Drought Response Plans for:

Otway Water Supply System,
Grampians Water Supply System,
Glenthompson Water Supply System, and
Groundwater Supply Systems

Dated:

November 2011

Report Name:	**Wannon Water Drought Response Plans**
Report Custodian:	**General Manager Assets**
Checked by:	**Executive Committee**
Approved by:	**Board of Wannon Water**
Date:	**18 November 2011**
Version No:	**6**

PO Box 1158
Warrnambool 3280

Dated: November 2011

Contents

Appendices

Part A

General

A1. Introduction

A1.1 Wannon Region Water Corporation

Wannon Region Water Corporation (Wannon Water) is a statutory corporation constituted on 1 July 2005 under the Water Act 1989. Wannon Water operates in an area of over 24,500 km^2, providing water and sewerage services to approximately 80,000 people across 34 customer districts.

Wannon Water has prepared a Drought Response Plan which incorporates all water supply systems across its region. The Drought Response Plan represents the following systems:

- Otway Water Supply System including Warrnambool and towns and other users connected to the North Otway pipeline;
- Grampians Water Supply System including the Hamilton system and Balmoral;
- Glenthompson Water Supply System; and
- Groundwater Water Supply Systems including the Port Campbell system, the Tullich system, Caramut, Darlington, Dartmoor, Heywood, Macarthur, Penshurst, Port Fairy and Portland.

These systems are illustrated in Figure A1.

Figure A1 Wannon Water's Water Supply Systems

A1.2 Structure of the Drought Response Plan Document

The content of this Drought Response Plan is summarised as follows:

PART A - General

Provides background information on Wannon Water and the water supply systems within its region, the structure of the Drought Response Plan and details from previous revisions of Drought Response Plans undertaken over recent years.

Part A also provides details relating to the overall legal framework in which Wannon Water manages the water supply systems including; legal entitlements to water, permanent water savings plans, water restriction by-laws and details of reporting responsibilities.

Part A outlines gaps identified in the Drought Response Plan that should be addressed progressively over the coming years.

PART B –Otway Water Supply System Drought Response Plan

Provides details of drought response planning activities specifically relating to the Otway Water Supply System including:

- Descriptions and details of the system, system demands, system yield and level of service objectives;
- A summary of the previously documented impacts of drought on the system and its water customers;
- Details on specific water supply options that have been assessed and could be implemented during periods of water shortage; and
- A sequential plan of action to assist Wannon Water to operate the system during periods of water shortage.

PART C –Grampians Water Supply System Drought Response Plan

Provides details of drought response planning activities, as summarised in Part B above, specifically relating to the water supply systems located within the Grampians System.

PART D –Glenthompson Water Supply System Drought Response Plan

Provides details of drought response planning activities, as summarised in Part B above, specifically relating to the Glenthompson Water Supply System.

PART E – Groundwater Supply Systems Drought Response Plan

Provides details of drought response planning activities, as summarised in Part B above, specifically relating to the water supply systems supplied by Groundwater.

A1.3 Revisions to Drought Response Plan

The previous Drought Response Plan was last updated in 2006 to amalgamate all drought planning documents held by predecessor organisations to Wannon Water.

This 2011 update of the Drought Response Plan is largely based on the 2006 Drought Response Plan. Specific variations have been made to;

- Improved linkages with the longer term supply and demand options detailed in the 2012-2060 Water Supply Demand Strategy (currently in preparation);
- General updating of system descriptions to reflect current configurations and operating practices;
- Updating with experiences from recent drought;
- Updating the operational and reporting framework which describes the processes Wannon Water implements to monitor system performance and initiate actions to respond to water shortages. This framework includes the establishment of a Drought Response Monitoring Committee; and
- Updating the drought response action plans to better reflect all available short term supply and demand options, which are aligned with triggers to initiate action as the water supply situation declines.

A1.4 Drought Response Plan Objectives

The purpose of this Drought Response Plan is to ensure a timely and effective short-term response to water shortages, with the aim of minimising the impacts (social, economic, and environmental) of such shortages.

There are two components involved in securing a water supply which provides the ability to mitigate the impacts during times of drought:

- The provision of an adequate supply system to satisfy current and future demands over a range of climatic conditions ensuring that shortfalls in supply are within 'acceptable' levels; and
- The specification of actions required when shortfalls in water supply occur as a result of drought.

The first component represents long term planning actions that determine the level of infrastructure development required to satisfy specified standards of supply.

The second component relates to management actions that are required to minimise the impacts of shortfalls in supply, which is the purpose of this Drought Response Plan.

The Drought Response Plan complements the long term planning process where the short term response needs to be aligned with the longer term security of supply (i.e. knowledge of the likely frequency and severity of water restrictions).

The aim of this Drought Response Plan is to ensure that key strategic, planning and operational objectives are met. The strategic, planning and operational objectives are summarised in Table A1.

Table A1 Strategic, Planning and Operational Objectives

Strategic Objectives
Provide timely warning of any water shortages which might occur during future drought events and to be prepared to deal with such shortages when they occur.
Develop and implement an appropriate action plan to respond to water shortages.
Planning Objectives
Identify all the necessary steps that need to be taken through a drought including identifying clear triggers to instigate actions.
Provide a basis for regular reviews of the plan as the system develops and more information becomes available.
Give direction for reviewing the plan during and following a drought where its performance can be evaluated.
Provide clear indicators to ensure that a reliable assessment of drought status is available.
Operational Objectives
Ensure that Wannon Water is aware of what stage of drought they are in and how severe the drought is likely to be.
Ensure that Wannon Water maintains information on current levels and patterns of demand and continually assesses customer expectations in relation to desirable levels of service.
Wannon Water commits to providing its urban and rural customers (excluding customers supplied by agreement) with a reliable water supply free of water restrictions on average for 95 in every 100 years.
During times of drought or water shortage, Wannon Water aims to ensure that its urban and rural customers (excluding customers supplied by agreement) are not restricted in their use of water beyond Stage 3 water restrictions.
During times of drought or water shortage, customers supplied by agreement will be restricted in accordance with the terms of their agreement.

A2. Legal and Institutional Context

A2.1 Introduction

Wannon Water sources water from a combination of surface water and groundwater resources under the provisions of the Water Act 1989. The quantity of water that may be harvested is specified in bulk entitlements for surface water resources and in groundwater licences for groundwater resources. These entitlements are described in the following sections.

Wannon Water's Statement of Obligations imposes obligations in relation to the performance of its functions and exercise of its powers as described in the Water Industry Act 1994. In relation to drought response, Section 18 requires Wannon Water to develop and implement an effective Drought Response Plan for each water supply system and make its drought response plans available to the public. In addition, Wannon Water is required to review, and if necessary amend, its drought response plans as follows:

(a) at intervals of no more than five years; and

(b) within twelve months of either:

(i) the lifting of any period of restriction imposed under the Drought Response Plan; or

(ii) any major change occurring to works or arrangements for conserving water for, or supplying water to, any water supply system.

A2.2 Bulk Water Entitlements (Surface Water)

Surface water diversions across the supply systems are defined in the Bulk Entitlement Conversion Orders (BEs). The BEs for the various systems define annual diversion limits as well as other operational requirements. The BEs currently held by Wannon Water are listed below and summarised in Table A2.

The relevant BEs include:

- Bulk Entitlement (Otway System) Conversion Order (1997);
- Bulk Entitlement (Hamilton) Conversion Order (1997);
- Bulk Entitlement (Wimmera and Glenelg Rivers – Wannon Water) Order 2010;
- Bulk Entitlement (Dunkeld) Conversion Order (1997);
- Bulk Entitlement (Glenthompson) Conversion Order (1997); and
- Bulk Entitlement (Coleraine, Casterton & Sandford) Conversion Order (1997).
- Bulk Entitlement (Willaura system – Wannon Water) Conversion Order 2011 (subject to a current application)

Table A2 Summary of Bulk Entitlement Conversion Orders

Supply System	BE Order	Maximum Annual Diversion (ML)	Other Conditions
Otway	Bulk Entitlement (Otway System) Conversion Order (1997)	12,580 ML	◗ Maximum diversion rates from sites with the Gellibrand Catchment. ◗ Subject to flow sharing rules.
Grampians	Bulk Entitlement (Hamilton) Conversion Order (1997)	3 ,435 ML	◗ Plus drought reserve of up to 520 ML/a. ◗ Passing flow requirements in tributary streams. ◗ Extraction rate not to exceed 12.8 ML/d.
	Bulk Entitlement (Wimmera and Glenelg Rivers – Wannon Water) Order 2010[1]	2,120 ML	◗ Annual water availability declared by seasonal allocation. ◗ Includes ability to carryover unused allocation from year to year. ◗ Includes water available for Balmoral.
	Bulk Entitlement (Dunkeld) Conversion Order (1997)[2]	170 ML	◗ Emergency supply for Dunkeld.
Glenthompson	Bulk Entitlement (Glenthompson) Conversion Order (1997)	94 ML	◗ Extraction rate not to exceed 0.9 ML/d.
	Bulk Entitlement (Willaura system – Wannon Water) Conversion Order 2011[3]	58 ML	◗ Extraction rate not to exceed 0.55 ML/d.
Konongwootong	Bulk Entitlement (Coleraine, Casterton & Sandford) Conversion Order (1997)[4]	855 ML	◗ Extraction rate not to exceed 4.5 ML/d. ◗ Supply for rural customers. ◗ Emergency supply for the Casterton system.

1. Primary supply source for Balmoral and secondary supply source for Hamilton.
2. Dunkeld was connected to the Hamilton system in 1999. Resource now kept as an emergency supply.
3. Willaura System volume and conditions are subject to an application for a Bulk Entitlement Conversion Order.
4. Casterton and Sandford were switched to 100% groundwater in 2004. Coleraine switched to 100% groundwater in 2009. The surface water resource (Konongwootong) will be kept as an emergency supply. Merino connected to system in December 2005.

Prior to 2010, Balmoral accessed water from Rocklands Reservoir under the Bulk Entitlement (Wimmera and Glenelg Rivers – Glenelg Water) Conversion Order 2004. This entitlement has now been consolidated into the Bulk Entitlement (Wimmera and Glenelg Rivers – Wannon Water) Order 2010. This increased entitlement volume allows water to be accessed for both Balmoral and the Hamilton systems.

A2.3 Groundwater Entitlements

Existing groundwater licences for water supply bores are summarised in Table A3 below.

Table A3 Summary of Groundwater Licence Volumes

System	Location	Licence No.	Number of Bores	Licensed Annual Volume (ML)
Otway	Koroit	841811	2	524
	Warrnambool	924202	3	750
	Mortlake	907049	2	335
	Carlisle River	9016487	2	1,800
	Curdie Vale	904309	1	2,150
Grampians	Bullawin, Headworks, Geerak, McCutcheons	911313	4	1,102
Groundwater	Casterton	885355	4	1,000
	Merino[1]	903701	2	100
	Port Campbell	904309	**1**	1,009
	Penshurst	914444	2	250
	Macarthur	4001451	1	130
	Caramut	924563	2	50
	Darlington	908150	2	10
	Portland	923621	3	6,222
	Heywood	900184	2	333
	Port Fairy	89042	2	1,026
	Dartmoor	9016786	1	170

1. Merino bores are no longer used.

A2.4 Permanent Water Savings Plan

In May 2006, Wannon Water introduced its Permanent Water Savings Plan designed to generate ongoing long-term water savings. The Permanent Water Savings Plan was subsequently revised and approved by the Minister for Water in August 2007. The Permanent Water Savings Plan is currently under review The rules in the Permanent Water Savings Plan are designed to support the commitment that Victorian communities have made to using water more efficiently.

The Permanent Water Savings Plan sets out a set of common sense rules that apply to our customers everyday use of water. The Plan aims to encourage the efficient use of water to avoid wasting this precious resource. The anticipated annual savings from such measures is expected to be about 2% of pre-2006 unrestricted demand through the implementation of the measures. The actual savings will vary considerably across the water supply systems, depending on the relative proportion of urban, rural, industrial and commercial customers.

This document assumes that water savings from the current Permanent Water Savings Plan have been already been achieved and are therefore included in estimates of current (2011) average annual demand presented throughout this document.

A copy of the Permanent Water Savings Plan is provided in Appendix A.

A2.5 Water Restriction By-Laws

Mandatory water restrictions provide an effective mechanism to reduce urban demand during times of water shortage. Water restrictions are designed to predominately impact on non-essential water uses (for example, garden watering and filling of pools), and minimise the impact on the use of water for commercial purposes, public health and essential residential use.

Wannon Water has developed a Schedule of Restrictions in accordance with the Victorian Uniform Drought Water Restriction Guidelines (VicWater, 2005). The restriction schedule has been given legal effect under By-Law No. 4. A copy of the By-Law is provided in Appendix B. The By-Law is currently under review.

Wannon Water's adopted restriction schedule defines four successive stages of water restrictions. The anticipated water savings under each stage of restriction effects storage response and assists to maintain the required level of water security. The estimated savings for each stage and the associated trigger levels for the implementation of water restrictions are described further in each of the relevant Drought Response Plans provided in the subsequent parts of this document.

A2.6 Responsibilities and Reporting

The communication of the status of each supply system leading into, during and following drought conditions forms an integral part of drought response planning.

There are various communication levels and protocols mandated by Wannon Water according to three separate modes of operation, these being; General Monitoring, Heightened Awareness and Drought Response. Table A4 summarises the reporting obligations. The operational modes detailed in this table are described further in each of the Drought Response Action Plans in the following sections.

Table A4 Summary of Reporting Obligations

Mode	Communication Actions	Purpose
1	General Monitoring	
	System Status Report	Weekly report providing base information on current supply-demand balance and trends. Prepared for the Executive Management Team for briefing and endorsement of recommendations.
	Annual Water Security Outlook	Report prepared in November each year covering current and forecast future supply status for each system. Prepared for the Executive Management Team and the Department of Sustainability and Environment.
2	Heightened Awareness	
	System Status Report	Weekly report providing base information on current supply-demand balance and trends. Prepared for the Executive Management Team for briefing and endorsement of recommendations.
	External Communications	Media advertising to increase awareness amongst customers and the community about reduced water availability and to promote water conservation behaviours/activities.
	Monthly Department of Sustainability and Environment Report	Report prepared for Department of Sustainability and Environment to advise current system status and actions being undertaken to monitor potential threats from reduced water availability.
3	Drought Response	
	System Status Report	Weekly report providing base information on current supply-demand balance and trends. Extended to project water supply status over coming 12 – 18 months. Prepared for the Executive Management Team for briefing and endorsement of recommendations.
	External Communications	Media advertising to increase awareness amongst customers and the community about reduced water availability and to promote water conservation behaviours/activities.

A2.7 Monitoring Programs

Wannon Water has comprehensive long term monitoring programs in place to collect data in each of the supply systems for operational, reporting and planning purposes. A summary of the monitoring programs is shown in Table A5 below.

Table A5 Summary of Wannon Water Monitoring Programs

Program	Details
Bulk Water Demand	Flow measurement from all major demand areas and customers. Documented in Quarterly and Annual Water Demand Reports.
Reservoir Monitoring	Storage level and quality readings at all Wannon Water storages. Data is held by Manager Operations Reporting and Projects.
Streamflow Monitoring	Monitors flow in key headworks streams. Data is held by Manager Operations Reporting and Projects.
Groundwater Bore Monitoring	Monitoring of groundwater levels in bores throughout the regions. Data is held by Manager Operations Reporting and Projects.
Climate Data	Climate data for Wannon Water sites is sourced from the Bureau of Meteorology.
Bulk Entitlement Metering Plan	The Bulk Entitlement Metering Plan has been developed for Wannon Water to measure and record compliance with the obligations of each surface water Bulk Entitlement. The Plan contains detailed information on the location and accuracy of meters and other data management information.
Water Security Outlook	This is a spreadsheet database that collates information on the status of each system. The Water Security Outlook provides key information for the preparation of weekly and monthly system status reports.

A3. Gaps in Information

There are several knowledge gaps identified which have prevented the finalisation some aspects of this Drought Response Plan. Wannon Water intends to progressively work on towards addressing these gaps in the coming years. The key gaps requiring further actions are detailed below:

Konongwootong System	• The Konongwootong System provides a raw water supply to rural users under a supply by agreement arrangement. This supply is also an emergency back-up supply for the Tullich groundwater system. Further work is required to understand the potential supply issues during drought periods including consideration for the development of a Drought Response Plan for this system.
Glenthompson Operational Rules	• Following finalisation of the bulk entitlement for the Willaura system, operational rules which detail the conditions for transferring water to the township of Glenthompson will need to be established.
Rural Customers	• Develop a restriction policy for rural customers during times of drought or water shortage.
All systems	• Develop protocols for the easing or removal of restrictions.

Part B

Otway System Drought Response Plan

B1. Otway Water Supply System

B1.1 Details of the Otway Supply System

B1.1.1 System Description

The Otway Water Supply System obtains its primary supply from two pumped offtakes on the Gellibrand River and by gravity diversions from weirs on three Arkins Creek tributaries. Water is diverted westwards via two pipelines to supply the townships of:

- Simpson;
- Camperdown;
- Cobden;
- Derrinallum;
- Lismore;
- Terang;
- Noorat;
- Glenormiston;
- Mortlake;
- Purnim;
- Allansford;
- Warrnambool;
- Koroit; and
- A number of smaller townships and numerous rural properties.

A schematic of the Otway system is provided in Figure B1.

The Otway Water Supply System is supplemented from two groundwater bores at Carlisle River. Supply to Warrnambool, Koroit and Allansford is augmented by a shallow groundwater bore field adjacent to the Warrnambool Water Treatment Plant at Albert Park contributing approximately 9% of the supplied water. The Otway supply to Mortlake is shandied with 30% groundwater from a bore in Prentices Lane Mortlake (Absaloms Bore).

In addition to urban supplies there are close to 1,000 rural connections to the North Otway pipeline. Approximately 460 services supply farms and the small rural communities of Carlisle, Carpendeit, Cudgee and Garvoc direct from the North Otway pipeline. The Camperdown (Otway) Rural District is an area mostly to the north and west of Camperdown providing around 370 services with a domestic, stock and dairy supply. This reticulated system is supplied by pipeline from Donalds Hill Reservoir.

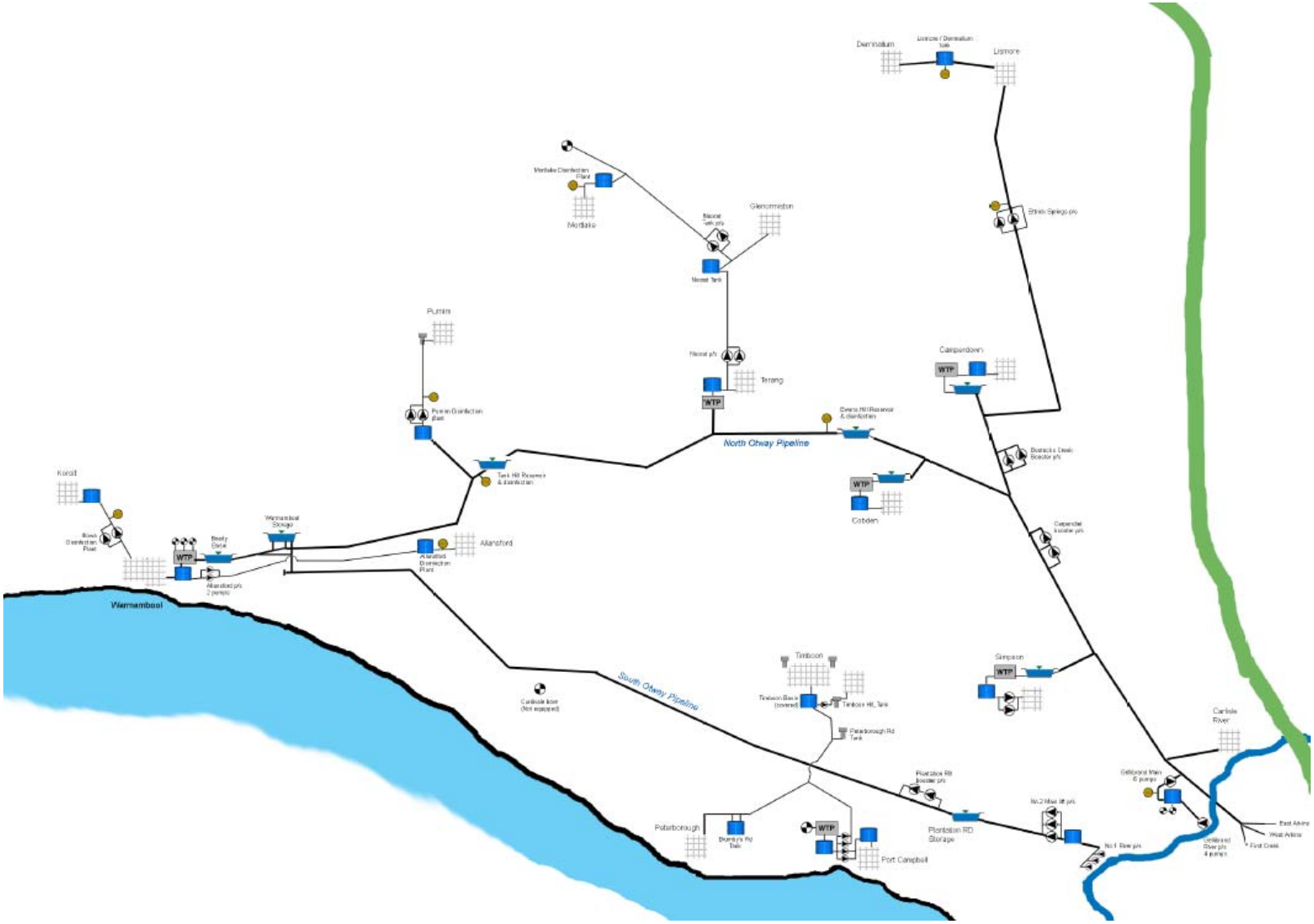
There are no permanent connections to the South Otway pipeline. Temporary connections to enable dam filling from air valves for properties adjacent to the pipeline have been allowed on request.

Diversions from the Gellibrand River at Carlisle and extractions from the Carlisle Bores are used to supplement flows from Arkins Creek into the North Otway pipeline. The maximum capacity of the North Otway pipeline is 22.5 ML/day and the maximum capacity of the South Otway pipeline is 21.5 ML/day.

The bore field at Carlisle River is licensed for a maximum daily extraction of 6 ML/day. This enables diversions from the Gellibrand River to be partly or completely replaced by bore water during a river contamination event or diversion limitation as part of the flow sharing rules. The groundwater licence entitles Wannon Water to a maximum annual extraction of 1,800 ML.

The Albert Park borefield has a groundwater licence of 750 ML/year, and an annual extraction of about 485 ML/year. The Mortlake bore has a groundwater licence of 295 ML/year, and an annual extraction of about 45 ML/year.

Figure B1 Otway System Schematic



Water storages located throughout the system are used to balance supply during peak periods. The system storages are summarised in Table B1. The active on-line storage is equivalent to less than 20% of the average annual demand. Consequently, during the peak summer demand period when storages are drawn down, less than one month of unrestricted demand may be available in storage.

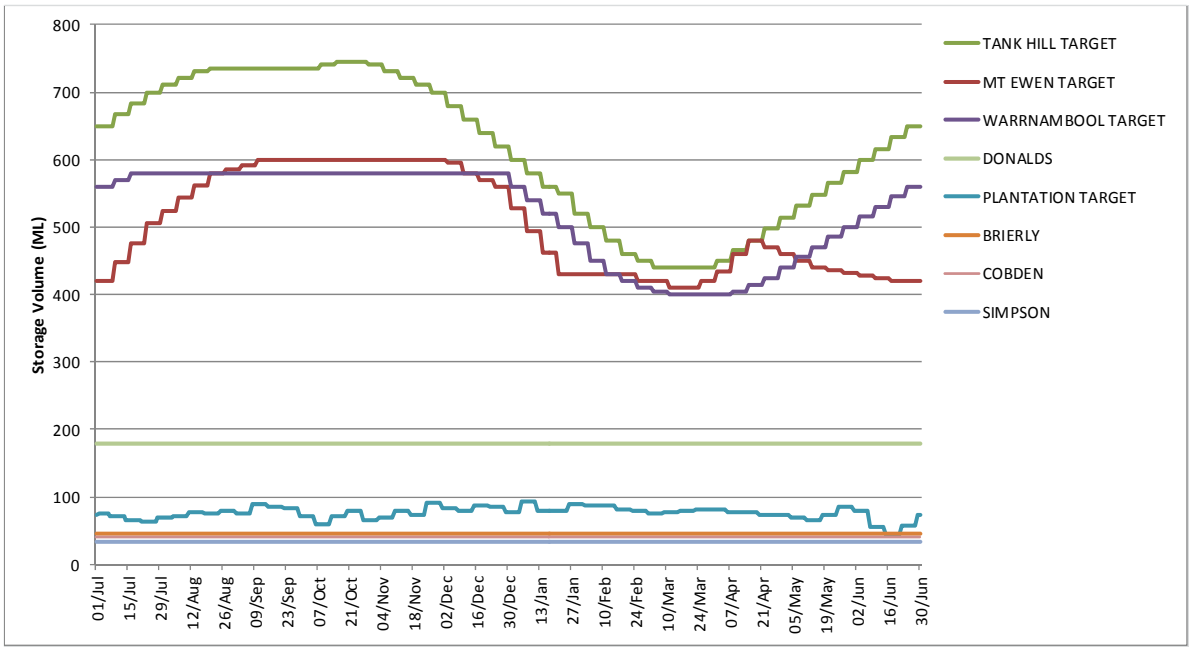
Table B1 System Storages

Storage Name	Volume (ML)
Simpson Storage	34
Donalds Hill Storage	207
Cobden Basin	52
Mt Ewen Reservoir	625
Tank Hill Reservoir	774
Warrnambool Basin	600[1]
Plantation Road Storage	100
Brierly Basin	51
Total Storage	***2,443***

1. Increased from 320 ML in 2007.

The system is operated to minimise the cost of pumping, which is defined by a set of operational curves for each of the storages described in Table B1. These operational curves provide control over the rate and magnitude of drawdown and filling, whilst providing a reserve volume in each storage for contingency purposes. The storage operating curves are provided in Figure B2 below.

Figure B2 Storage Operating Curves - Otway System



A set of storage based triggers define the severity of a water shortage event in the Otway System and are used to trigger a range of drought response actions. Further details on these actions and triggers are provided in Section B1.4.

B1.1.2 System Demands and Consumption

The total demand represents the unrestricted water usage from the headworks, inclusive of system distribution losses. The current (2011) average annual demand for the system is adopted for long term planning purposes, including the development of Wannon Water's water restriction policies.

The estimated total average annual demand (in 2011) for the Otway Water Supply System is about 10,000 ML/year. The components of demand are detailed in the table below.

Table B2 Components of the Current (2011) Average Annual Demand - Otway

Component	Total Demand (ML)	Base Demand (ML)	Restrictable Demand (ML)
Residential	2,920	2400	520
Non Residential	940	760	180
Rural	1,600	1,600	-
Major	1,800	1,800	-
Water Cartage	40	-	-
Total Consumption	**7,300**	**6,600**	**700**
Nonrevenue Water	1,200	1,200	-
Bulk Usage (WTP Outflow)	8,500		
WTP Losses	500	500	-
Headworks Losses	1,000	1,000	-
Total Raw Water Usage	10,000	**9,300**	**700**

Note 1 – Base demand was estimated at 80% based on data collected on residential use over the recent drought.

Water connections and consumption in 2009/2010 for each of the towns supplied by the Otway Water Supply System is provided in Table B3. This year was chosen as the basis for establishing the average annual demand since demand over 2005-2009 was steadily declining, and 2010/2011 was an unusually wet year with further reduced demand.

Table B3 Summary of Connections and Consumption in 2009/10 - Otway

	Residential		Non-Residential		Major		Rural		Total	
Supply District	*No.*	**Vol.**	*No.*	**Vol.**	*No.*	**Vol.**	*No.*	**Vol.**	*No.*	**Vol.**
Allansford	*291*	52	*40*	39			*7*	16	*338*	107
Camperdown	*1563*	237	*210*	75					*1773*	312
Camperdown Rural							*381*	586	*381*	586
Cobden Rural							*18*	22	*18*	22
Cobden Urban	*692*	108	*101*	45	*1*	340	*85*	113	*879*	605
Koroit	*631*	92	*55*	25	*1*	57	*2*	3	*689*	176
Lismore & Derrinallum	*335*	40	*71*	13			*75*	47	*481*	100
Mortlake	*563*	75	*115*	27			*1*	0	*679*	102
Noorat & Glenormiston	*143*	27	*16*	34			*75*	64	*234*	125
Purnim							*85*	13	*85*	13
Simpson	*78*	10	*18*	13	*1*	46	*10*	17	*107*	86
Terang	*941*	153	*146*	49			*1*	6	*1088*	208
Warrnambool	*12949*	2124	*1485*	607	*4*	636	*27*	17	*14465*	3385
North Otway Pipeline			*1*	12	*1*	700	*450*	683	*452*	1395
Total	***18186***	**2918**	***2258***	**938**	***8***	**1779**	***1217***	**1586**	***21669***	**7221**

Figures exclude nonrevenue water, water cartage, and other system losses. Volumes in ML.

B1.1.3 System Yield and Security of Supply

The yield of a water supply system is defined as the average annual level of total (raw water) demand that can be supplied from the water supply system, subject to resource availability, operational rules, demand patterns and adopted reliability criteria.

For the Otway Water Supply System, the Average Annual Demand that can be supplied whilst meeting Wannon Water's level of service objectives is 13,200 ML/a or 130% of current average annual demand (GHD, 2011). At this level of demand, restrictions are required at a frequency of 1 in 20 years (95% of years) and the severity of restrictions is not greater than Stage 3 restrictions.

The estimated reliability of the current demand (10,000 ML/a) under historical streamflow and forecasted 2030 climate change conditions is 100%.

Table B4 illustrates the sources of supply and how the distribution varies as climatic conditions change.

Table B4 Otways Diversions from the Environment by Source (in ML)

	2006/07	2007/08	2008/09	2009/10	2010/11
Arkins Creek diversions	2,770	3,492	3,606	3,493	4,502
North Otway Pump Station	3,330	2,157	1,818	2,195	464
Carlisle River Bores	249	70	434	10	2
South Otway Pump Station	4,018	3,485	3,520	3,760	3,531
Albert Park bores	411	437	432	472	466
Mortlake bores	41	36	26	19	27
Otways total raw water	**10,819**	**9,677**	**9,836**	**9,949**	**8,992**

B1.2 Drought Experience

Over the last 40 years the Otway Water Supply System has experienced restrictions during the following droughts: 1967/1968, 1971/1972, 1972/1973, 1973/1974, 1980/1981 and 1982/1983. The maximum restrictions applied were level two of an eight-stage policy, over a maximum duration of one month. Since the 1970s, augmentation of the supply system has included the South Otway pipeline (1976) and Warrnambool Basin (1985). During the 1982/1983 drought, restrictions were not required for the Otway system specifically, but were implemented to reflect the serious water shortages throughout most of Victoria at the time.

Water restrictions were not required during the summer of 1999/2000, although diversions from the Gellibrand River at Carlisle were reduced under the flow sharing arrangements specified in the Otway Water Supply System Bulk Entitlement Order. Flow share restrictions, reducing allowable diversions from the Gellibrand River into the North Otway system, were imposed between 5 February and 26 March 2000. This resulted in an allowable diversion 200 ML less than the maximum possible had flow share restrictions not been in place.

The reduction in allowable diversions combined with increased water usage and increased evaporation losses from storages resulted in some concern that water restrictions may have had to be imposed on customers in all districts supplied from the North Otway pipeline upstream of Tank Hill Reservoir. Storages were however able to be maintained above minimum desirable levels. Another two weeks of flow share restrictions would probably have resulted in water restrictions being implemented in towns supplied solely from the North Otway pipeline.

Gellibrand River flow sharing rules were applied to reduce irrigator's access to water from 3 February 2001 to 16 April 2001, and Wannon Water was restricted to an allowance of 17.5 ML/d from 9 March

2001 to 15 March 2001. Southern Rural Water placed Gellibrand irrigators on level one restrictions in 2005/2006. However restrictions have not been placed on Wannon Water extractions since 2001. The Carlisle River bores were brought online in 2001, and have been used in 2001/2002, 2002/2003 and 2005/2006 to supplement supply.

Flow sharing arrangements under the bulk entitlement were implemented in 2006, although there was negligible impact on Wannon Water's ability to maintain the system storages at the desired operating levels.

In 2007, the capacity of the Warrnambool basin was increased by 320 ML providing additional off stream storage capacity. The Warrnambool Roofwater harvesting project was completed in 2011. This infrastructure has the capacity to supply up to 450 ML of additional water to Warrnambool per year.

In summary, Wannon Water has not implemented water restrictions in the Otway system since 1982/1983. Whilst annual rainfall totals in the Gellibrand River catchment have been typically low over the last decade, flows in the Gellibrand River and tributaries have been sufficient (combined with use of the Carlisle River bores) to avoid the need for water restrictions.

B1.3 Drought Response Options

B1.3.1 Introduction

Drought response options within the Otway system can be classified into two broad categories; demand management and supply augmentation. This section of the Drought Response Plan identifies and evaluates the options that are currently available to Wannon Water to mitigate the impacts of water shortages.

B1.3.2 Demand Reduction During Droughts

Summary of Options

There are a number of demand reduction options that can be employed during times of water shortage. A summary of these demand reduction options is shown in Table B5 below.

Table B5 Summary of Demand Reduction Options

Option	Details	Comments
Community Education Programs	Water efficiency awareness (showerhead rebates, information brochures), linked to ongoing State Government programs. Estimated savings are around 2-5% of total demand.	Being progressively implemented by Wannon Water.
Voluntary Demand Reduction Measures	Self regulated water conservation measures aimed at increasing effectiveness of measures within the Permanent Water Savings Plan.	Water savings from this option are expected to exceed the savings already achieved from the Permanent Water Saving Plan.
WaterMAP	The Government has implemented a voluntary program for all non-residential customers (5ML/year or greater).	Wannon Water to promote this voluntary measure during periods of heightened awareness or during drought response operating modes.
Mandatory Water Restrictions	Option available under By-Law No. 4.	Revised as per VicWater Guidelines in 2011. See Appendix B for requirements and prohibitions on water usage.
Compliance Officer/s	Additional resources may be required during extended periods of moderate to severe restrictions to monitor the performance of targeted water savings measures.	

Wannon Water's long-term demand reduction strategies attempt to reduce both base demand and restrictable demand by encouraging more efficient water use in all circumstances.

Short term drought response strategies largely target discretionary water use. Recent experience across Wannon Water's systems has shown that short term savings can be achieved across residential, non-residential and commercial sectors.

The current unrestricted average annual demand of the Otway Water Supply System is estimated to be 10,000 ML/a (including system losses). Historical records show that demand can be quite variable from year to year. Generally, demand tends to increase during hot and dry periods when outdoor usage increases. Hence, water shortages resulting from reduced inflows during drought conditions tend to be exacerbated by increased demand levels.

Voluntary Demand Reduction Measures

Voluntary demand measures are an initial measure in the event of a drought. The importance of public awareness, understanding and involvement in meeting demand reduction objectives cannot be underestimated.

Wannon Water is committed to communicating effectively with its Otway Water Supply System customers to encourage take up of voluntary water saving measures and in turn deliver the best possible outcomes in demand reduction.

Supporting these voluntary water saving measures with initiatives including showerhead exchanges, trigger nozzles and other merchandise, Wannon Water aims to encourage its customer base to play an active role in managing their water supply and play their part in times of water shortages to ensure efficient use of their precious resource.

A broad base of local media (press and electronic) can be utilised to raise community awareness of system supply levels and encourage voluntary water saving measures.

Wannon Water will raise the profile of system levels and support the take-up of voluntary measures through extensive 'tips' and media coverage on its website, regular informative media releases, advertising, distributing publications with customer accounts and distributing information at community events throughout the service region. Wannon Water will also liaise with its Customer Engagement Committee where appropriate and consider holding community information sessions to raise awareness.

Publication of information including changes in water usage, rainfall levels, streamflows or bore performance details can assist in raising the profile of shortages and demand needs. Recent experience has shown that in combination, all of the above communication tools have been effective in heightened public awareness and consciousness of water efficiency measures, particularly over summer months.

As well as engaging the community in voluntary demand reduction measures Wannon Water can liaise with major consumption customers to work out strategies to reduce consumption. Major customers include the local shire, community groups, industrial and rural water users.

WaterMAP

WaterMAP is a voluntary water management action plan for non-residential customers using 5 ML of potable (drinking) water or more per year at any one site from an urban water supply. A WaterMAP allows eligible non-residential water customers to:

- Assess their current water use;
- Identify inefficiencies and opportunities for water savings;
- Prepare an action plan to implement water conservation actions; and
- Report on implementation of water conservation actions.

Wannon Water will continue working with its major customers to encourage and implement water saving measures.

Mandatory Water Restrictions

As mentioned in Part A of this document, Wannon Water applies a four-stage water restriction policy in accordance with the Victorian Uniform Drought Water Restriction Guidelines (VicWater, 2005). The policy defines trigger levels corresponding to the total volume of water held in system storages (refer Table B1). The current restriction triggers for the system are provided in the Drought Response Plan Action Plan.

The anticipated water savings for each level of restriction is shown in Table B6. These savings have been tested by comparing residential KL per connection over the period 2005/2006 to 2010/2011 for

Hamilton against other towns not subject to water restrictions. The residential consumption rates shown in Table B6 provide guidance on the level of consumption which should be targeted to achieve the stated water savings.

Table B6 Anticipated Water Savings from Water Restrictions for the Otway System

Restriction Level	Estimated Water Saving			Target Residential Consumption Rate	
	% of Restrictable Demand[1]	Volume (ML)	% of Total Raw Water Use[2]	KL/ connection/ yr	L/ person/ day
PWSM				160	190
Stage 1	13% - 16%	90-110	1%	156	185
Stage 2	40% - 50%	300-350	3%	146	173
Stage 3	60% - 75%	420-520	5%	140	166
Stage 4	95% -100%	700	7%	130	154

1. Ranges adopted from VicWater, 2005.
2. Total raw water extracted from the environment.

B1.3.3 Supply Augmentation Options During Drought

Options to augment the supply system during extended low rainfall periods are limited to some extent due to lead times required to implement these alternatives. It is therefore essential to consider the larger scale options as part of longer term water supply planning. However, there are several options available to augment supply during drought. The feasibility of each option depends to a large extent on the size of the population being serviced, the physical characteristics of the supply system and, ultimately, on the severity of the drought. A summary of the short term supply augmentation options for the Otway Water Supply System is shown in Table B7.

Table B7 Supply Augmentation Options During Drought

Option	Details	Available Supply
Emergency Groundwater Bores[1]	Curdie Vale Bore – 30 year old bore pump tested to 8 ML/day available for use during an emergency. Delivery to W'bool Storage to reduce impact of higher salinity and temperature.	2,150 ML/year
	Koroit – two existing bores in railway reserve still equipped but power disconnected. Would need to reinstall disinfection system, connect power and replace pumps (likely to be unusable). Higher salinity water may be of concern to customers especially Murray Goulburn.	524 ML/yr
	Lismore and Camperdown	To be determined[3]
	Albert Park Bores	250 ML/yr[2]
	Mortlake	250 ML/yr[2]
Reservoir Dead Storage	Measures may need to be taken to access water below pipe offtakes. Water quality in reservoirs generally deteriorates when water falls below offtake levels.	50 ML Tank Hill 200 ML Mt Ewen 40 ML Donalds Hill 80 ML Warrnambool
Water Cartage	Not a viable option for large towns such as Warrnambool, but could be used to supply many of the smaller satellite towns across the system.	
Qualification of Rights	Apply to the Minister to increase surface and/or groundwater extractions beyond the conditions of our entitlements.	

1. Emergency groundwater bores are not brought online until Action 4 under the Drought Response Mode (refer Table B10).
2. These volumes are in addition to current usage of 500 ML/yr at Albert Park and 45 ML/yr at Mortlake.
3. Further assessment required to determine available supply.

B1.4 Drought Response Actions

System monitoring is undertaken to assess the status of the supply system according to one of the following three operational modes:

Mode 1 – General Monitoring

Mode 2 – Heightened Awareness

Mode 3 – Drought Response

B1.4.1 Mode 1 – General Monitoring (Pre-Drought Phase Activities)

The zone for the General Monitoring mode is defined by the system storage capacity as the upper bound and a trigger which is set just below the system operating curve, as the lower bound.

There are a number of important factors in pre drought monitoring and planning which will influence the decision to declare the system as being in the General Monitoring mode. These include:

- Storage contents, river flows and bore performance data to monitor availability of supply;
- Climatic trends and seasonal outlooks as indicators of the possible onset of drought;
- Consumption trends to indicate changes in Customer's usage of water; and
- Forecasting storage behaviour over a 6-12 month period.

The Water Security Outlook tool is used to monitor supply and demand side aspects of the system. During the General Monitoring mode, the system status is updated on a weekly basis and a report prepared weekly. A summary of the key system performance indicators for the Otway Water Supply System which should be included in the Water Security Outlook and System Status Report is provided in Table B8.

Table B8 Requirements for Water Security Outlook and System Status Monitoring and Reporting

Item	Requirements
Rainfall, seasonal climate outlook	Information accessed from Bureau of Meteorology website.
State-wide status	Bureau of Meteorology and Department of Sustainability and Environment websites provide status reports on rainfall, streamflow, storage levels, groundwater and urban water restrictions across Victoria on a monthly basis.
System storage contents	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.
Gellibrand River gauging stations downstream of both the pump offtakes.	Monitoring of passing flow level and flow details are provided by telemetered data loggers. Two models have been developed to facilitate prediction of demand trends and storage contents.
Water levels in shallow ground water supply systems are monitored at least monthly and are able to be compared against pump depths.	The frequency of monitoring should be increased to weekly or daily if a decline in water level raises concern on the security of the system.
System Demands (bulk meter consumption)	All towns monitored at least weekly and recorded in an operational database.

The trigger mechanism for actions is the total system storage volume for the Otway system storages, using the Drought Response Triggers shown in Figure B3.

Forward look projections of storage response forms an integral part of the short term planning during a drought. Projections assist to anticipate the “likely” response based on current climatic conditions. At a minimum, Wannon Water makes projections over the next 3-12 months based on its experience in previous droughts. However, seasonal forecasting over three month, six month and 12 month periods, incorporating information from low-frequency climate signals such as the El Nino Southern Oscillation Index and sea surface temperatures, may also be useful in this assessment.

The Water Security Outlook tool has been set up to enable system monitoring including forecasts to be completed.

The drought response triggers are an informative guideline, and are not used as rigid bands or triggers that guarantee the implementation of the specified action, such as the implementation of water restrictions.

B1.4.1 Mode 2 – Heightened Awareness

The zone for the Heightened Awareness mode is designed to provide early warning of a pending water shortage. The Heightened Awareness mode is triggered following consideration of:

- Storage contents, river flows and bore performance data to monitor availability of supply;
- Climatic trends and seasonal outlooks;
- Consumption trends to indicate changes in Customer's usage of water; and
- Forecasting storage behaviour over a 3-6 month period.

The key actions are summarised in Table B9 (in order of increasing impact from water shortages).

Table B9 Otway Water Supply System Action Plan for Mode 2 – Heightened Awareness

Action	Trigger	Response
Action 1	High likelihood that total storage contents cannot be maintained above the System Operating Curves	1. Reconvene the Drought Response Monitoring Committee
Action 2	Moderate to high likelihood that total storage contents cannot be maintained above the Level 1 Drought Response Trigger	2. Provide weekly updates of the System Status Report 3. Implement demand reduction options such as Community Education Programs, Voluntary Demand Reduction Measures via increased media advertising,
Action 3	High likelihood that storage contents cannot be maintained above the Level 1 Drought Response Trigger	4. Alert public to the imminent water shortages and possible need for restrictions in the future. 5. Promote “voluntary restrictions” via media advertising campaigns to inform consumers about water conservation programs. 6. Declare operational mode as Mode 3 - Drought Response.

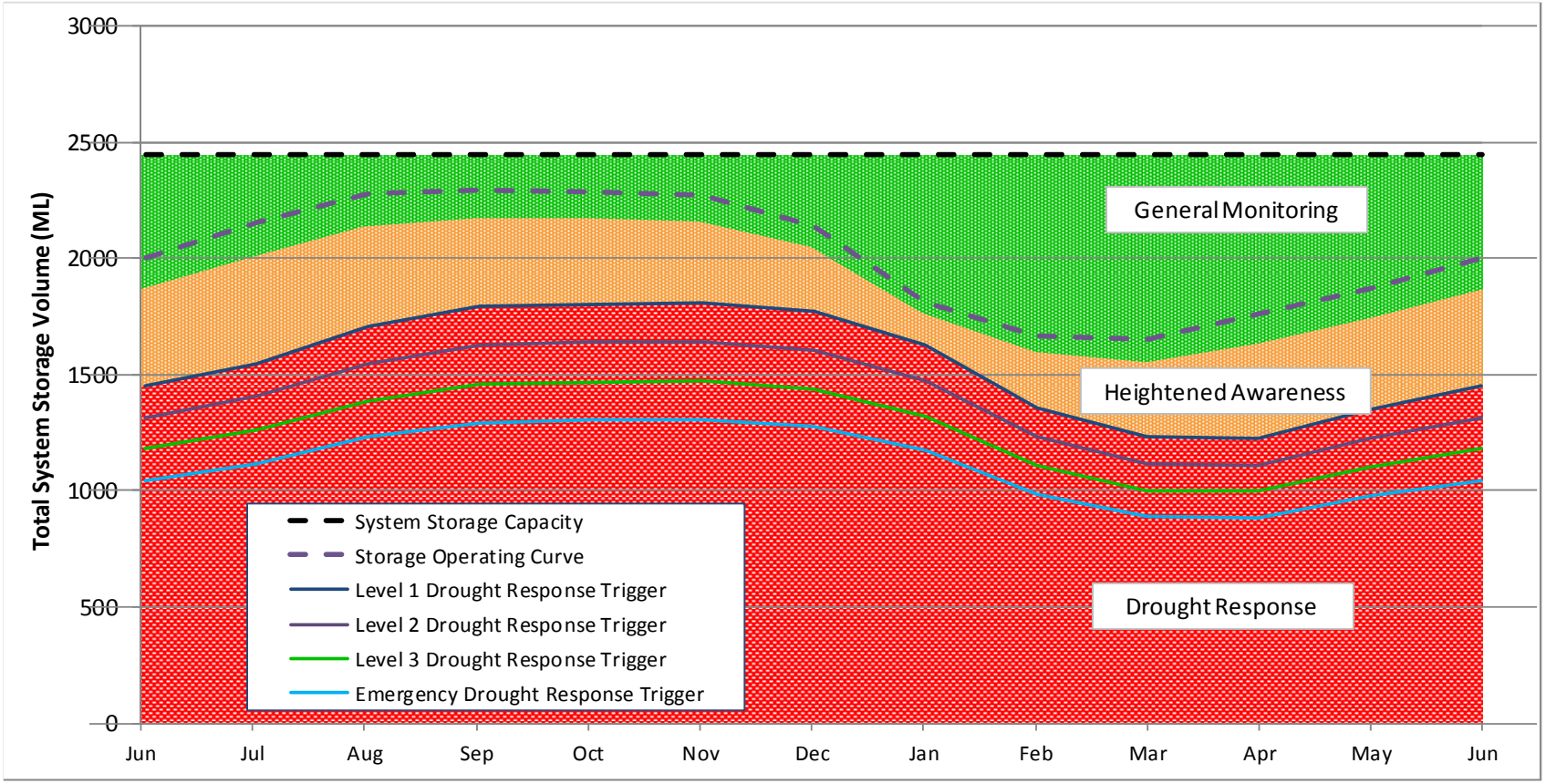
B1.4.2 Mode 3 - Drought Response

Mode 3 defines an active drought response period where supply and/or demand side measures are required to maintain supply security. Restriction rule curves are used to trigger an increase in the severity of the water shortage. Actions during each level of restriction are summarised in Table B10.

Table B10 Otway Water Supply System Action Plan for Mode 3 – Drought Response

Action	Trigger	Response
Action 4	Total storage contents unable to be maintained above Level 1 Drought Response Trigger.	7. Consider implementation of Stage 1 Restrictions. 8. Introduce advertising campaign using all appropriate forms of media. 9. Monitor storage volume response and perform regular forward look storage volume projections. 10. Make standby arrangements to bring Curdie Vale bore into service. 11. Advise major users of Otway system that Curdie Vale groundwater supply may have to be introduced.
Action 5	Total storage contents unable to be maintained above Level 2 Drought Response Trigger	12. Consider implementation of Stage 2 Restrictions. 13. Continue media advertising. 14. Daily monitoring of storages. 15. Bring Curdie Vale bore pumping infrastructure into service. 16. Monitor storage volume response and perform regular forward look storage volume projections.
Action 6	Total storage contents unable to be maintained above Level 3 Drought Response Trigger	17. Consider implementation of Stage 3 Restrictions. 18. Continue media advertising. 19. Daily monitoring of storages. 20. Monitor storage volume response and perform regular forward look storage volume projections. 21. Identify and plan for implementation of emergency options.
Action 7	Total storage contents unable to be maintained above Level 4 Drought Response Trigger (Emergency Level)	22. Consider implementation of Stage 4 Restrictions. 23. Continue media advertising. 24. Daily monitoring of storages. 25. Monitor storage volume response and perform regular forward look storage volume projections. 26. Implement other emergency supply options. 27. Tankering water to areas of critical shortage.

Figure B3 Drought Response Triggers - Otway Water Supply System



B1.5 Post Drought Assessments

Actions to be considered after a drought has occurred are summarised in Table B11. These include evaluating the appropriateness of the actions within each of the operational models and the associated triggers, the effectiveness of demand reduction and emergency supply augmentation options and the effectiveness of each level of restriction.

Table B11 Evaluate Operational Modes Trigger Levels and Associated Actions

Operational Mode	Action Sequence	Description	Assessment Procedure
General Monitoring	NA	Monitoring and evaluation	Were the indicators being used to monitor system performance appropriate?
Heightened Awareness	Actions 1-6	Planning	Was there adequate time to undertake the activities detailed in Actions 1-3.
		Voluntary Demand Reduction	Was the community responsive? Was there a significant reduction in demand? Was the trigger level appropriate?
Drought Response	Actions 7-27	Water Restrictions	Was the expected reduction in demand achieved for each stage? Were the trigger levels appropriate? Were policing methods effective, if so, how?
		Groundwater pumping	Was groundwater effective at this stage or should it be started earlier? Was timing of groundwater input appropriate? Were pumps and equipment available? Was water quality acceptable to customers, particularly for industrial customers? Were any problems identified with the specific flow sharing arrangements with the Gellibrand River with Southern Rural Water?
		Implement other emergency supply options	To what level was demand reduced? What was the cost and practicality of carting water if undertaken? Were individual emergency options implemented too late? Did other options arise; if so, what other options were available?

Table B12 summarises the assessment procedure for evaluating the impact of water restrictions on customers, authority staff and supply systems. The intention is to learn from the methodologies that have been applied in order to minimise any future incidents of this nature.

Table B12 Evaluate the Impact of Restrictions

Stakeholders	Assessment Procedure
Domestic Users	Were the restrictions too severe? Was the right mix of media used to disseminate information? Was there enough warning of impending drought? If not, how could this be improved?
Diverters	Were flow sharing arrangements appropriate? What was the irrigator's reaction to restrictions?
Environmental	Were flow triggers appropriate? Should environmental flows be reassessed? What were the effects upon the aquifer and other users of pumping? What methods have been put into place to rectify any environmental effects? Effects upon identified groundwater dependent ecosystems?
Wannon Water Staff	Were many instances reported of restriction violations? Was it possible to effectively enforce the restriction policy? Were sufficient staff available to monitor system performance?
Supply Systems	Did restrictions achieve expected levels of water savings? Have supply systems been replenished? If so, how long did it take to achieve this level? What procedures were put in place to achieve this?

Table B13 summarises the assessment procedure for establishing the effectiveness of pumping groundwater to replenish the supply systems during drought.

Table B13 Evaluate Effectiveness of Groundwater Pumping

Action	Assessment Procedure
Evaluate effectiveness of ground water pumping	Did water quality problems occur? Should groundwater supplies have been introduced prior to where programmed in the Drought Response Plan? Did the volume of water extracted stay within the groundwater licence limits (daily volumes and annual volumes)? Review predictive models / bore performance / water quality and recalibrate predictive models / water balances / assessment tools?

Part C

Grampians System Drought Response Plan

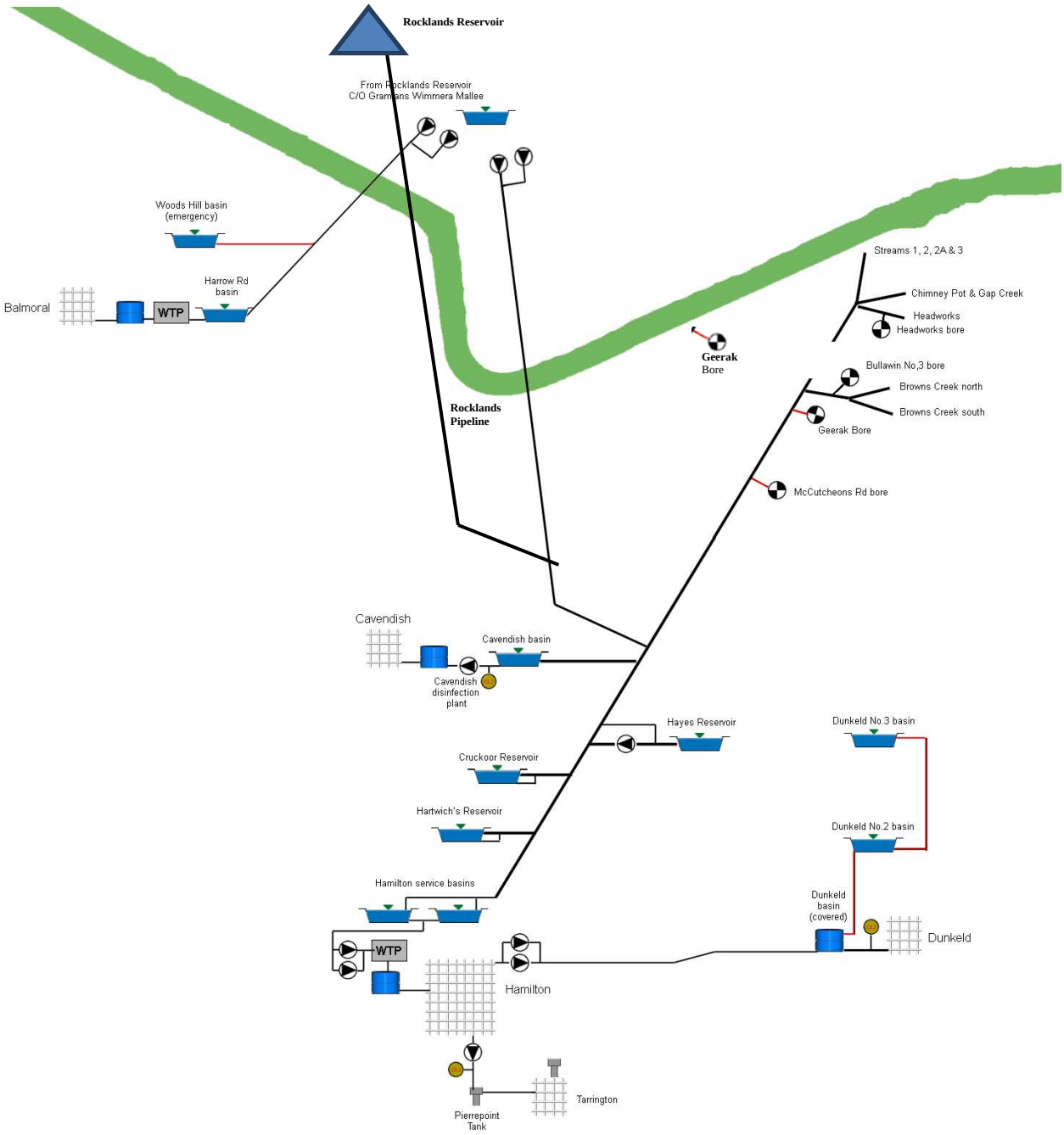
C1. Grampians Water Supply System

C1.1 Details of the Grampians Water Supply System

C1.1.1 System Description

The Grampians Water Supply System provides water supplies to the customer districts of Hamilton, Balmoral, Cavendish, Tarrington and Dunkeld and also to a number of other consumers located along the main supply pipelines to the four urban centres. A schematic of the Grampians Water Supply System is provided in Figure C1.

Figure C1 Grampians Water Supply System



Water is sourced from the western slopes of the Victoria Range in the Grampians National Park. Water is diverted from eight small streams and four bores (Bullawin, Headworks McCutcheons and Geerak Bores). The first diversion, on Headworks Creek, has been in place since 1904 and the most recent diversions on Nos. 2 and 3 streams, since 1960. The Department of Conservation and Natural Resources (now Sustainability and Environment) sought to protect natural flows in the diverted streams in the lead up to the construction of Hayes Reservoir. The Hamilton Bulk Entitlement specifies passing flow requirements in five of the headworks streams.

The water is then supplied via gravity to the storages north of Hamilton. The maximum capacity of the supply system is approximately 12.8 ML/d. There are a number of tappings along the main supply line serving properties within the rural district surrounding Hamilton.

The groundwater bores have traditionally been used as emergency supplies during drought, with the Headworks and Bullawin bores activated following the implementation of Stage 2 restrictions. A licence condition prevents the Geerak Bore from being utilised until Stage 4 restrictions are implemented. The bore licence has an annual extraction limit of 1,102 ML. As of 2011 maintenance works have been undertaken on the Headworks bore and it is currently not equipped with a production pump.

A 52km pipeline was completed in 2010 providing a connection between Rocklands Reservoir and the Hamilton System. Wannon Water has a 2,120 ML bulk entitlement from the Wimmera-Glenelg system and receives an annual allocation, which is subject to the flow sharing arrangements in the bulk entitlement. Water available under this bulk entitlement is also used to supply the township of Balmoral via a separate pipeline.

Water brought to Hamilton is stored in five main storages located along the pipeline to the north of Hamilton. The total capacity of the local storages is approximately 2,714 ML. These storages are summarised in Table C1.

Table C1 System Storages

Storage Name	Volume (ML)
Hayes Reservoir	1,200
Cruckoor Reservoir	990
Hartwichs Reservoir	381
No. 1 and 2 storages	132
Clear Water Storage	11
Total Storage	**2,714**

Hartwichs Reservoir was constructed in 1950, with a capacity of 381 ML, and is located approximately 2 km north of Hamilton. Cruckoor Reservoir was constructed in 1969, with a capacity of 990 ML, and is located approximately 4.5 km north of Hamilton. The most recent storage constructed is Hayes Reservoir which was constructed in 1993, with a capacity of 1,200 ML and is located approximately 11.5 km north of Hamilton.

Nos. 1 and 2 storages are located on high ground on the northern outskirts of Hamilton and serve the city as raw water balancing basins. The basins are interconnected and have a combined capacity of 132 ML (66 ML each).

The five storages are filled by gravity and all, with the exception of Hayes Reservoir, are emptied by gravity. Treated water is delivered to an 11 ML clear water storage tank before being supplied to the reticulation system.

The township of Tarrington was connected to the Hamilton system in 1972 and is supplied via a pumped rising main to a storage located on the top of Mount Pierrepoint. Water then gravitates from this storage to a small elevated tower in Tarrington and then by gravity to the township.

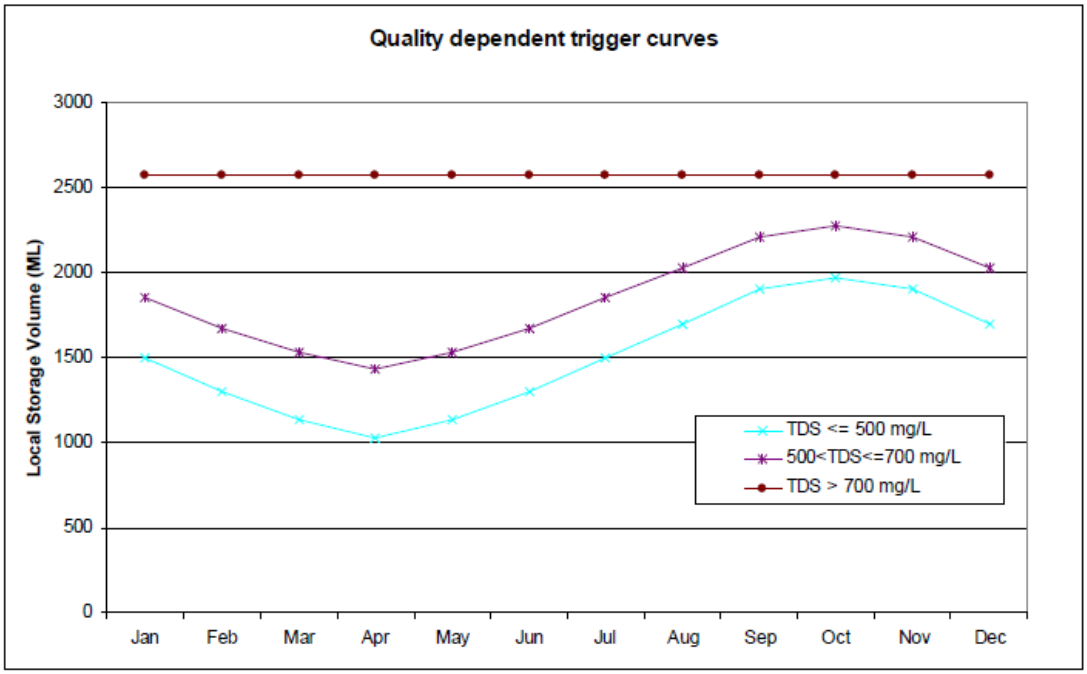
The township of Cavendish was connected to the Hamilton system in 1970 via a 100 mm diameter diversion pipeline from the main Grampians pipeline serving Hamilton. The township of Cavendish is supplied via a gravity main from the main Grampians pipeline to a storage on high ground to the east of the township. Water gravitates from the reservoir to the township.

The township of Dunkeld was connected to the Hamilton system in 1998 by pumping via a 33 km pipeline to a new clear water (lined and covered) storage (6.3 ML). The new storage was constructed in a section of one of the previous earthen storages.

Prior to connection to the Hamilton system, the Dunkeld system consisted of three storages, being the No. 1 Service Basin (36 ML), the No. 2 Service Basin (36 ML) and the No. 3 Reservoir (110 ML). The system relied on water from Waterfall Creek and Wannon River. The Wannon River supply was disconnected some years ago. Waterfall Creek is still connected to the system. The creek supplies water to the 110 ML No. 3 and 36 ML No. 2 storages. Although not treated, this system could be used as an emergency supply as was the case in the 2006 bushfires. The creek dries up each year, and in fact does not run at all in some years. The No. 3 Reservoir has a storage capacity greater than the average yield from the two catchments supplying it and it was sized so that it could also be used as a storage for future sources of supply.

Operating rules have been developed which aim to maximise the yield from the combined supply sources, whilst mitigating water quality risks associated with the higher salinity supply from Rocklands Reservoir. Storage operating curves have been developed which define usage of the total available resource according to the quality of water in Rocklands Reservoir. When the quality of water in Rocklands Reservoir is less than 500 mg/L TDS, the risk that the resource will become unsuitable for use is relatively low, therefore water is preferentially retained in Rocklands Reservoir and use of the local storages is maximised. When the quality of water in Rocklands Reservoir increases above 500 mg/L TDS, then a larger reserve volume is required in local storages to facilitate blending which prolongs the use of the Rocklands resource. The adopted storage operating curves are illustrated in Figure C2.

Figure C2 Operating Curves for Hamilton System Storages



The system operating rules specify the usage of the available resource in the following priority order:

- Streamflow is diverted from the Grampians Headworks streams, subject to individual passing flow requirements with a total diversion up to 12.8 ML/d;
- Water transferred from Rocklands Reservoir up to 8 ML/d with transfers limited to the allocation held in Wannon Water's allocation bank account (including water held as carryover). Allocations are based on 2,120 ML/a bulk entitlement volume;
- Diversion from the Grampians Bores, up to 400 ML/a;
- The local storage are filled in the following priority order, Hartwichs Reservoir ; Cruckoor Reservoir then Hayes Reservoir, noting that for water quality purposes water from Rocklands Reservoir is never stored in Cruckoor Reservoir; and
- Hartwichs Reservoir is used for blending purposes.

The Balmoral township sources its water directly from Rocklands Reservoir. The Rocklands Reservoir was constructed in 1953 and Balmoral was connected to it in 1966. Water is pumped from Rocklands to a service basin in Harrow Road, which is located adjacent to the High School. The capacity of this basin is 0.54 ML. The reticulation system is pressurised by a multi-stage booster pump station.

C1.1.2 System Demands and Consumption

The total demand represents the unrestricted water usage from the headworks, inclusive of system distribution losses. The current (2011) average annual demand for the system is adopted for long term planning purposes, including the development of Wannon Water's water restriction policies. Despite the fact that stage 2 water restrictions were in place, 2009/2010 was chosen as the basis for establishing the average annual demand since 2005-2009 was subject to severe water restrictions and 2010/2011 was

an unusually wet year. Unrestricted residential and non residential demand in 2009/2010 was found to be 13% greater than observed demand and this is factored into Table C2.

Table C2 Components of the Current (2011) Average Annual Demand - Grampians

Component	Total Demand (ML)	Base Demand (ML)	Restrictable Demand (ML)
Residential	840	670	170
Non Residential	230	184	46
Rural	83	83	-
Major	35	35	-
Water Cartage	2	-	-
Total Consumption	**1,190**	**970**	**220**
Nonrevenue Water	180	180	-
Bulk Usage (WTP Outflow)	1,370		
WTP Losses	80	80	-
Headworks Losses	300	300	
Total Raw Water Usage	1,740	**1,520**	**220**

Note 1 – Base demand was estimated at 80% based on data collected on residential use over the recent drought.

Water connections and consumption in 2009/2010 for each of the towns supplied by the Grampians Water Supply System is provided in Table C3.

Table C3 Summary of Connections and Consumption in 2009/2010 - Grampians

	Residential		Non-Residential		Major		Rural		Total	
Supply District	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**
Balmoral	*103*	13	*27*	11			*19*	16	*149*	41
Cavendish	*65*	8	*22*	2			*11*	4	*98*	14
Dunkeld	*303*	36	*51*	12			*28*	8	*382*	56
Hamilton	*4615*	662	*573*	172	*1*	35	*50*	31	*5239*	901
Hamilton Pipeline							*35*	18	*35*	18
Tarrington	*118*	21	*6*	1			*17*	5	*141*	28
Total	***5204***	**741**	***679***	**200**	***1***	**35**	***160***	**83**	***6044***	**1058**

Figures exclude nonrevenue water, water cartage, and other system losses. Volumes in ML. System subject to Stage 2 water restrictions in 2009/2010.

C1.1.3 System Yield and Security of Supply

For the Grampians System, the average annual demand that can be supplied at the adopted 95% annual reliability is 2,800 ML/a or 165% of current average annual demand (GHD, 2011). The frequency of Stage 1 restrictions is adopted by Wannon Water as the measurement of system reliability. A 95% annual reliability target equates to a 1 in 20 year frequency for restrictions.

The estimated reliability of the current demand (1,700 ML/a) under historical streamflow and forecasted 2030 climate change conditions is 100%.

Table C4 shows the sources of supply. Note however that the patterns in the table are not indicative of the future since the headworks streams are now subject to passing flow requirements (which will greatly reduce extractions in a dry year). Also note that the Rocklands-Hamilton pipeline was connected in July 2010.

Table C4 Diversions from the Environment by Source (in ML)

	2006/07	2007/08	2008/09	2009/10	2010/11
Rocklands Reservoir	55	59	67	92	32
Grampians Headworks Streams	924	1,368	1,103	1,163	2,637
Grampians Bores	624	319	238	243	13
Total	**1,603**	**1,746**	**1,408**	**1,498**	**2,682**

C1.2 Drought Experience

C1.2.1 Brief Analysis of Historic Droughts

Prior to, and including the 1982/1983 drought, restrictions on water use were regularly imposed. The 1982/1983 drought was the most severe drought experienced in the area in recent years. Water restrictions were imposed on consumers, limiting garden watering to a hand held hose for one hour on alternate days.

To meet water demands during the 1982/1983 drought the then Hamilton Water Board supplemented the system by operating its groundwater bores in the headworks catchment.

Bullawin Bore was re-commissioned on 2 November 1982, (this bore had been constructed during the 1967/1968 drought) and operated until 22 March 1983 producing a total flow of 182 ML (1.3 ML/day). Headworks Bore was commissioned on 19 January 1983 and operated intermittently until 23 February 1983. When operating, this bore produced approximately 0.7 ML/day. When both bores were operating they contributed 2 ML/day to the supply system.

After the drought the Hamilton Water Board embarked on a 10 year program to increase the harvest of winter flows and to increase the storage capacity. Over 30 km of pipeline duplications and replacements have seen the pipeline capacity increase from 7 ML/day to 12.8 ML/day (only 12.8 ML/day when filling

Hayes Reservoir). Water can be pumped from Hayes Reservoir at the rate of 15 ML/day. Hayes Reservoir, with a capacity of 1 200 ML, was commissioned in 1993.

Hamilton also had water restrictions for two weeks during February 1990 but this was due to the last section of mainline to Nos. 1 and 2 not being capable of supplying enough water to meet the demand. This section of main was duplicated in 1991 and the entire pipeline system now has a capacity of 12.8 ML/day under gravity feed.

Restrictions were regularly imposed for the Dunkeld Water Supply System during the 1990s. The level of water in this system dropped to a point in 1998 and the township was in danger of running out of water. Stage 3 restrictions were applied and a pipeline was constructed from Hamilton, culminating in restrictions being lifted in April 1999. Dunkeld is now permanently connected to the Hamilton system and the original Dunkeld system is maintained as an emergency supply. This emergency supply was used, for the first time, during the 2006 Australia Day bush fire and from December 2006 to September 2007 to conserve the supply in the Hamilton reservoirs for the Hamilton and Tarrington systems.

The Hamilton system had restrictions imposed during 2000 and 2001. Restrictions were again re-introduced in January 2006, following a relatively dry spring inflow period. By late 2006, storages fell to critically low levels following the driest spring period in recent history. By December 2006, Stage 4 restrictions were introduced and remained in place until November 2007 when they were replaced with Stage 3 restrictions. The level of restriction was further reduced to Stage 2 in November 2009.

In 2007, planning work commenced to augment the system via a 52km pipeline connection to Rocklands Reservoir. This pipeline was commissioned in 2010. The groundwater bores in the Grampians headworks were operated during the times that restrictions were in place (two additional bores, Geerak and McCutcheons, were constructed during this period). Stage 2 restrictions were lifted in August 2010.

During the 1967/1968 drought, the level of the Rocklands Reservoir was very low. While there was adequate water to meet normal demands the State Rivers & Water Supply Commission requested that water restrictions be implemented in Balmoral. Restrictions were applied from 1 December 1967 and were not lifted until 1 July 1968.

It was necessary to extend the pump suction line in the Reservoir in order to maintain supply.

In March of 1988 the State Rivers & Water Supply Commission advised that in future droughts the level of Rocklands would not be allowed to fall below 5 000 acre feet (6 200 ML) with such water being reserved for Balmoral and landholders along the Glenelg River.

Consumers were informed of the need for restrictions by circular.

In the 1982/1983 drought restrictions were implemented on the 1 April 1983 and lifted in October the same year. No other operational measures were necessary.

Stage 1 restrictions were imposed in January 2003 as a result of the recent ongoing drought. The restrictions moved to Stage 2 in April 2006 and to Stage 4 in October 2006. Stage 4 restrictions remained in place until they were lifted in October 2009.

A summary of water restrictions since 1995 is provided in Table C5.

Table C5 Recent History of Restrictions

Date	System	Stage	Action
4/03/1995	Dunkeld[1]	2	Introduced
17/06/1995	Dunkeld [1]	2	Lifted
13/09/1997	Dunkeld[1]	1	Introduced
26/02/1998	Dunkeld[1]	2	Introduced
29/08/1998	Dunkeld[1]	3	Introduced
17/04/1999	Dunkeld	3	Lifted
5/02/2000	Hamilton	1	Introduced
11/03/2000	Hamilton	2	Introduced
21/09/2000	Hamilton	1	Reduced from Stage 2
14/10/2000	Hamilton	1	Lifted
27/01/2001	Hamilton	1	Introduced
10/03/2001	Hamilton	2	Introduced
8/09/2001	Hamilton	2 & 1	Lifted
18/01/2003	Balmoral	1	Introduced
21/01/2006	Hamilton	1	Introduced
01/04/2006	Hamilton, Balmoral	2	Introduced
14/10/2006	Balmoral	4	Introduced
4/11/2006	Hamilton	3	Introduced
5/12/2006	Hamilton	4	Introduced
3/11/2007	Hamilton	3	Reduced from Stage 4
04/10/2009	Balmoral	PWSR	Stage 4 Lifted – returned to PWSR
1/11/2009	Hamilton	2	Reduced from Stage 3
1/08/2010	Hamilton	PWSR	Stage 2 Lifted – returned to PWSR

1. Operated as an independent system prior to 1999.

C1.3 Drought Response Options

C1.3.1 Introduction

Response options in the Grampians System can be classified into two broad categories; demand management and supply enhancement. In this section of the Drought Response Plan, potential demand management and supply enhancement options for the Wannon Water are identified.

C1.3.2 Demand Reduction During Droughts

Summary of Options

There are a number of demand reduction options that can be employed during times of water shortage. A summary of demand reduction options is shown in Table C6 below.

Table C6 Summary of Demand Reduction Options

Option	Details	Comments
Community Education Programs	Water efficiency awareness (showerhead rebates, information brochures), linked to ongoing State Government programs. Estimated savings are of 2-5% of total demand over next 2 years.	Being progressively implemented by Wannon Water.
Voluntary Demand Reduction Measures	Self regulated water conservation measures aimed at increasing effectiveness of measures within the Permanent Water Savings Plan, and potential savings if water restrictions are implemented.	Water savings from this option are expected to exceed the savings already achieved from the Permanent Water Saving Plan.
WaterMAP	The Government has implemented a voluntary program for all non-residential customers (5ML/year or greater).	Wannon Water to promote this voluntary measure during periods of heightened awareness or during drought response operating modes.
Mandatory Water Restrictions	Option available under By-Law No. 4.	Revised as per VicWater Guidelines in 2011. See Appendix B for requirements and prohibitions on water usage.
Compliance Officer/s	Additional resources may be required during extended periods of moderate to severe restrictions to monitor the performance of targeted water savings measures.	
Restrict Supply to Rural Customers	Possible under agreement only.	A restriction policy for rural customers requires further development.

Voluntary Demand Reduction Measures

Voluntary demand measures are an initial measure in the event of a drought. The importance of public awareness, understanding and involvement in meeting demand reduction objectives cannot be underestimated.

Wannon Water is committed to communicating effectively with its Grampians System customers to encourage take up of voluntary water saving measures and in turn deliver the best possible outcomes in demand reduction.

Supporting these voluntary water saving measures with initiatives including showerhead exchanges, trigger nozzles and other merchandise, Wannon Water aims to encourage its customer base to play an active role in managing their water supply and play their part in times of water shortages to ensure efficient use of their precious resource.

A broad base of local media (press and electronic) can be utilised to raise community awareness of system supply levels and encourage voluntary water saving measures.

Wannon Water will raise the profile of system levels and support the take-up of voluntary measures through extensive 'tips' and media coverage on its website, regular informative media releases, advertising, distributing publications with customer accounts and distributing information at community events throughout the service region. Wannon Water will also liaise with its Customer Engagement Committee where appropriate and consider holding community information sessions to raise awareness.

Publication of information including changes in water usage, rainfall levels, streamflows or bore performance details can assist in raising the profile of shortages and demand needs. Recent experience has shown that in combination, all of the above communication tools have been effective in heightened public awareness and consciousness of water efficiency measures, particularly over summer months.

As well as engaging the community in voluntary demand reduction measures Wannon Water can liaise with major consumption customers to work out strategies to reduce consumption. Major customers include the local shire, community groups, industrial and rural water users.

Mandatory Water Restrictions

The main purpose of water restrictions is to conserve dwindling supplies during drought periods.

Drought response triggers have been revised following augmentation of the system in 2010 with the completion of the pipeline from Rocklands Reservoir. The revised drought response triggers are related to the total volume of water available in the local Hamilton storages and water held by Wannon Water in the Available Bank Account from the Wimmera/Glenelg system.

The anticipated water savings for each level of restriction is shown in Table C7. These savings have been tested by comparing residential KL per connection over the period 2005/2006 to 2010/2011 for Hamilton against other towns not subject to water restrictions. The residential consumption rates shown in Table C7 provide guidance on the level of consumption which should be targeted to achieve the stated water savings.

Table B7 Anticipated Water Savings from Water Restrictions for the Hamilton System

Restriction Level	Estimated Water Saving			Target Residential Consumption Rate	
	% of Restrictable Demand[1]	Volume (ML)	% of Total Raw Water Use[2]	KL/ connection/ yr	L/ person/ day
PWSM				167	200
Stage 1	13% - 16%	30-35	2%	156	185
Stage 2	40% - 50%	90-110	5-6%	146	173
Stage 3	60% - 75%	130-160	8-9%	140	166
Stage 4	95% -100%	220	13%	130	154

1. Ranges adopted from VicWater, 2005.
2. Total raw water use inclusive of distribution, treatment and headworks losses.

C1.3.3 Supply Augmentation Options During Drought

A summary of the short term supply augmentation options for the Grampians System is shown in Table C8 .

Table C8 Supply Augmentation Options During Drought

Option	Details	Available Supply / Notes
Groundwater Pumping	Headworks , Bullawin , Geerak and McCutcheons	• Pumps are remote from Hamilton and are powered using diesel motors and hence need checking on a daily basis. • Geerak bore cannot be used until emergency trigger levels (ie Stage 4 restrictions) are in place.
Dunkeld Storages	Accessing water from unused supplies held in Dunkeld storages	• 146 ML/yr (total). • Low reliability and variable water quality. • Possible emergency supply for Dunkeld.
Purchase Additional Water	Purchase additional allocation from Wimmera-Glenelg System	• Early warning of intent to trade may be necessary to ensure storage operator reserves water in Rocklands Reservoir.
Qualification of Rights	Apply to the Minister to increase surface and/or groundwater extractions beyond the conditions of the entitlements.	

Wannon Water is able to carry-over unused allocation in the Glenelg/Wimmera system from year to year. Water that is carried over is held in a spillable water account, which can accumulate from year to year. Water which is carried over is effectively stored in what would otherwise have been “air space” in the reservoir. However, this means that if the storages spill, then all water held in the spillable water account is lost.

For Wannon Water, carryover provides an effective method to mitigate the impacts of low allocation years which may occur in the Glenelg/Wimmera system. That is, when base allocations are low, Wannon Water may be able to call on water which has been carried over, to maintain minimum supply requirements.

C1.4 Drought Response Actions

System monitoring is undertaken to assess the status of the supply system according to one of the following three operational modes:

Mode 1 – General Monitoring

Mode 2 – Heightened Awareness

Mode 3 – Drought Response

C1.4.1 Mode 1 – General Monitoring (Pre-Drought Phase Activities)

The zone for the General Monitoring mode is defined by the system storage capacity as the upper bound and a trigger which is set just above the system operating curve, as the lower bound.

There are a number of important factors in pre drought monitoring and planning which will influence the decision to declare the system as being in the General Monitoring mode. These include:

- Storage contents, stream flows and bore performance data to monitor availability of supply;
- Climatic trends and seasonal outlooks as indicators of the possible onset of drought;
- Consumption trends to indicate changes in Customer's usage of water; and
- Forecasting storage behaviour over a 6-12 month period.

The Water Security Outlook tool is used to monitor supply and demand side aspects of the system. During the General Monitoring mode, the system status is updated on a weekly basis and a report prepared weekly. A summary of the key system performance indicators for the Grampians Supply System which should be included in the Water Security Outlook and System Status Report is provided in Table C9.

Table C9 Requirements for Water Security Outlook and System Status Monitoring and Reporting

Item	Requirements
Rainfall, seasonal climate outlook	Information accessed from Bureau of Meteorology website.
State-wide status	Bureau of Meteorology and Department of Sustainability and Environment websites provide status reports on rainfall, streamflow, storage levels, groundwater and urban water restrictions across Victoria on a monthly basis.
System storage contents	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.
Inflows from Headworks streams	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.
Allocation Forecasts	Seeking updates on allocations within the Wimmera/Glenelg system and information on likely increases during low allocation periods.
Water levels in ground water supply systems are monitored at least monthly and are able to be compared against pump depths.	The frequency of monitoring should be increased to weekly or daily if a decline in water level raises concern on the security of the system.
System Demands (bulk meter consumption)	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.

The trigger mechanism for actions is the total system resource volume, using the Drought Response Triggers shown in Figure C1.

Forward look projections of storage response forms an integral part of the short term planning during a drought. Projections assist to anticipate the “likely” response based on current climatic conditions. At a minimum, Wannon Water makes projections over the next 3-12 months based on its experience in previous droughts. However, seasonal forecasting over three month, six month and 12 month periods, incorporating information from low-frequency climate signals such as the El Nino Southern Oscillation Index and sea surface temperatures, may also be useful in this assessment. System modelling tools such as REALM can also be utilised when undertaking forward look projections, as they can account for antecedent conditions such as soil moisture levels, and can translate rainfall and demand projections into changes in storage levels.

C1.4.2 Mode 2 – Heightened Awareness

The zone for the Heightened Awareness mode is designed to provide early warning of a pending water shortage. The Heightened Awareness mode is triggered following consideration of:

- Storage contents, stream flows and bore performance data to monitor availability of supply;
- Climatic trends and seasonal outlooks;
- Consumption trends to indicate changes in Customer's usage of water; and
- Forecasting storage behaviour over a 3-6 month period.

The key actions are summarised in Table C10 (in order of increasing impact from water shortages).

Table C10 Grampians System Action Plan for Mode 2 – Heightened Awareness

Action	Trigger	Response
Action 1	High likelihood that total storage contents cannot be maintained above the System Operating Curves	1. Reconvene the Drought Response Monitoring Committee
Action 2	Moderate to high likelihood that total storage contents cannot be maintained above the Level 1 Drought Response Trigger	2. Provide weekly updates of the System Status Report 3. Implement demand reduction options such as Community Education Programs, Voluntary Demand Reduction Measures via increased media,
Action 3	High likelihood that storage contents cannot be maintained above the Level 1 Drought Response Trigger	4. Alert public to the imminent water shortages and possible need for restrictions in the future. 5. Promote “voluntary restrictions” via media advertising campaigns to inform consumers about water conservation programs. 6. Declare operational mode as Mode 3 - Drought Response.

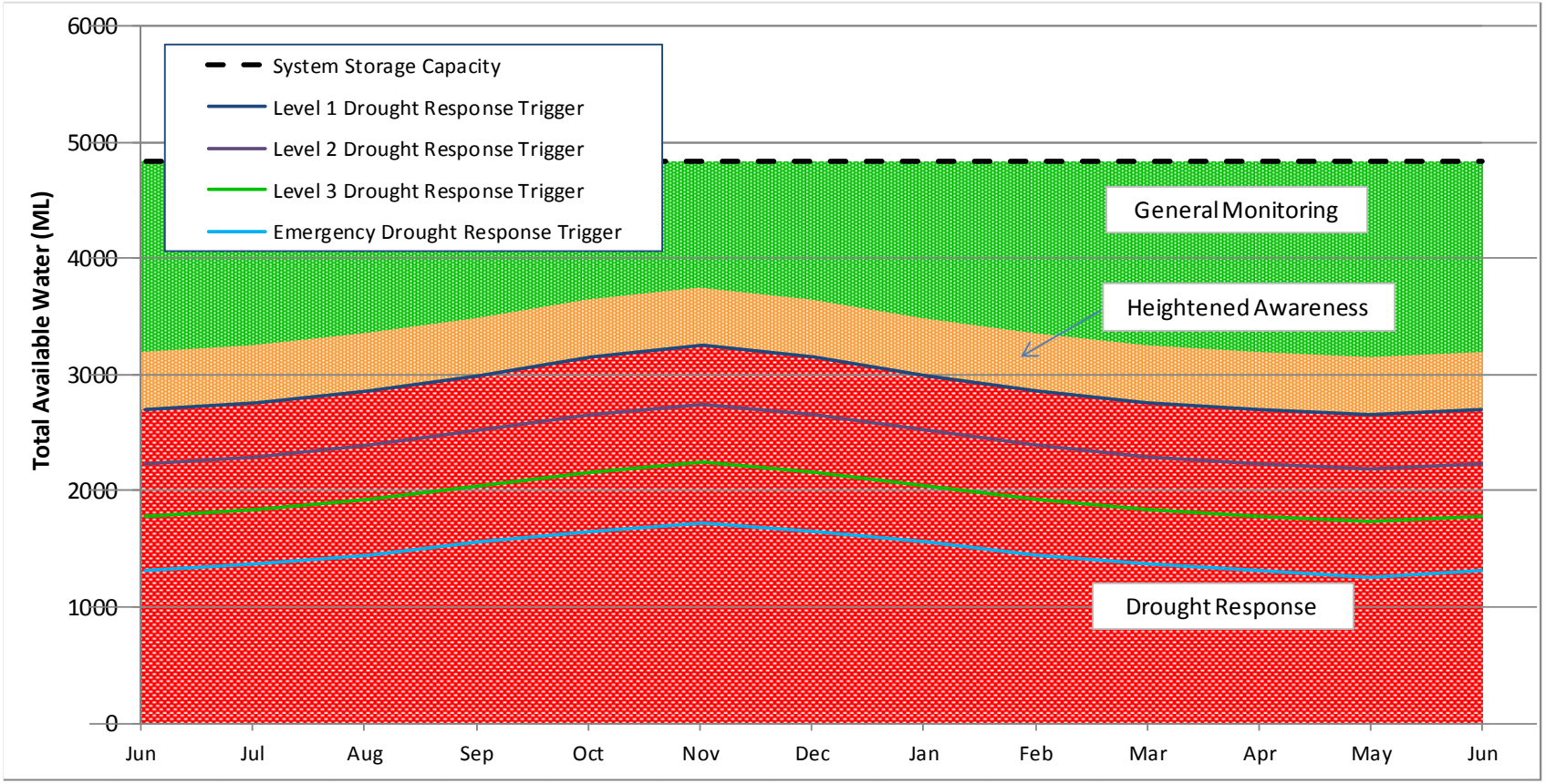
C1.4.3 Mode 3 - Drought Response

Mode 3 defines an active drought response period where supply and/or demand side measures are required to maintain supply security. Restriction rule curves are used to trigger an increase in the severity of the water shortage. Management actions during each level of restriction are summarised in Table C11.

Table C11 Grampians System Action Plan for Mode 3 – Drought Response

Action	Trigger	Response
Action 4	Total storage contents unable to be maintained above Level 1 Drought Response Trigger.	7. Consider implementation Stage 1 restrictions. 8. Monitor storage volume response and perform regular forward look storage projections. 9. Initiate an intensive advertising campaign and issue relevant leaflets.
Action 5	Total storage contents unable to be maintained above Level 2 Drought Response Trigger	10. Consider implementation Stage 2 restrictions, water patrols etc. 11. Monitor storage volume response and perform regular forward look storage projections. 12. Commence pumping from groundwater bores.
Action 6	Total storage contents unable to be maintained above Level 3 Drought Response Trigger	13. Consider implementation Stage 3 restrictions. 14. Monitor storage volume response and perform regular forward look storage projections. 15. Utilise Dunkeld resources 16. Implement preparatory steps for emergency action, including initial contact with water tanker contractors.
Action 7	Total storage contents unable to be maintained above Level 4 Drought Response Trigger (Emergency Level)	17. Consider implementation Stage 4 restrictions. 18. Monitor storage volume response and perform regular forward look storage projections.

Figure C3 Drought Response Triggers - Grampians Water Supply System



C1.5 Post Drought Phase

Actions to be considered after a drought has occurred are summarised in Table C12. These include evaluating the appropriateness of the actions within each of the operational models and the associated triggers, the effectiveness of demand reduction and emergency supply augmentation options and the effectiveness of each level of restriction.

Table C12 Evaluate Operational Modes Trigger Levels and Associated Actions

Operational Mode	Action Sequence	Description	Assessment Procedure
General Monitoring	NA	Monitoring and evaluation	Were the indicators being used to monitor of system performance appropriate?
Heightened Awareness	Actions 1-6	Planning	Was there adequate time to undertake the activities detailed in Actions 1-3.
		Voluntary Demand Reduction	Was the community responsive? Was there a significant reduction in demand? Was the trigger level appropriate?
Drought Response	Actions 7-18	Water Restrictions	Was the expected reduction in demand achieved for each stage? Were the trigger levels appropriate? Were policing methods effective, if so, how?
		Groundwater pumping	Was groundwater effective at this stage or should it be started earlier? Was timing of groundwater input appropriate? Were pumps and equipment available? Was water quality acceptable to customers, particularly for industrial customers?
		Implement other emergency supply options	To what level was demand reduced? What was the cost and practicality of carting water if undertaken? Were individual emergency options implemented too late? Did other options arise; if so, what other options were available?

Table C13 summarises the assessment procedure for evaluating the impact of restrictions applied to customers, authority staff and supply systems. The intention is to learn from the methodologies that have been applied in order to minimise any future incidents of this nature.

Table C13 Evaluate the Impact of Restrictions

Stakeholders	Assessment Procedure
Domestic Users	Were the restrictions too severe? Was the right mix of media used to disseminate information? Was there enough warning of impending drought? If not, how could this be improved?
Environmental	Were flow triggers appropriate? What were the effects upon the aquifer and other users of pumping? What methods have been put into place to rectify any environmental effects?
Wannon Water Staff	Were many instances reported of restriction violations? Was it possible to effectively enforce the restriction policy? Was sufficient staff available to monitor system performance?
Supply Systems	Did restrictions achieve expected levels of water savings? Have supply systems been replenished? If so, how long did it take to achieve this level? What procedures were put in place to achieve this?

Table C14 summarises the assessment procedure for establishing the effectiveness of pumping groundwater to replenish the supply systems during drought.

Table C14 Evaluate Effectiveness of Groundwater Pumping

Action	Assessment Procedure
Evaluate effectiveness of ground water pumping	Did water quality problems occur? Should groundwater supplies have been introduced prior to where programmed in the Drought Response Plan? Did the volume of water extracted stay within the groundwater licence limit.

Part D

Glenthompson System Drought Response Plan

D1. Glenthompson Water Supply System

D1.1 Details of the Glenthompson Water Supply System

D1.1.1 System Description

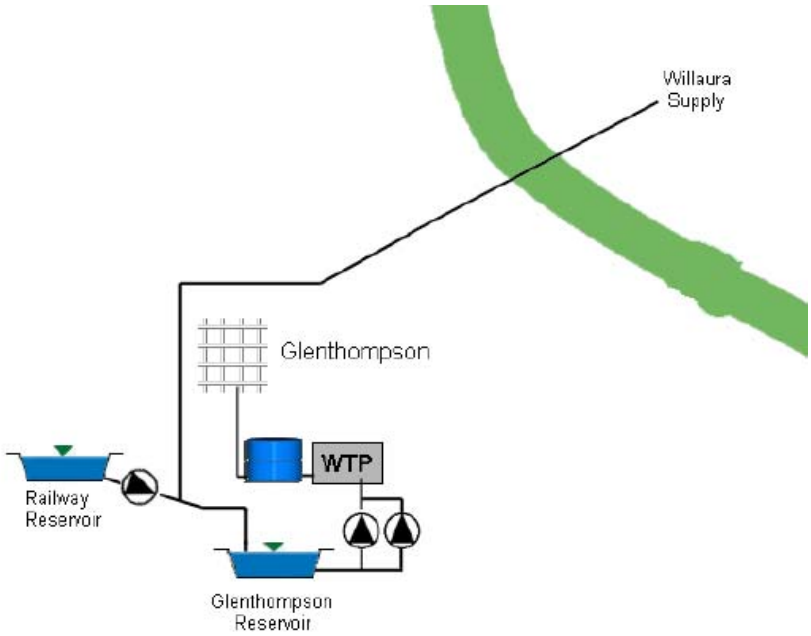
The existing system has three (3) sources of supply. Capacities of these are:

- Glenthompson Reservoir — 110 ML
- Railway Reservoir — 34 ML
- Grampians Wimmera Mallee Water via Willaura Pipeline — 58 ML (Subject to a current Bulk Entitlement application)

The Glenthompson and Railway Reservoirs are located close to the township and have surface catchments, while the Willaura pipeline draws water from Grampians Wimmera Mallee Water's (GWMWater) Willaura System. The source for the Willaura system is surface run-off from offtakes in the Grampians National Park, supplemented by supply from a borefield. Wannon Water liaises with GWMWater in respect of the supply mode, timing and quantities delivered from the Willaura pipeline.

A schematic of the supply system is given in Figure D1.

Figure D1 Glenthompson Water Supply System



D1.1.2 System Demands and Consumption

The total demand represents the unrestricted water usage from the headworks, inclusive of system distribution losses. The current (2011) average annual demand for the system is adopted for long term planning purposes, including the development of Wannon Water's water restriction policies.

The estimated total average annual demand for the Glenthompson Water Supply System is 32 ML/year. The components of this demand are presented in Table D1.

Table D1 Components of the 2010/11 Average Annual Demand Estimate

Component	Total Demand (ML)	Base Demand (ML)	Restrictable Demand (ML)
Residential	8	6	2
Non Residential	1	1	-
Rural	23	23	-
Major			
Water Cartage			
Total Consumption (Bulk Meter)	32		
Unaccounted for Water	0		
Bulk Usage (WTP Outflow)	32		
WTP Losses			
Total Raw Water Usage	32	30	2

Water connections and consumption in 2009/2010 (i.e. the base year for establishing average annual demand) for Glenthompson is provided in Table D2.

Table D2 Summary of Connections and Consumption in 2009/2010 – Glenthompson

	Residential		Non-Residential		Major		Rural		Total	
Supply District	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**
Glenthompson	*95*	8	*25*	1			*8*	1	*128*	10
Willaura Pipeline							*30*	22	*30*	22
Total	***95***	**8**	***25***	**1**			***38***	**23**	***158***	**32**

Figures exclude nonrevenue water, water cartage, and other system losses. Volumes in ML. System subject to Stage 2 water restrictions to October 2009.

D1.1.3 System Yield and Security of Supply

For the Glenthompson Water Supply System, the average annual demand that can be supplied at the adopted 95% annual reliability is approximately 60 ML/a or 180% of current demand (GHD, 2011). The frequency of Stage 1 restrictions is adopted by Wannon Water as the measurement of system reliability. A 95% annual reliability target equates to a 1 in 20 year frequency for restrictions.

The system yield estimate is subject to finalisation of the Glenthompson Bulk Entitlement and the conditions of supply included in the bulk entitlement.

System reliability has been determined using the current drought response triggers. These triggers may need to be updated once the conditions of supply from the Willaura system have been finalised.

D1.2 Drought Experience

During the 1982/1983 drought the Glenthompson Reservoir was full (110 ML) at the beginning of September, 1981, and did not receive any runoff for the period through to mid April, 1983, a period of 21 months. The storage was rapidly depleted and by 1 April, 1982, held only 17 ML. From that time until the drought ended the Glenthompson system was almost totally reliant on the Willaura pipeline. An estimated 3 ML was held in the storage just prior to the drought breaking.

Since 1995, restrictions have been implemented frequently as the reliability of inflows to the two local storages has been significantly lower due extended low rainfall conditions. Water restrictions were required continuously over the period 1995 to 2009, including a 12 month period of Stage 4 restrictions from October 2006. Whilst water restrictions only impacted the residential customers, demand from the rural customers taking raw water from the system was also lower as de-stocking occurred from 2007/2008 onwards.

Following customer concerns about the severity of the supply situation, exemptions were made under the Stage 4 restrictions allowing bucket watering of gardens. Restrictions were lifted in October 2009.

A summary of the restrictions since 1995 is provided in Table D3.

Table D3 Glenthompson System Recent History of Restrictions

Date	Stage	Action
18/02/1995	2	Introduced
17/06/1995	2	Lifted
17/01/1998	1	Introduced
11/07/1998	1	Lifted
12/09/1998	1	Introduced
12/12/1998	2	Introduced
21/09/2000	1	Reduced from Stage 2
14/10/2000	1	Lifted
12/11/2005	1	Introduced
01/04/2006	2	Introduced
14/10/2006	4	Introduced
3/11/2007	2	Reduced from Stage 4
4/10/2009	PWSR	Stage 2 Lifted – returned to PWSR

D1.3 Drought Response Options

D1.3.1 Introduction

There are two methods which can be applied in the event of a drought or water shortage, these being demand reduction and supply augmentation.

On the basis of the performance of existing systems during past droughts it is considered that demand management should form the first stage in this drought response program. Supply augmentation would be considered if this stage failed to achieve the response or if the severity of the drought necessitates it.

A condition of the Glenthompson bulk entitlement (subject to current application) will be the requirement to restrict urban demands in the system when GWMWater imposes water restrictions in their supply systems which source water from the Willaura system or reduce the maximum daily rate of taking water from the Willaura headworks to a rate agreed to by GWMWater.

Options for both these measures are detailed below.

D1.3.2 Demand Reduction During Droughts

There are a number of demand reduction options that can be employed during times of water shortage. A summary of demand reduction options is shown in Table D4.

Table D4 Summary of Demand Reduction Options

Option	Details	Comments
Community Education Programs	Water efficiency awareness (showerhead rebates, information brochures), linked to ongoing State Government programs. Estimated savings are of 2-5% of total demand over next 2 years.	Being progressively implemented by Wannon Water.
Voluntary Demand Reduction Measures	Self regulated water conservation measures aimed at increasing effectiveness of measures within the Permanent Water Savings Plan, and potential savings if water restrictions are implemented.	Water savings from this option are expected to exceed the savings already achieved from the Permanent Water Saving Plan.
Mandatory Water Restrictions	Option available under By-Law No. 2.	Revised as per VicWater Guidelines in 2011. See Appendix B for requirements and prohibitions on water usage.
Compliance Officer/s	Additional resources may be required during extended periods of moderate to severe restrictions to monitor the performance of targeted water savings measures.	
Restrict Supply to Rural Customers	Possible under agreement only.	A restriction policy for rural customers requires further development.

Monitoring of the Glenthompson system is important due to reliance on surface supplies and limited access to supplementary sources. Accordingly, demand reduction forms the basis of the Drought Response Plan for Glenthompson and needs to be implemented early to be effective.

As with the Grampians System, it is proposed that the first phase of demand reduction should involve a request to the consumers for voluntary reduction in water usage.

Half of Glenthompson's demand is from supply-by-agreement rural users on the pipeline from Willaura. If supply from the Willaura system failed, supply to these users would not be guaranteed. For the Glenthompson township, voluntary and mandatory restrictions combined with community education programs would be the main tools used to manage demand.

The anticipated water savings for each level of restriction is shown in Table D5. These savings have been tested by comparing residential KL per connection over the period 2005/2006 to 2010/2011 for Hamilton against other towns not subject to water restrictions. The residential consumption rates shown in Table D5 provide guidance on the level of consumption which should be targeted to achieve the stated water savings.

Table D5 Anticipated Water Savings from Water Restrictions for Glenthompson

Restriction Level	Estimated Water Saving			Target Residential Consumption Rate	
	% of Restrictable Demand[1]	Volume (ML)	% of Total Raw Water Use[2]	KL/ connection/ yr	L/ person/ day
PWSM				167	200
Stage 1	13% - 16%	0.3	1%	156	185
Stage 2	40% - 50%	1	3%	146	173
Stage 3	60% - 75%	1.5	4%	140	166
Stage 4	95% -100%	2	6%	130	154

1. Ranges adopted from VicWater, 2005.
2. Total raw water use inclusive of distribution, treatment and headworks losses.

D1.3.3 Supply Augmentation Options During Drought

A summary of the range of short-term supply augmentation options for Glenthompson is shown in Table D6.

Table D6 Supply Augmentation Options During Drought

Option	Details	Available Supply
Existing Groundwater Bores	Willaura System bores operated by GWMWater.	Delivered via the Willaura pipeline, this resource is additional to the Bulk Entitlement and could be made available by agreement with GWMWater.
Water Cartage	From Dunkeld, Mortlake or Penshurst.	

D1.4 Drought Response Actions

System monitoring is undertaken to assess the status of the supply system according to one of the following three operational modes:

Mode 1 – General Monitoring

Mode 2 – Heightened Awareness

Mode 3 – Drought Response

The triggers for drought response actions have been based on the restriction rules curves developed in 2007. These triggers may need to be updated once the conditions of supply from the Willaura system have been finalised.

D1.4.1 Mode 1 – General Monitoring (Pre-Drought Phase Activities)

The zone for the General Monitoring mode is defined by the system storage capacity as the upper bound and a trigger which is set just above the system operating curve, as the lower bound.

There are a number of important factors in pre drought monitoring and planning which will influence the decision to declare the system as being in the General Monitoring mode. These include:

- Storage contents, stream flows and bore performance data to monitor availability of supply;
- Climatic trends and seasonal outlooks as indicators of the possible onset of drought;
- Consumption trends to indicate changes in Customer's usage of water;
- Forecasting storage behaviour over a 6-12 month period;
- Regular consultation with GWMWater regarding the supply status for the Willaura System.

The Water Security Outlook tool is used to monitor supply and demand side aspects of the system. During the General Monitoring mode, the system status is updated on a weekly basis and a report prepared weekly. A summary of the key system performance indicators for the Glenthompson Supply System which should be included in the Water Security Outlook and System Status Report is provided in Table D7.

Table D7 Requirements for Water Security Outlook and System Status Monitoring and Reporting

Item	Requirements
Rainfall, seasonal climate outlook	Information accessed from Bureau of Meteorology website.
State-wide status	Bureau of Meteorology and Department of Sustainability and Environment websites provide status reports on rainfall, streamflow, storage levels, groundwater and urban water restrictions across Victoria on a monthly basis.
System storage contents	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.
Inflows Willaura System	Monitored by GWMWater.
Water levels in ground water supply systems are monitored at least monthly and are able to be compared against pump depths.	The frequency of monitoring should be increased to weekly or daily if a decline in water level raises concern on the security of the system.
System Demands (bulk meter consumption)	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.

D1.4.2 Mode 2 – Heightened Awareness

The zone for the Heightened Awareness mode is designed to provide early warning of a pending water shortage. The Heightened Awareness mode is triggered following consideration of:

- Storage contents, stream flows and bore performance data to monitor availability of supply;
- Climatic trends and seasonal outlooks;
- Consumption trends to indicate changes in customer's usage of water; and
- Forecasting storage behaviour over a 3-6 month period.

The key actions are summarised in Table D8 (in order of increasing impact from water shortages).

Table D8 Glenthompson System Action Plan for Mode 2 – Heightened Awareness

Action	Trigger	Response
Action 1	High likelihood that total storage contents cannot be maintained above the System Operating Curves	1. Reconvene the Drought Response Monitoring Committee
Action 2	Moderate to high likelihood that total storage contents cannot be maintained above the Level 1 Drought Response Trigger	2. Provide weekly updates of the System Status Report 3. Implement demand reduction options such as Community Education Programs, Voluntary Demand Reduction Measures via increased media advertising,
Action 3	High likelihood that storage contents cannot be maintained above the Level 1 Drought Response Trigger	4. Alert public to the imminent water shortages and possible need for restrictions in the future. 5. Promote “voluntary restrictions” via media advertising campaigns to inform consumers about water conservation programs. 6. Declare operational mode as Mode 3 - Drought Response.

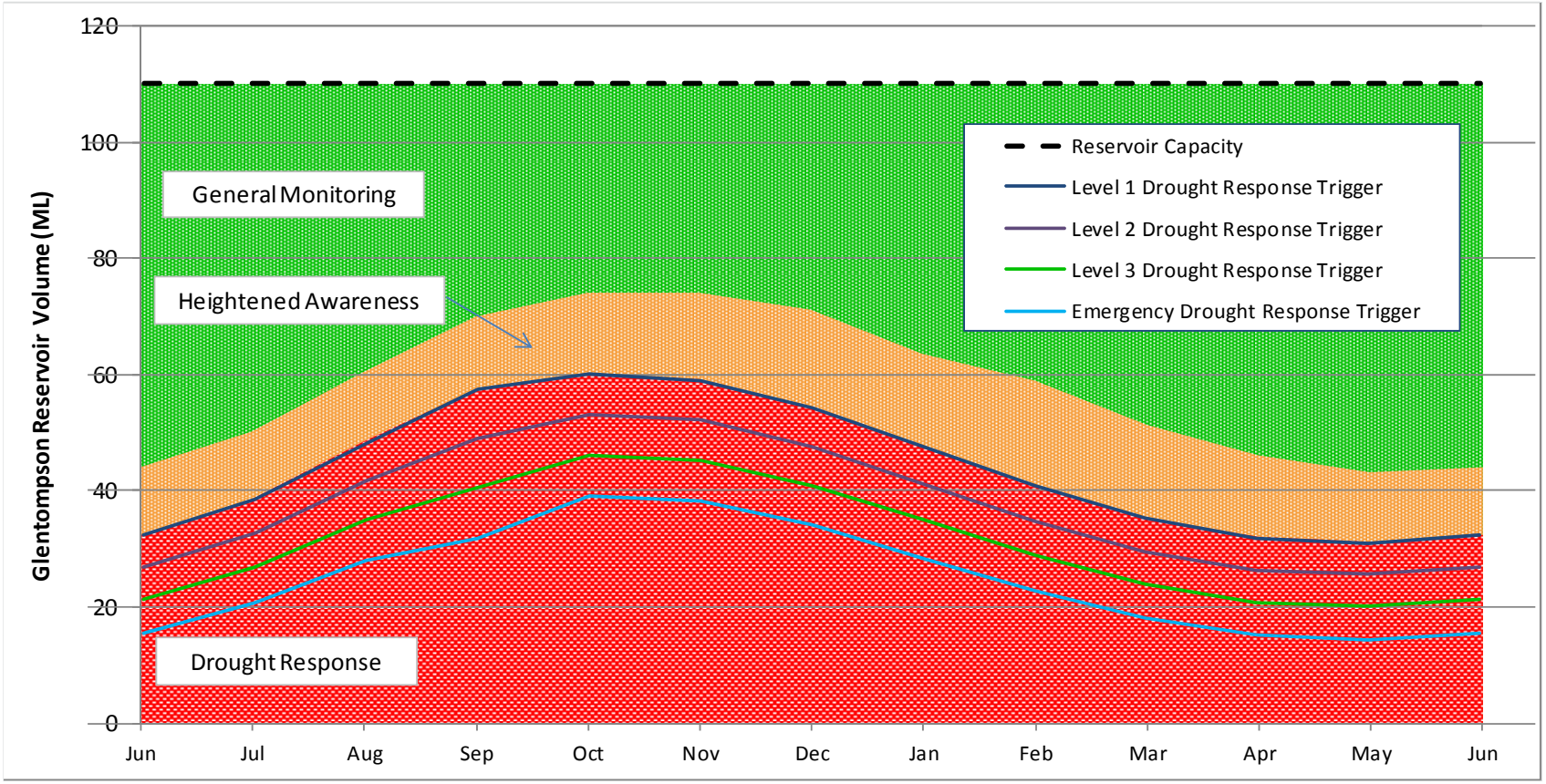
D1.4.3 Mode 3 - Drought Response

Mode 3 defines an active drought response period where supply and/or demand side measures are required to maintain supply security. Restriction rule curves are used to trigger an increase in the severity of the water shortage. Management actions during each level of restriction are summarised in Table D9.

Table D9 Glenthompson System Action Plan for Mode 3 – Drought Response

Action	Trigger	Response
Action 4	Total storage contents unable to be maintained above Level 1 Drought Response Trigger.	7. Consider implementation Stage 1 restrictions. 8. Monitor storage volume response and perform regular forward look storage projections. 9. Initiate an intensive advertising campaign and issue relevant leaflets.
Action 5	Total storage contents unable to be maintained above Level 2 Drought Response Trigger	10. Consider implementation Stage 2 restrictions, water patrols etc. 11. Monitor storage volume response and perform regular forward look storage projections.
Action 6	Total storage contents unable to be maintained above Level 3 Drought Response Trigger	12. Consider implementation Stage 3 restrictions. 13. Monitor storage volume response and perform regular forward look storage projections. 14. Implement preparatory steps for emergency action, including initial contact with water tanker contractors.
Action 7	Total storage contents unable to be maintained above Level 4 Drought Response Trigger (Emergency Level)	15. Consider implementation Stage 4 restrictions. 16. Monitor storage volume response and perform regular forward look storage projections. 17. Tanker water to Glenthompson

Figure D2 Restriction Rule Curves for the Glenthompson Water Supply System



D1.5 Post Drought Phase

Actions to be considered after a drought has occurred are summarised in Table D10. These include evaluating the appropriateness of the actions within each of the operational models and the associated triggers, the effectiveness of demand reduction and emergency supply augmentation options and the effectiveness of each level of restriction.

Table D10 Evaluate Operational Modes Trigger Levels and Associated Actions

Operational Mode	Action Sequence	Description	Assessment Procedure
General Monitoring	NA	Monitoring and evaluation	Were the indicators being used to monitor of system performance appropriate?
Heightened Awareness	Actions 1-6	Planning	Was there adequate time to undertake the activities detailed in Actions 1-3.
		Voluntary Demand Reduction	Was the community responsive? Was there a significant reduction in demand? Was the trigger level appropriate?
Drought Response	Actions 7-17	Water Restrictions	Was the expected reduction in demand achieved for each stage? Were the trigger levels appropriate? Were policing methods effective, if so, how?
		Implement other emergency supply options	To what level was demand reduced? What was the cost and practicality of carting water if undertaken? Were individual emergency options implemented too late? Did other options arise; if so, what other options were available?

Table D11 summarises the assessment procedure for evaluating the impact of restrictions applied to customers, authority staff and supply systems. The intention is to learn from the methodologies that have been applied in order to minimise any future incidents of this nature.

Table D11 Evaluate the Impact of Restrictions

Stakeholders	Assessment Procedure
Domestic Users	Were the restrictions too severe? Was the right mix of media used to disseminate information? Was there enough warning of impending drought? If not, how could this be improved?
Rural Customers	What was the rural customers' reaction to restrictions?
Environmental	Were flow triggers appropriate? Should environmental flows be reassessed? What were the effects upon the aquifer and other users of pumping? What methods have been put into place to rectify any environmental effects?
Wannon Water Staff	Were many instances reported of restriction violations? Was it possible to effectively enforce the restriction policy? Were sufficient staff available to monitor system performance?
Supply Systems	Did restrictions achieve expected levels of water savings? Have supply systems been replenished? If so, how long did it take to achieve this level? What procedures were put in place to achieve this?

Part E

Groundwater Systems Drought Response Plan

E1. Groundwater Supply Systems

E1.1 Details of Groundwater Supply Systems

E1.1.1 System Descriptions

Wannon Water manages 10 water supply systems that use groundwater as the primary source of water. Whilst most of these systems typically supply one township, two have been set up to supply multiple townships via a piped distribution network. There are also distinct hydrogeologic regions which water is extracted from to supply these towns, these being from either shallower groundwater sources or from a deeper groundwater resource referred to as the Lower Tertiary Aquifer (LTA) system. The towns supplied from groundwater resources are shown in Tables E1 and E2.

Table E1 Shallow Groundwater Supply Systems

System	Towns Supplied and Other Users	Sources of Supply	Entitlements (ML)
Tullich	Casterton, Sandford, Merino, Coleraine	4 bores west of Casterton Konongwootong Reservoir[1]	1000 + 100
Penshurst	Penshurst	2 bores	250
Caramut	Caramut	2 bores	50
Darlington	Darlington	2 bores	10

Note 1 Used as an emergency backup supply for the Tullich System

Table E2 Deep Groundwater Supply Systems

System	Towns Supplied and Other Users	Sources of Supply	Entitlements (ML)
West LTA			
Dartmoor	Dartmoor	1 bore	170
Heywood	Heywood	2 bores	333
Portland	Portland	3 bores	6222
Port Fairy	Port Fairy	2 bores	1026
East LTA			
Port Campbell	Port Campbell, Peterborough, Timboon	1 bore	1009
Other			
Macarthur	Macarthur	1 bore	130

Further details for each of the supply systems are provided in the following sections.

E1.1.2 Shallow Groundwater Systems (East Lower Tertiary Aquifer)

Tullich Groundwater System

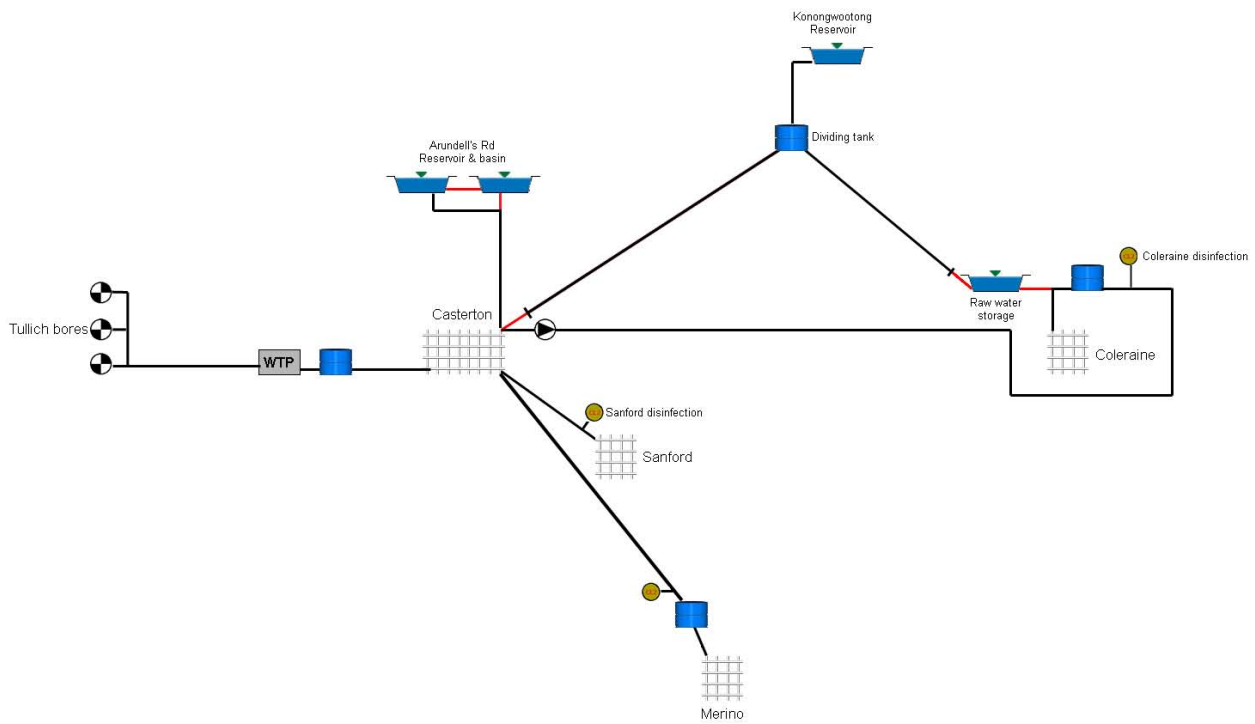
The Tullich Borefield consists of four production bores all of which are equipped. There are also two observation bores. Two production bores were constructed in 1989 and the other two in 2004. The observation bores were constructed in 2004.

Water from the Tullich Borefield is pumped to the treatment plant which is located on the western side of Casterton. The treated water is then fed into the Casterton, Coleraine, Sandford and Merino systems.

Merino was previously supplied with groundwater from the Mocamboro borefield but has been supplied from Casterton since December 2005. Water is pumped via a 14 km, 100 mm diameter rising main from Casterton via Sandford to the Merino service basin.

Coleraine has been supplied from the Tullich system since 2009.

Figure E1 Tullich Groundwater System

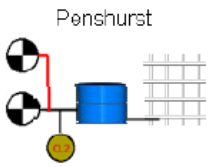


Penshurst Groundwater System

This water supply system consists of a main production bore located on the flanks of Mount Rouse adjacent to two service basins to the south of the township. The service basins have a combined capacity of 2 ML and act as a balancing storage.

A second emergency bore is located adjacent to the Hawkesdale Road to the south of the township and can be connected into the feeder main that supplies the town from the main Mount Rouse production bore.

Figure E2 Penshurst Groundwater System



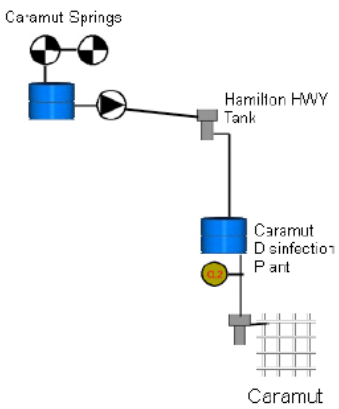
Caramut Groundwater System

The original supply to this small rural community was sourced from spring water which was collected in a small concrete basin and then pumped 11 km to a 45 kL elevated tank. Overflow from the elevated tank was then piped into an adjacent 15.5 ML service basin. Water then gravitated through a further 8.5 km of pipeline to a 45 kL elevated tank supplying the township.

In 1999 a 0.6 ML concrete tank was constructed adjacent to the service basin and the basin was taken out of service. The spring is no longer in use and two production bores have been installed at the spring site.

The transfer pump from the bores to the Caramut Tank has a design capacity of 30 000 L/hour.

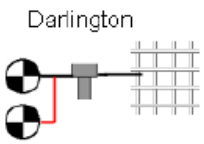
Figure E3 Caramut Groundwater System



Darlington Groundwater System

Two bores at Darlington provide a non potable water supply to 21 customers. The bores are both shallow (less than 40 m deep) and located adjacent to the Darlington CFA station. Construction of both bores is poorly understood. The newer of the two bores (58343) is used preferentially, and the second bore is retained as an emergency backup.

Figure E4 Darlington Groundwater System



E1.1.3 Deep Groundwater Systems (West Lower Tertiary Aquifer)

Portland, Heywood, Port Fairy & Dartmoor Groundwater Systems

Deep bores extracting water from the Lower Tertiary Aquifer provide 100% of water supply for the towns of Portland, Heywood, Dartmoor and Port Fairy. The bore characteristics for the four towns are shown in Table E3.

Table E3 Bore Details for Portland, Heywood, Dartmoor and Port Fairy

Location	Depth (m)	Year Installed	Storage Available
Portland			
Bald Hill 3	1242	2008	36 ML Basin
Bald Hill 4	1241	2008	
Wyatt Street	1400	1958	4.5 ML Basin
Heywood			
No. 3	486	1975	4.5 ML Basin
No. 4	494	2004	0.3 ML Tower
Dartmoor			
No. 1	104	2004	0.4 ML Tower
Port Fairy			
No. 3	786	2001	2.27 ML Tower
No. 4	771	2004	

Figure E5 Portland Groundwater System

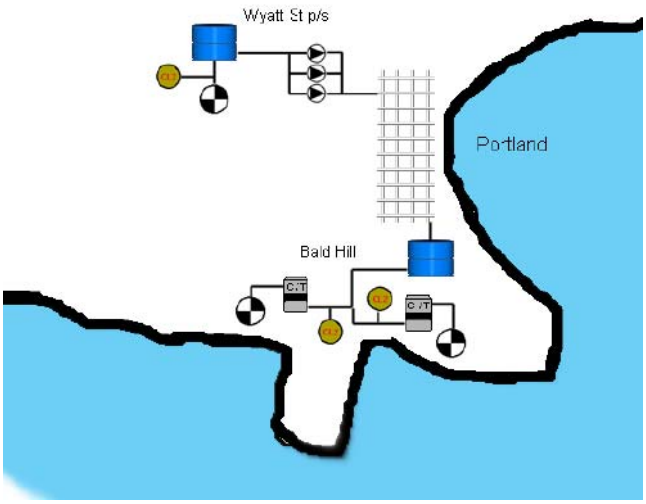


Figure E6 Port Fairy Groundwater System

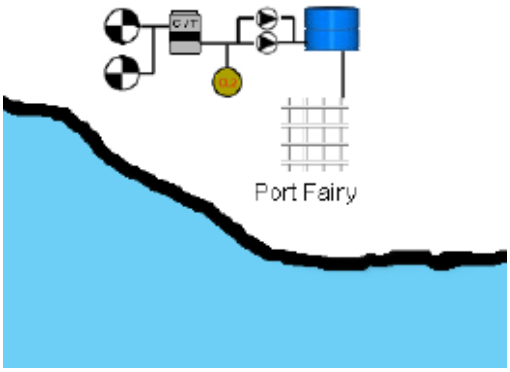


Figure E7 Heywood Groundwater System

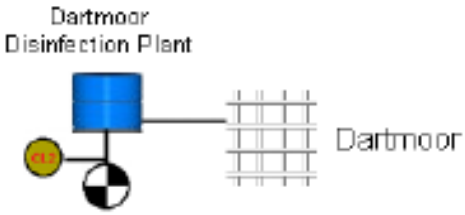
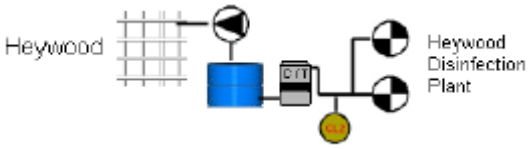


Figure E8 Dartmoor Groundwater System



Port Campbell Groundwater Systems

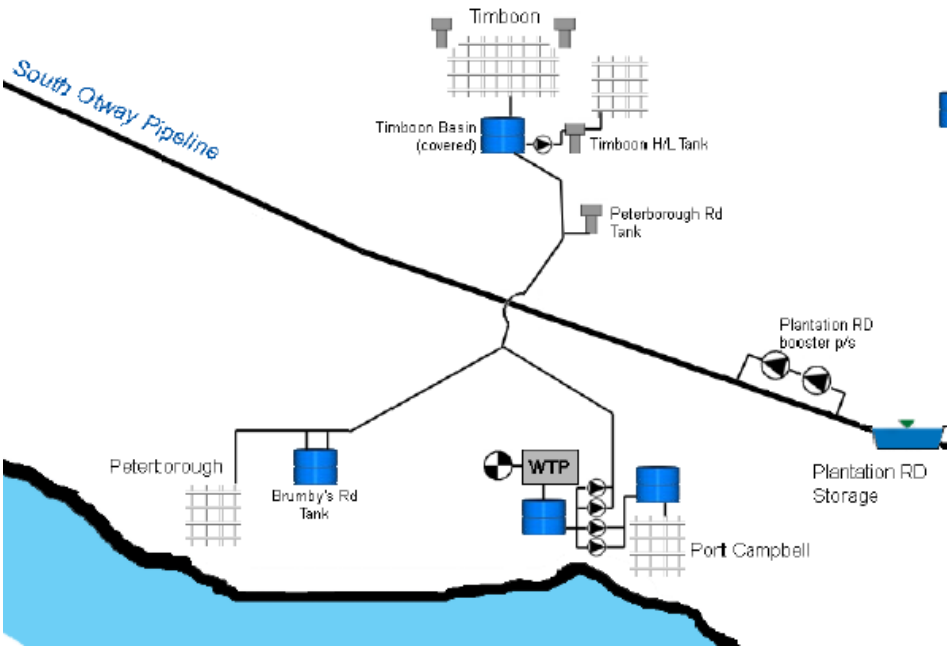
The townships of Port Campbell, Timboon and Peterborough are supplied from an artesian bore harvesting water from the Port Campbell sub formation of the Dilwyn aquifer.

The supply bore was constructed at Port Campbell in 1998, originally supplying only Port Campbell and Timboon. The bore is 520 metres deep, has a small artesian flow and can be pumped at rates up to 40 litres/sec. Following the completion of a new supply system Peterborough was connected to the Port Campbell bore in December 1998.

Storage within this supply system includes a service basin, three ground level tanks, an elevated tank and several water towers

Demand for water at Port Campbell and Peterborough varies seasonally due to the high tourist population during summer. Some 40 rural users also draw water direct from the rising main supplying Peterborough and Timboon.

Figure E9 Port Campbell Groundwater System

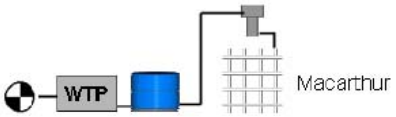


Macarthur Groundwater System

The Macarthur water supply system was commissioned in 1994 and is supplied with groundwater from one production bore, referred to as Macarthur No.1, which is located approximately 1 km to the north of the township.

Water from the bore is pumped to a treatment plant and then stored in a 500 kL clear water storage tank prior to being gravity fed to the township.

Figure E10 Macarthur Groundwater System



E1.1.4 System Demands and Consumption

Table E4 shows water connections and consumption in 2009/2010 for each of the towns supplied by the Groundwater systems.

Table E4 Summary of Connections and Consumption in 2009/10 - Groundwater

	Residential		Non-Residential		Major		Rural		Total	
Supply District	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**	**No.**	**Vol.**
Casterton	*808*	124	*144*	56			*26*	11	*978*	191
Coleraine	*518*	66	*83*	26			*15*	11	*616*	102
Merino	*124*	16	*19*	5			*37*	14	*180*	35
Sandford	*56*	11	*6*	6			*27*	10	*89*	27
Tullich Pipeline							*7*	1	*7*	1
Tullich Total	***1506***	**218**	***252***	**93**			***112***	**46**	***1870***	**357**
Penshurst	***254***	**44**	***54***	**15**			***3***	**2**	***311***	**60**
Caramut	*54*	9	*16*	5			*8*	3	*78*	17
Caramut pipeline							*12*	3		
Caramut Total	***54***	**9**	***16***	**5**			***20***	**6**	***90***	**20**
Darlington	***19***	**1**	***3***	**0**					***22***	**2**
Dartmoor	*118*	13	*17*	2					*135*	15
Heywood	*637*	103	*101*	32			*7*	2	*745*	137
Port Fairy	*1921*	259	*221*	148	*1*	211	*2*	0	*2145*	618
Portland	*4884*	764	*637*	299	*2*	451	*6*	1	*5529*	1516
West Dilwyn Total	***7560***	**1140**	***976***	**480**	***3***	**662**	***15***	**4**	***8554***	**2286**
Peterborough	*285*	19	*14*	36			*6*	7	*305*	62
Port Campbell	*248*	26	*43*	40					*291*	66
Timboon	*407*	59	*76*	30			*102*	76	*585*	165
East Dilwyn Total	***940***	**105**	***133***	**106**			***108***	**83**	***1181***	**293**
Macarthur	***136***	**14**	***39***	**4**			***2***	**1**	***177***	**20**

Figures exclude nonrevenue water, water cartage, and other system losses. Volumes in ML.

E1.1.5 System Yields and Security of Supply

For the systems supplied from groundwater, the yield of the system is assumed to be equivalent to the current licensed volume (or entitlement). This yield estimate is currently not linked to reliability measures such as the frequency of restrictions. The adopted yield for each groundwater supplied system is summarised in Table E5.

Table E5 Estimated System Yield for Groundwater Systems

	Yield (ML/a)
Shallow Groundwater System	
Tullich	1,000
Penshurst	100
Caramut	50
Darlington	10
Deep Groundwater Systems	
West Dilwyn	
Dartmoor	170
Heywood	333
Portland	6,222
Port Fairy	1,026
East Dilwyn	
Port Campbell	1,009
Other	
Macarthur	130

The yield in all groundwater systems exceeds estimated demand.

Analysis has shown that all groundwater systems are currently reliable at the current level of development and are quite resilient to the impacts from climate change. The shallow groundwater systems have also been shown to be highly reliable at the full licence volume level of development. There is uncertainty about the reliability of the deeper groundwater systems at levels of demand which are higher than present.

E1.2 Drought Experience

Records indicate that all towns supplied by groundwater have not had water supply concerns as a result of drought, except for Caramut and Merino. Since 2006, water restrictions have not been required for any of Wannon Water's towns that are supplied with groundwater. Coleraine had Stage 1 restrictions in force from December 2006 to June 2007 while still supplied from the Konongwootong Reservoir water supply system.

Caramut

The Caramut water supply system was constructed in 1977. The spring supply proved to be totally inadequate during a drought. Severe water restrictions were imposed during 1982 and maintained until the drought broke in April 1983.

A bore was constructed adjacent to the spring in 1983 and a second bore was drilled in 1999. Whilst the spring ceased to flow over the summer of 2000 the bores maintained supply within acceptable drawdown limits. No water restrictions at Caramut have been required since 1983.

Merino

The Merino system was constructed during 1976 and so did not experience the 1967/1968 drought.

During the 1982/1983 drought restrictions were applied during January 1983 and remained in force until the end of the drought. With these in place the Merino system adequately catered for demand and had reasonable reserves at the end of the drought. It is noted that there was considerable demand for water from the Merino standpipe by people from outside the waterworks district.

In 2005 Merino was connected to the Casterton system and the Merino bores (Mocamboro borefield) were taken off-line.

Casterton, Coleraine and Sandford

The Konongwootong Reservoir did not receive any run-off during the winter of 1967 and accordingly the storage level was low. Restrictions were applied in September of 1967 for both Casterton and Coleraine and all of the rural consumers along the supply lines. The restrictions were up-graded in October 1967 to severe levels which banned the use of hoses. At the same time a series of investigations were commenced on alternative sources of supply.

In January of 1968 preliminary arrangements were made to facilitate pumping of water from the Konongwootong Reservoir from below the outlet level and these were subsequently implemented.

Restrictions were lifted in May of 1968 at the end of the drought.

The Tullich Borefield was identified as a supplementary water source for Casterton and brought on line in 1969 after the drought ended.

During the 1982/1983 drought the Tullich Borefield was used to provide as much water as possible for the Casterton Supply. As water levels at Konongwootong were somewhat higher at the end of the 1982 winter than they had been in 1967 and with the dual benefit of the Tullich supply and restrictions, the system catered for demands with the Konongwootong Reservoir dropping to a low of 3.4 m just prior to the end of the drought.

Restrictions were applied in early January of 1983 and remained in place until the end of the drought.

Some problems have been experienced at Tullich due to pumpset failures and diminished output from the bores. The bore problems were associated with clogging of the screens and not reduced output from the aquifer. This resulted in the construction of two new bores with improved construction materials in 1989.

For Casterton, Sandford and Coleraine Stage 1 restrictions were imposed in February 2000 and lifted in October 2000. Also Stage 1 restrictions were imposed in January 2001 and lifted in September 2001.

Coleraine, Sandford and two-thirds of Casterton were supplied from Konongwootong until March 2004 requiring the restrictions in 2000 and 2001.

A third and forth production bore were constructed in 2005, however only one of the new bores (Bore No.4) was equipped. In 2010, the remaining bore (Bore No.3) was equipped. . The expanded Tullich borefield has successfully supplied Casterton, Sandford and Merino since 2005. Stage 1 restrictions were introduced on 16 December 2006 and remained for approximately 6 months until they were removed on 9 July 2007.

A pipeline was constructed from Casterton to Coleraine with Coleraine being supplied from the Tullich system from 2009.

The Konongwootong Reservoir is maintained as the supply for rural customers and as an emergency supply for the Tullich system.

E1.3 Drought Response Options

E1.3.1 Introduction

For the shallower groundwater systems, reducing the extraction rate (through the implementation of restrictions) may have an impact on the rate of drawdown of the resource, however in most circumstances, the pressures placed on the resource by other groundwater users and a lack of recharge (considered in a more regional context), may be having a greater influence on drawdown.

Preceding climatic conditions will be the major factor associated with the decline in the resource, and therefore alternative supply arrangements should be considered as the primary method for responding to short term water shortages.

For deeper groundwater systems, resource drawdown is influenced by events which have significant lead times, and response to drought conditions is often suppressed by these lag times. Therefore, reducing demand in unlikely to be an effective method of mitigating supply shortfalls. Furthermore, bores tapping the deeper groundwater systems, e.g., Lower Tertiary Aquifer, have a greater capacity to accommodate deepening of pumps to ensure continued extraction.

Further details on demand and supply side options during drought are provided in the following tables.

E1.3.2 Demand Reduction During Droughts

There are a number of demand reduction options that can be employed during times of water shortage. A summary of demand reduction options is shown in Table E6.

Table E6 Summary of Demand Reduction Options

Option	Details	Comments
Community Education Programs	Water efficiency awareness (showerhead rebates, information brochures), linked to ongoing State Government programs. Estimated savings are of 2-5% of total demand over next 2 years.	Being progressively implemented by Wannon Water.
Voluntary Demand Reduction Measures	Self regulated water conservation measures aimed at increasing effectiveness of measures within the Permanent Water Savings Plan, and potential savings if water restrictions are implemented.	Water savings from this option are expected to exceed the savings already achieved from the Permanent Water Saving Plan.
Mandatory Water Restrictions	Option available under By-Law No. 2.	Revised as per VicWater Guidelines in 2011. See Appendix B for requirements and prohibitions on water usage.
Compliance Officer/s	Additional resources may be required during extended periods of moderate to severe restrictions to monitor the performance of targeted water savings measures.	
Restrict Supply to Rural Customers	Possible under agreement only.	A restriction policy for rural customers requires further development.

E1.3.3 Supply Augmentation Options During Drought

A summary of the range of short-term supply augmentation options for (shallow) groundwater systems is shown in Table E7.

Table E7 Supply Augmentation Options During Drought

Option	Details	Available Supply
Water Cartage	Cartage from adjacent system where surplus exists.	Available as either raw water or potable water. Supplied under Stage 4 restrictions to reduce supply volume.
Construct Emergency bores	Reduce demand pressure on existing bores	Lead times may be significant.

E1.4 Drought Response Actions

System monitoring is undertaken to assess the status of the supply system according to one of the following three operational modes:

Mode 1 – General Monitoring

Mode 2 – Heightened Awareness

Mode 3 – Drought Response

E1.4.1 Mode 1 – General Monitoring (Pre-Drought Phase Activities)

The zone for the General Monitoring mode is defined by the groundwater level as the upper bound and a trigger which is set above pump level, as the lower bound.

There are a number of important factors in pre drought monitoring and planning which will influence the decision to declare the system as being in the General Monitoring mode. These include:

- Short and longer term trends in the groundwater level;
- Climatic trends and seasonal outlooks as indicators of the possible onset of drought;
- Consumption trends to indicate changes in customer's usage of water; and
- Forecasting groundwater levels over a 6-12 month period.

The Water Security Outlook tool is used to monitor supply and demand side aspects of the system. During the General Monitoring mode, the system status is updated on a weekly basis and a report prepared weekly. A summary of the key system performance indicators for all groundwater systems which should be included in the Water Security Outlook and System Status Report is provided in Table E8.

Table E8 Requirements for Water Security Outlook and System Status Monitoring and Reporting

Item	Requirements
Rainfall, seasonal climate outlook	Information accessed from Bureau of Meteorology website.
State-wide status	Bureau of Meteorology and Department of Sustainability and Environment websites provide status reports on rainfall, streamflow, storage levels, groundwater and urban water restrictions across Victoria on a monthly basis. Review of observation bore data (remote from borefield) for seasonal trends. Review of Groundwater Management Area monitoring documents prepared by Southern Rural Water to assess monitoring trends and use trends.
Water levels in ground water supply systems are monitored at least monthly and are able to be compared against pump depths[1].	The frequency of monitoring should be increased to weekly or daily if a decline in water level raises concern on the security of the system.
System Demands (bulk meter consumption)	Monitored at least weekly and recorded in an operational database. Data recorded for all towns.

Note: 1. Enables determination of available drawdown, i.e. the amount of water above the pump intake

E1.4.2 Mode 2 – Heightened Awareness

The zone for the Heightened Awareness mode is designed to provide early warning of a pending water shortage. The Heightened Awareness mode is triggered following consideration of:

- Short term trend in the groundwater level;
- Climatic trends and seasonal outlooks;
- Consumption trends to indicate changes in Customer's usage of water; and
- Forecasting groundwater levels over a 3-6 month period.

The key actions are summarised in Table E9 (in order of increasing impact from water shortages).

Table E9 Groundwater Systems Action Plan for Mode 2 – Heightened Awareness

Action	Trigger	Response
Action 1	Moderate likelihood that groundwater levels will fall below the Mode 3 Trigger	1. Provide weekly updates of the System Status Report 2. Implement demand reduction options such as Community Education Programs, Voluntary Demand Reduction Measures via increased media advertising,
Action 2	High likelihood that groundwater levels will fall below the Mode 3 Trigger	3. Alert public to the imminent water shortages and possible need for restrictions in the future. 4. Promote “voluntary restrictions” via media advertising campaigns to inform consumers about water conservation programs. 5. Develop contingency plans for alternative supplies if water levels were to fall below pump levels. 6. Declare operational mode as Mode 3 - Drought Response.

E1.4.3 Mode 3 - Drought Response

Mode 3 defines an active drought response period where supply and/or demand side measures are required to maintain supply security. Water restrictions may be used to reduce demand to reduce the requirements from alternative supplies. Management actions for consideration during Mode 3 are summarised in Table E10.

Table E10 Groundwater Systems Action Plan for Mode 3 – Drought Response

Action	Trigger	Response
Action 3	Moderate likelihood that groundwater levels will fall below the pump level	7. Consider implementation of mild restrictions such as Stage 2, as preparedness for making alternative supply arrangements; 8. Progress contingency plans for alternative supplies to an implementation ready status, including obtaining any necessary permits or approvals. 9. Monitor bore condition and water quality. 10. Review and maximise pump depth setting' or if such capacity exists, install additional pump rising main and switch to hi-lift pump
Action 4	High likelihood that groundwater levels will fall below the pump level	11. Monitor groundwater levels and perform regular forward look storage projections. 12. Consider implementation Stage 3 restrictions, as preparedness for making alternative supply arrangements; 13. Communicate to customers the potential future impacts to supply their arrangements; 14. Implement contingency plans for alternative supplies.
Action 5	Groundwater levels fall below the pump level	15. Implementation Stage 4 water restrictions. 16. Communicate to customers the altered supply arrangements; 17. Commence alternative supplies. 18. Commence tankering water where required

Note that when there is a likelihood of water levels approaching pump intakes, there is an increased likelihood of damage to the pumps and possibly the bore i.e. increased maintenance, and water quality issues

It is therefore appropriate to continually review and maximise pump depth setting' or if such capacity exists, install additional pump rising main and switch to hi-lift pump. Permanently setting pumps at too great a depth results in higher operational costs outside of the drought periods.

E1.4.4 Drought Response Triggers

Shallow Groundwater Systems

The shallow groundwater systems developed by Wannon Water are mostly unconfined to semi-confined aquifers which are directly recharged by infiltrating rainfall. Therefore aquifer storage, groundwater use and water levels are affected by changes and in climate and dry conditions.

Water levels in the production bores can be used as a trigger to indicate the appropriate drought management regime. The current pump depth settings are indicated in Table E11. All elevations are approximate and in some cases pump depth setting was estimated and requires confirmation.

A water level at the pump intake will result in inability to extract water from the bore, additional drought response action must be taken if this occurs.

A level of 3 m above the pump will risk ability to extract water. A water level within 3 m of the pump, or the lowest pump for town supplied by multiple bores, indicate that drought response actions would have been implemented. The relevant drought response water level for each system is indicated in Table E11.

It is desirable that pre drought (Mode 2) actions be considered some time before drought action is required. An antecedence of 3 months is desirable from a management perspective, however in some cases water levels fluctuate widely and there is insufficient drawdown available to allow for a 3 month lag until drought response action is required. In these cases a lesser antecedence has been adopted to ensure that pre-drought actions are not considered too frequently. Drought response actions are ineffective if they need to be adopted every year.

As noted previously water quality (and bore maintenance) issues can occur if water levels fall below the top of the uppermost screen interval. It is suspected that this has occurred at the Tullich borefield, evidenced by an increase in iron precipitation. For this reason, the pre drought response trigger is considered to be the top of screen. Whilst extraction can continue to occur when water levels fall within the screen interval addition actions may be required:

- Increased frequency of water quality monitoring;
- Increased frequency of bore and infrastructure maintenances, e.g. bore development, pipe pigging, sludge removal; and,
- Consideration of post drought treatments:
  - Bore condition assessment;
  - Pump replacement / rebuild.

Table E11 includes a time lag to provide a response horizon for management. Modelling has been completed for some of the borefields and the time lag is calculated based on the average rate of drawdown in the worst year modelled. Where model data was not available, historic monitoring data has been used. The time lag is considered conservative as the modelled and recorded groundwater levels for the borefields in Table E11 typically do not approach the drought response trigger under both current demands, and historic climate. Where the time lag approaches 6 months or greater, it is likely that the real lag is greater than 1 year as the system will recover in winter before potentially continuing to decline.

Figure E11 Groundwater Systems Drought Reponse Triggers

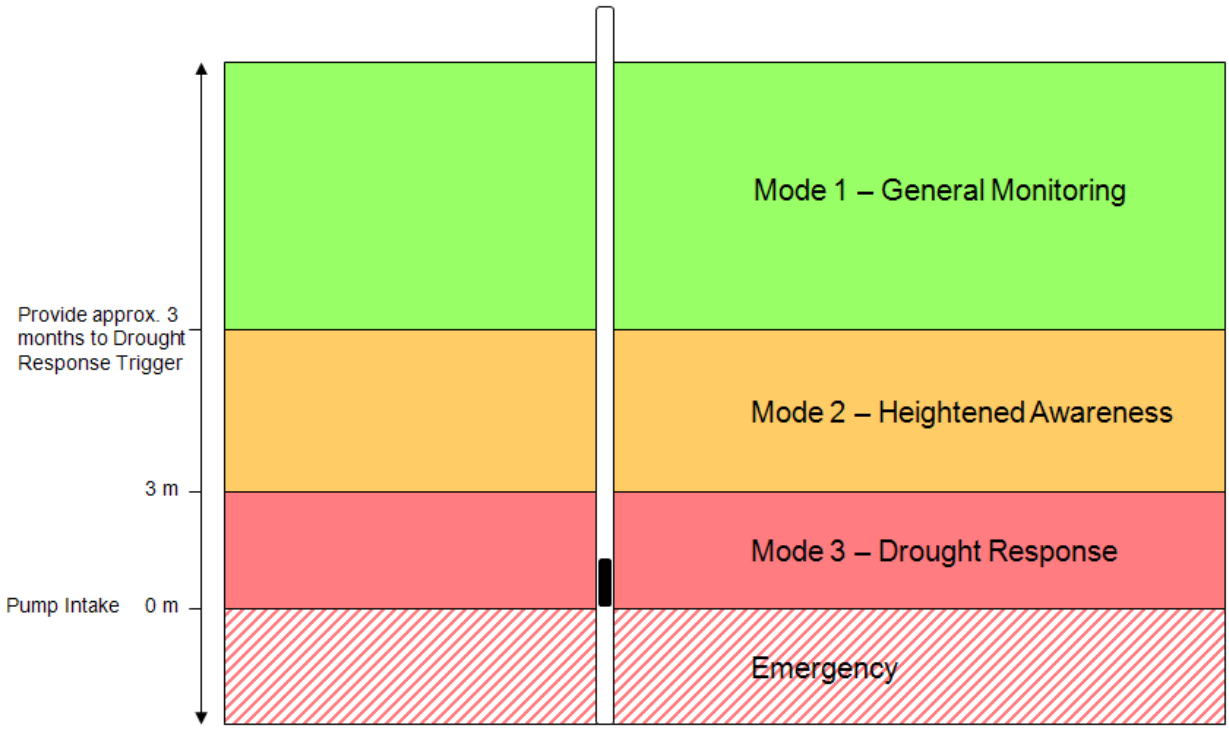


Table E11 Drought Response Action Triggers for Shallow Groundwater Systems

	Pump depth (depth to top of casing)	Mode 3 Trigger depth to top of casing)	Mode 2 Trigger (depth to top of casing)	Estimated Time Lag[1]
Caramut (No. 1)	43 m	40 m	22.6 m	3 months
Darlington (No. 1)	30 m	27 m	17 m	1 month[2]
Mortlake	22 m	19 m	17.5 m	< 1 month
Penshurst (No 2)	101 m	98 m	95 m	Unknown[3]
Tullich (no 2)	34.7 m	31.7 m	22 m	6 months

Note 1 – Time lag between Pre-drought response and drought response triggers in historic design drought (historic climate with current demand)

Note 2 – Darlington does nor respond to drought under model conditions, so only based on a historic drawdown over 2 weeks.

Note 3 – Water levels at the Penshurst bores need to be investigated, levels indicated an unexpected potentiometric gradient thus drought action triggers solely based on pump depth setting not draw down.

Deep Groundwater Systems

The coastal systems of Port Campbell, Portland, Heywood and Port Fairy are deeply confined and would not be affected by relatively short term drought conditions. A similar drought mode response regime to that developed for the shallow systems could be adopted, if water pressures in the deep confined aquifers were to drop for any reason.

The Dartmoor borefield, whilst behaving as a confined aquifer local to the bore, is located close to an interpreted intake area for the Lower Tertiary Aquifer system, i.e. where the Lower Tertiary Aquifer changes from confined through to unconfined conditions up basin. The Carlisle River borefield (part of the Otway Supply System) is also interpreted as having connection with surface water flows in the Gellibrand River. Under these conditions, both of these borefields are potentially susceptible to drought conditions as there may be a shortened lag time between drought and affects at the bore headworks.

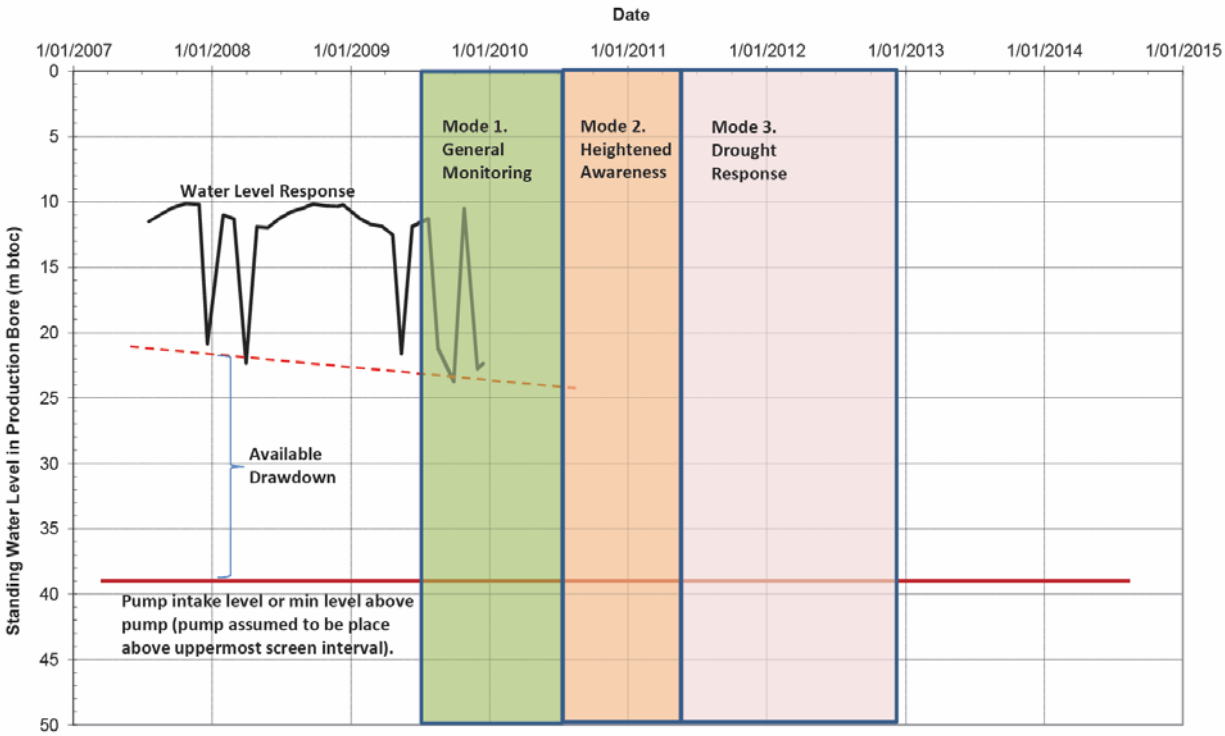
An issue with the bores developing the Lower Tertiary Aquifer, and the Macarthur production bore that develops the Clifton Formation, is that both of these aquifers have an underlying declining water level trend. Under these conditions, excluding the impact of a drought which may or may not be significant, the available drawdown in a production bore is being steadily eroded over time. This decline in available drawdown would be accelerated by changes in demand, which could be seasonal, or through growth. The establishment of a drought mode response using a trigger based solely on maintaining a minimum head above a production pump may not provide sufficient time for management intervention. A process that could be considered as been proposed below:

- The pumping water level response is monitored for each production bore in operation mode 1 – General Monitoring. Production bore hydrographs are prepared to identify seasonal response through the Water Security Outlook Tool;
- Monitoring in a pumping bore can provide a ‘noisy’ response owing to the variable operation of production pumps. Therefore, filtering of the water level data is required. If the seasonal minimum is greater than 10% of the 95% confidence limit, operation mode 2 – Heightened Awareness is implemented. More frequent water level monitoring is implemented to characterise the rate of decline (and thus management planning horizon).
- Drought response (mode 3) is implemented based on the level of drawdown remaining in the bore.

This is shown schematically in Figure E12, and takes into account the potential for available drawdown to be eroded over time. This should provide management sufficient time to consider the need to replace or lower production pumps before available drawdown is reduced to supply threatening levels. A blanket approach adopted a minimum head above a production pump may limit time, particularly for cases where available drawdown can be eroded rapidly, e.g. under extreme conditions, interference effects may occur at Portland if sufficient recovery time between pumping events of individual production bores is not allowed for.

This is particularly useful as the deep groundwater systems tend to have limited surface storage, i.e. are not suited to long pumping stand-downs, and replacement pumps (owing to high yield and groundwater temperature requirements) can have significant procurement lead times. It is noted that for most deep groundwater supplies, underlying regional water level declines may be more significant than increased usage affected by drought conditions.

Figure E12 Deep Groundwater Systems Drought Reponse Triggers



References

Otway Water Supply System Drought Response Plan

GHD (2011), Water Supply Demand Strategy 2011-2060 Water Resources Modelling Baseline Supply-Demand Forecasts, Report prepared for Wannon Water, October.

SWWA (2000), Drought Response Plan, South West Water Authority.

VicWater (2005), Victorian Uniform Drought Water Restriction Guidelines, Final, September.

Wannon Water (2005), Permanent Water Savings Plan & Permanent Water Savings Rules, Wannon Region Water Authority, Draft, September.

Grampians Systems Drought Response Plan

DCNR (1991), Water Victoria – The Next 100 Years.

GHD (2001), Hamilton/Casterton/Coleraine Report on Demand Review.

GHD (2011), Water Supply Demand Strategy 2011-2060 Water Resources Modelling Baseline Supply-Demand Forecasts, Report prepared for Wannon Water, October.

Glenelg-Wannon Water Board (1992) Drought Response Plan for Balmoral, Casterton, Coleraine, Sandford and Merino, November 1992.

Hamilton Water Board (1994) Drought Response Plan, April 1994.

Kesari N. and McFarlane S. (1991), A Simpler and Practical Restriction Schedule for Melbourne Water Corporation, Draft Report September 1991.

RWC (1991), Trend Analyses of Major Aquifers in Portland – South Australian Border Area, Rural Water Commission of Victoria.

Semple L. (1993), *Supply Enhancement Options for Water Supply Systems,* Drought Management Plan for Victoria's Water Resources, Background Report – S2, Department of Conservation and Natural Resources.

Shire of Mount Rouse (1992), DRP for Dunkeld, Glenthompson and Penshurst (July 1992).

SKM (1996), Report on the Determination of Restriction Curves for the Dunkeld, Coleraine and Glenthompson Water Supply Systems, January 1996.

Srikanthan R. and Stewart B.J. (1992), *Drought Assessment for Victoria: A Case Study,* Bureau of Meteorology, October 1992.

VicWater (2005), Victorian Uniform Drought Water Restriction Guidelines, Final, September.

Groundwater Systems Drought Response Plan

GHD (2006d), Groundwater Sourced Urban Supplies – Overview of Groundwater Sustainability, July 2006.

GHD (2011), Water Supply Demand Strategy 2011-2060 Water Resources Modelling Baseline Supply-Demand Forecasts, Report prepared for Wannon Water, October.

PCWA (2000), Portland DRP.

SWWA (2000), Drought Response Plan, South West Water Authority.

VicWater (2005), Victorian Uniform Drought Water Restriction Guidelines, Final, September.

Wannon Water (2005), Permanent Water Savings Plan & Permanent Water Savings Rules, Wannon Region Water Authority, Draft, September.

Wannon Water (2006), Emergency Management Plan – Wannon Water.

Glossary of Terms

AAD	Average Annual Demand The AAD represents the total (unrestricted) water usage from the headworks, inclusive of system distribution losses.
Action	A management response undertaken by Wannon Water as part of the Drought Response Plan when a trigger has been reached.
BE	Bulk Entitlement A bulk entitlement is a right to use and supply water which may be granted to water corporations, the Minister for Environment and other specified bodies under the *Water Act* (1989).
BE Metering Plan	The Bulk Entitlement Metering Plan has been developed to enable Wannon Water to demonstrate compliance with the obligations of each of it's surface water Bulk Entitlements.
DRMC	Drought Response Monitoring Committee
GWMWater	Grampians Wimmera Mallee Water
LTA	Lower Tertiary Aquifer system. Generally a deeply buried, regionally extensive aquifer system encompassing a number of geological formations, including the Dilwyn Formtion.
Mode	Wannon Water has three modes of operation: General Monitoring, Heightened Awareness and Drought Response Mode. A shift in operation mode will trigger a management response from Wannon Water, e.g. management responsibilities, communications and obligations.
REALM	REsource ALlocation Model – a software tool used to model harvesting and bulk distribution of surface water resources.
Reliability (of supply)	The ability to maintain a water supply free of water restrictions. Wannon Water has an objective of achieving a 95% reliability, i.e., restriction free on average for 95 in every 100 years.
Restrictions (water)	By Laws prepared by Wannon Water that are used to prevent or limit the use of water. The restrictions are consistent with the Victorian Uniform Drought Water Restriction Guidelines (VicWater, 2005)
Restricted (demand)	Demand for water (volume rate) with water restrictions implemented.
Stage (restrictions)	Wannon Water defines four stages of water restrictions (Stage 1 to 4) which influence domestic garden watering, vehicle washing, swimming pool topping etc.
System (water supply)	Linked networks of water sources (surface water, groundwater), storages, treatment and delivery pipelines. Wannon Water WSDS defines the following supply systems: Otway System (North and South Otway Pipelines), Hamilton System, Glenthompson System, and the Groundwater Systems.
TDS	Total Dissolved Solids A measure of groundwater salinity.
Trigger	Generally related to the total storage volume and the ability to maintain such a volume with specified restrictions in place. When triggers are reached, Wannon Water implements specified actions.
WaterMAP	WaterMAP is a voluntary water management action plan for non-residential customers using 5 ML of potable (drinking) water or more per year at any one site from an urban water supply. A WaterMAP encourages water conservation.
Water Security Outlook	A process undertaken by Wannon Water to manage water supply and demands. It includes current and forecast water supply issues.
WSPA	Water Supply Protection Area. Victoria relies on three basic forms of groundwater managements units to regulate groundwater resources: GMAs (Groundwater Management Areas, WSPAs, and unincorporated areas (areas falling outside a declared GMA or WSPA).

Appendix A

Permanent Water Savings Plan

Appendix B

By-Law No 4

Appendix C

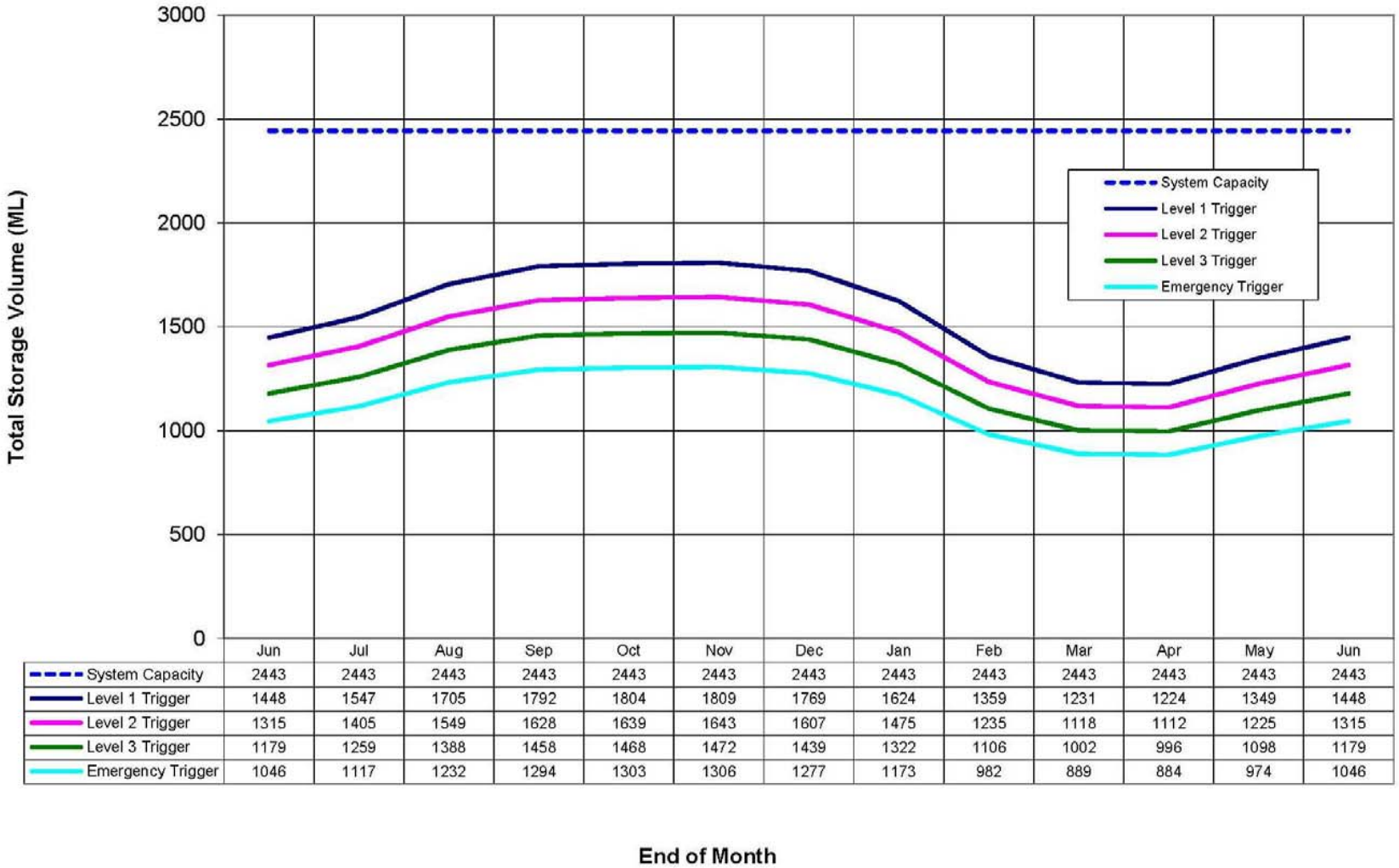
Drought Response Triggers

C1 Otway System

C2 Grampians System

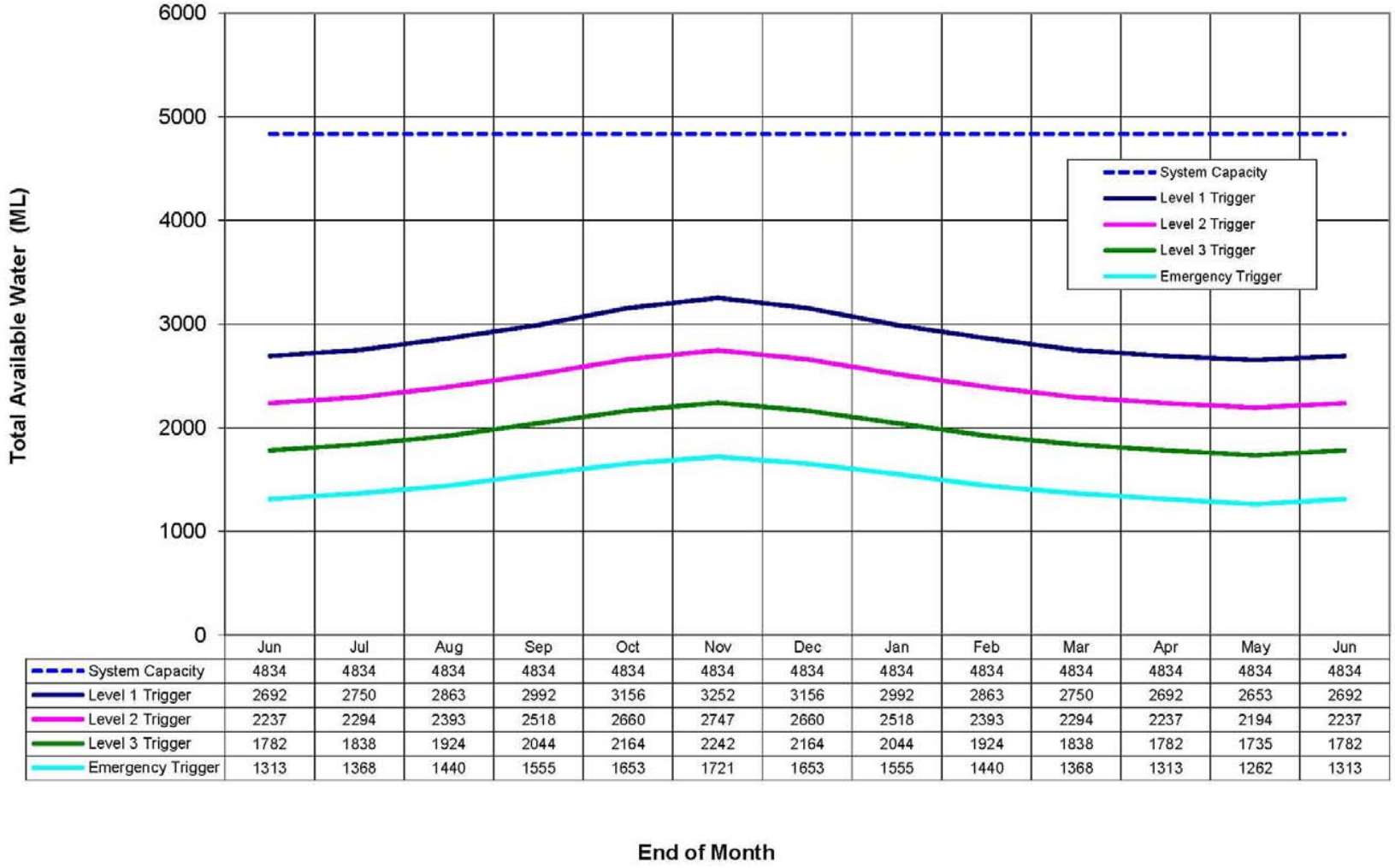
C3 Glenthompson System

APPENDIX C1. Otway System Drought Response Triggers



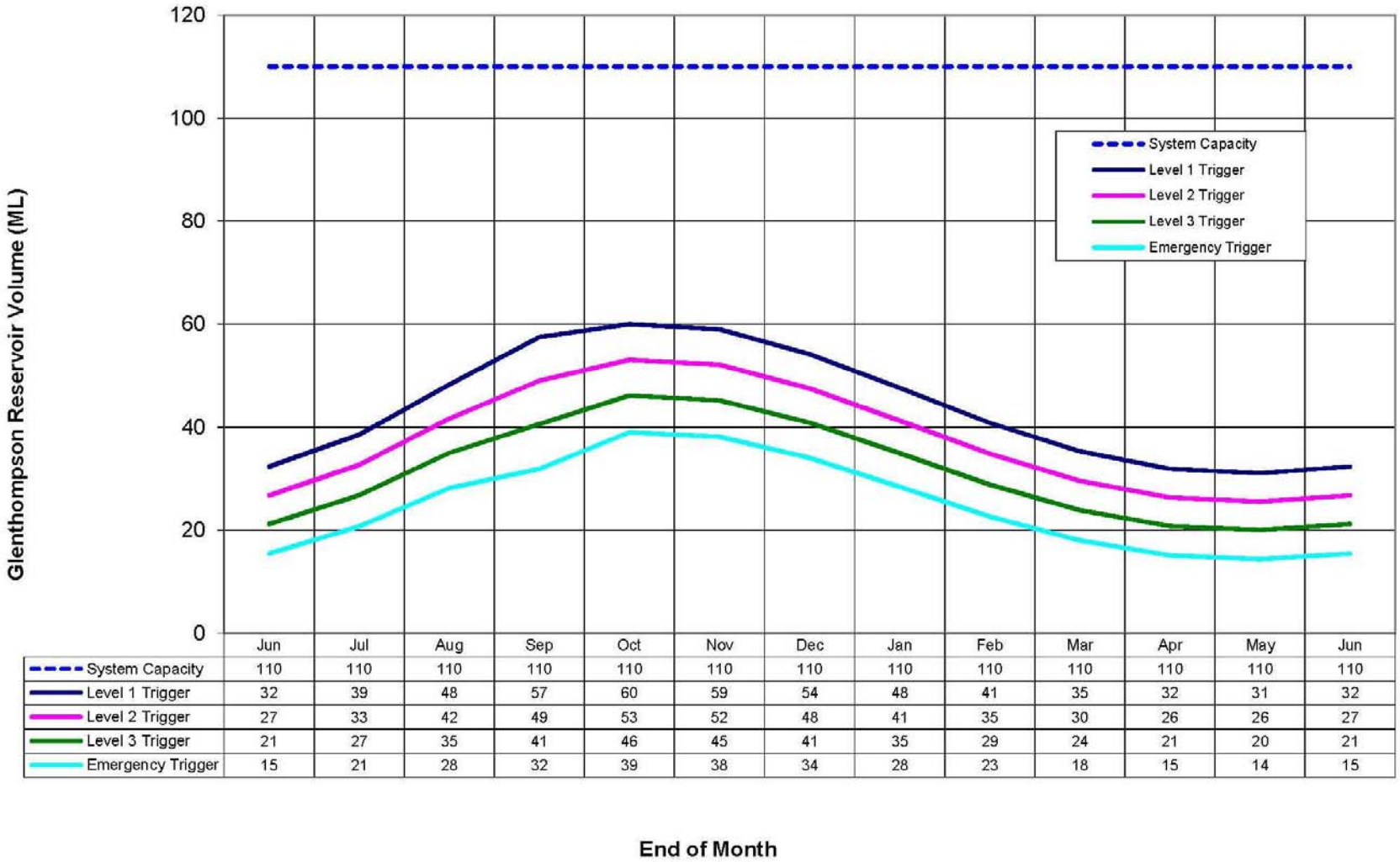
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
System Capacity	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443	2443
Level 1 Trigger	1448	1547	1705	1792	1804	1809	1769	1624	1359	1231	1224	1349	1448
Level 2 Trigger	1315	1405	1549	1628	1639	1643	1607	1475	1235	1118	1112	1225	1315
Level 3 Trigger	1179	1259	1388	1458	1468	1472	1439	1322	1106	1002	996	1098	1179
Emergency Trigger	1046	1117	1232	1294	1303	1306	1277	1173	982	889	884	974	1046

APPENDIX C2. Grampians System Drought Response Triggers



	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
System Capacity	4834	4834	4834	4834	4834	4834	4834	4834	4834	4834	4834	4834	4834
Level 1 Trigger	2692	2750	2863	2992	3156	3252	3156	2992	2863	2750	2692	2653	2692
Level 2 Trigger	2237	2294	2393	2518	2660	2747	2660	2518	2393	2294	2237	2194	2237
Level 3 Trigger	1782	1838	1924	2044	2164	2242	2164	2044	1924	1838	1782	1735	1782
Emergency Trigger	1313	1368	1440	1555	1653	1721	1653	1555	1440	1368	1313	1262	1313

APPENDIX C3. Glenthompson System Drought Response Triggers



	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
System Capacity	110	110	110	110	110	110	110	110	110	110	110	110	110
Level 1 Trigger	32	39	48	57	60	59	54	48	41	35	32	31	32
Level 2 Trigger	27	33	42	49	53	52	48	41	35	30	26	26	27
Level 3 Trigger	21	27	35	41	46	45	41	35	29	24	21	20	21
Emergency Trigger	15	21	28	32	39	38	34	28	23	18	15	14	15