



# Loddon Highlands Water Supply Protection Area Groundwater Management Plan

Annual Report

For year ending 30 June 2016

# Document History and Distribution

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# Foreword

Goulburn-Murray Water (GMW) is pleased to present the annual report for the Loddon Highlands Water Supply Protection Area Groundwater Management Plan (the Plan) for the 2015/16 water year.

GMW is responsible for the implementation, administration and enforcement of the Plan, which was approved by the Minister administering the *Water Act 1989* (the Minister) in November 2012.

This report has been prepared in accordance with section 32C of the *Water Act 1989* (the Act).

This report provides an overview of the groundwater management activities in the Loddon Highlands Water Supply Protection Area and documents the successful operation under the Plan in the 2015/16 water year.

A copy of this report is available for inspection at the GMW Tatura office, or it can be downloaded from the GMW website.



Neil Brennan

INTERIM MANAGING DIRECTOR

Date

# Executive summary

The Loddon Highlands Water Supply Protection Area (WSPA) Groundwater Management Plan (the Plan) was approved by the Minister in November 2012.

The 2015/16 water year marks the fourth year of operation under the Plan.

Groundwater levels were lower in 2015/16 compared to the previous water year, which can be largely attributed to reduced rainfall recharge due to drier than average conditions.

Allocations in 2015/16 were 100% in all management zones of the Loddon Highlands WSPA except in the Newlyn Zone, which had an allocation of 75%.

Metered use in the Loddon Highlands WSPA was 10,148.3 ML, 49% of total licence entitlement in 2015/16. This is the highest recorded use in a water year.

There was moderate licence trade activity during 2015/16, with 26 temporary licence transfers for a total of 1,063.3 ML/yr and two permanent transfers for a total of 35 ML/yr.

Licence holders in the Loddon Highlands WSPA are entitled to carryover a maximum of 15% of their licence entitlement. A total of 2,789 ML of licence entitlement has been carried over to 2016/17.

Groundwater monitoring and metering programmes continue to be successfully undertaken to support the objectives of the Plan.

The Loddon Highlands WSPA Groundwater Management Plan is continuing to achieve its stated objectives.

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# 1 Introduction

## 1.1 Purpose

This annual report has been prepared to meet the requirements of Prescription 7 of the Plan and section 32C of the Act.

This report provides an overview of groundwater management activities undertaken in accordance with the Plan from 1 July 2015 to 30 June 2016.

## 1.2 Water Supply Protection Area

The Loddon Highlands WSPA, declared in June 2010, extends from Newlyn and Learmonth in the south to Dunolly in the north, and includes the townships of Creswick, Waubra, Clunes, Talbot and Maryborough.

The Loddon Highlands WSPA incorporates groundwater resources to all depths.

There are seven management zones in the Loddon Highlands WSPA, which are the Talbot, Waubra, Ascot, Ullina, Newlyn, Blampied and Mollonghip Zones (Figure 1).

## 1.3 Groundwater Management Plan

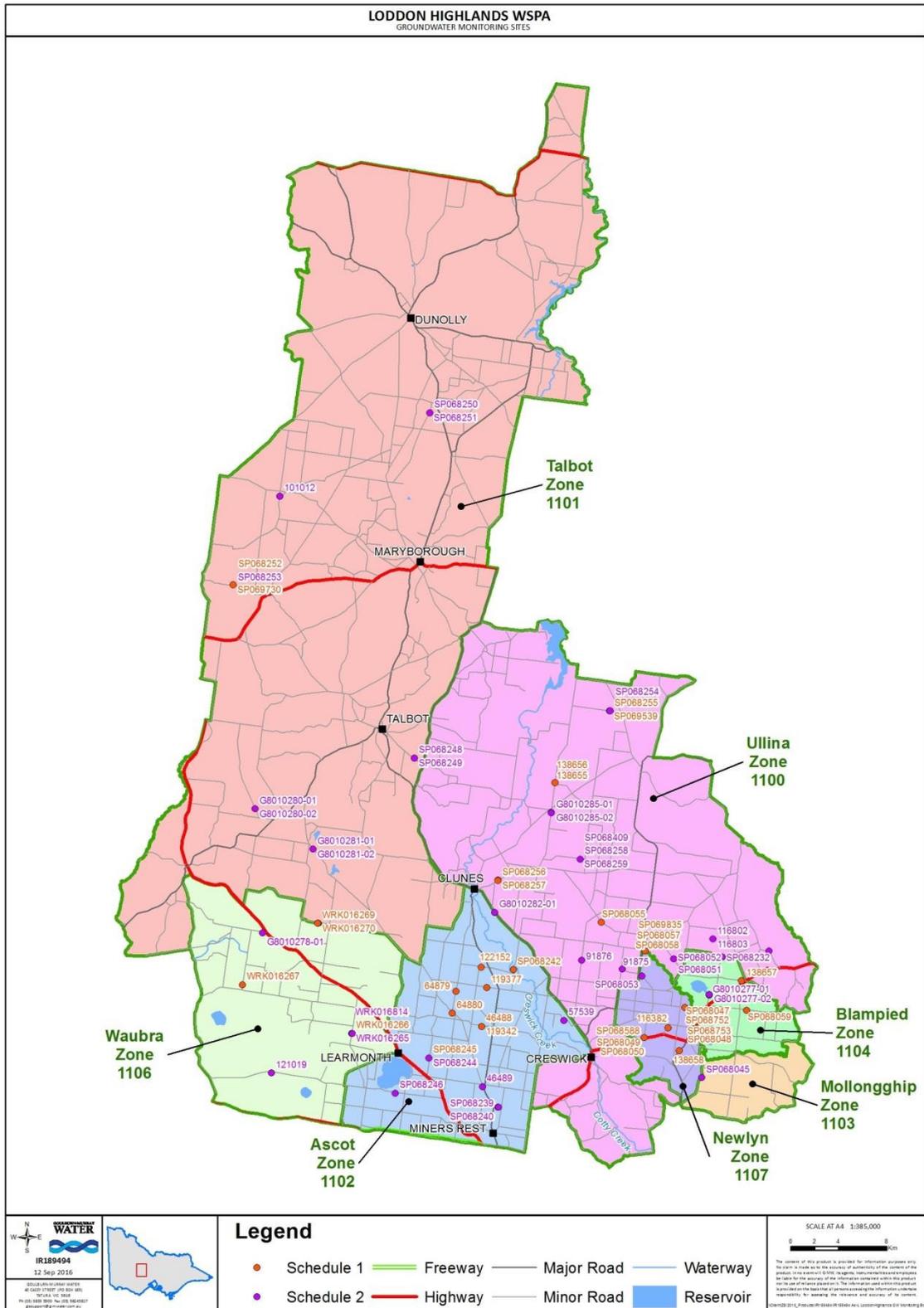
The Plan was approved by the Minister in accordance with section 32A(6) of the Act on 21 November 2012.

The objective of the Plan is to make sure that groundwater resources are managed in an equitable manner so as to ensure the long term sustainability of those resources. More specifically, the plan seeks to:

- manage the resources to protect groundwater users and the environment;
- enable equitable access of groundwater resources to realise the potential for its use; and
- provide effective and transparent communication of Plan objectives, management rules and resource status.

GMW is responsible for the implementation, administration and enforcement of the Plan. A summary of GMW's activities in accordance with Plan prescriptions is presented in Appendix A.

A copy of the Plan can be downloaded from GMW's website [www.g-mwater.com.au](http://www.g-mwater.com.au).



**Figure 1 Loddon Highlands Water Supply Protection Area**

## 2 Groundwater management

### 2.1 Licence volume

The Minister declared the Permissible Consumptive Volume to be 20,697 megalitres per year (ML/yr) in March 2013 (Victorian Government Gazette, 2013).

At 30 June 2016 the licence volume in the Loddon Highlands WSPA was 20,667 ML/yr (Table 1).

**Table 1 Licence entitlement in the Loddon Highlands WSPA**

Zone	Licences	Licensed bores	Licence volume (ML/yr)
Ullina - 1000	21	26	3,081.2
Talbot - 1101	13	15	1,265.7
Ascot - 1102	64	104	7,068.2
Mollonghip - 1103	3	7	318.0
Blampied - 1104	22	26	1,252.5
Waubra - 1106	31	63	4,707.8
Newlyn - 1107	26	46	2,973.6
<b>Total</b>	<b>180</b>	<b>287</b>	<b>20,667.0</b>

Licence entitlement as at 30 June 2015 was 20,690.5 ML/yr. The 23.5 ML/yr reduction in licence entitlement to 30 June 2016 is due to a surrendered licence in the Waubra Zone.

### 2.2 Groundwater allocations

Allocations are a percentage of licence entitlement that may be extracted in a given water year. They are determined by comparing average maximum groundwater recovery levels from key State observation bores against trigger levels stated in the Plan. Allocations are announced in September based on the August groundwater level readings each year. Groundwater levels are monitored over spring and the allocations may be increased if there is sufficient recovery to November. The State observation bores used to determine seasonal allocations in each management zone are shown in Figure 1.

**Table 2 State observation bores used to determine seasonal allocations**

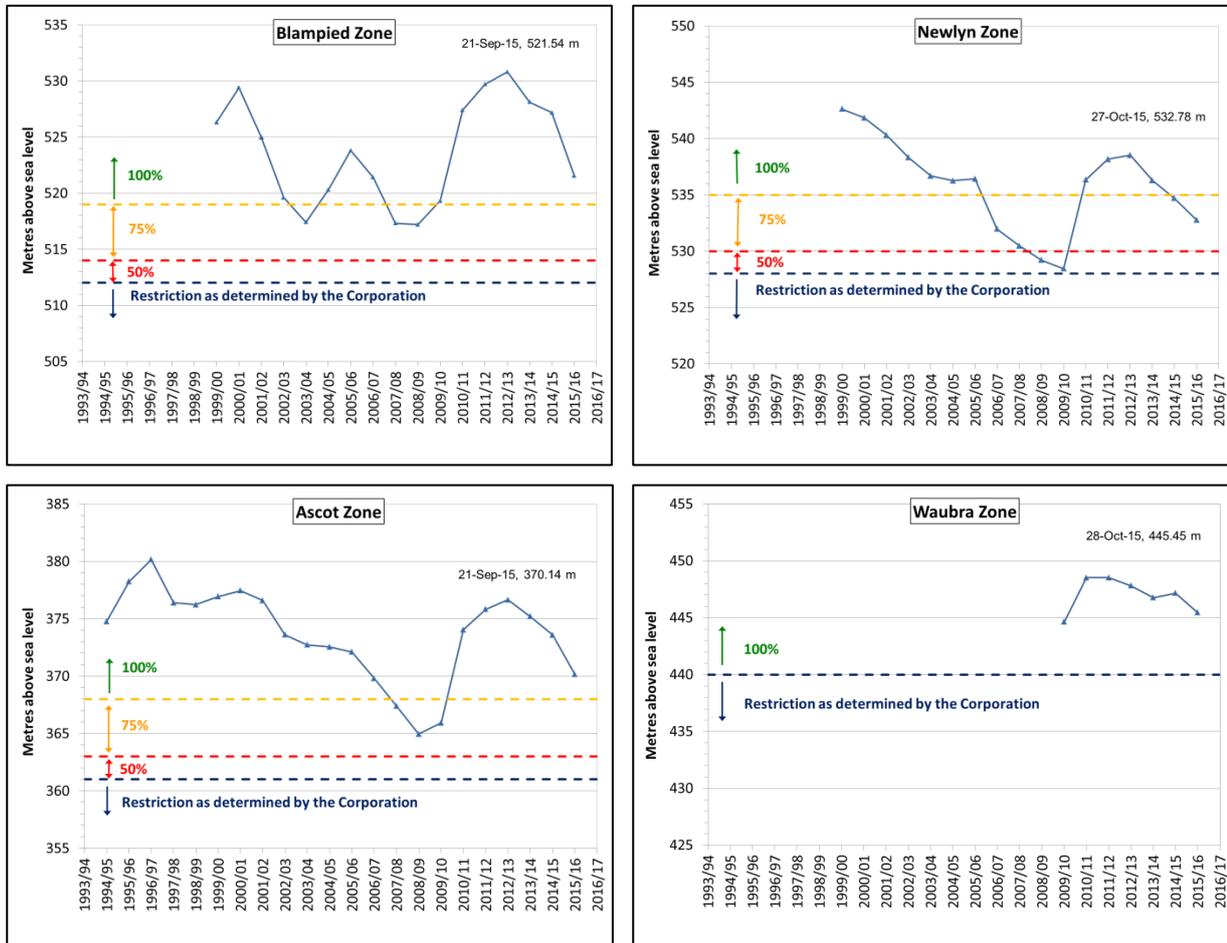
Zone	Bore number
Ascot - 1102	64879, 64880, 122152, 119377, 119342
Blampied - 1104	138657
Waubra - 1106	WRK016266, WRK016267, WRK016269
Newlyn - 1107	138658, 116382

Groundwater trigger levels and restrictions are in place for the Blampied, Newlyn, Ascot and Waubra Zones in the Plan due to:

- large volume of licence entitlement;
- historical seasonal drawdown; and
- greater rates of groundwater level decline during dry periods.

Seasonal allocations of 100% were announced in September 2015 for all zones in the Loddon Highlands WSPA, except for the Newlyn Zone which had an initial allocation of 75%.

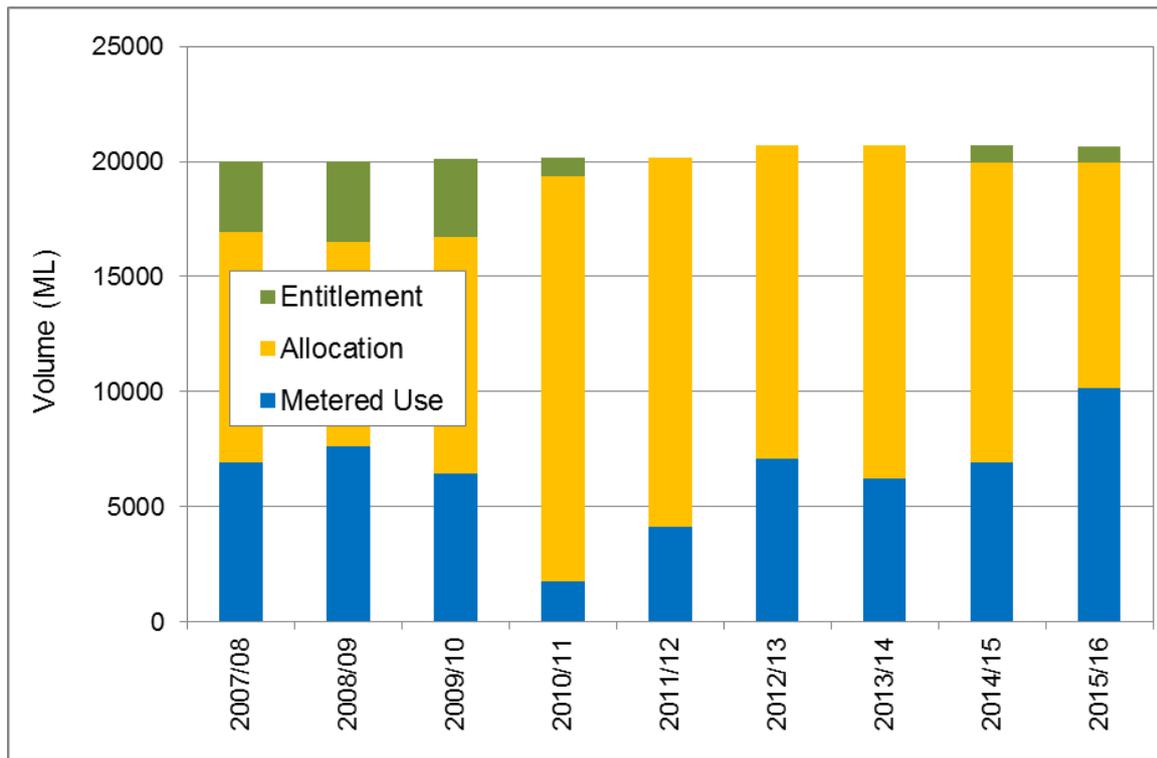
Groundwater levels were monitored over spring, but there was insufficient aquifer recovery in the Newlyn Zone to November 2015 to warrant an allocation increase. Allocations in the Newlyn Zone therefore remained at 75% of licence entitlement for 2015/16 (Figure 2).



**Figure 2 Average maximum groundwater recovery levels compared to trigger levels to November 2015**

### 2.3 Groundwater use

Metered use in the Loddon Highlands WSPA in 2015/16 was 10,148.3 ML. This equates to 49% of licence entitlement which is the highest recorded use (Figure 3).



**Figure 3 Metered use in the Loddon Highlands WSPA**

Metered use was highest in the Ascot Zone. Licence holders in the Ascot and Blampied Zones used the greatest percentage of licence entitlement (Table 3).

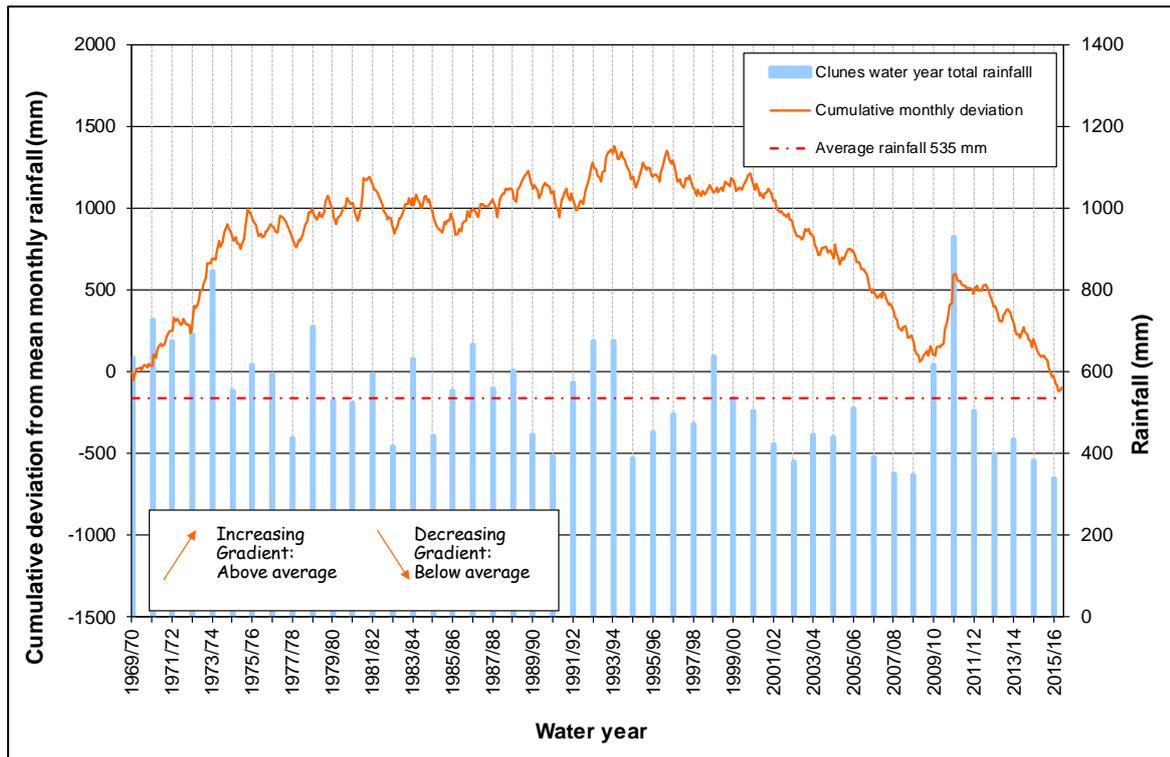
**Table 3 Metered use in the Loddon Highlands WSPA in 2015/16**

Zone	Licence volume (ML/yr)	Metered use (ML)	Percentage of licence entitlement
Ullina - 1000	3,081.2	362.5	12%
Talbot - 1101	1,265.7	469.9	37%
Ascot - 1102	7,068.2	4,513.7	64%
Mollonghip - 1103	318.0	163.9	52%
Blampied - 1104	1,252.5	964.8	77%
Waubra - 1106	4,707.8	2,351.6	50%
Newlyn - 1107	2,973.6	1,321.9	44%
<b>Total</b>	<b>20,667.0</b>	<b>10,148.3</b>	<b>49%</b>

Note: Licence volume extracted from Victorian Water Register 30 June 2016, metered use extracted from IPM 1 July 2016.

## 2.4 Rainfall

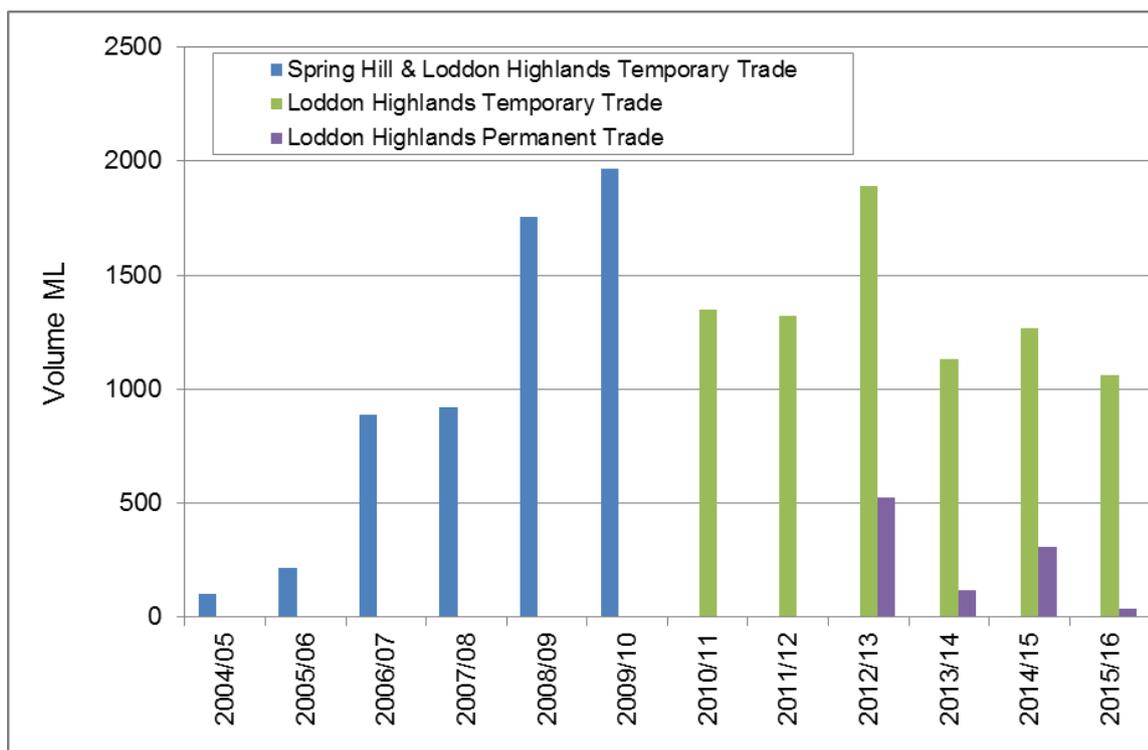
Rainfall data from the Bureau of Meteorology (BoM) weather station at Clunes is provided below in Figure 4 as a good indicator of trends across the WSPA. The data shows that rainfall was generally above average in the early–1970s; remained relatively steady to the mid–1990s; and was the below average until the high rainfall events in 2010/11. In recent years rainfall has mostly been below average which has resulted in reduced recharge to the groundwater system.



**Figure 4 Rainfall at Clunes (BoM station 088015)**

## 2.5 Transfer of entitlement

The Plan allows groundwater licence holders to temporarily or permanently transfer licence entitlement. In 2015/16 there were 26 temporary transfer transactions for a total of 1,063.3 ML/yr; and two permanent transfer transactions for a total of 35 ML/yr. This level of transfer activity is similar to previous water years (Figure 5).



**Figure 5 Total licence transfer volume transferred in the Loddon Highlands WSPA**

The majority of temporary transfers occurred within the same management zones (Table 4). There was some trading between zones with 53.4 ML/yr temporarily transferred into the Mollonghip Zone, 45 ML/yr into the Ullina Zone, and 15 ML/yr transferred from the Waubra Zone. There was a total of 98.4 ML/yr temporarily transferred out of the Newlyn Zone and 15 ML/yr out of the Waubra Zone

Both of the permanent transfers of 30 ML/yr and 5 ML/yr were within the Ullina Zone.

**Table 4 Licence transfers in the Loddon Highlands WSPA in 2015/16**

Zone	Temporary				Permanent			
	Transfer from		Transfer to		Transfer from		Transfer to	
	No. of transfer	Volume (ML/yr)						
Ullina - 1000	2	80.0	2	95.0	2	35	2	35
Talbot - 1101			2	45.0				
Ascot - 1102	8	390.4	8	390.4				
Mollonghip - 1103			1	53.4				
Blampied - 1104	7	303.0	7	303.0				
Waubra - 1106	4	108.0	3	93.0				
Newlyn - 1107	5	181.9	3	83.5				
<b>Total</b>	<b>26</b>	<b>1,063.3</b>	<b>26</b>	<b>1,063.3</b>	<b>2</b>	<b>35</b>	<b>2</b>	<b>35</b>

## 2.6 Carryover

The Minister declared that groundwater licence holders in the Loddon Highlands WSPA were authorised to take carryover from November 2012 (Victorian Government Gazette, 2012).

The maximum amount of entitlement that may be carried over by a licence holder in a water year is 15% of their licence volume which is a total 3,100 ML in the Loddon Highlands WSPA.

There was a total of 2,525 ML of carryover available to licence holders in the Loddon Highlands WSPA in the 2015/16 water year.

At the conclusion of the 2015/16 water year, groundwater licence holders in the Loddon Highlands WSPA were able to carryover 2,789 ML into the 2016/17 water year.

## **2.7 Domestic and stock bore applications**

GMW received two bore completion reports for bores constructed for domestic and stock purposes in the Loddon Highlands WSPA during the 2015/16 water year.

## 3 Monitoring program

### 3.1 Groundwater levels

The Department of Environment, Land, Water and Planning (DELWP) monitor 73 bores from the State Observation Bore Network on a quarterly basis in the Loddon Highlands WSPA (Figure 1).

GMW conducted monthly monitoring of 36 key State observation bores identified in Schedule 1 of the Plan (Appendix B). Groundwater recovery levels were generally lower in 2015/16 compared to 2014/15 which can be largely attributed to reduced rainfall recharge.

Groundwater recovery levels have been declining since the wet conditions experienced in 2010/11 largely in response to reduced rainfall recharge. Groundwater recovery levels have generally fallen by less than 5 metres (m) between 2010/11 and 2015/16, but larger falls are seen in State observation bores located in areas of intensive extraction in Blampied, Newlyn and Ascot. Despite these declines, groundwater levels are mostly within the historical range.

Seasonal drawdown was typically less than 10 m across the WSPA. In the Ascot Zone, where the greatest volume of groundwater was extracted, drawdown up to 16.8 m was recorded in bore 64880. The drawdowns were close to, and some cases exceeded, the highest seasonal drawdown levels observed to date.

### 3.2 Groundwater quality

Groundwater quality testing was undertaken by taking samples from two nested State observation bore sites in the Loddon Highlands WSPA. Nested sites feature two or more bores in close proximity, each monitoring a different aquifer. The State observation bores used for water quality testing are located in the Talbot and Ullina Zones and monitor groundwater in both the Deep Lead and basalt aquifers.

Groundwater chemistry results are presented in Appendix C – Groundwater chemistry. The analysis indicates that groundwater salinity levels are higher in the basalt aquifers than the underlying Deep Lead aquifers at both sites (Table 5). Ongoing annual monitoring of these key bores will enable natural variance to be established and any trends in groundwater quality to be observed.

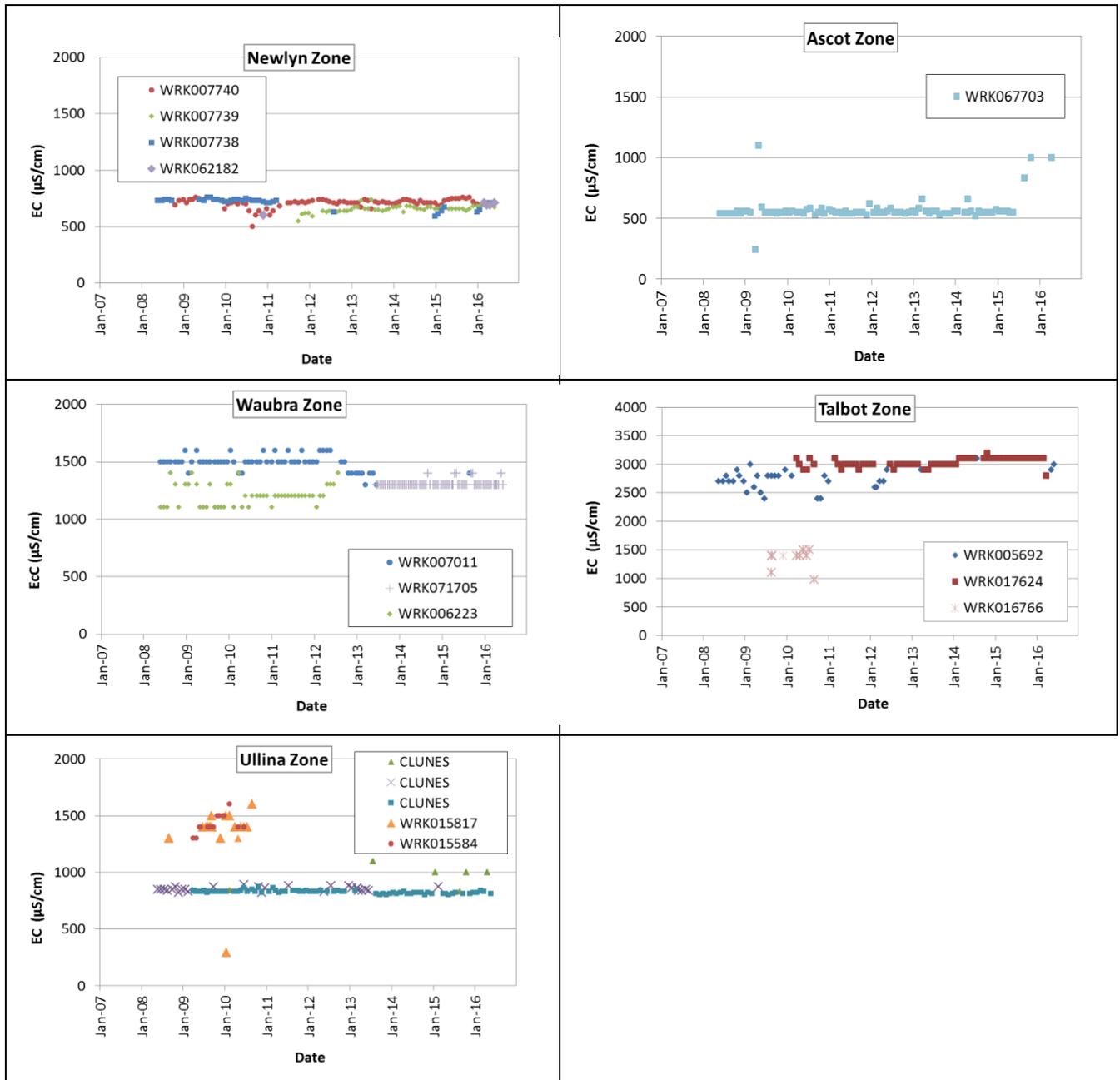
**Table 5 Salinity of groundwater in key monitoring bores in the Loddon Highlands WSPA**

Bore number	Zone	Screen depth below natural surface (m)	EC Jun 2012	EC Sep 2012	EC Mar 2014	EC Oct 2014	EC Oct 2015
SP069539	Ullina	114.2-119.9 m (Deep Lead)	1,760	1,680	1,620	1,680	1,820
SP068255	Ullina	33.1-35.9 m (basalt)	6,350	7,130	6,830	6,840	6,790
SP069730	Talbot	92.2-97.8 m (Deep Lead)	2,260	2,390	2,180	2,110	2,360
SP068252	Talbot	57-60 m (basalt)	3,720	4,050	3,690	3,520	3,950

Note: EC is the electrical conductivity @ 25°C measured in  $\mu\text{S}/\text{cm}$

Groundwater salinity data from Central Highlands Water (CHW) licensed and monitoring bores has also been used to monitor any changes in groundwater quality. Data is obtained from the

CHW bore fields in Newlyn (Forest Hill), Ascot (Learmonth), Ullina (Clunes), Waubra (Waubra) and Talbot (Bung Bong) Zones (Figure 6). The data indicates that groundwater salinity levels are relatively stable and within historical ranges.



**Figure 6 Groundwater salinity monitoring results from Central Highlands Water bores**

### 3.3 Metering

All operational licensed bores in the Loddon Highlands WSPA were metered as of 30 June 2016. There were 41 meters that required maintenance activity across the WSPA in 2015/16 (Table 6). All meters were read at least twice during the 2015/16 water year.

**Table 6 Metering activities**

<b>Metering activity</b>	<b>Year ending 30 June 2016</b>
Number of meters installed	4
Number of meters replaced	10
Meter maintenance events	41
Total number of meters in WSPA	238
Total number of meter reads	476

### **3.4 Licence compliance**

There were no prosecutions or convictions relating to groundwater matters in the Loddon Highlands WSPA in 2015/16.

There were nine incidents of unauthorised take and use of groundwater and two other compliance cases requiring further action. These incidents have been investigated and GMW has taken action in accordance with the National Framework for Compliance and Enforcement of Systems for Water Resource Management (DSEWPC, 2012). This includes verbal and written notification not to take water without authorisation; a direction to apply to transfer entitlement to account for use; and providing information on groundwater licence transfer options.

# 4 Future management considerations

## 4.1 Groundwater Reference Committee

The Groundwater Reference Committee, appointed in accordance with Prescription 7(c) of the Plan, met on 1 September 2015. Key points of discussion included:

- Dry conditions;
- Metered use;
- Trading;
- Carryover;
- Groundwater level response; and
- Groundwater salinity.

There were no actions from the meeting.

It should be noted that GMW undertook investigations to confirm the response from trigger bores in the Newlyn Zone were representative of other monitoring bores in that zone for the Loddon and Campaspe Regional Water Services Committee. The outcomes of that work, which found that the current trigger bores are the most appropriate bores for resource management, were presented to the Groundwater Reference Committee.

## 4.2 SOBN review

The State Observation Bore Network (SOBN) is owned and managed by DELWP.

DEWLP completed the review of the SOBN in 2015/16, which has resulted in a reduction in the number of bores to be monitored in the future.

GMW will seek its customers' views on future groundwater monitoring needs through its Regional Water Services Committees and the Groundwater Reference Committee.

## 4.3 Installation of monitoring bores near Birch Creek

The North Central Catchment Management Authority continues to monitor bores that it installed adjacent to Birch Creek to investigate interaction between groundwater and surface water.

These investigations will assist with better understanding of the impacts of groundwater pumping on stream base flow.

## 5 References

Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2012. National Framework for Compliance and Enforcement of Systems for Water Resource Management. Viewed 28 August 2014, <http://www.environment.gov.au/system/files/resources/d4367a3b-28a9-430d-a869-2effbda8a447/files/ris-water-compliance-enforcement.pdf>

BoM, 2015, Climate Statistics for Australian Sites – Clunes station number 088015. Bureau of Meteorology. Retrieved 20 August 2015, [http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p\\_nccObsCode=139&p\\_display\\_type=dataFile&p\\_startYear=&p\\_c=&p\\_stn\\_num=088015](http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=088015)

Department of Sustainability and Environment, 2012. Loddon Highlands Water Supply Protection Area Groundwater Management Plan November 2012. Department of Sustainability and Environment, Melbourne

Victorian Government, 2012. Victorian Government Gazette No. S389 Wednesday 21 November 2012. Victoria Government, Melbourne

Victorian Government, 2013. Victorian Government Gazette No. G10 Thursday 7 March 2013. Victoria Government, Melbourne

## Appendix A – Assessment of activities against Plan prescriptions

Prescription	Activity	Compliant
<p><b>Prescription 1: Carryover</b></p> <p>The Corporation shall:</p> <ul style="list-style-type: none"> <li>a) Apply to the Minister for Water to declare the availability of carryover in the Loddon Highlands WSPA up to a maximum of 15% of licence entitlement that will not be subject to restriction in the form of allocations.</li> <li>b) Consult with the Groundwater Reference Committee about the need to alter the percentage of carryover.</li> </ul>	<p>The Minister declared that licence holders in the Loddon Highlands WSPA may carryover up to 15% licence entitlement volume from November 2012.</p>	<p>Yes</p>
<p><b>Prescription 2: Triggers and restrictions</b></p> <p>The Corporation shall:</p> <ul style="list-style-type: none"> <li>a) By 15 September each year determine the maximum seasonal groundwater recovery level in the relevant bore/s, or its replacement, and corresponding seasonal allocation as detailed in the Plan.</li> <li>b) Determine a seasonal allocation for the relevant zone based on the outcomes of a review of available data. The review will be undertaken when the 50% allocation is triggered in the Blampied, Newlyn or Ascot Zone. The Corporation shall consult with the Groundwater Reference Committee during the review.</li> <li>c) Determine a seasonal allocation for the Waubra Zone and consult with Groundwater Reference Committee.</li> <li>d) Announce seasonal allocations by listing them on its website; sending letters to all licence holders and placing public notices in local newspapers.</li> <li>e) Review allocations based on groundwater level readings to November each year and announce an increase if triggered.</li> </ul>	<p>GMW announced allocations by 15 September 2015. All zones received an allocation of 100% except for the Newlyn Zone, which had an initial allocation of 75%. GMW reviewed allocations in the Newlyn Zone based on groundwater levels to November 2015, but there was insufficient recovery to increase allocations. Licence holders were then advised that allocations would remain at 75% for the water year. GMW announced allocations by listing them on their website, sending letters to all licence holders and placing public notices in local newspapers.</p>	<p>Yes</p>
<p><b>Prescription 3: Trading between zones</b></p> <p>The Corporation may approve a temporary or permanent transfer of groundwater licence entitlement under section 62 of the Water Act 1989 provided section 53 matters have been considered and the following conditions are satisfied:</p> <ul style="list-style-type: none"> <li>a) The permanent transfer of licence entitlement is between zones as specified in the Plan.</li> </ul>	<p>GMW processed 26 transactions for temporary transfer of licence totalling 1,063.3 ML and 2 transactions for permanent transfer of licence totalling 35 ML in 2015/16. All transfers were compliant with Prescription 3.</p>	<p>Yes</p>

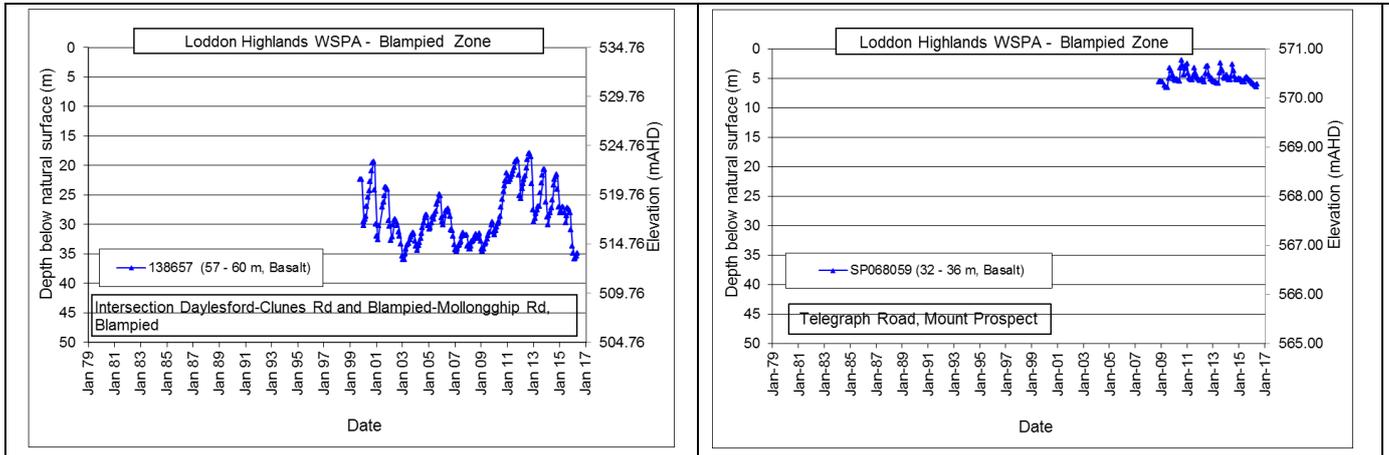
<ul style="list-style-type: none"> <li>b) The temporary transfer of licence entitlement is between zones as specified in the Plan.</li> <li>c) Despite (b) above, a temporary transfer of licence entitlement may be considered where bores are located within 2.5 km of each other across an internal zone boundary.</li> <li>d) Licence entitlement may be temporarily traded into, or out of, the Loddon Highlands WSPA provided that the PCV is not exceeded.</li> </ul>			
<p><b>Prescription 4: Groundwater level interference</b></p> <p>The Corporation may approve an application to take and use groundwater under section 51 or a transfer under section 62 of the <i>Water Act 1989</i> provided that section 53 matters have been considered and the following conditions are satisfied:</p> <ul style="list-style-type: none"> <li>a) Licence entitlement may be temporarily or permanently transferred up to 1,000 ML/yr within 2.5 km radius of a licensed bore.</li> <li>b) Where the licence entitlement within a 2.5 km radius of a licensed bore exceeds 1,000 ML/yr then:</li> </ul>		<p>GMW processed all groundwater licence applications in accordance with Plan Prescription 4.</p>	<p>Yes</p>
<p>(i). For temporary transfer of licence entitlement</p>	<ul style="list-style-type: none"> <li>1. Trade with usage in any one season limited to 115% of entitlement, whether it occurs through trade or carryover (this could include transferring from outside the 2.5 km radius); or</li> <li>2. Trade from others within 2.5 km radius of the applicant's bore for usage to exceed 115% of entitlement; or</li> <li>3. Assess the application to consider other relevant information such as historical use and, if required undertake detailed investigations, when seeking to use more than 115% of your licence entitlement to demonstrate no unacceptable impacts are likely to occur. This could include transferring from outside the 2.5 km radius.</li> </ul>		
<p>(ii). For permanent transfer of licence entitlement</p>	<ul style="list-style-type: none"> <li>1. Trade from others within 2.5 km radius of the applicant's bore; or</li> <li>2. Undertake detailed investigations to demonstrate no unacceptable impacts are likely to occur. This could include transferring from outside the 2.5 km radius.</li> </ul>		

<p><b>Prescription 5: Groundwater monitoring</b></p> <p>The Corporation shall:</p> <ul style="list-style-type: none"> <li>(a) Obtain monthly groundwater level readings, where practicable, from State observation bores listed in Schedule 1 or their replacement (up to 288 readings per season).</li> <li>(b) Establish a targeted groundwater salinity monitoring program to collect and analyse groundwater samples from selected licensed bores each year.</li> <li>(c) Collect groundwater samples from selected State observation bores identified in Schedule 1 where practicable, or their replacement, and send them to a NATA accredited laboratory for analysis.</li> </ul>	<p>GMW obtained monthly groundwater level readings from bores listed in Schedule 1 of the Plan where practicable.</p> <p>GMW used groundwater salinity monitoring data provided by Central Highlands Water from their urban supply bores to fulfil the requirements of a targeted salinity monitoring program.</p> <p>GMW collected groundwater samples from nested State observation bores identified in Schedule 1 and sent them to a NATA accredited laboratory for analysis.</p>	<p>Yes</p>
<p><b>Prescription 6: Metered licensed use</b></p> <p>The Corporation shall:</p> <ul style="list-style-type: none"> <li>(a) Ensure that a meter is fitted to all operational licensed bores.</li> <li>(b) Read each meter at least twice each season.</li> </ul>	<p>GMW ensured that a meter was fitted to all operational licensed bores and read each meter in January/February and May/June during 2015/16.</p>	<p>Yes</p>
<p><b>Prescription 7: Plan implementation</b></p> <p>The Corporation shall:</p> <ul style="list-style-type: none"> <li>(a) By 30 September each year: <ul style="list-style-type: none"> <li>(i). prepare an annual report on the administration and enforcement of the Plan for the Minister for Water and relevant agencies.</li> <li>(ii). mail a newsletter to groundwater licence holders, and domestic and stock users upon request, summarising the outcomes in the annual report.</li> </ul> </li> <li>(b) Post on its website the Plan; annual report, newsletters and groundwater level monitoring results.</li> <li>(c) Meet with a Groundwater Reference Committee at least once each year to report on the implementation of the Plan and consider the need to review the Plan.</li> <li>(d) Undertake a review of the Plan after five years from its approval, or sooner if warranted by any prescription contained within the Plan.</li> </ul>	<p>GMW has prepared this annual report for the 2015/16 water year on administration and enforcement of the Plan for the Minister and relevant agencies and sent a newsletter to licence holders summarising the information in this report.</p> <p>GMW has posted on its website the Plan, this annual report and a water year summary newsletter.</p> <p>GMW updates hydrographs of groundwater levels every three months on its website in accordance with the Plan.</p> <p>GMW met with the Groundwater Reference Committee in September 2015 to discuss the implementation of the Plan.</p>	<p>Yes</p>

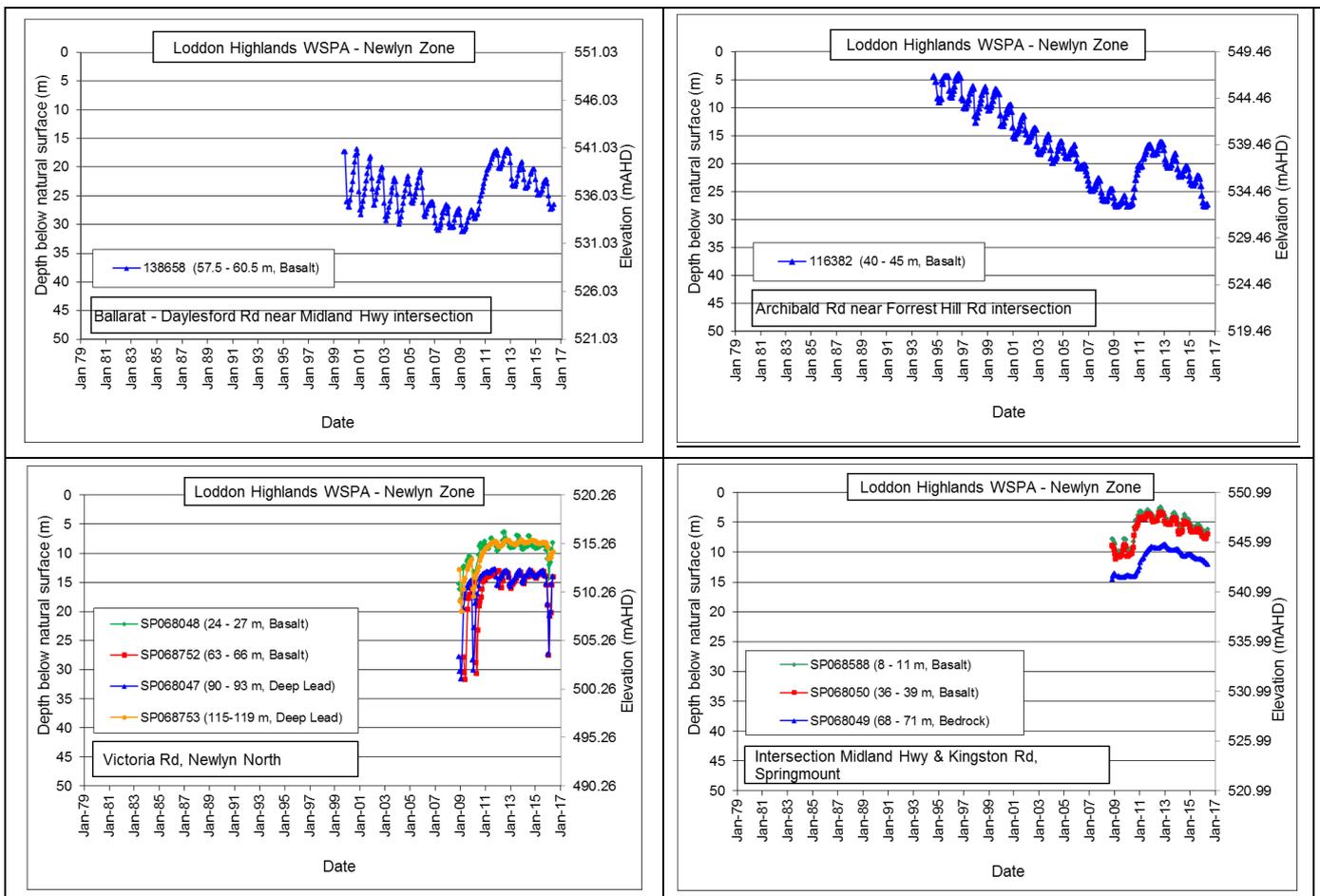
# Appendix B – Hydrographs

Hydrographs for key monitoring bores listed in the Plan. Further groundwater level information from other State observation bores is available on the Visualising Victoria's Groundwater website at <http://www.vvg.org.au/>.

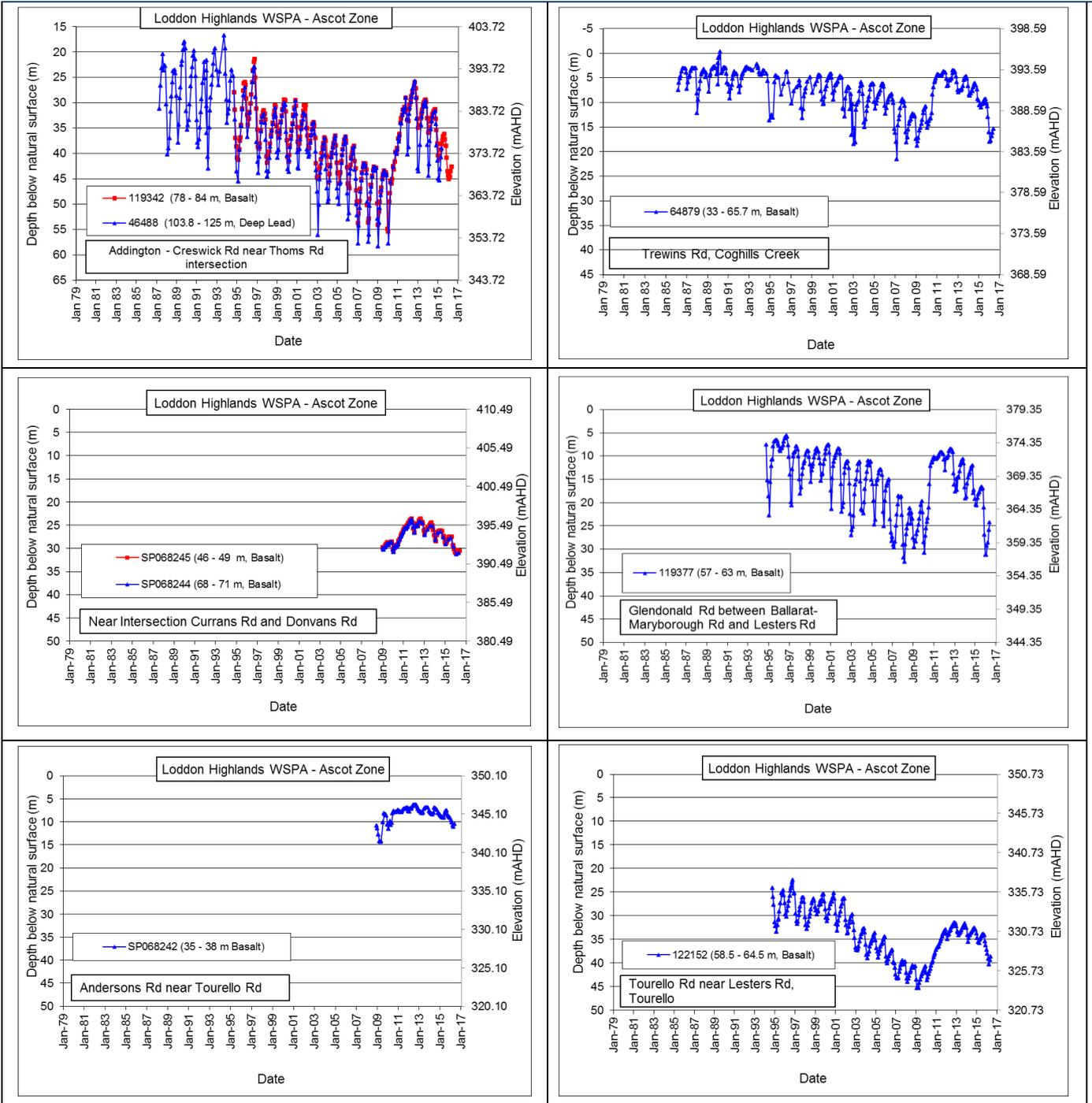
## Zone 1104 – Blampied

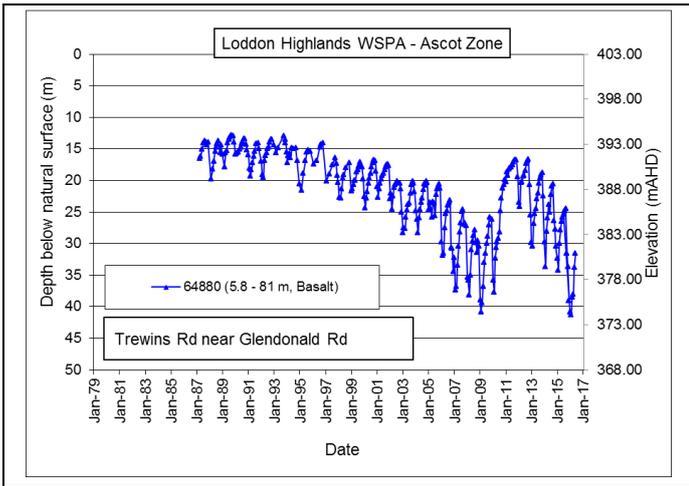


## Zone 1107 – Newlyn

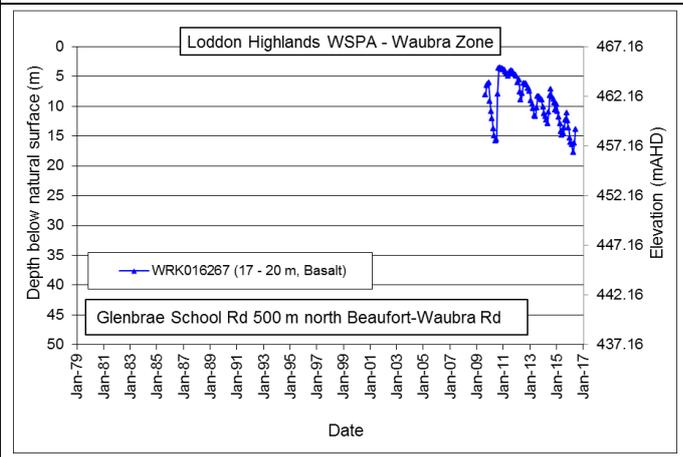
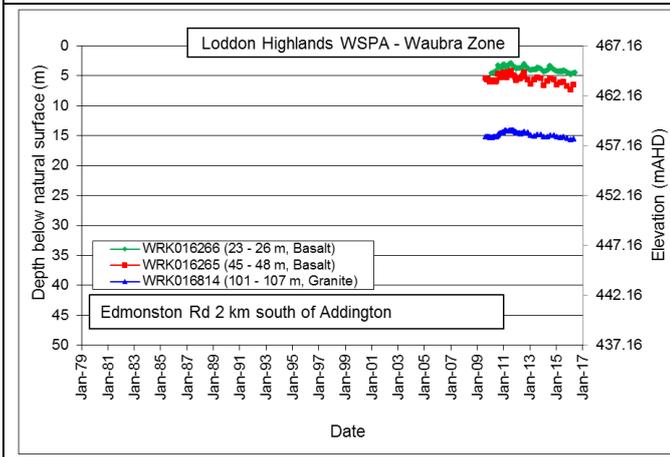
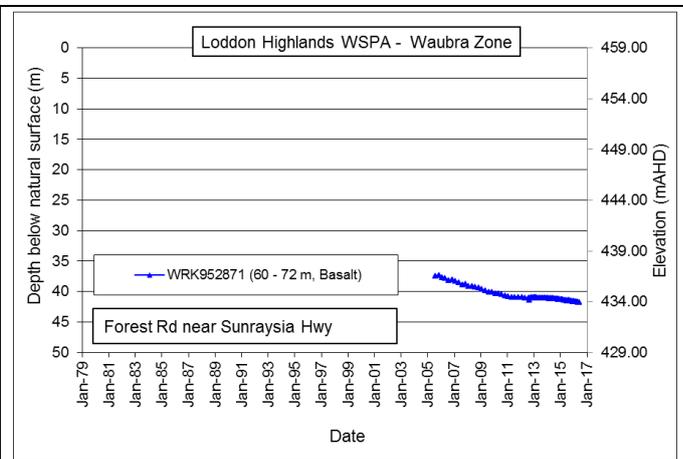
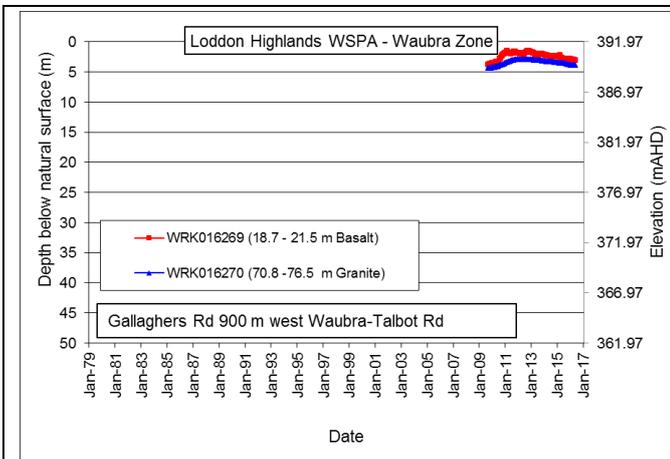


# Zone 1102 – Ascot

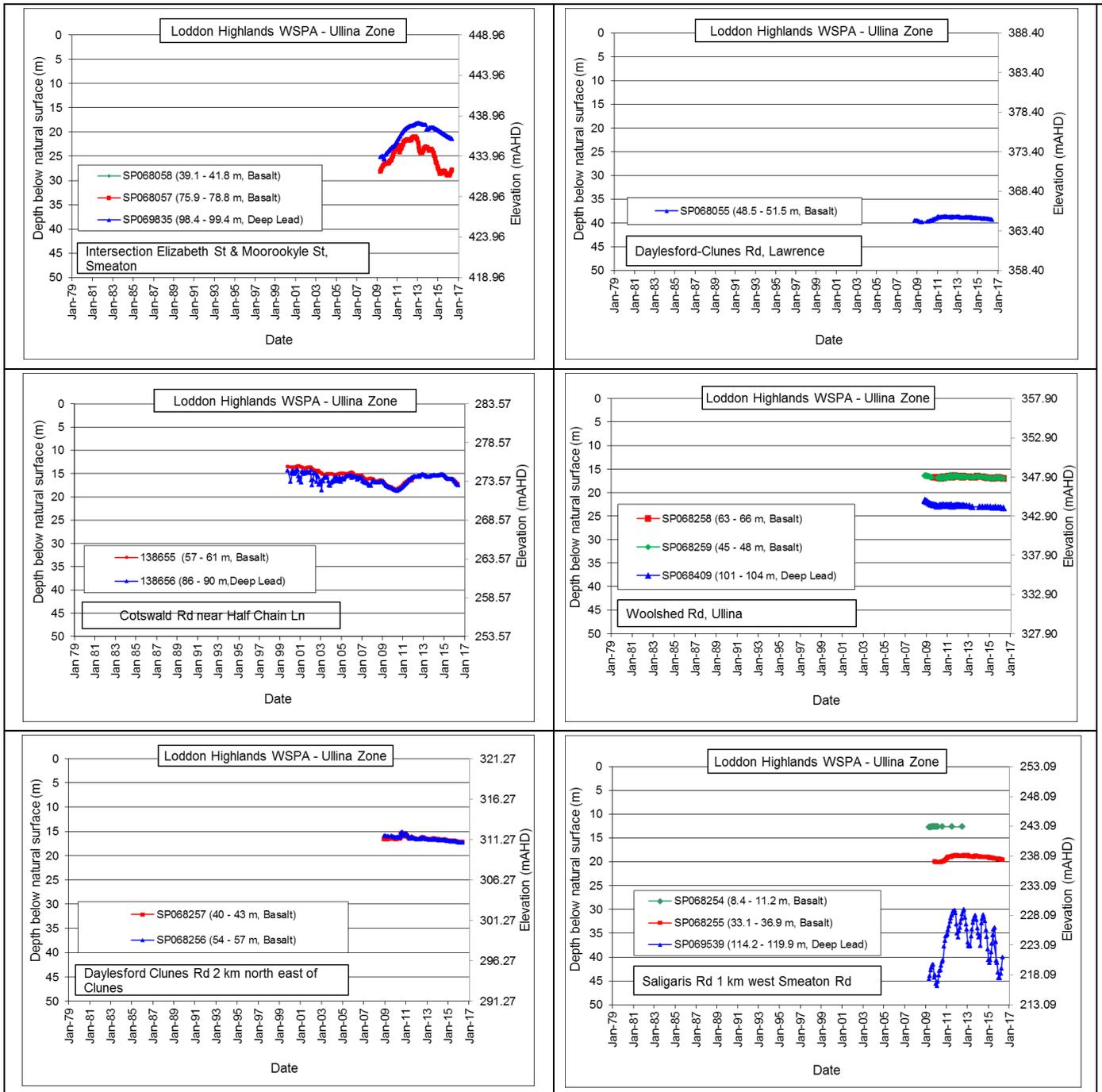




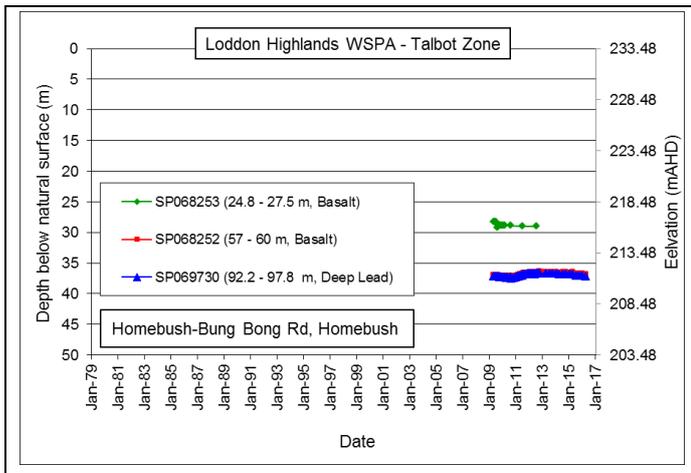
## Zone 1106 – Waubra



# Zone 1100 – Ullina



## Zone 1101 – Talbot



# Appendix C – Groundwater chemistry

## Groundwater chemistry from nested State observation bores

	Bore	SP069539	SP068255	SP069730	SP068252
	Aquifer	Deep Lead	Basalt	Deep Lead	Basalt
Analyte	Date	13/10/2015	13/10/2015	13/10/2015	13/10/2015
pH Value	pH Unit	6.98	7.64	7.64	7.65
Electrical Conductivity @ 25°C	µS/cm	1820	6790	2360	3950
Total Dissolved Solids @180°C	mg/L	940	4140	1290	2280
Turbidity	NTU	0.7	0.8	18.5	1.1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	mg/L	409	258	290	317
Carbonate Alkalinity as CaCO <sub>3</sub>	mg/L	<1	<1	<1	<1
Hydroxide Alkalinity as CaCO <sub>3</sub>	mg/L	<1	<1	<1	<1
Total Alkalinity as CaCO <sub>3</sub>	mg/L	409	258	290	317
Sulfate as SO <sub>4</sub> - Turbidimetric	mg/L	35	304	72	156
Chloride	mg/L	353	1700	553	951
Calcium	mg/L	42	111	58	77
Magnesium	mg/L	74	338	95	173
Potassium	mg/L	9	13	6	8
Sodium	mg/L	220	729	259	455
Arsenic	mg/L	<0.001	<0.001	0.003	0.002
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	<0.001	0.001	0.002	0.002
Copper	mg/L	<0.001	0.002	<0.001	<0.001
Iron	mg/L	0.29	<0.05	<0.05	<0.05
Lead	mg/L	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.079	0.009	<0.001	<0.001
Nickel	mg/L	0.001	0.003	0.002	0.006
Zinc	mg/L	0.015	0.008	<0.005	<0.005
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001
Ammonia as N	mg/L	0.19	0.69	0.03	0.06
Nitrite as N	mg/L	<0.01	0.13	<0.01	0.01
Nitrate as N	mg/L	0.04	3.48	1.71	4.37
Nitrite + Nitrate as N	mg/L	0.04	3.61	1.71	4.38
Total Kjeldahl Nitrogen as N	mg/L	0.2	0.7	<0.1	0.3
Total Nitrogen as N	mg/L	0.2	4.3	1.7	4.7
Total Phosphorus as P	mg/L	0.06	0.14	0.09	0.08
Ionic Balance	%	2.39	4.76	1.7	2.23
Total Anions	meq/L	18.8	59.4	22.9	36.4
Total Cations	meq/L	18	65.4	22.1	38.1
Total Organic Carbon	mg/L	<1	2	<1	<1