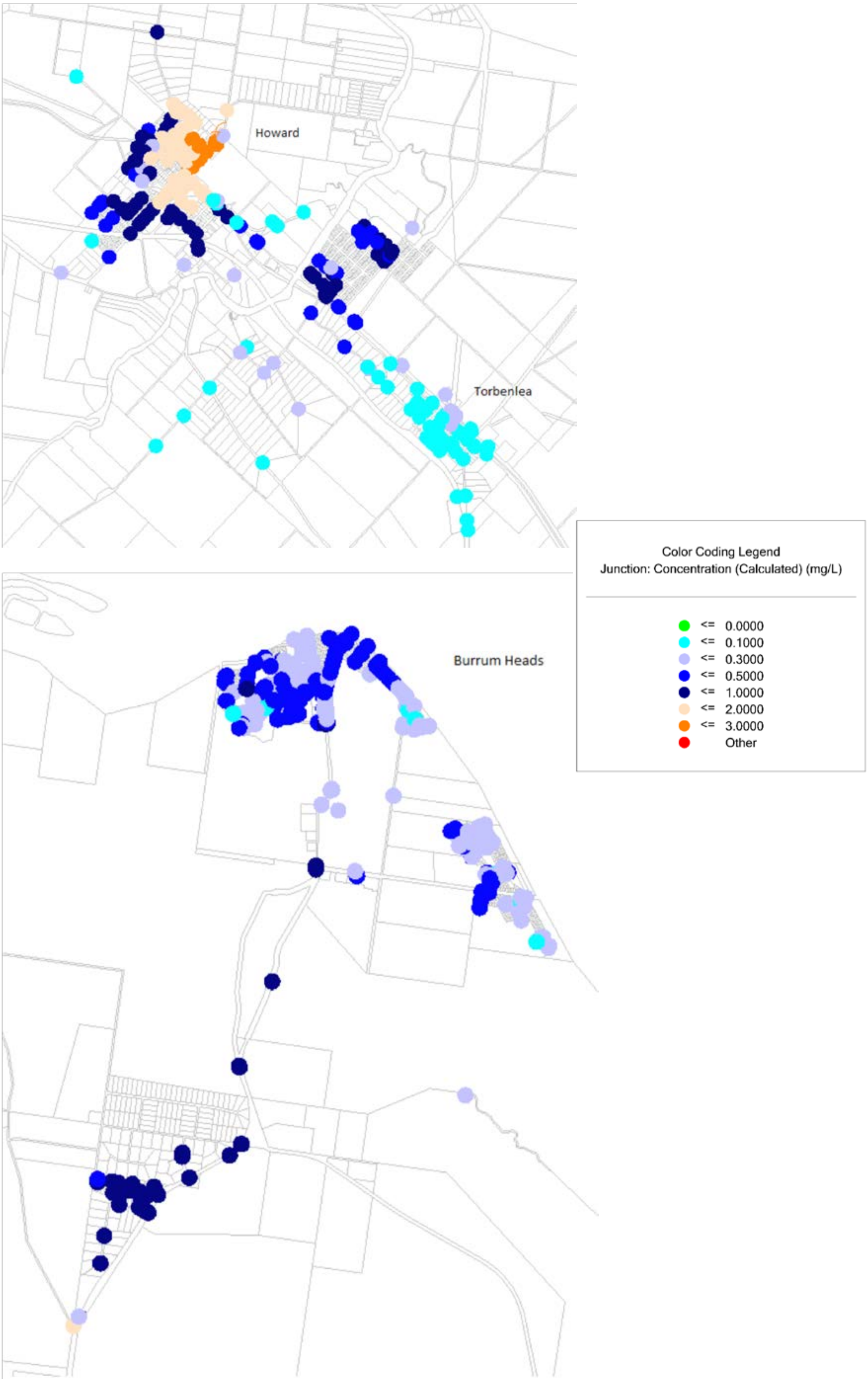


Figure 5-24: Howard and Burrum Heads Modelled Cl_2 Levels at Current Dosing Regime

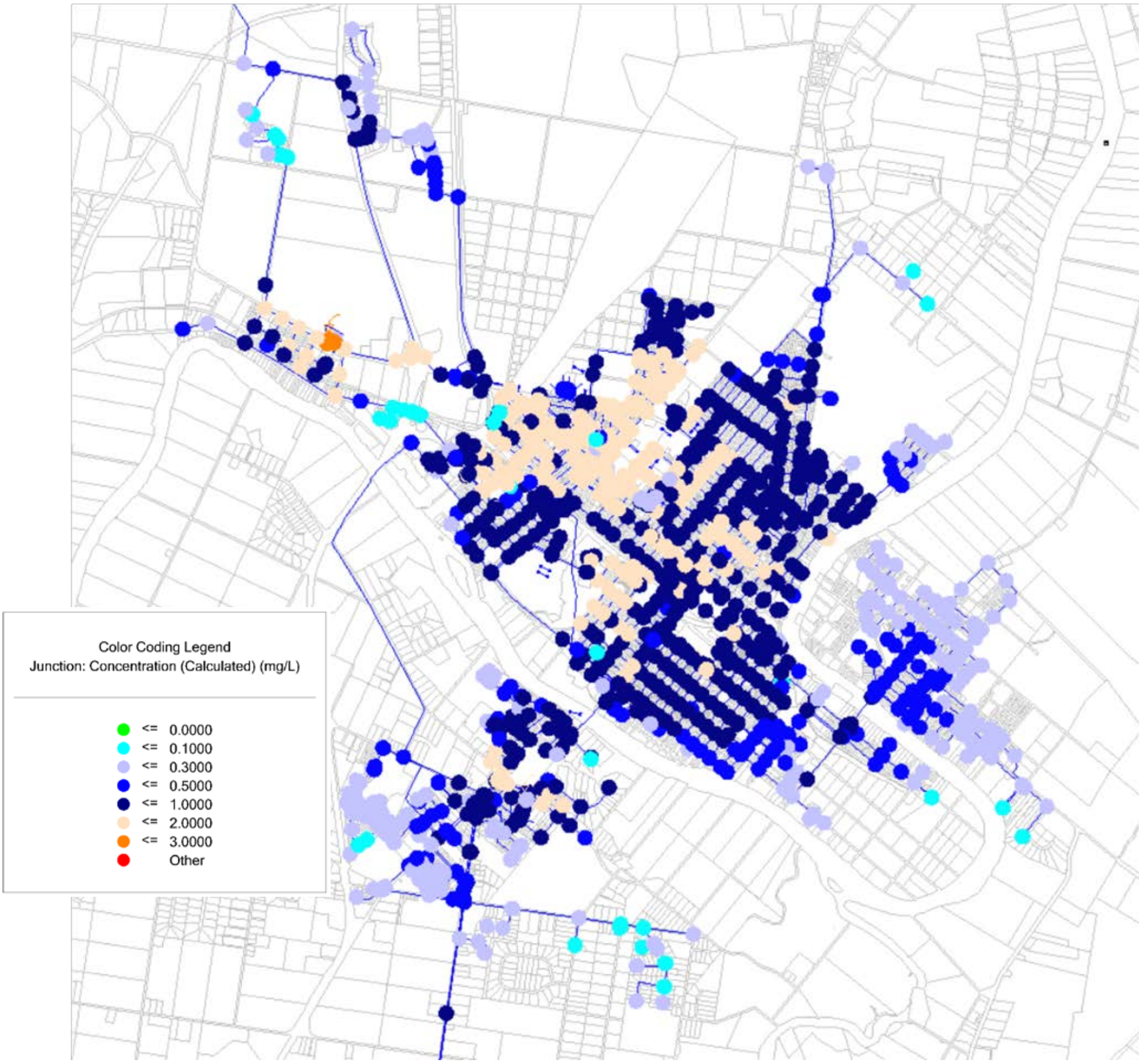


Figure 5-25: Maryborough Modelled Cl_2 Levels at Current Dosing Regime

The modelled chlorine residual levels in Maryborough shown in Figure 5-25 demonstrate the following areas of concern;

- High chlorine residual levels around the Aberdeen Ave, Showgrounds and Tinana areas.
- Low chlorine residual levels in Granville and along the periphery of the network.

The areas of high residual chlorine levels generally coincide with the locations of the chlorine boosters. The areas of low residual chlorine levels generally coincide with the extremities of the system.

Additional Chlorine Booster Stations

The modelling has identified that Point Vernon and Eli Waters (DCP2) have low residual chlorine levels and in order to maintain chlorine residuals in this area WBWC operators have been forced to increase the chlorine dosing levels effectively driving up the chlorine residuals in Urangan, Torquay, Scarness and Pialba.

It is proposed that a chlorine booster be installed for the Eli Waters/Point Vernon zones to allow the chlorine residuals in other areas to be reduced. A flow paced booster is recommended to be installed so that it services both the 375mm mains to Point Vernon and DCP2 at the same time. There are several locations available including; Boat Harbour Dr, Old Maryborough Rd, Nissen St and on the DN600 on Urraween Rd. If these locations are not suitable then two chlorine boosters may be required.

A new chlorine booster is also recommended to service Torbanlea. This would require some pipework so that Burrum Town can also be chlorinated.

Previously in this report (Section 5.5.1.2.) it was proposed to create a new zone at Ann St which involves the reinstatement of the Ann St Reservoir and pump station. Through the chlorine modelling it was identified that the introduction of the Ann St DMA will have a positive impact on water quality by reducing water age (the supply is direct from Two Mile), however to ensure adequate chlorine residuals in the zone and also particularly at Granville it is required that a new chlorine booster site be established.

Likewise the proposed Bell Hilltop Zone creation also provides positive water quality outcomes by tuning over the High Zone Elevated Reservoir more regularly. There are sufficient chlorine levels from the High Zone chlorine booster and the Showgrounds chlorine booster that this zone will not require any further chlorine boosting.

Modelling shows that Granville can sustain reasonable chlorine residuals from the Ann St Zone, however in some of the areas a modelled residual chlorine level of 0.1mg/L was calculated. At some point into the future a new chlorine booster might be considered for Granville.

The creation of the Takura Water Supply Concept may mean that water is detained in the Takura Reservoir for extended periods of time. A chlorine booster will be required here to maintain chlorine levels at some periods during any given year.

Table 5-19: Proposed Chlorine Booster Sites Cost Estimate

	Ann St ($)	Point Vernon / DCP2 ($)	Torbanlea ($)	Takura Reservoir ($)
Civil Works	40,000	40,000	40,000	40,000
Electrical Works	15,000	15,000	15,000	15,000
Chlorination Equipment	40,000	80,000	40,000	40,000
Telemetry	12,000	12,000	12,000	12,000
Flow meter and Associated works	6,000	6,000	6,000	6,000
Housing	50,000	50,000	50,000	50,000
Design	5,000	5,000	5,000	5,000
Contingency (20%)	32,600	40,600	32,600	32,600
Pipework			75,000	
Total	**200,600**	**248,600**	**275,600**	**200,600**

RECOMMENDATION: A new chlorine booster site be established at the Ann St Reservoir. The cost associated with the installation is estimated to be $200k and would be required when the pump station is reinstated in 2018.

RECOMMENDATION: A new chlorine booster site be established to service DCP2 and Point Vernon. The cost associated with the installation is estimated to be $250k and would be required 2016.

RECOMMENDATION: A new chlorine booster site be established at Torbanlea. The cost associated with the installation of associated pipework is estimated to be $275k and would be required in 2016.

RECOMMENDATION: A new chlorine booster site be established at the Takura Reservoir. The cost associated with the installation is estimated to be $200k and would be required when the Takura Water Supply Concept is realised in 2018.

Chlorine Booster Recommendations

The modelling undertaken for average demand periods indicates that the chlorine set points could be reduced to the following levels as shown in Table 5-20.

Table 5-20: Chlorine Set Points

	Summer		Winter	
Location	**Current Typically Achieved Residual from Booster**	**Proposed Setting**	**Current Typically Achieved Residual from Booster**	**Proposed Setting**
Burgowan WTP	2-3	2-3	2-3	2
Belmont Park Re-chlorination Station	2	2	3	1
Booral Pump Station	3	3	2.5	1
Dundowran Pump Station	2.5	2.5	2.5	1.5
Howard ET	3.5	3.5	3.5	2
Toogoom Bush Pump Station (target at reservoir outlet)	2.25	2.25	2.75	1
Urraween Reservoir Site	2.4	2.4	2.5	1.2
Point Vernon (new)	n/a	TBA	n/a	1.2
DCP2 (new)	n/a	TBA	n/a	1.0
Torbanlea (new)	n/a	TBA	n/a	1.2
Teddington WTP	2-3.5	2-3.5	2-3.5	2
High Zone PS	3	3	2	1
Low Zone PS	2.5	2.5	2	1.5
Showgrounds ET	1.6	1.6	1.5	1
Tinana Water Pump Station	2	2	1.5	1.2
Ann St DMA	n/a	TBA	n/a	1

NB: it is recommended that the summer figures maintain status quo until a study has been done on the chlorine usage during the warmer summer period.

Revised Chlorine Levels

In Hervey Bay the aim was to reduce the chlorine dosage and minimising the residual chlorine in the reticulation system. To affect this, a new booster site was identified at Point Vernon, DCP2 and Torbanlea. The installation of the booster site to service Point Vernon and DCP2 allows the chlorine levels to be dropped significantly at the Urraween chlorine booster site. Consequently the residual chlorine levels in Urangan, Torquay, Scarness and Pialba were reduced to more acceptable levels.

Moving the chlorine booster from the Toogoom Bush Pump Station to the Takura Heights (Toogoom) Reservoir site allows the water in the reservoir to be maintained at a consistent chlorine level and allows good mixing of the chlorine with the water before reaching the customer.

Moving the booster chlorination from Booral Pump Station to the River Heads Reservoir had a positive impact on water quality. Currently there are a number of properties that rely on this chlorination as they are connected to the rising main from Booral Pump Station. Therefore the relocation of the chlorine booster cannot be undertaken until a new dedicated main from Booral Pump Station River Heads Reservoir is completed in 2017.

Likewise the chlorine booster at Aberdeen Ave to the Boys Ave Reservoir site will allow more consistent chlorine levels and will allow the chlorine levels to be maintained in the reservoirs with sufficient contact time to neutralise any contaminants.

With these changes the booster chlorine levels were able to be reduced.

RECOMMENDATION: Relocated the chlorine booster from Toogoom Bush Pump Station to the Takura Heights (Toogoom) Reservoir site at an estimated cost of $100k in 2016.

RECOMMENDATION: Relocated the chlorine booster from Booral Pump Station to the River Heads Reservoir site at an estimated cost of $100k in 2017. Note that this cannot be undertaken until a new dedicated rising main from Booral Pump Station to River Heads Reservoir is constructed.

RECOMMENDATION: Relocated the chlorine booster from Aberdeen Ave to the Boys Ave Reservoir site at an estimated cost of $100k in 2017.

RECOMMENDATION: Preparation of a chlorine dosing regime to be followed by treatment staff to ensure optimised disinfection.

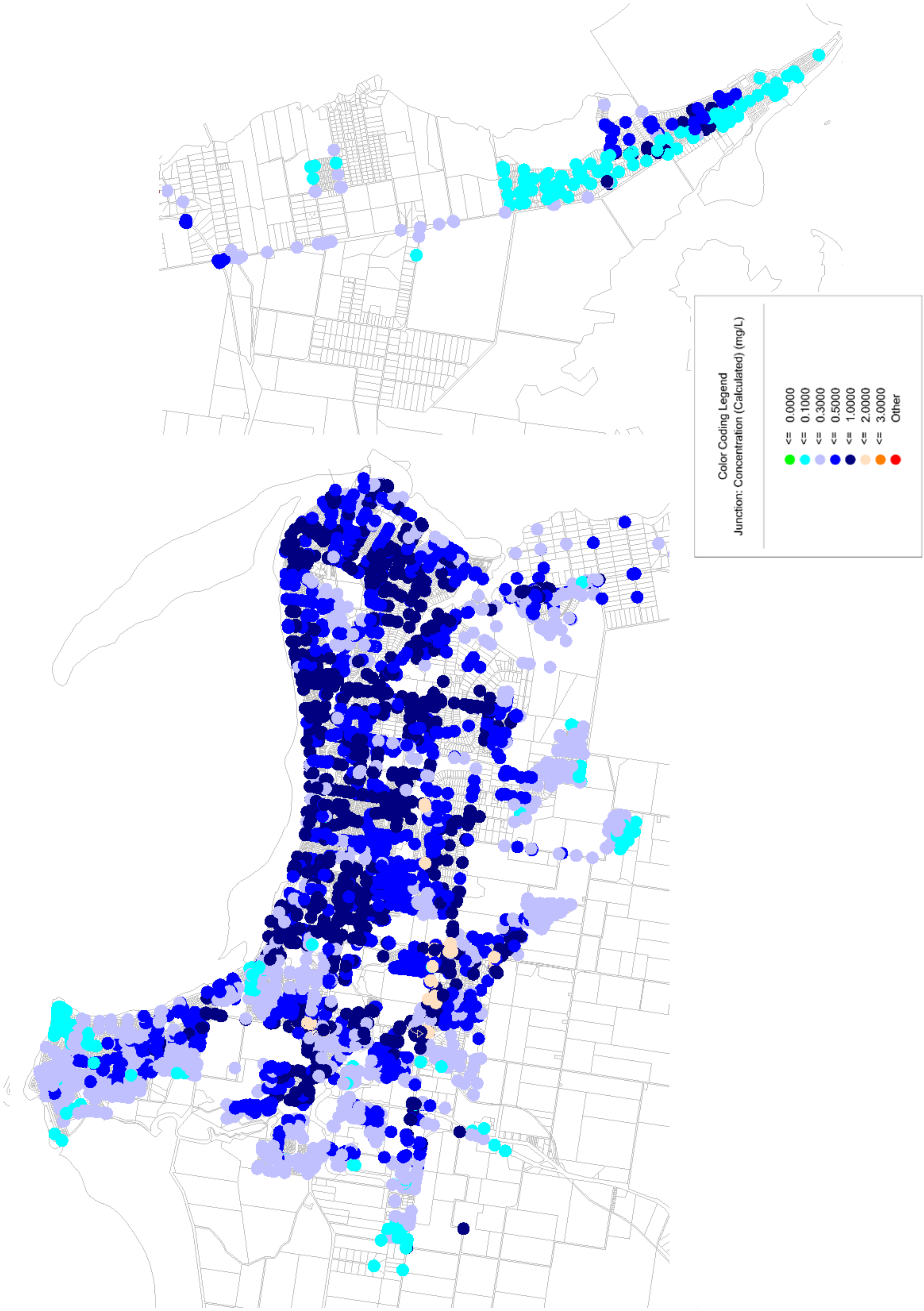


Figure 5-26: Hervey Bay and River Heads Revised Chlorine Levels

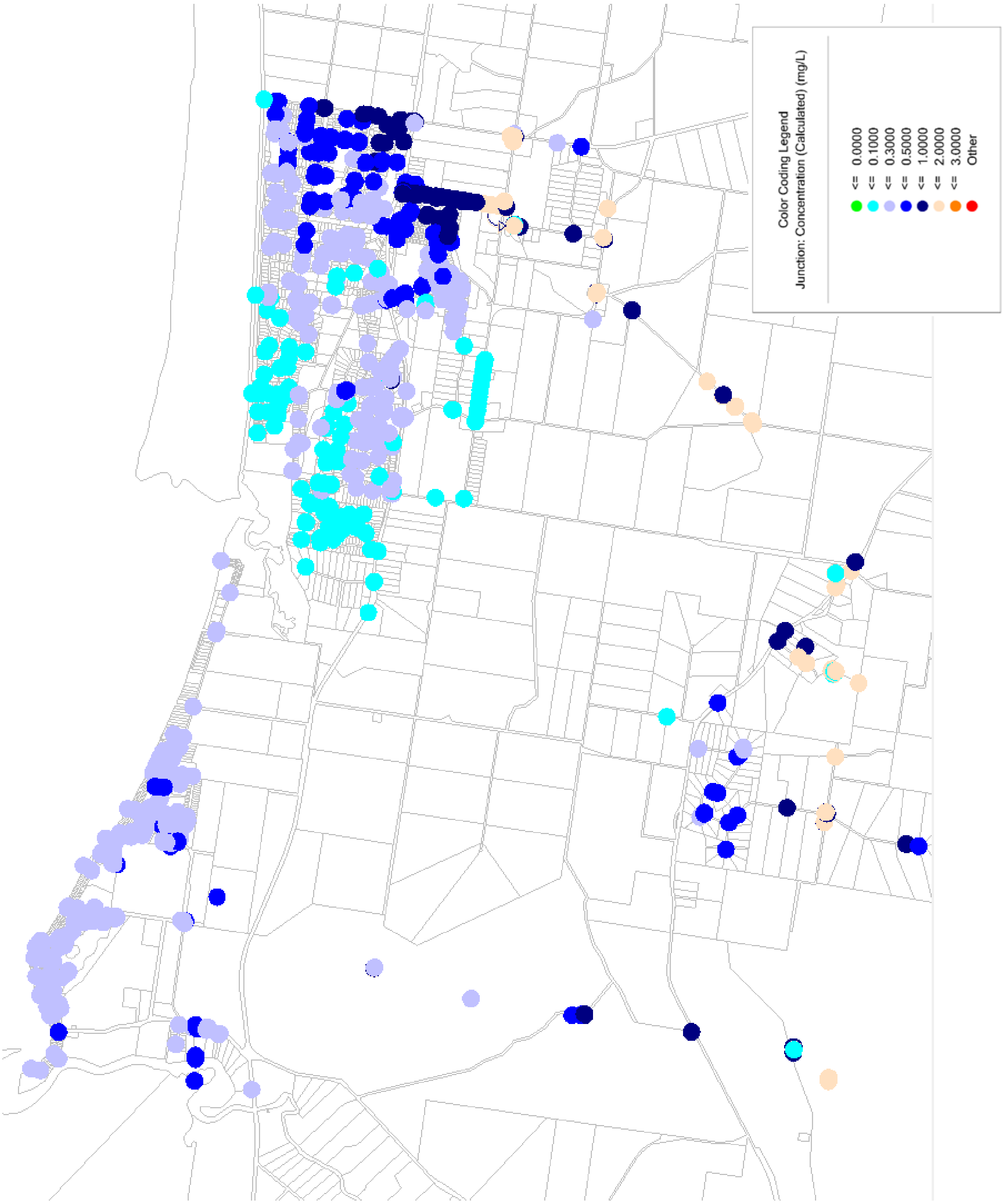


Figure 5-27: Dundowran and Toogoom Revised Chlorine Levels

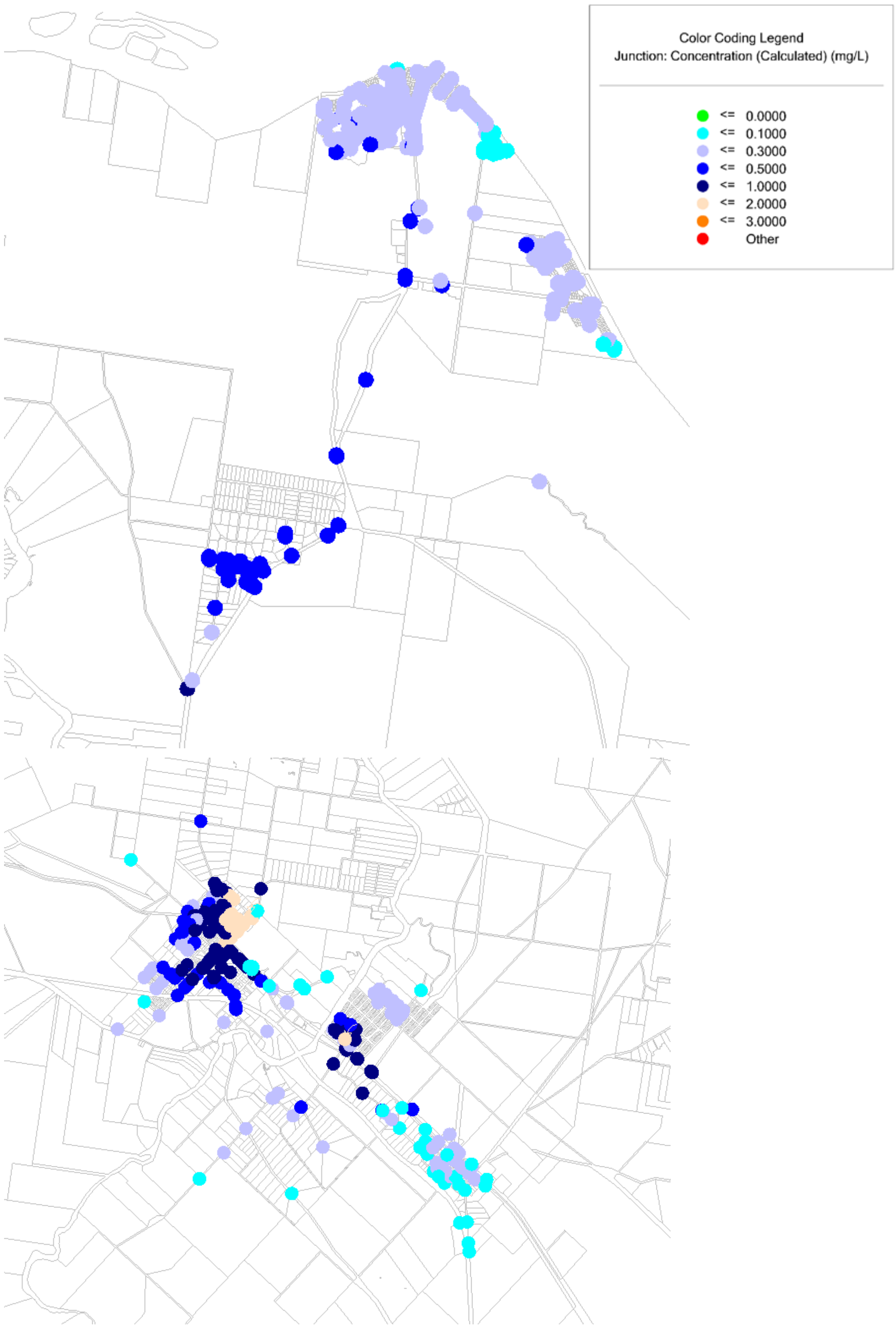


Figure 5-28: Burrum Heads, Howard and Torbanlea Revised Chlorine Levels

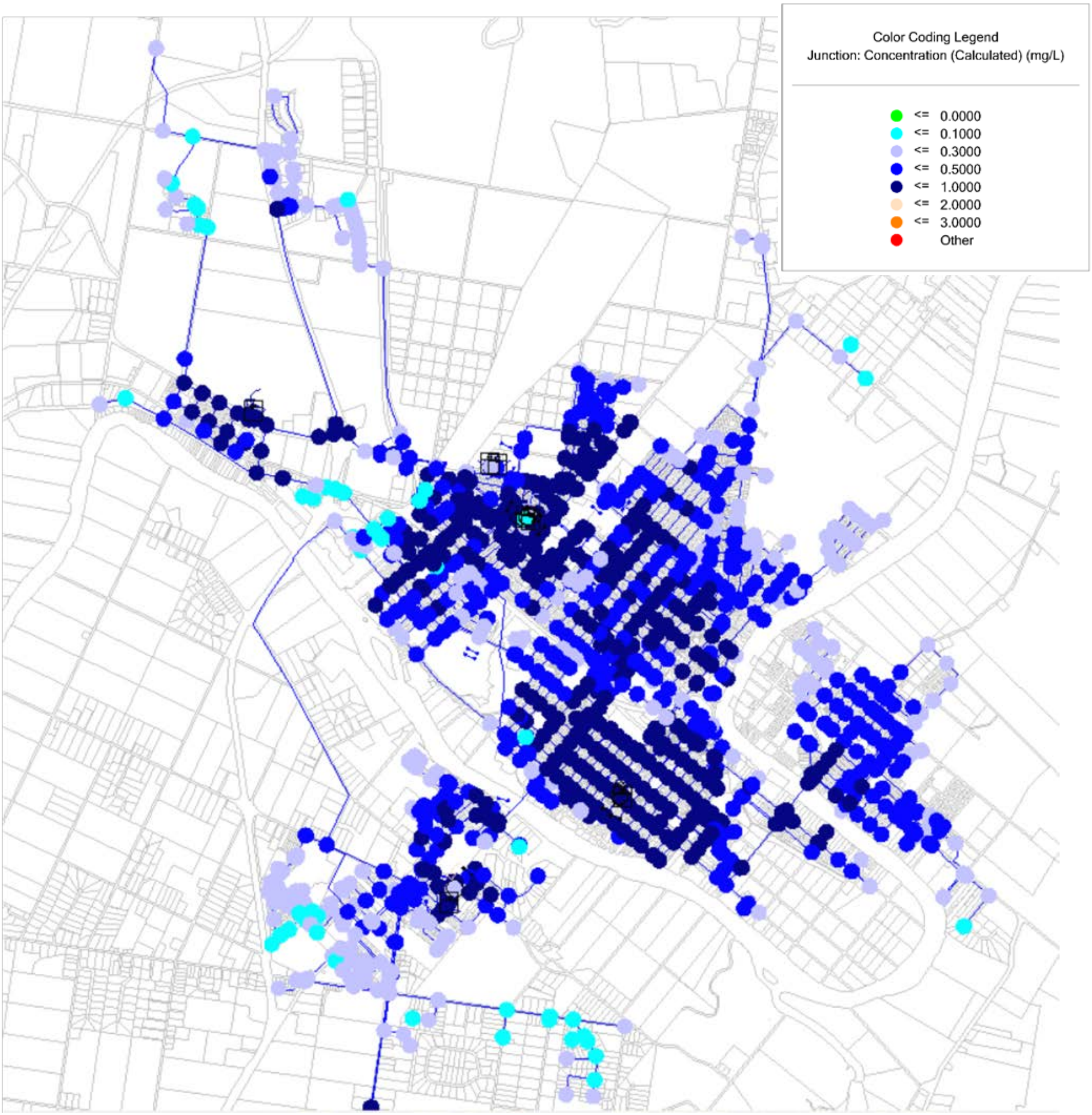


Figure 5-29: Maryborough Revised Chlorine Levels

In Maryborough a combination alterations were made to the system to provide better water quality outcomes. These include;

- reducing the transmission system to a single main
- the creation of Ann St DMA and a new chlorine booster at this site.
- moving a small pocket of residential dwellings west of Neptune St from the CBD zone to the High zone DMA.
- the introduction of Bell Hilltop zone which includes the dedicated use of the High Zone Elevated Reservoir.

- the reduction in booster settings as per Table 5-20.

These modifications overall had a positive impact on the system and reduces residual chlorine levels throughout the system.

Even though the modelling shows minimal chlorine levels in some parts of the system the model did not indicate any areas with no chlorine residual. None the less some areas will need to be monitored and there may even be the need for a flushing program to be established. The areas of concern include;

- the north western part of the network which is mainly industrial but does include; a residential subdivision to the north of the TAFE and a corrections facility.
- the south east of Tinana. This is a rural residential area and chlorine levels may need to be monitored in this area.

5.6.5.3. System Operations

The least chemically intensive option to maintaining adequate chlorine residuals may be operational adjustments to reduce water detention times. Some possible operational implementations are considered in this section.

Reducing Detention Times through Operation of Infrastructure

Calculations indicate that the time from chlorination to the time that the water reaches the distribution system varies depending on seasonal demand fluctuations. Table 5-15 shows the typical detention times in the system.

Table 5-21: Average Detention Times in Transmission (current Configuration)

Source	Through	To	Detention Time (hrs)	
			2016 MDMM Flow	2031 MDMM Flow
Burgowan	Through Transmission Mains and Takura Reservoirs	To Urraween Reservoir	7.5-40	18-30
Teddington	Transmission mains and Two Mile Reservoir	Aberdeen Ave	23*	22*
Tiaro	Tiaro WTP	Forgan St Elevated Reservoir site	2	1.6

* Calculation ignores the detention time in 2 Mile Reservoir

Minimising the detention times reduces the chlorine consumption and hence the formation of THM's.

Significant reductions in detention times can be achieved in the Maryborough transmission system. Maryborough has two large transmission mains to Aberdeen Ave. Modelling shows that the entire town can be supplied by just one of these transmission mains. Ignoring the detention time at Two Mile and using a single 525mm transmission main to Aberdeen Ave, the detention time can be reduced from 23 hours to approximately 10 hours. It is recognised that careful management of the system will be required to ensure that the second transmission main can be brought on line for emergency or operational reasons. Consideration needs to be given to the maintenance of these mains to ensure that their water quality is maintained. Strategies such as alternating the use of these transmission mains or the regular flushing of these mains may be appropriate.

The Hervey Bay system transmission mains consist of a number of 300 / 375 / 450 / 525 and 600mm sections of main. The combined mains are capable of maintaining an inflow to Urraween Reservoir of 600L/s which is sufficient to meet the MDMM until 2031. In contrast to the Maryborough system there is no opportunity to reduce the number of mains feeding Urraween without compromising the MDMM flow required.

The Tiaro transmission system consists of a single main from the Tiaro WTP to the Forgan St Elevated Reservoir. There exists no scope for reducing the number of transmission mains in this system. Tiaro has small detention times due to the demand and the small distance from the WTP to the reticulation system.

RECOMMENDATION: Use a single transmission main (DN525) from Teddington WTP to Aberdeen Ave.

Maintaining Minimum Reservoir Levels to Satisfy Demands

During average demand periods of the year it is possible to lower the top water level of reservoirs to reduce detention times in these reservoirs. During high demand times it is required that more storage is available and the water levels would revert to full top water level in most cases.

An assessment has been undertaken of the lowest operating level permissible in the reservoirs during average demand periods. The assessment takes into account a volume of storage for firefighting which is retained in addition to the operating storage required by the Planning Guidelines for Water Supply and Sewerage (DEWS, 2014).

These levels could be used from the months of May to August in the Fraser Coast.

RECOMMENDATION: Implement reduced water levels in ground level reservoirs in accordance with this report.

Table 5-22: Proposed Low Demand Storage Reservoir Levels

		2016					2031				
Reservoir	Full Storage Capacity(Ml)	Full TWL (mAHD)	Detention Time at AD flow (hrs)	Min Storage Required + Fire Fighting Storage (ML)*	Min TWL to satisfy Storage requirement	Detention Time at AD flow (hrs)	Full TWL (mAHD)	Detention Time at AD flow (hrs)	Min Storage Required + Fire Fighting Storage (ML)*	Min TWL to satisfy Storage requirement	Detention Time at AD flow (hrs)
Takura	9.0	95.5	47.3	4.5	91.5	23.9	95.5	38.5	5.5	92.4	23.4
Urraween/Ghost Hill No.1,No.2	35.4	32.5	50.3	15.6	Not calculated	22.2	32.5	35.4	22.0	Not calculated	22.0
Ghost Hill No.2	6.7	80.8	165.0	1.3	73.2	32.2	80.8	96.7	1.9	74.0	27.8
Dundowran	0.3	61.0	32.7	0.6	64.5	68.7	61.0	31.0	0.6	64.6	66.3
River Heads	1.0	55.7	40.1	1.0	55.6	38.9	55.7	27.5	1.2	56.5	33.5
Toogoom	0.7	76.4	22.8	1.1	79.0	36.1	76.4	17.1	1.3	80.4	32.4
Ann St	4.5	30.3	34.5	3.3	28.7	24.9	30.3	32.9	3.4	28.9	24.8
Boys Ave	19.1	30.8	98.7	4.6	26.4	23.8	30.8	96.4	4.7	26.5	23.8
Tinana	4.5	48.4	83.1	1.6	44.7	29.6	48.4	60.9	2.0	45.3	27.5
Tiaro	1.3	30.3	155.3	0.9	29.8	109.8	30.3	120.4	1.0	30.0	97.8

* Requirements from Planning Guidelines for Water Supply and Sewerage (DEWS, 2014).

Elevated Reservoirs

Elevated reservoirs provide a regulated pressure head to the system and generally provide small storage volumes due to the costs associated with their construction. The average detention time in these elevated reservoirs is relatively small compared to their ground level counterparts. However it is important that the configuration of these elevated reservoirs be optimised to encourage full mixing and discourage conditions such as compartmental zoning and LIFO (Last in First Out). It is uncommon for elevated reservoirs to contain the ideal scenario where there is a separate inlet and outlet, however even a combined single inlet/outlet can be augmented to improve the mixing capability and improve water quality of the discharge water.

Operating modifications can ensure that reservoirs are turned over adequately to alleviate water quality concerns. Allowing the reservoirs to drain during low usage periods (say overnight) will ensure at least one turnover per day. And will help maintain good water quality in the elevated reservoirs.

RECOMMENDATION: Review of the inlet configurations and recommend enhancements to promote mixing at a cost of $10,000 in 2016/17

RECOMMENDATION: Review of altitude valve configurations to promote higher turnover and deeper cycling of elevated reservoirs.

Pipework Modifications

The introduction of Demand Management Areas (DMA) in the Fraser Coat has been fundamental in the reduction of usage, number of bursts and, where bulk meters were installed, the early detection of system leakage. When DMA's were introduced into the Fraser Coast, they were created by limiting the flow into an area to one or two locations. This meant that many dead ends were created which, in some instances resulted in poor flow through mains, long detention times, and poor water quality to the system.

The removal of these dead ends has a positive impact on the water quality in the system and it is recommended that a program of works be investigated to economically remove as many dead ends as possible along zone boundaries and at the extremities of the system.

Assessment of the model and network has identified the following package of works as presented in Table 5-23.

Table 5-23: Water Quality Improvement Pipeline Projects

Item	Description	Component	Est Cost
HB1	Bideford St - Truro St to Esplanade	1 x boundary valves	$5,000
		190m of 200mm water main	$100,000
HB2	Grevillea St - Honeysuckle Ave to Meledie Ave	2 x boundary valves	$10,000
		100m of 150mm water main	$40,000
HB3	McNally St - Boat Harbour Dr to John St	125m of 100mm water main	$30,000
HB4	Bideford and Boat Harbour Drive Interconnection	2 x boundary valves	$10,000
		200mm interconnector main	$20,000
HB5	Sandpiper St – Curlew Tce to Turnstone Bvd	2 x boundary valves	$10,000
		90m 100mm water main	$20,000
HB6	Elizabeth St Interconnection	150mm water main interconnection	$25,000
HB7	Bergin to Colyton St Interconnection	100mm water main interconnection	$15,000
HB8	Booral Rd, Urangan - Beck Rd and Don Adams Dr	150mm 740m water main interconnection	$154,000
MB1	Jupiter St and Aberdeen Ave Boundary Valve Relocation	1 x boundary valve	$10,000
MB2	Aberdeen Ave – Matthies St to Connolly St and associated boundary valves	2 x boundary valves	$10,000
		92m of 100mm water main	$20,000
MB3	Interconnection between Ariadne St and North St	2 x boundary valves	$10,000
		Remove Boundary Valve	$5,000
		100mm interconnector main	$15,000
MB4	Sussex St and Amity St Interconnector	2 x boundary valves	$10,000
		100mm interconnection main and road crossing	$20,000
MB5	Poincianna Ct and Laurel Ct interconnection	100mm interconnection main	$24,000
MB6	Kent St, MBH - Ferry to Fort St	100mm interconnection main	$36,000
T1	Gee St to River St	75m of 100mm water main	$25,000
T2	River St to Short St	75m of 100mm water main	$25,000
T3	Smith Ave and Walter St Interconnection	80m of 100mm water main	$25,000
T4	Burgess St – Tiaro St to Bruce highway	310m of 100mm water main	$70,000

RECOMMENDATION: Adopt the Water Quality Improvement Projects identified in this section for construction at the timings identified in Appendix 1.

Pipework Maintenance

Chlorine is consumed primarily in two ways; through the disinfection of the water itself and through the disinfection of naturally occurring biofilm which occurs on the inside of pipe walls.

This biofilm can build up where there is insufficient chlorine to deactivate it. Where these cases have been identified through water quality modelling it is recommended that a program of flushing and pigging be implemented.

Flushing is often perceived as a waste of water by the public. Therefore it is important that this strategy be limited to those areas where it is absolutely required.

RECOMMENDATION: Review and continue or implement a program of flushing and pigging or swabbing for known areas of water quality issues.

5.6.5.4. Disinfection By-product Reduction

Trihalomethane's are a disinfection by-product produced when free chlorine reacts with organic compounds dissolved in water.

THM's have been linked to health issues in humans and the ADWG recommends a health limit of 0.25mg/L in water supplies. The Fraser Coast water supply systems exceed this value particularly in Maryborough where measured values ranged between 0.245mg/L and 0.28mg/L with previously recorded average levels of 0.35mg/L (WBWC, 2010).

In Hervey Bay the levels are lower due to the treatment process employed. Ozone/BAC destroys and removes some of the organic compounds in the water supply. THM measurements between 2008 and 2011 indicate THM levels ranging as low as 0.084mg/L to as high as 0.373mg/L (WBWC, 2011). It should be noted that these results occurred while the Howard WTP was operating and is known not to be able to remove THM forming organics from the water supply.

The reduction of THM's can be achieved in three ways

- Reducing organics prior to chlorination
- Using non THM forming disinfectants
- Removing formed THM's through aeration prior to reaching customers.

NOM/DOC Removal

A study entitled *'An Investigation on Parameters For Modeling THMs Formation'* complied in 2008 attempts to mathematically describe all variables which contribute to THM formation. In Chowdhury & Champange's report DOC/NOM concentration is determined to be roughly proportional to the concentration of THM's generated.

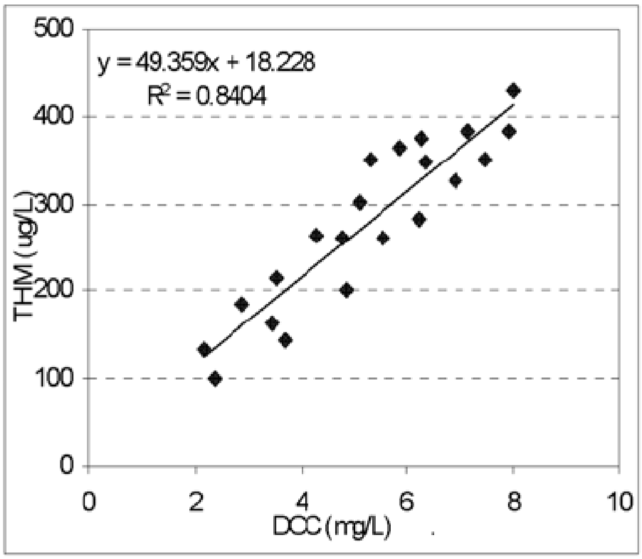


Figure 5-30: DOC relationship with THM formation (Chowdhury & Champange, 2008)

A mathematical equation was developed to describe the relationship between DOC and THM formation. While the exact formula is still unknown, it appears that there is a correlation between the two parameters.

Therefore the removal of the dissolved organic carbon prior to disinfection with chlorine should reduce the level of THM formation.

WBWC (2011), WBWC (2012) and HWA (2012) suggest the following treatment options for DOC/NOM removal/reduction;

- MIEX
- Ozone/BAC
- Membrane Filtration

MIEX

MIEX is a proprietary process offered by Orica. The process involves small ion exchange resin beads with a slight magnetic component. These beads attract the negatively charged DOC by exchange with a chloride ion resulting in lower DOC and increased chloride levels in the discharge water.

The beads undergo a reversed ion exchange to replace the DOC with new chloride ions and the DOC is transferred to a waste stream.

Previous jar testing on the MIEX system at Teddington WTP concluded a reduction in DOC of 50% was achievable through this process.

Ozone/BAC

Ozone/BAC is used at the Burgowan WTP and has been successful in the reduction of DOC to approximately half that at Howard WTP. Ozonation is a highly effective and powerful oxidant capable of oxidising soluble manganese. Ozone is expensive to generate and would only be considered in situations where multiple benefits were achievable such as decreasing of NOM. It also requires biological filtering to prevent biodegradable organics being assimilated by biomass in the distribution system (HWA, 2012). Ozone is expected to remove an average of 40% NOM (Yode, 2006).

Because ozone degenerates quickly it is required to be generated on site but also requires a secondary disinfectant to produce a residual in the system.

Membrane Filtration

Membrane Filtration involves reverse osmosis or nanofiltration technology to filter out organic DOC. The feed water to these plants needs to be extremely clean and free of solids. Both reverse osmosis and nanofiltration are very expensive options, hence are unlikely to be viable solutions due to their cost.

RECOMMENDATION: A comprehensive planning and economic assessment of the NOM/DOC removal options be undertaken at a cost of $50k in 2016.

Alternative Water Disinfectants

Chlorine is widely used as a disinfectant in public water supplies because it disinfects water supplies against substances harmful to humans such as bacteria and pathogens. It is the most commonly used disinfectant in the world and many references claim that it is the single largest advancement to public health in history.

Hypochlorite or gaseous chlorine as a disinfectant are the most common forms used. These produce free chlorine in water supplied which has a disinfecting or bleaching effect on harmful pathogens and bacteria. Chlorination in any form produces by products and free chlorine disinfection produces a group of by-products known as THM's. These THM's have been linked to causing cancer in humans so there is now a gradual move towards other disinfection types that minimise the production of THM's or eliminate their production altogether. As a result disinfection methods such as;

- Chloramination;
- Chlorine dioxide;
- Ultra violet disinfection.

These forms of disinfection have all become increasingly popular. Each, however, has its advantages and disadvantages.

Chloramination

Chloramination occurs when ammonia and free chlorine residual react to form chloramines (combined chlorine). This combined chlorine is a much weaker oxidant when compared to free chlorine. This means that longer contact times are required to achieve the same level of disinfection of free chlorine disinfection. For this reason it is often used in conjunction with stronger forms of disinfection to produce a chlorine residual. Although a reduction in THM's was expected, WBWC (2010) found through experimentation that chloramination had an insignificant decrease in THM formation when compared with free chlorine. Conversely Hunter Water Australia argue that chloramination is ideally suited to situation where there is high formation potential for THM's and is often used to maintain chlorine residuals in distribution systems (HWA, 2012). The report goes on to list that disadvantages to using chloramination such as the formation of other carcinogenic by-products (NDMA), potential for nitrification, effects on brass and elastomeric materials.

Particularly because of the undesirable by-products of this disinfection process, this option is not considered appropriate for disinfection in the Fraser Coast (WBWC, 2011).

Chlorine Dioxide

Chlorine Dioxide is approximately three times as strong as chlorine as a disinfectant. It is particularly effective in the oxidation of Manganese. This form of disinfection breaks down the organics and does not combine with the organics as it does in chlorination to form halogenated organics (HWA, 2012). The chlorite ion is a by-product of the process and is known to be harmful to humans. Therefore it is important that the residuals be managed carefully. Manufacturers of chlorine dioxide indicate that for each part of chlorine dioxide used approximately 50-60% of the dose will form chlorite ions. An assessment by WBWC (2011) has found that, for the Fraser Coast water supplies, this equates to approximate chlorite ion concentrations of 0.48-0.6mg/L in Maryborough and 0.4-0.48mg/L in Hervey Bay. In both cases this exceeds the ADWG health limit of 0.3mg/L. Therefore this option is not considered appropriate for disinfection in the Fraser Coast (WBWC, 2010; WBWC, 2011).

Ultra violet disinfection

Ultra violet disinfection deactivates microorganisms rather than oxidising them. It does this by exposing water to electromagnetic radiation. This involves large power consumption if the amount of water to be treated is high. It is also affected if the water is not clear. One of the other disadvantages is that it provides no downstream residual disinfection and is usually combined with another form of disinfection to provide a residual chlorine level. It is questionable if this method of disinfection reduces the formation of THM's. A study by Yonkyu (2009) demonstrated that UV disinfection combined with chlorination can increase the formation of THM's. Given the high capital, maintenance and operational costs coupled with the inability to provide a residual disinfection and may increase THM formation, this option is not considered appropriate for the Fraser Coast water supplies (WBWC, 2010; WBWC, 2011).

Removal of Formed THM's

Aeration can be used to remove formed THM's from a water supply. THM's are volatile organic compounds (VOC) dissolved in water. Because they are volatile, they can be transferred from the liquid phase to the gas phase by the introduction of aeration.

Trails conducted at Maryborough's Two Mile Reservoir show an approximate reduction in THM's of up to 40%. Table 5-24 is extracted from the Hunter Water report on Teddington WTP THM Formation Jar Testing (HWA, 2015).

Table 5-24: Two Mile Reservoir THM Removal through Aeration

Date	Two Mile Reservoir Inlet Total THM (mg/L)	Two Mile Reservoir Outlet Total THM (mg/L)	% Reduction
22/4/15	0.420	0.270	36
29/4/15	0.450	0.270	40

There were concerns that aeration would potentially strip chlorine residuals from the water supply also, however, this hasn't proven to be the case in the results obtained in the trial. These findings are consistent with AWWA (2013) who reports that;

> *THM's … are very susceptible to removal by aeration while not significantly reducing existing chlorine residual levels*

5.6.5.5. Other Water Quality Issues

Removal of Iron and Manganese

Iron and Manganese are prevalent in the Fraser Coast Water Supply, and can cause customer complaints, particularly when these metals precipitate during laundering. Manganese can also deposit on the interior of water mains, reducing the internal bore of the main and increasing maintenance requirements. It is also known that soluble iron and manganese can be assimilated by iron and manganese bacteria to form biofilms on reticulation pipe walls.

Manganese levels in the raw water supply exceed the ADWG (2011) of 0.5mg/L on occasion as shown in the following graphs (Figure 5-31 through to Figure 5-37).

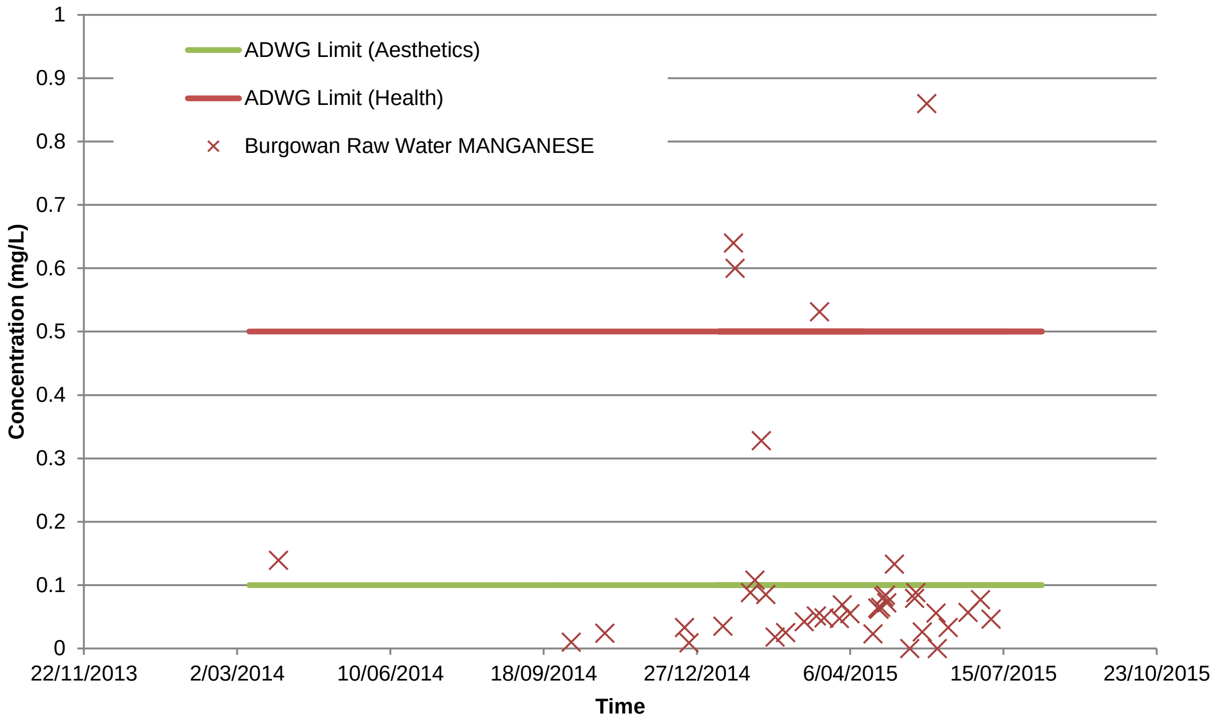


Figure 5-31: Burgowan Raw Water - Manganese Concentrations

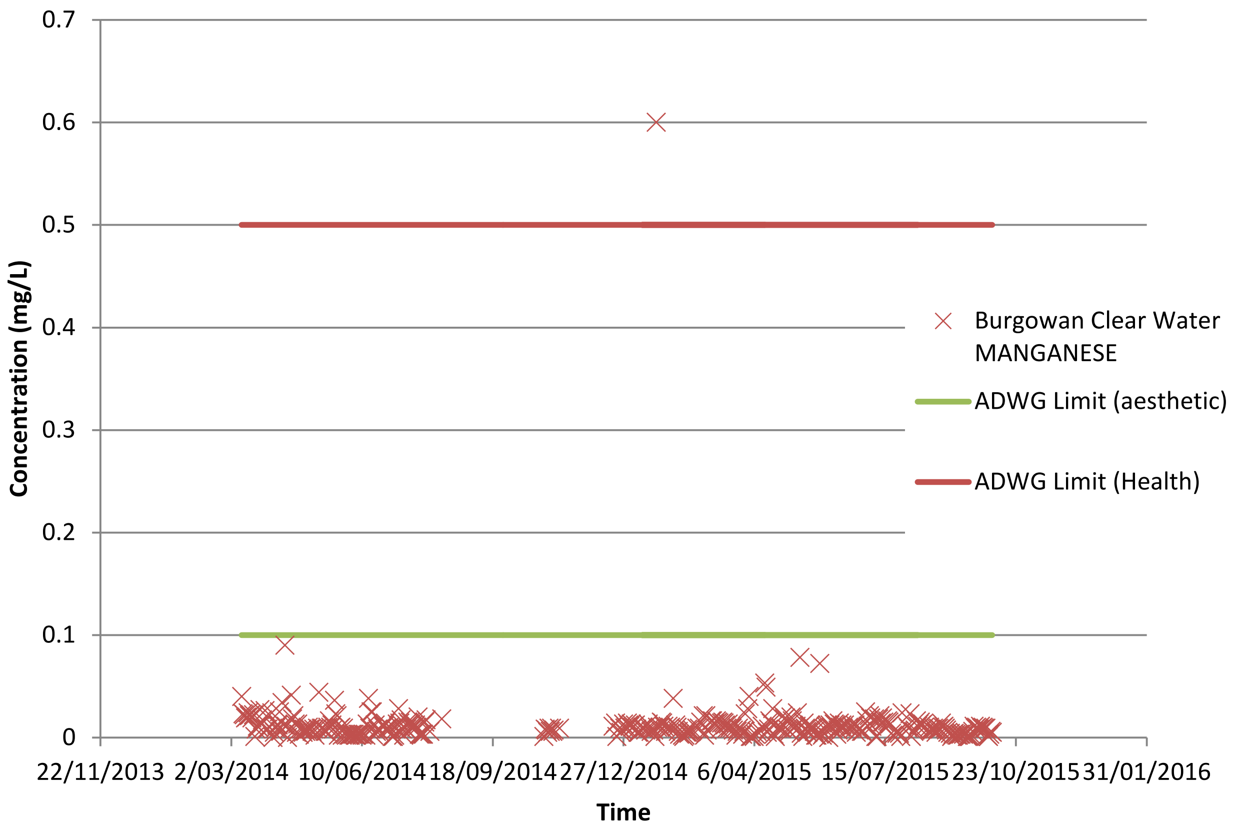


Figure 5-32 Burgowan Clear Water - Manganese Concentrations

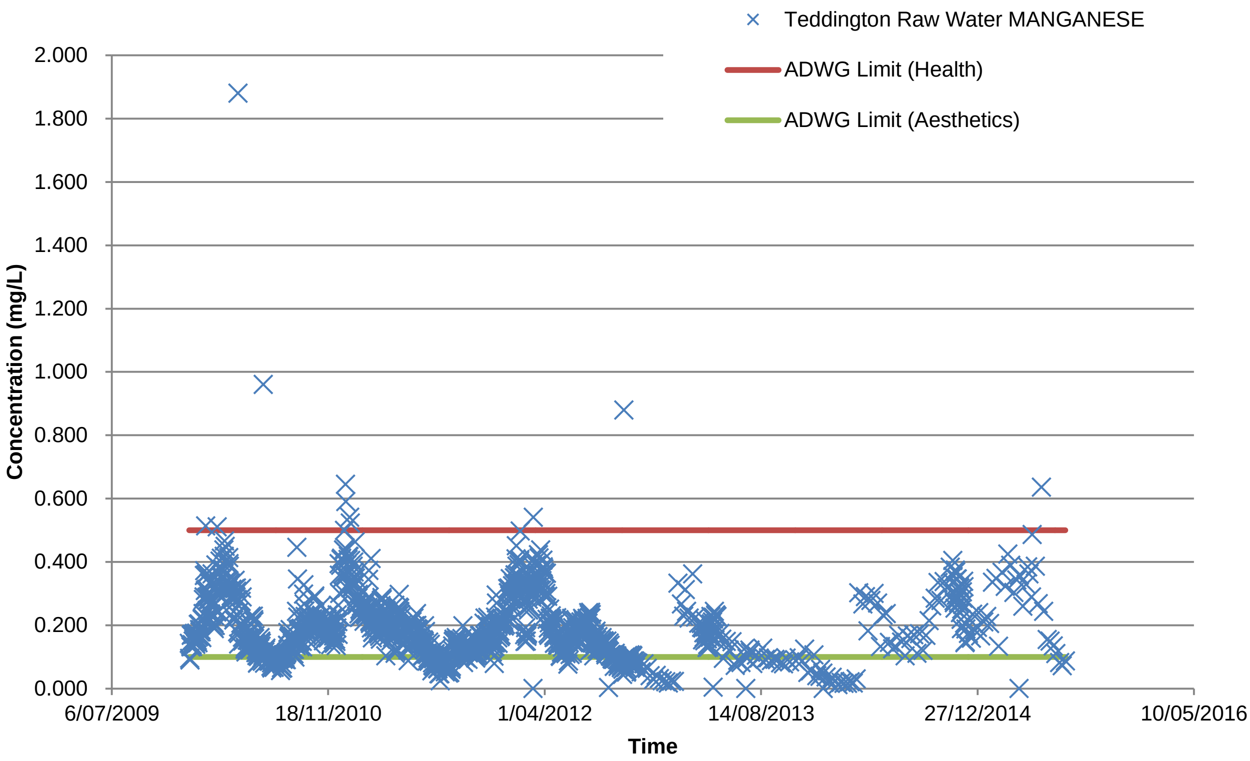


Figure 5-33: Teddington Raw Water - Manganese Concentrations

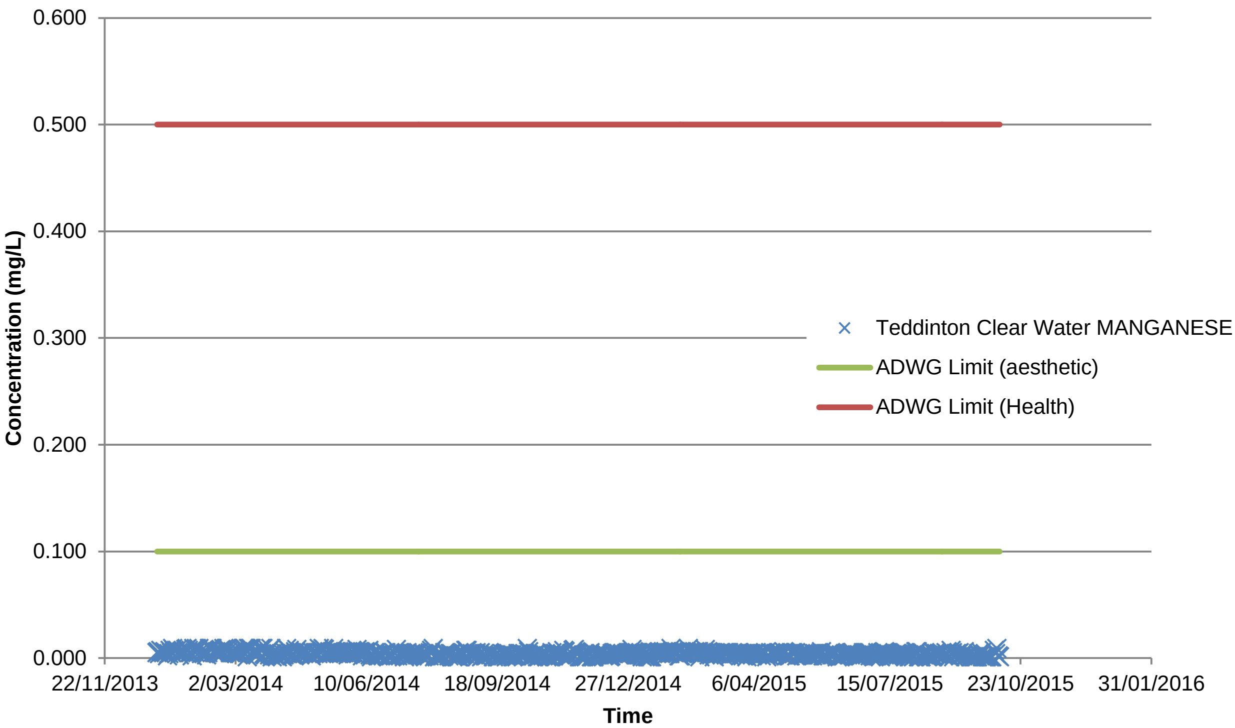


Figure 5-34 Teddington Clear Water - Manganese Concentration

While there is no current health limits on the concentration of iron in water supplies, the measured iron levels regularly exceed the aesthetic value in the ADWG (2011).

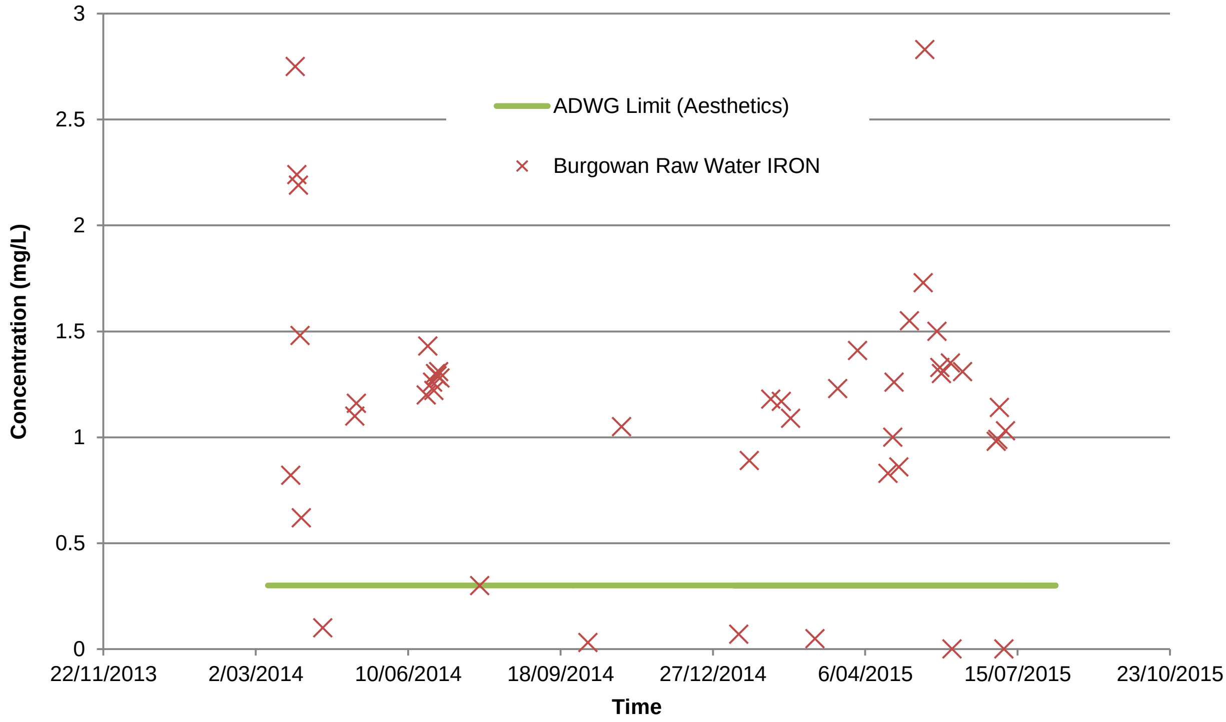


Figure 5-35: Burgowan Raw Water - Iron Concentrations

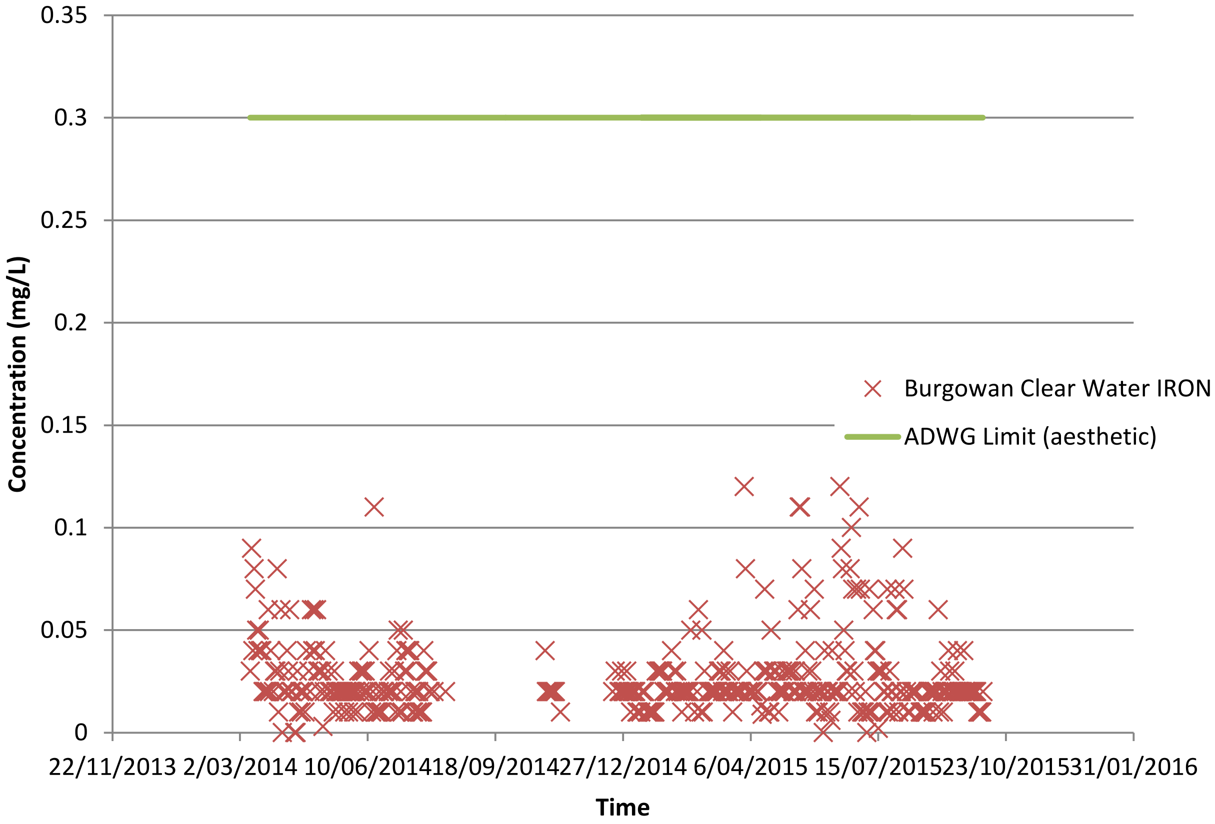


Figure 5-36 Burgowan Clear Water - Iron Concentrations

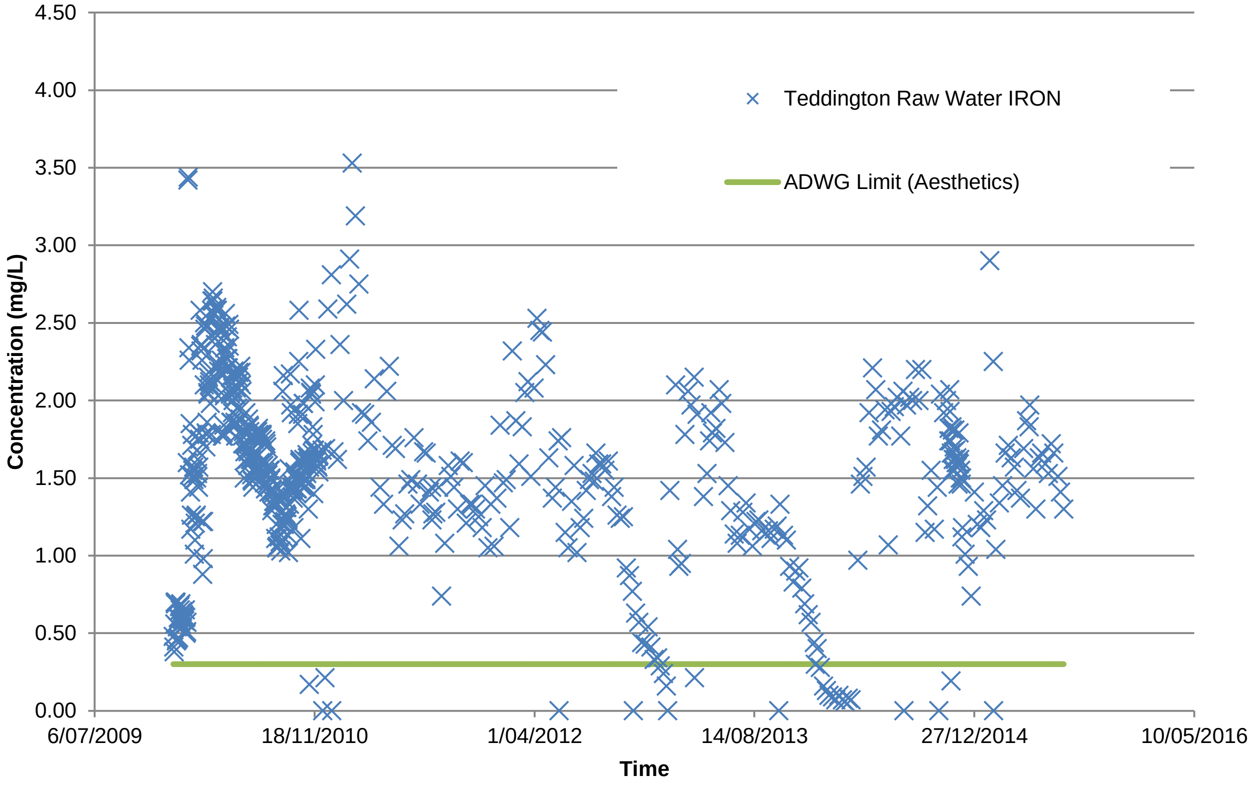


Figure 5-37: Teddington Raw Water - Iron Concentrations

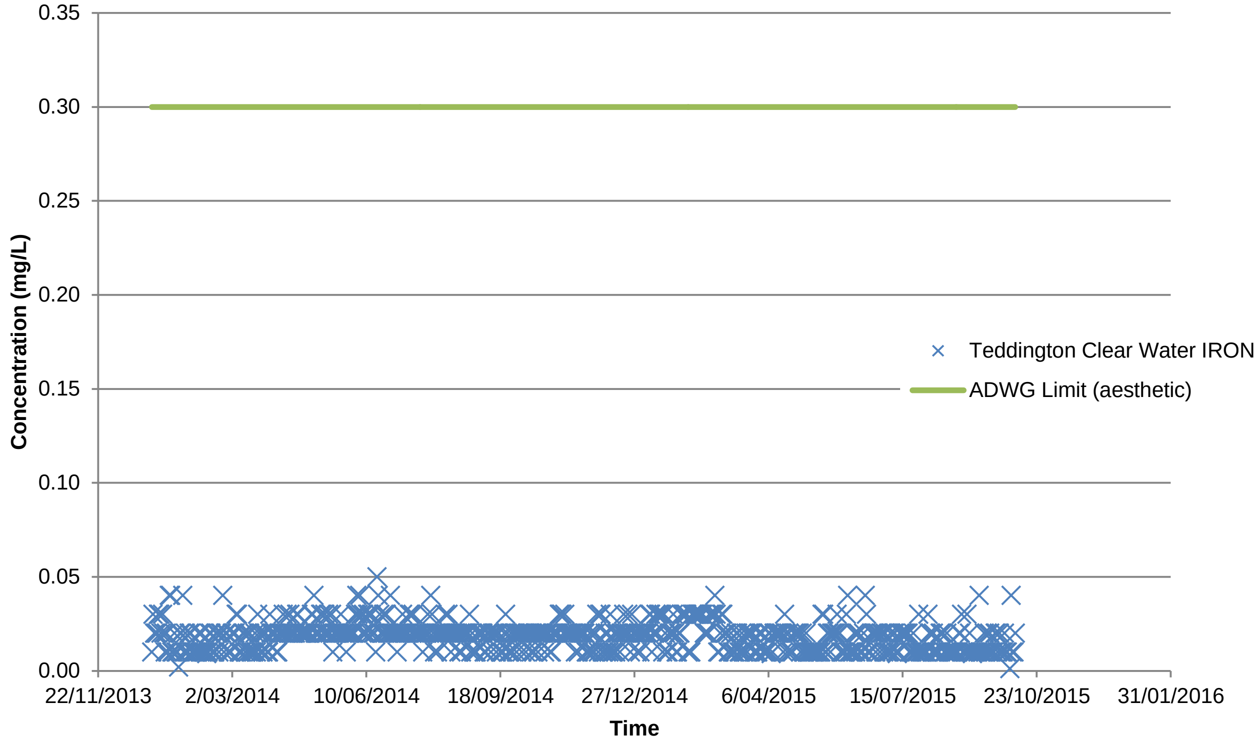


Figure 5-38 Teddington Clear Water - Iron Concentration

Currently WBWC uses chlorination to oxidise iron and manganese for removal by filtration and as can be seen from Figure 5-31 through to Figure 5-38 the current treatment processes achieve consistent reduction in manganese and iron. However, as discussed in Section 5.6.5.4 the use of chlorine as an oxidising agent encourages the formation of THM's.

In addition to some of the other strong oxidation methods discussed earlier in the section for the disinfection of water supplies which are effective in oxidising iron and manganese, the following methods can be used to remove iron and manganese from the water supply.

- Aeration
- Potassium Permanganate

Aeration

Aeration is reasonably effective for the oxidisation of soluble iron because the rate of reaction is relatively quick. The rate of reaction for the removal of manganese is relatively slow and therefore aeration is not usually considered for the removal of manganese.

Potassium permanganate

Potassium permanganate is a reasonably strong oxidiser and is quicker at oxidising manganese then chlorine (HWA, 2012). Potassium permanganate does not decrease the chlorine demand of the treated water but using it as a pre-oxidant in the place of chlorine, puts the initial chlorine dosing further downstream in the process. Potassium Permanganate is a powerful oxidant and therefore it is important that the potassium permanganate be fully removed from the water prior to transmission for consumption (WBWC, 2011). Failure to fully remove or use all the potassium permanganate may result in discoloured (pink) water.

The use of potassium permanganate to oxidise iron and manganese has the added advantages of;

- Enhancing flocculation and sedimentation.
- Dosing is simple and well understood in the industry.
- Reducing organic carbon.
- Taste and odour removal.

5.6.5.6. Proposed Strategies

Disinfection

The proposed strategy is to maintain the chlorine disinfection systems using gaseous or liquid chlorine and implement management strategies for minimising the production of THM's.

- Reduce reservoir levels during months May through to August inclusive as recommended in this report.

- Reduce the boosted chlorine levels during the months May through to August inclusive as recommended in this report.
- Reduce detention times in transmission mains.

Reduction/Removal of THM's

The Teddington WTP Disinfection By Product Report (WBWC, 2010) recommends that the approach to lowering THM's is to attempt to comply with the ADWG by;

- Minimising the detention times in the transmission system.
- Introducing aeration into the Two Mile Reservoir.
- Scouring and maintenance of water mains.

The recommendations of the original report were enhanced to also include

- Additional aeration of Boys Ave No.2 Reservoir.
- Modification of pipework from Aberdeen Ave to Boys venue to direct all water from Two Mile Reservoir to Boys Ave Reservoirs to allow the reservoirs to operate in series.

Once Ann St DMA is implemented consideration will be given to the implementation of aeration at this site.

Should these measures not reduce THM levels to below ADWG limits then and secondary strategy consisting of the implementation of ozone/BAC or similar process for the destruction of THM forming organics may need to be implemented, prior to chlorination, at the Teddington WTP.

As discussed in a previous section of the report the preferred option for the Hervey Bay network is to consolidate water treatment at the Burgowan WTP and no longer use the Howard WTP for the public supply. As such, any treatment plant upgrades would occur at Burgowan WTP. The Burgowan WTP produces water with approximately half of the DOC of Howard (WBWC, 2011, Table 3). This reduced DOC is partially explained because Burgowan has two water sources it can choose from; Burrum River and Cassava Dams. Cassava is known to have less NOM than the Burrum River. None the less, part of the reduction is due to the Ozone/BAC treatment process which reduces the NOM.

The following chart is reproduced from the Hervey Bay Disinfection By-Product Report (WBWC, 2011). It demonstrates that the greater the usage of Howard the greater the THM level in the system. Clearly reducing the amount of water produced from Howard has a significant impact on the THM production. In fact with the data available it can be seen that ADWG values for THM (0.25mg/L) are not exceeded when Burgowan is exclusively used to treat water for Hervey Bay.

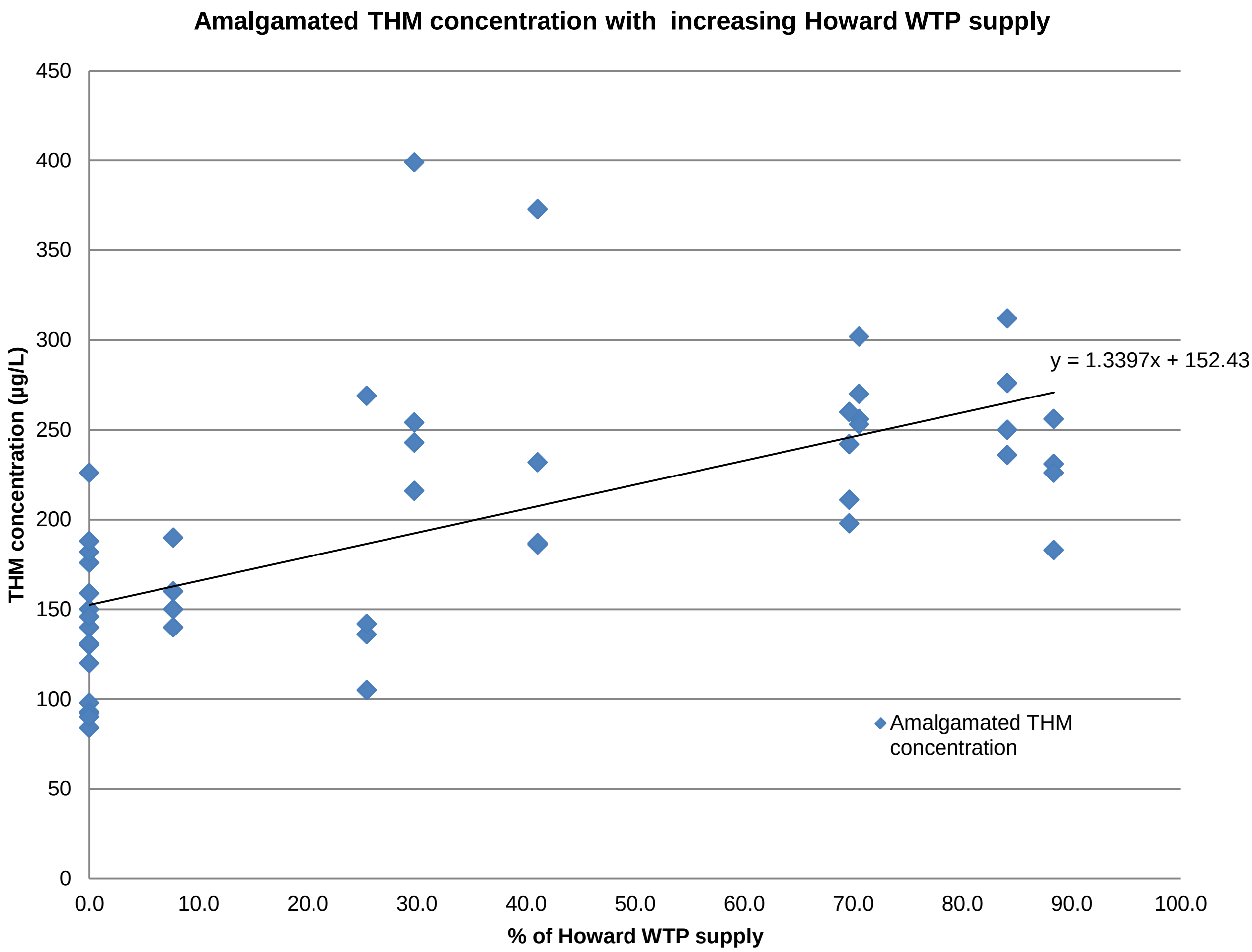


Figure 5-39: THM formation with varying % supply from Howard WTP (source: WBWC, 2011, Figure 2)

Removal/ Reduction of Manganese/Iron

Potassium permanganate (KMnO4) is used primarily to control taste and odours, remove colour, control biological growth in treatment plants, and remove iron and manganese. In a secondary role, potassium permanganate may be useful in controlling the formation of THMs and other DBPs by oxidizing precursors and reducing the demand for other disinfectants (Hazen and Sawyer, 1992). The mechanism of reduced DBPs may be as simple as moving the point of chlorine application further downstream in the treatment train using potassium permanganate to control taste and odours, colour, algae, etc. instead of chlorine. Although potassium permanganate has many potential uses as an oxidant, it is a poor disinfectant (EPA, 1999).

The proposed strategy is to trial potassium permanganate as an alternative oxidising agent for the removal of iron and manganese. If the trials are successful, then implement them into the water treatment plants throughout the Fraser Coast, primarily at Teddington WTP but potentially extending to Burgowan WTP also.

5.7. Demand Management

Further demand management initiatives, compulsory fitting of rainwater tanks to all new residential buildings, pricing initiatives and on-going public education programs could assist in deferring the need for augmentation of the treatment capacity at WBWC's WTP facilities and may defer water source augmentation also.

Water saving devices, retrofitted to large commercial users such as hospitals and hotels have generated some promising results for other water utilities around Australia. However most of these areas have very high water consumption per capita. The water consumption per capita is reasonably low in the Fraser Coast so demand management may have a reduced affect here. Demand management can provide some benefit to a valuable resource and should be investigated further.

Any decrease in water consumption needs to be long term, and therefore these programs will need to be ongoing for full effectiveness.

RECOMMENDATION: Investigate the cost and benefit of demand management initiatives for the Fraser Coast in 2018 at a cost of $60k.

6. 20 YEAR CAPITAL EXPENDITURE PROGRAM

The detailed 20 year program is included in Appendix 1. It extends to 2046 with some projects. The total program to 2031 is $127m.

Table 6-1: Capex Program to 2031

Year	Cost($000's)
2016	10,224
2017	3,764
2018	7,083
2019	8,837
2020	5,703
2021	31,860
2022	1,531
2023	1,513
2024	1,195
2025	2,453
2026	4,338
2027	33,252
2028	1,453
2029	614
2030	4,362
2031	8,499
Total	**126,681**

Table 6-2: Capex Program 2031 - 2046

Year	Cost($000's)
2032	1,528
2033	2,506
2034	3,119
2035	566
2036	2,513
2037	1,679
2038	1,982
2041	4,963
2046	93,182
Total	**112,038**

Some operational planning projects have been identified during the process of preparing this report. These projects are investigative by nature and require some assessment and optioneering prior to a decision being made on capital expenditure. These types of projects are deemed operational and are identified for inclusion in the operational budgets.

Table 6-3: Operational Expenditure Program to 2031 Identified from Capex

Year	Cost ($000's)
2016	205
2017	275
2018	180
2019	80
2023	200
Total	**940**

The following graph shows the forecast expenditure over the 2016-2046 period identified in this report. There is significantly higher expenditure in the first few years due to asset replacements due to condition of the Cast Iron pipelines in Maryborough. Year 2021 shows significant expense due mostly to the installation of a 24km link between Hervey Bay and Maryborough at a cost of $31m. In 2027 there is significant expenditure for the upgrade to the Burgowan WTP at $30m. The other significant variance is in year 2046, this is due to the need for a new source supply at this time, at an estimated cost of $91m.

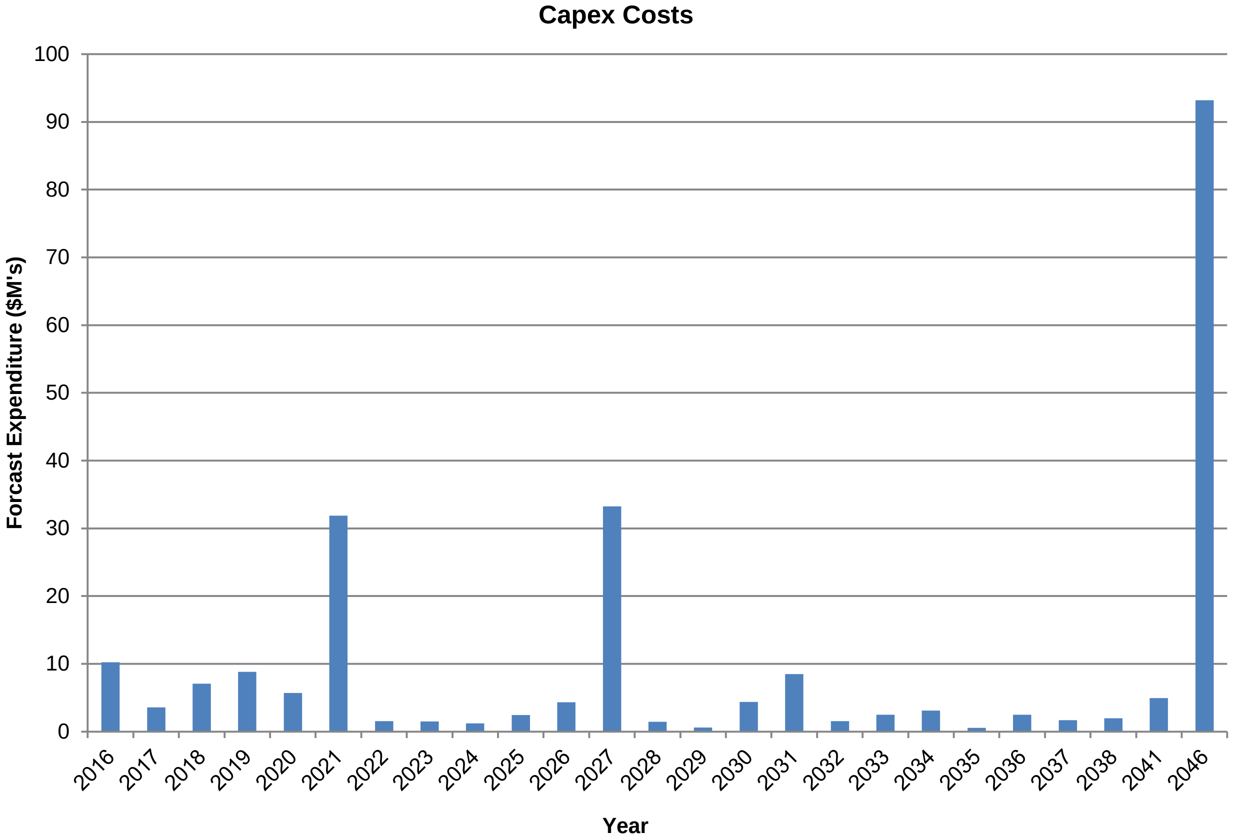


Figure 6-1: Capex Expenditure Identified in this Report

6.1. Impact on Infrastructure Charges

An estimate of infrastructure charges to the 2031 timeframe across the entire Fraser Coast has been developed to allow comparison between projected costs and the amount recouped from developer charges.

The infrastructure costs over the period was restricted to projects that are considered headwork's and;

- are water quality projects,
- benefit multiple land owners (generally pipelines over DN150),
- are growth projects,
- are required to meet firefighting requirements,
- are required for reliability or standards of service,
- Is not a replacement project.

Table 6-4: Costs used for Infrastructure Charges ($000's)

Sum of Cost ($000's)							
Project Type	**Efficiency**	**Fire Flow**	**Growth**	**Reliability**	**SOS**	**Water Quality**	**Total**
DMA	85						85
Reservoir			2006				2,006
Treatment			35,500			7,659	43,159
Water Main		2,074	25,317	32,003		105	59,499
Water PRV			65				65
Water Pump Station			3,509	450	360		4,319
Grand Total	**85**	**2,074**	**66,397**	**32,453**	**360**	**7,764**	**109,133**

Based on a residential and non-residential ED growth of 16,500ED (to 2031) and a capital expenditure of $109m, the cost to provide water infrastructure to meet projected demands is estimated at $6,640/ED.

State Government currently caps developer charges in Queensland under the State Planning Regulatory Provisions (SPRP) at a maximum total charge of $28,000 for dwellings. Determining charges for non-residential development is more complex and based on floor area.

Currently the proportion of developer charges allocated to water infrastructure is 7% (source: FCRC Management Policy - Table 1). This equates to approximately $1,596/ED using the current charge of $22,800 for a residential lot.

7. CONCLUSIONS

The development of a Water Supply Strategy document for WBWC has provided the basis of a capital development programme covering the period to 2031 and also identifying some major capital development projects through to 2046.

A capital investment program valued at $127m will be required to the year 2031, with some major expenditure for water security and upgrades to the Burgowan WTP in Hervey Bay. $940k has been identified for investigative and planning studies over this period.

An additional $113m has been identified in capital investment works between 2031 and 2046. The majority of expenditure during this period is due to the need for a new water source to sustain the forecast growth in the region.

Many assumptions are made in the preparation of the water supply strategy including demand forecasts, demand per property and likely sequencing of development activity. These factors change from time to time and require review periodically.

8. RECOMMENDATIONS

The following recommendations are made with respect to the above report:

1. That the WBWC Board adopts the Fraser Coast Water Supply Strategy Report 2015 as the basis for partial development of a Capital Works Programme for the period to 2031 with major projects identified to 2046.

2. That the WBWC Board notes the required expenditure of $127m for capital investment and $940k for investigations and planning studies to the year 2031.

3. That this Water Supply Strategy report be reviewed every five years, as a minimum, to address any changes to water demand, population growth rates and development sequencing.

9. REFERENCES

1. API, 2015, DataBank – Vacancy Rates, Australian Property Investor, March 2015, pp 116.

2. AWWA, 2013, "White Paper on Aeration to Reduce Trihalomethane's", Ohio Section.

3. Cardno, 2009, "Maryborough – Water Supply Planning Report", Cardno, QLD

4. Cardno, 2012, "Two Mile Reservoir Structural Investigation and Options Report", Cardno , QLD

5. Cardno, 2012, "Ann Street – Reservoir 21 Reservoir Structural Investigation and Costings Report", Cardno , QLD

6. Cardno and Davies, 1998, "Maryborough City - Water Supply System Water Supply Planning Report - Final Draft", Cardno and Davies, QLD

7. Cardno and Davies, 1999, "Maryborough City Council – Fire Flow Investigation", Cardno and Davies, QLD

8. DEWS, 2014, "Planning Guidelines for Water Supply and Sewerage", Department Energy and Water Supply, DEWS, March 2014

9. DLGP, 2011, "Wide Bay Burnett Regional Plan", Department Local Government and Planning, QLD

10. DNR&M, 2005, Letter regarding groundwater investigations around Maryborough, Natural Resources and Mines , QLD

11. EM Operations, 2014, "Drinking Water Quality Management System – Manual – Drinking Water HACCP Plan", WBWC, Hervey Bay

12. EPA, 2011, *Water Treatment Manual Disinfection*, web document accessed 27 May 2015, *http://www.epa.ie/pubs/advice/drinkingwater/disinfection2_web.pdf*

13. EPA, 1999, *Alternative Disinfectants and Oxidants*, CH5, EPA

14. Hunter Water Australia, 2003, "Review of Chemical Dosing Systems – Teddington WTP", HWA, Newcastle

15. Hunter Water Australia, 2012, "Shoalhaven Water Disinfection Strategy Discussion Paper", HWA, Newcastle

16. Hunter Water Australia, 2012, "Teddington WTP THM Formation Jar Testing", HWA, Newcastle

17. JWP, 1994, "Hervey Bay Water Supply – Strategy Report on Water Supply and Augmentation Works to the Year 2004", John Wilson and Partners, Brisbane, QLD

18. JWP, 2001, "Hervey Bay Future Water Source Options Study", John Wilson and Partners, Brisbane, QLD

19. Kohpaei, A.J. & Sathasivan, A., 2011, "Chlorine decay prediction in bulk water using the parallel second order model: An analytical solution development",

20. Kowalska, B. et al, 2006, "Chlorine Decay in Water Distribution Systems", Environmental Protection Engineering, vol 32, no. 2

21. Liemberger, R., 2005, Water Loss Performance Indicators, article accessed 12 August 2015, http://www.miya-water.com/user_files/Data_and_Research/miyas_experts_articles/2_NRW/15_Water%20Loss%20Performance%20Indicators.pdf

22. Mohammed, R. , 2011, "Effects of Flow Rate and Pipe Diameter on Wall Chlorine Decay Rates",

23. Montgomery Watson, 1999, Hervey Bay Water Supply System Water Quality Strategy Study, Montgomery Watson, October 1999

24. SunWater, 2014, “Fees and Charges Schedule 2014-15 - Burnett Water Prices Paradise Dam” website accessed 31/3/15, http://www.sunwater.com.au/__data/assets/pdf_file/0020/13619/Fees_Charges_Schedule_-_Burnett_Water_2014-15.pdf

25. SunWater, 2014, “Fees and Charges Schedule 2014-15 – Lower Mary River” website accessed 31/3/15, http://www.sunwater.com.au/__data/assets/pdf_file/0012/13440/Fees_and_Charges_Schedule_-_Mary_River_Lower_2014-15.pdf

26. Watson, D. & Wedlock, B., 2005, “Country to Coast - a healthy sustainable future VOLUME 5F Priority Action Plan 2 PAP 2.1 Water Quality Theme Mary and Burrum Basins - Final Reports”, Burnett Mary Regional Group.

27. WBWC, 2009, “Water Supply Strategy 2009”, WBWC, Hervey Bay, QLD

28. WBWC, ?, “Process Review – Maryborough Water Treatment Plant”

29. WBWC, 2011, “Teddington WTP Disinfection By-product Report - An investigation and proposal for the reduction of THM formation”, WBWC, Maryborough, QLD

30. WBWC, 2011, “Hervey Bay Disinfection By-product Report - An investigation and proposal for the reduction of THM formation”, WBWC, Hervey Bay, QLD

31. WBWC, 2014, “DRAFT REPORT Fraser Coast Water Supply - Water Grid and Future Source”, August 2014, Hervey Bay, QLD

32. WBWC, 2014, “Briefing Report – Raw Water Options Fraser Coast”, WBWC , Hervey Bay, QLD

33. WSAA, 2002, “WSA 03 – 2002 - Water Supply Code of Australia”, Water Services Association of Australia, 2002

34. Yode, Y. 2006, “Marabrough Water Quality Enhancement Project”, Newcastle, HWA.

35. Yonkyu, C. 2009, “The effects of UV disinfection on drinking water Quality”, Water Research, pp115-122.

WIDE BAY water
CORPORATION

29-31 Ellengowan Street
Hervey Bay Queensland 4655
t 1300 808 888
f 07 4125 5118
www.widebaywater.qld.gov.au

water today water tomorrow