

# Annual Bulk Entitlement Report

Anglesea groundwater  
2019–2020

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# 1 Introduction

The Anglesea Borefield is one of a number of water sources that can supplement the existing Greater Geelong water supply system in response to low storage levels. Our diverse water supply mix is part of a balanced approach to managing the region's water resources and providing greater water security. The Anglesea Borefield extracts groundwater from the Lower Eastern View Formation in the Jan Juc Groundwater Management Area and contains seven production bores that are licensed to extract a maximum of 40 ML in any day, 10,000 ML in any year, and 35,000 ML in any 5-year period.

Groundwater from the Anglesea Borefield is pre-treated at the Anglesea Pre-Treatment Plant before it is transferred to Wurdee Boluc Reservoir, where it is stored and eventually undergoes full treatment before being supplied to customers.

Operation for commissioning and testing of the borefield first commenced in October 2009 and ceased in June 2012, with a total of 7,617 ML pumped during that period. Due to low water storage levels, recommissioning of the borefield began in August 2019 to supplement the existing Greater Geelong water supply system. Between August 2019 and end of June 2020, a total of 2177.3 ML was extracted from the Anglesea Borefield.

The Anglesea Borefield has been operating with community oversight through the Anglesea River Working Group. Barwon Water also shares groundwater extraction rates, monitoring data and operational updates with Barwon Water's Environmental Advisory Committee, and the broader community via the Anglesea Borefield web page.

Barwon Water operates the Anglesea Borefield under the Bulk Entitlement (Anglesea Groundwater) Order 2009 (the Order), which requires us to prepare an annual report called the Annual Bulk Entitlement Report (Anglesea Groundwater). The annual report includes information on groundwater extraction rates, water quality sampling, trigger levels and any issues or difficulties in complying with the Order. This report will be available for stakeholders, agencies, our customers and community.

The Order requires Barwon Water to also establish a Monitoring and Assessment Program (MAP), which was undertaken in 2009. The objective of the MAP is to protect environmental values and the health of groundwater dependent ecosystems, whilst also continuing to collect data to build an understanding of the long-term sustainability of groundwater resources in the Anglesea area.

Under the Order, Barwon Water is also required to undertake periodic reviews of the Bulk Entitlement (Anglesea Groundwater) Order 2009. The review conducted in 2013 identified a number of areas of the MAP that should continue to be monitored, as well as areas that are no longer considered to be dependent on groundwater from the Lower Eastern View Formation and, therefore, could be subject to reduced monitoring. As a result of the 2013 review, a revised MAP was established and subsequently approved by the Minister for Water in September, 2014. We have since implemented the revised MAP 2014 and have been operating in accordance with it.

In accordance with the Order, Barwon Water has prepared an annual report that covers groundwater extraction rates, water quality sampling and any difficulties in compliance with the MAP 2014 over the reporting period of 1 July 2019 to 30 June 2020.

## 2 Groundwater extraction (Clauses 16.2 A, 16.2 B and 16.2 C)

Under the bulk entitlement, and subject to ongoing appropriate environmental monitoring, Barwon Water is permitted to extract a maximum of 40 ML in any one day; 10,000 ML in any one year; and 35,000 ML in any five-year period. Recommissioning of the Anglesea Borefield commenced in August 2019, and between September 2019 and end of June 2020 a total of 2177.3 ML was extracted. Table 1 shows the daily extraction rates and Table 2 shows the total extraction per bore of the Anglesea Borefield during 2019–2020.

**Table 1: Total daily/monthly groundwater extraction 2019–2020**

Date	Groundwater extraction rates (ML)											
	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020
1	0.0	0.0	0.0	0.0	1.1	9.0	8.7	2.2	9.1	10.6	8.9	10.1
2	0.0	0.0	0.0	0.0	0.0	9.6	9.5	3.4	9.6	10.5	8.9	10.1
3	0.0	0.0	0.0	0.0	3.1	11.8	11.0	3.5	11.2	10.5	8.9	10.2
4	0.0	0.0	0.0	0.0	8.4	11.5	11.8	5.4	11.5	10.5	8.9	10.4
5	0.0	0.0	0.0	0.0	9.2	11.4	11.8	9.0	7.2	7.3	8.9	10.3
6	0.0	0.0	0.0	0.0	8.9	11.6	11.9	11.0	10.9	10.6	8.9	10.3
7	0.0	0.0	0.0	0.0	8.7	10.2	11.8	11.2	10.7	10.9	9.7	10.2
8	0.0	0.0	0.0	0.0	8.9	8.4	11.3	11.0	10.6	10.8	9.8	10.2
9	0.0	0.0	0.0	0.0	9.4	10.6	11.7	10.7	10.5	10.8	9.1	10.2
10	0.0	0.0	0.0	0.0	9.2	10.8	11.6	10.5	9.8	10.7	9.1	10.2
11	0.0	0.0	0.0	0.0	8.0	11.9	11.6	6.3	9.9	10.7	9.1	9.4
12	0.0	0.0	0.0	0.0	5.5	11.7	11.6	10.5	6.8	10.7	9.1	8.8
13	0.0	0.0	0.0	0.0	6.0	11.7	7.6	11.0	6.7	10.6	10.3	8.5
14	0.0	0.0	0.0	0.0	6.1	11.7	3.8	10.3	10.1	10.7	10.2	8.5
15	0.0	0.0	0.0	0.0	8.1	8.0	2.6	10.7	10.0	10.8	8.9	9.7
16	0.0	0.0	0.5	0.0	9.3	11.3	4.0	10.6	9.9	9.3	9.0	10.3
17	0.0	0.0	0.0	0.0	9.1	10.6	8.7	10.5	9.8	10.8	9.0	10.3
18	0.0	0.0	0.0	0.0	9.0	10.9	7.5	5.0	9.8	10.7	9.0	10.2
19	0.0	0.0	0.0	0.0	9.0	11.3	7.4	1.9	9.7	10.7	10.0	10.2
20	0.0	0.0	0.7	0.0	9.4	11.4	8.8	4.6	9.7	10.7	8.1	10.2
21	0.0	0.0	0.0	0.0	9.5	4.4	8.8	5.1	9.6	10.6	9.5	10.1
22	0.0	0.0	0.0	0.0	9.6	5.8	7.6	5.1	9.6	10.6	9.8	10.1
23	0.0	0.0	0.0	0.0	9.6	9.6	7.0	5.1	10.7	10.6	9.3	10.1
24	0.0	0.0	0.9	0.0	9.6	11.6	6.8	5.1	11.4	10.0	8.7	7.1
25	0.0	0.0	0.0	0.0	9.5	11.4	3.3	5.1	10.6	8.8	9.6	3.3
26	0.0	0.0	0.0	0.0	9.5	11.3	3.3	5.1	10.9	8.8	10.4	3.4
27	0.0	0.0	0.0	0.0	9.4	11.3	3.3	7.8	10.9	8.8	8.1	3.5
28	0.0	0.0	0.0	0.0	9.3	11.1	3.3	7.0	10.8	8.9	9.2	3.5
29	0.0	0.0	0.0	0.0	8.3	11.3	3.3	9.8	10.7	8.9	10.2	3.5
30	0.0	0.0	0.0	0.0	9.1	11.1	3.3		10.7	8.9	10.2	3.6
31	0.0	0.0		0.1		10.1	2.0		10.6		10.2	
Total	0.0	0.0	2.2	0.1	239.9	324.5	236.9	214.6	310.1	303.9	288.5	256.7
Prog. Total	0.0	0.0	2.2	2.3	242.2	566.7	803.6	1018.2	1328.3	1632.2	1920.6	2177.3
Max. Flow	0.0	0.0	0.9	0.1	9.6	11.9	11.9	11.2	11.5	10.9	10.4	10.4
Min. Flow	0.0	0.0	0.0	0.0	0.0	4.4	2.0	1.9	6.7	7.3	8.1	3.3
Ave. Flow	0.0	0.0	0.1	0.0	8.0	10.5	7.6	7.4	10.0	10.1	9.3	8.6

**Table 2: Annual groundwater extraction by bore 2019-2020**

<b>Production bores</b>	<b>Groundwater Extraction (ML)</b>
GW220 (GW 1)	383
GW221 (GW 2)	345
GW222 (GW 3)	626
GW223 (GW 4)	776
GW224 (GW 5)	47
GW211A (GW 6)	0
GW225 (GW 7)	0
<b>Annual total</b>	<b>2177</b>

## 3 Water quality sampling (Clause 16.2 D)

### 3.1 Groundwater quality

The 2014 MAP stipulates that groundwater salinity is to be measured twice a year at five deep observation bores (between 165 – 490m deep) as well as 10 shallow observation bores (less than 80m deep). The deep observation bores monitor the Upper Eastern View Formation (UEVF) and the Lower Eastern View Formation (LEVF), while the shallow observation bores monitor the perched water table as well as the UEVF and LEVF.

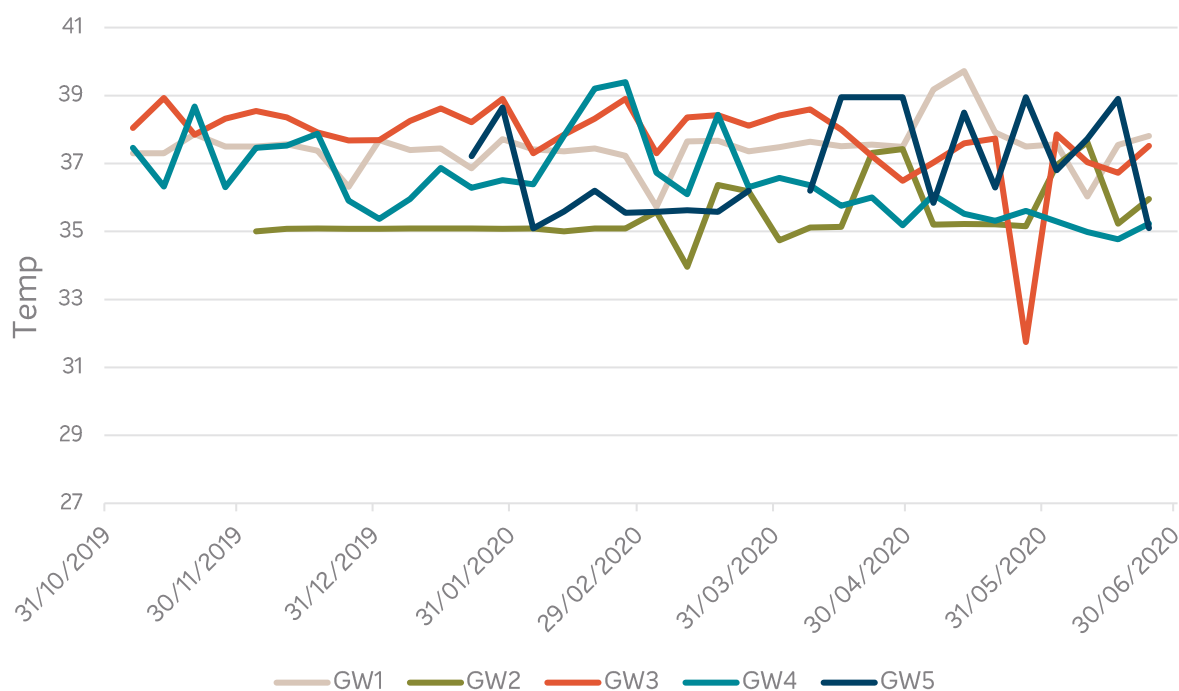
The objective of this groundwater sampling is to detect any potential change in groundwater quality in the aquifers as a result of groundwater extraction and in particular any changes associated with potential inter-aquifer flow and saline intrusion.

#### **Production bores**

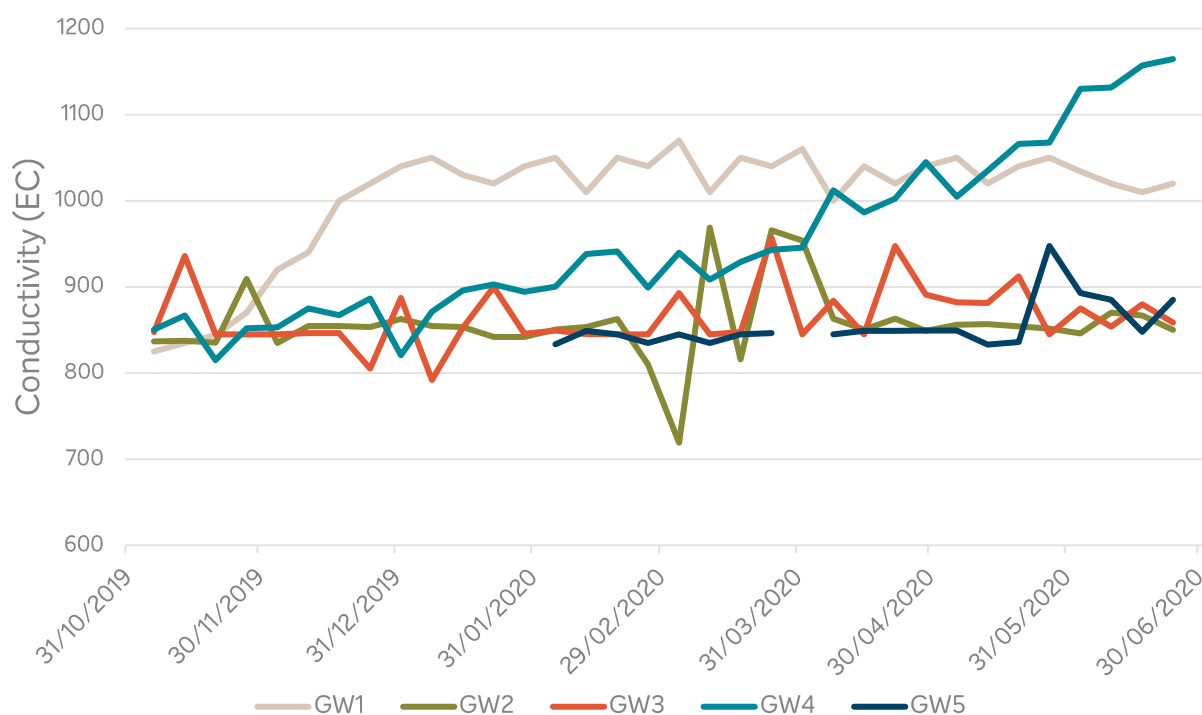
The MAP requires weekly monitoring of field salinity and temperature in each production bore (GW1-GW7) that is being pumped when the borefield is in operation. Figure 1 and 2 below show weekly results of monitoring for temperature and electrical conductivity (EC) taken from telemetry on each bore while in operation.

The data shows that EC remains relatively stable for all production bores except GW4, which displays an upwards trend. This is believed to be due to increased interconnection between the LEVF and UEVF in proximity to GW4 resulting from observation bores screening both aquifers. Alcoa is proposing to decommission these bores as part of their mine rehabilitation works. Barwon Water will continue to monitor for any changes in salinity trends following decommissioning of these bores.

**Figure 1: Groundwater quality results for temperature – production bores**



**Figure 2: Groundwater quality results for salinity (EC) – production bores**



### Deep observation bores

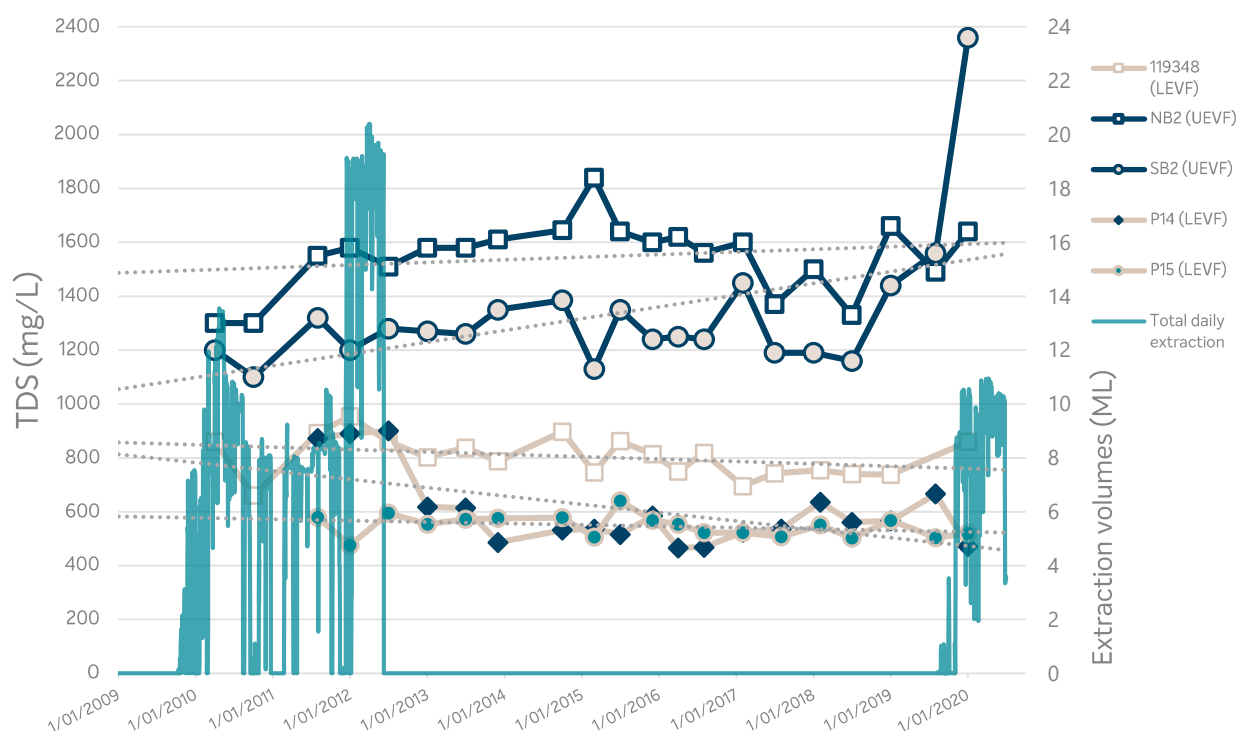
The 2019–2020 groundwater salinity results from the deep observation bores are provided in Table 3, while the results over the whole monitoring period (from April 2010 onwards) have been provided graphically in Figure 3. This figure depicts the salinity measurements against the groundwater extraction and recovery periods. A linear regression line has been

developed for each site in order to compare the results over the monitoring period. Laboratory testing also occurs at these groundwater bores and has been provided in Appendix E.

**Table 3: Groundwater Quality Results – Deep Observation bores**

Bore ID	Aquifer	Depth (m)	Date	Field Parameters			Lab Result	
				Temp °C	pH	EC (µS/cm)	EC (µS/cm)	TDS (mg/L)
119348	LEVF	N/A	Aug-19	No sampling conducted while DELWP completed refurbishment works				
			Jan-20	17.4	8.9	1383	1440	860
SB2	UEVF	229	Aug-19	14.7	5.6	2798	2810	1560
			Jan-20	16.4	5.6	4264	4300	2360
NB2	UEVF	165	Aug-19	14.0	5.7	2423	2440	1490
			Jan-20	19.7	5.8	2500	2520	1640
P14	LEVF	504	Aug-19	13.4	6.2	1039	1050	666
			Jan-20	19.4	5.8	802	800	472
P15	LEVF	466	Aug-19	15.6	5.0	864	886	504
			Jan-20	17.7	5.0	916	943	520

**Figure 3: Groundwater quality results – deep observation bores**



The field readings taken for the Electrical Conductivity (EC) are conducted during the bore purging process. Both the Total Dissolved Solids (TDS) and EC are taken to measure the salinity in groundwater samples. The TDS readings are taken in controlled laboratory conditions by weighing the residual solids that remain after the water from the sample is evaporated. This

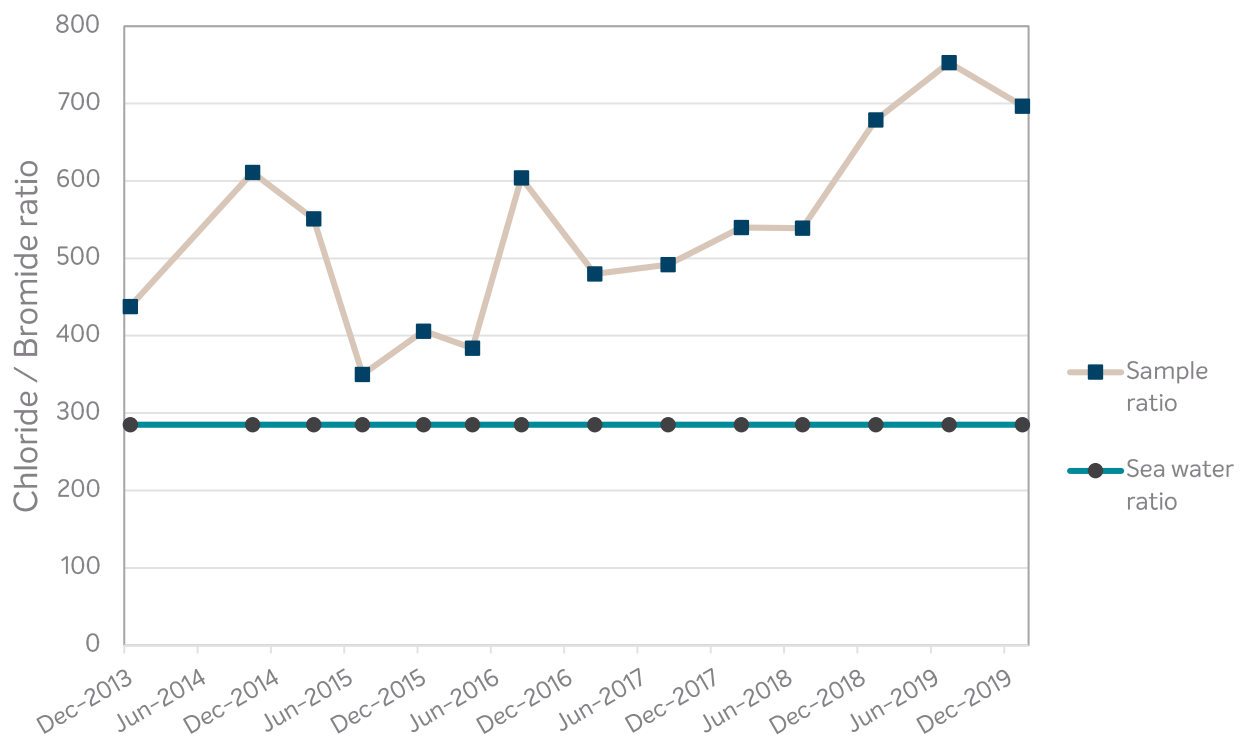
method is proven to be much more accurate than the EC readings, where an electrical current is passed through the sample and measured. Since the TDS yields more accurate results, these results have been used to analyse the trends in the groundwater salinity.

The salinity results from the sampling undertaken in January 2020 at SB2 were higher than what we have observed through previous monitoring. At this stage the reason for this increase is uncertain.

To further investigate this increase an airlift of the bore is planned to flush out any stagnate water that may be sitting in the bore. In addition to this, monthly water quality has been organised along with including groundwater quality monitoring at nearby bore 116459. This further information will assist to determine if this increase is a real trend, or erroneous data.

Given its proximity to the coastline, P14 is also tested for chloride and bromide to monitor for potential seawater intrusion. Seawater in an open ocean has a constant chloride/bromide ratio of approximately 285g/1g (285:1). Therefore, a decreasing chloride/bromide ratio, in conjunction with rising salinity can be indicative of saline intrusion.

**Figure 4: Illustrates the chloride/bromide ratios over time. The trend remains above the 285:1 ratio associated with seawater. Hence there continues to be no indication of saline intrusion at P14 to date.**





## Shallow observation bores

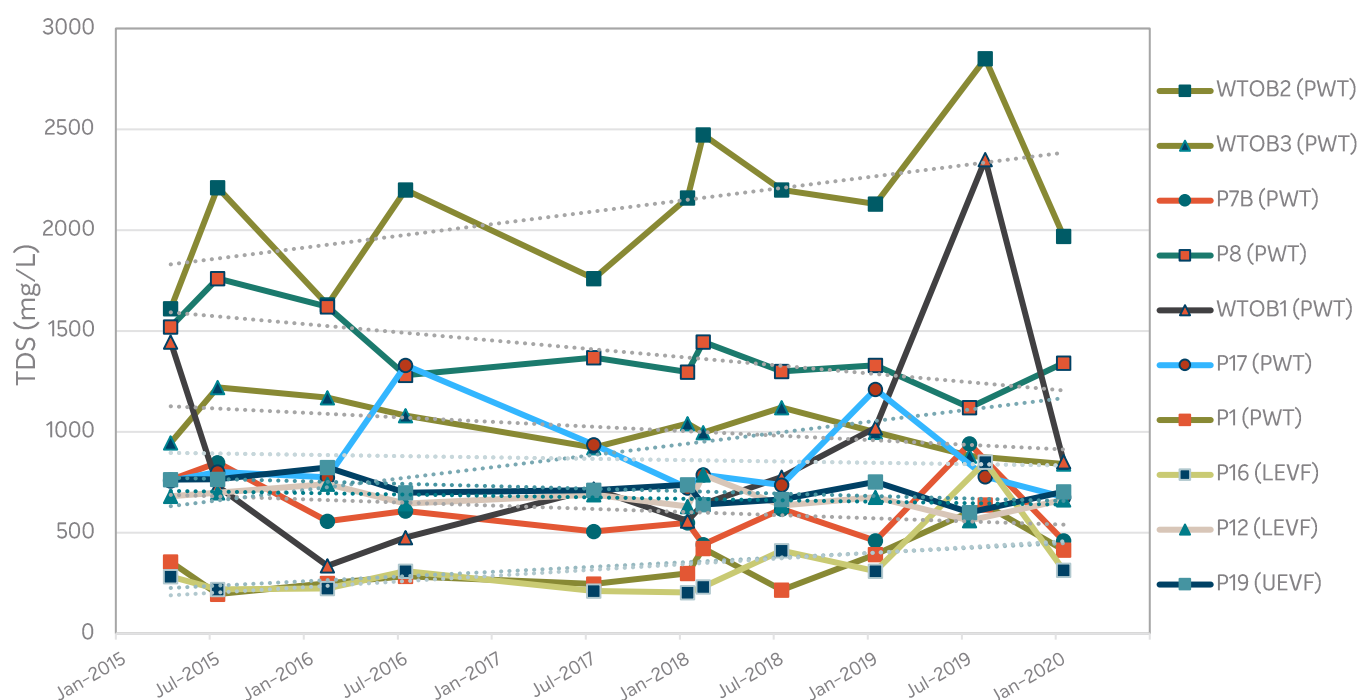
The 2019–2020 groundwater salinity results from the shallow observation bores are provided in Table 4. Groundwater salinity monitoring at the shallow observation bores commenced in April 2015 and as such there is limited data to observe long-term trends. However, Figure 5 shows the trend of each shallow observation bore over time using the data available.

The assessment of groundwater quality is primarily focused on salinity as the main indicator of changes in the aquifer system. As expected the salinity levels in the perched water table fluctuate more than in the upper or lower eastern view formations. This is due to the variable nature of the water level in the perched water table as a result of climatic variation, which is demonstrated in the graphs provided in Appendix G.

**Table 4: Groundwater Quality Results – Shallow Observation bores**

		Field Parameters			Lab Result	
Bore ID	Date	Temp °C	pH	EC (µ/cm)	EC (µ/cm)	TDS (mg/L)
Anglesea River Catchment						
WTOB3	Jul-19	14.4	5.44	1599	1640	880
	Jan-20	15.6	5.33	1606	1670	840
P7B	Jul-19	12.4	3.87	844	850	940
	Jan-20	15	3.66	839	884	460
P8	Jul-19	11.5	5.16	2095	2130	1120
	Jan-20	15.4	5.09	2117	2200	1340
P19	Jul-19	15.2	5.8	1218	1200	600
	Jan-20	16.3	5.6	1198	1230	703
P12	Jul-19	19.2	5.92	1150	1150	560
	Jan-20	19.6	5.75	1149	1170	663
WTOB2	Aug-19	10.5	4	3738	3850	2850
	Jan-20	14.9	3.99	3128	3320	1970
Salt Creek Catchment						
P16	Aug-19	11.3	4.23	446	481	850
	Jan-20	14.7	4.24	472	499	314
P17	Aug-19	13.1	6.55	1138	1080	777
	Jan-20	15.8	6.35	1291	1270	676
P1	Aug-19	12	5.47	387	371	637
	Jan-20	15.3	5.88	565	510	413
WTOB1	Aug-19	14.3	5.26	1156	1180	2350
	Jan-20	17.3	5.13	982	1010	852

**Figure 5: Groundwater quality results – shallow observation bores**



### 3.2 Surface water quality – field testing

As outlined in the MAP 2014, Barwon Water monitors surface water quality at the sites listed in Table 5. The objective of this sampling is to:

- monitor baseline surface water quality, and monitor for any potential quality changes over time
- assist in the assessment of groundwater and surface water interactions in many areas, by reviewing the water quality data collected over time, in conjunction with groundwater and surface water level monitoring
- assist in the assessment of the process of acid generation in the catchments.

The water quality parameters tested are Electrical Conductivity (EC), Total Dissolved Solids (TDS), pH, Dissolved Oxygen (DO) and temperature. The location of the surface water sites has been provided in Appendix B and the results of the water quality testing in Appendix C.

In August 2019, prior to operation of the borefield, the surface water quality field testing was not undertaken for the month due to transition of this monitoring into the DELWP Regional Water Monitoring Partnership and subsequent change of service provider.

**Table 5: Surface water quality sites – field testing**

Catchment	BW ID	Site ID	SINo.	Site description	Monitoring frequency
Salt Creek	SV3	GS7	235274A	Breakfast Creek Tributary @ V notch	Monthly
	SV1	GS1	235273A	Breakfast Creek @ Road Bridge	Monthly
	SV4	GS2	235276A	Salt Creek @ Denhams Track	Monthly
	SV2	GS3	235222A	Salt Creek (Encoder) @ Alcoa	Monthly
	SGP2-B (pool)	N/A	235275A	Salt Creek (Pool) above swamp @ Denham Track	Monthly

Catchment	BW ID	Site ID	SINo.	Site description	Monitoring frequency
Anglesea River	AGP1-B (pool)	N/A	235271A	Upper Anglesea River @ AARC	Monthly
	AV1	GS4	235270A	Upper Anglesea River @ AARC (V notch)	Monthly
	AV3	GS6	235277A	Anglesea River @ Gumflats Road	Monthly
	ASP7 (pool)	N/A	235280A	Anglesea Swamp @ Vegetation Site P7	Monthly
	AGP2 (pool)	N/A	235272A	Anglesea Wetlands @ Allardyne Track	Monthly
	AV2	GS5	235260A	Anglesea River (Marshy Creek) @ Alcoa	Monthly

### 3.3 Surface water quality – laboratory testing

Barwon Water conducts laboratory sampling at all sites listed in Table 6 as outlined in the MAP 2014. This sampling is conducted biannually and the tested parameters include; major cations and anions, salinity and pH. Water samples are taken by Australian Laboratory Services (ALS) to be independently tested. The results from the laboratory testing of surface water sites are provided in Appendix D.

**Table 6: Surface water quality sites – laboratory testing**

Catchment	BW ID	Site ID	SINo.	Site description
Salt Creek	SV3	GS7	235274A	Breakfast Creek Tributary @ V notch
	SV1	GS1	235273A	Breakfast Creek @ Road Bridge
	SV4	GS2	235276A	Salt Creek @ Denhams Track
	SV2	GS3	235222A	Salt Creek (Encoder) @ Alcoa
Anglesea River	AV1	GS4	235270A	Upper Anglesea River @ AARC (V notch)
	AV3	GS6	235277A	Anglesea River @ Gumflats Road
	AV2	GS5	235260A	Anglesea River (Marshy Creek) @ Alcoa

### Observations

The following trends have been identified from the surface water quality results taken from the field and laboratory testing:

- As the water flows downstream through the swamp the salinity levels increase, with the highest levels recorded at the downstream monitoring sites AV2 and SV2. The higher surface water salinities recorded at the downstream ends of both catchments reflects the storage and concentration of salts in the main swamps through evapotranspiration. The salts then remain stored in the swamps until sufficient rainfall is generated to flush the salts downstream into the Anglesea Estuary. This is supported by the results in Table 7 that shows results from upstream to downstream in both the Salt Creek and Anglesea River catchment.

**Table 7: Surface water results (2019–20), indicating increasing salinity from upstream to downstream through the Salt Creek and Anglesea River catchments**

Date	Salt Creek				Anglesea River		
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
30/07/2019	362	437	323	1653	482	804	6266
00/08/2019							
17/09/2019	334	547	312	1424	634	812	4960
15/10/2019	333	381	298	1657	697	Dry	4880
14/11/2019	343	390	261	1773	789	Dry	4910
12/12/2019	348	454	368	2950	Dry	Dry	5210
13/01/2020	Dry	Dry	Dry	Dry	Dry	Dry	5730
10/02/2020	Dry	Dry	Dry	1540	Dry	Dry	5430
17/03/2020	Dry	Dry	337	1868	Dry	Dry	5400
15/04/2020	505	Dry	222	560	Dry	Dry	5310
13/05/2020	466	Dry	236	697	Dry	Dry	5420
12/06/2020	231	Dry	228	628	Dry	Dry	5440

Table 8 shows the continuing trend of pH values decreasing as water flows downstream through the swamps, with the lowest pH value being recorded at the downstream end of the Anglesea catchment. These results are consistent with the current understanding that the source of acidity in the catchments is the presence of naturally occurring sulphides (pyrites). When the catchment is subjected to wetting and drying cycles the pyritic sediments are oxidised, which causes acid generation in the swamps.

The acid is released from the swamp when a large rainfall event flushes the stored acid from the downstream end of the swamp to the estuary. The water quality results show no correlation between the values observed and groundwater extraction periods. These results indicate that the acid generation and subsequent acid events that occur in the Anglesea estuary are naturally occurring events.

**Table 8: Surface water results (2018–19 & 2019–20), indicating decreasing pH from upstream to downstream in the Anglesea catchment**

Date	Salt Creek				Anglesea River		
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
18/07/2018	5.64	5.75	6.75	4.98	Dry	Dry	Dry
13/08/2018	5.81	6.8	5.68	4.81	6.34	Dry	Dry
25/09/2018	4.9	5.2	5.3	4.2	4.9	Dry	2.7
18/10/2018	4.6	5.3	5.2	4	Dry	Dry	2.6
8/11/2018	5	5.8	5.4	3.9	Dry	Dry	2.6
13/12/2018	5.5	Dry	5.6	Dry	Dry	Dry	2.7
21/01/2019	6	Dry	Dry	Dry	Dry	Dry	2.7
12/02/2019	Dry	Dry	Dry	Dry	Dry	Dry	Dry
14/03/2019	Dry	Dry	Dry	Dry	Dry	Dry	Dry
8/04/2019	Dry	Dry	Dry	Dry	Dry	Dry	Dry
27/05/2019	4.3	Dry	5.2	4.4	Dry	Dry	Dry
19/06/2019	4.6	5.5	5.2	4.9	5.4	4	3.2
30/07/2019	4.5	5.8	5.2	4.6	5.4	4.1	2.9

Date	Salt Creek				Anglesea River		
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
00/08/2019							
17/09/2019	5.1	5.7	5.4	3.65	5.1	4.1	2.6
15/10/2019	4.8	5.7	5.4	3.6	5.3	Dry	2.7
14/11/2019	6	7	6.1	3.5	6.5	Dry	2.6
12/12/2019	6.68	6.9	6.6	3.6	Dry	Dry	2.9
13/01/2020	Dry	Dry	Dry	Dry	Dry	Dry	3
10/02/2020	Dry	Dry	Dry	3.6	Dry	Dry	2.69
17/03/2020	Dry	Dry	6.2	1.98	Dry	Dry	2.84
15/04/2020	5.4	Dry	5.2	4.3	Dry	Dry	2.81
13/05/2020	5.6	Dry	6.9	4.2	Dry	Dry	2.7
12/06/2020	6.2	Dry	6.45	4	Dry	Dry	2.7

To further understand the distribution of acid sulfate soils across the Salt Creek and Anglesea River catchment, Monash University has been contracted by Barwon Water to undertake soil sampling for potential acid sulfate soils. This report is currently being finalised.

All the data collected through the monitoring and assessment program will be pivotal in informing the next bulk entitlement review. It is through this process that more detailed analysis of the longer term data sets will be undertaken.

## 4 Groundwater trigger levels (Clause 16.2 E)

The groundwater trigger levels were revised in 2014 following the Bulk Entitlement review. The revised Bulk Entitlement's groundwater trigger levels were established with the objective of maintaining groundwater levels in the perched water table to within the likely range of natural variation, and ensure that there is no significant drawdown recorded in the perched water table associated with pumping from the Anglesea Borefield. If the perched water table is maintained within these natural variations, then impacts to surface water flow, acid generation processes and, therefore, ecology should not occur as a result of groundwater extraction from the Lower Eastern View Formation. The groundwater trigger levels are set for the two bores in the Anglesea Swampland:

- Bore P19: Monitoring the Upper Eastern View Formation
- Bore P8: Monitoring the Perched Water Table

The trigger mechanism accounts for the seasonal variation in the groundwater levels using groundwater levels measured at bore P17, which sits outside the area of influence for the Anglesea Borefield. These trigger levels use daily recorded values, which are converted to a monthly average and are calculated based on the following formulae:

$$P8 = 0.3131 * P17 + 9.4666 - 2 \text{ Standard Deviations of Error}$$

$$P19 = 0.2391 * P17 - 16.82 - 2 \text{ Standard Deviations of Error}$$

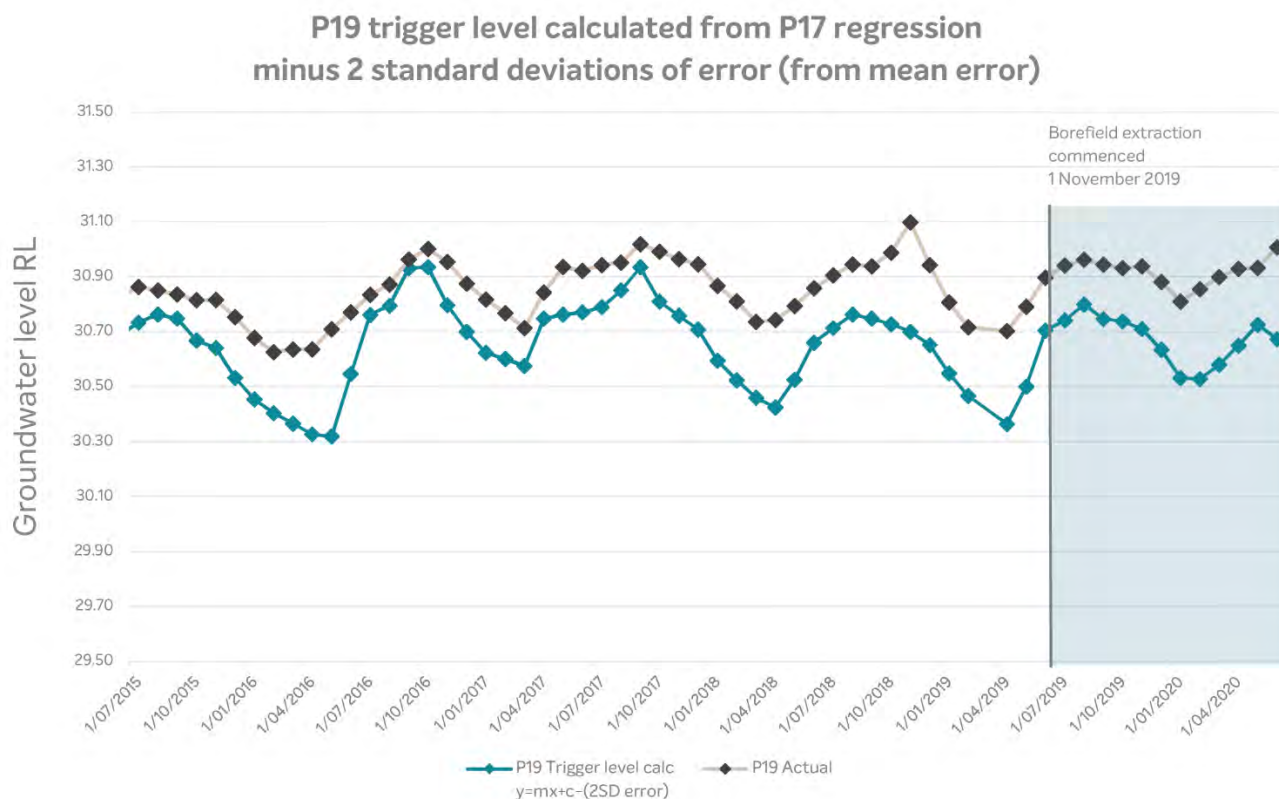
It should be noted that these formulae are the amended calculation as discussed in section 5.2.



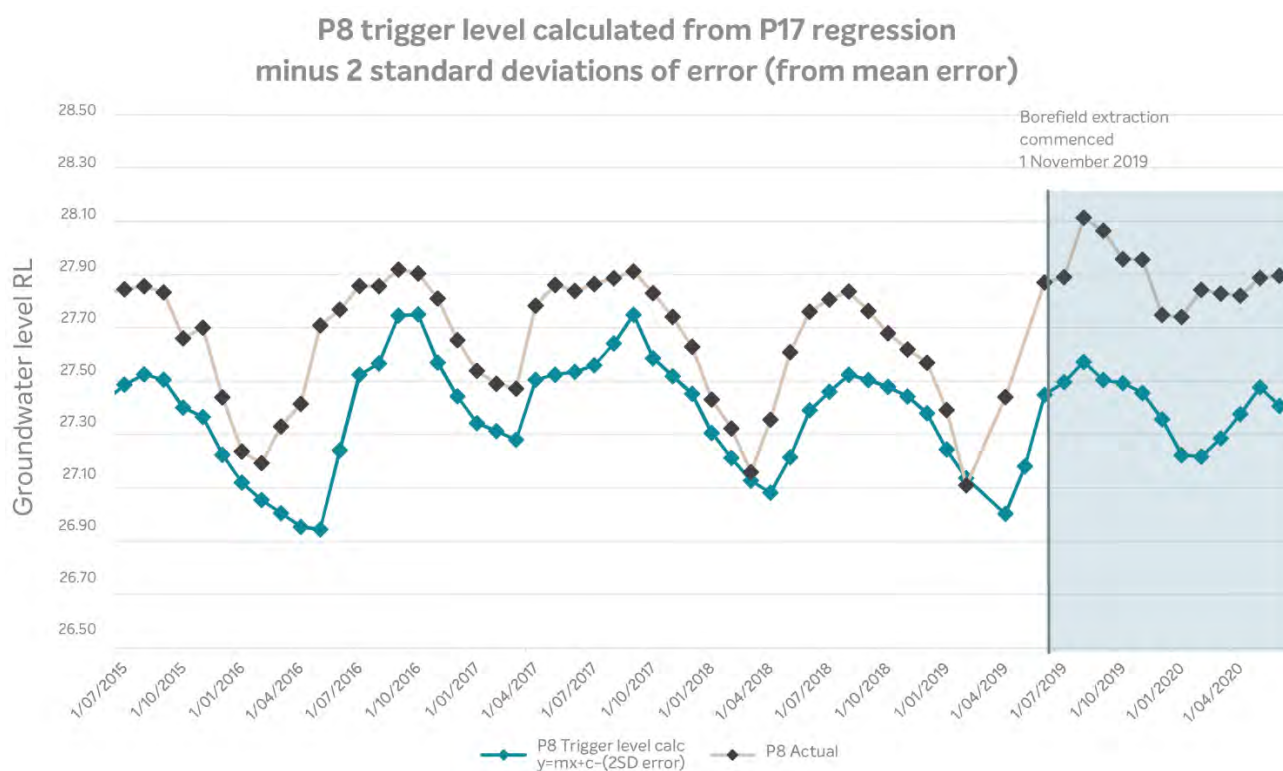
The trigger levels are shown in Figure 6 and

Figure 7. At all times during 2019–2020 the groundwater levels were above the required trigger levels.

**Figure 6: Groundwater level and the trigger level for P19 in the upper eastern view formation.**



**Figure 7: Groundwater level and the trigger level for P8 in the perched water table.**



During February last year (2019), Barwon Water was not extracting water; however, based on the data available, P8 exceeded the trigger level. This followed the warmest January (2019) on record for Victoria, coupled with below average rainfalls across the state, with some areas like Aireys Inlet recording its lowest January rainfall on record. This demonstrates the conservative nature of the triggers and the strong influence of climate – hot, dry days in summer can lead to the triggers being exceeded without pumping.

## 5 Issues in implementing the program or restoring groundwater levels (Clause 16.2 F)

### 5.1 Water quality sampling

Monthly water quality sampling is conducted at eleven sites to observe pH, temperature, DO and EC. Some of the sampling sites were dry for a period of time during the past year. Water quality sampling could not be completed when a sampling site was dry.

In August 2019, prior to operation of the borefield, the surface water quality field testing was not undertaken for the month due to transition of this monitoring into the Regional Water Monitoring Partnership and subsequent change of service provider.

### 5.2 Bulk Entitlement Minor Amendment

There is an error in the formula described in the Order that is used to calculate the trigger level in observation bore P14. This typographical error does not impact on the trigger levels; however, Barwon Water is working with DELWP on an amendment notice to reflect the original intent. Barwon Water plans to submit an application in accordance with section 45 of the Water Act 1989, to apply to amend the Bulk Entitlement (Anglesea Groundwater) Order 2009.

Barwon Water will request approval to correct the groundwater trigger level formula as listed in the Order and subsequent Bulk Entitlement (Anglesea Groundwater) Amendment Order 2014 (the Amendment Order) to reflect the trigger level formula as intended.

After the 2013 Bulk Entitlement Review, Barwon Water applied to have the trigger level formulas amended to better protect the areas identified in the review to be of higher ecological risk. These trigger level formulas were approved in the Amendment Order.

Barwon Water would also like to request to amend clause 16.3 of the Bulk Entitlement Amendment Order 2014 regarding timing of the Annual Bulk Entitlement Report (Anglesea Groundwater). Currently this clause does not provide an explicit timeframe for submission of the Annual Bulk Entitlement Report. To avoid confusion in the future, we have proposed an amendment of the clause to require submission of the report within a period of 60 days following the end of the financial year.

### 5.3 Amendment to the Monitoring and Assessment Program (MAP)

There have been no amendments to the MAP in 2019–2020.

Future amendments may be required as a result of the mine rehabilitation works being undertaken by Alcoa. Alcoa currently has a license to extract from the Upper Eastern View Formation and are currently applying to undertake a 12-month pump test to help inform a possible future amendment of their license to allow use of groundwater to assist with filling the former coalmine. As part of this process, Alcoa is proposing to decommission some of their observation bores and install new monitoring bores. This may require changes to the 2014 MAP as the MAP currently includes monitoring of some of Alcoa's monitoring bores.

## 6 Arrangements with existing groundwater users (Clause 16.2 G)

There have been no arrangements entered into that would trigger this clause.

## 7 Independent Arbitration (Clause 16.2 H)

Independent arbitration has not been necessary.

## 8 Difficulties in compliance with the order (Clause 16.2 I)

### 8.1 Bore 115868 (UEVF) and 119349 (UEVF) replacements

DELWP has advised that bores 115868 and 119349 are in poor condition and are scheduled for decommissioning and replacement. Following notification of the planned decommissioning, a condition assessment was undertaken on each bore in July 2019 and independently reviewed by Barwon Water's consultants. The recommendation was that both bores are beyond refurbishment and should be decommissioned and replaced.

Bore 119349 was decommissioned in 2019, DELWP have not yet confirmed a date for the decommissioning of bore 115868. Replacement of both bores is scheduled by Barwon Water for summer 2020/21.

### 8.2 Data logger replacement program

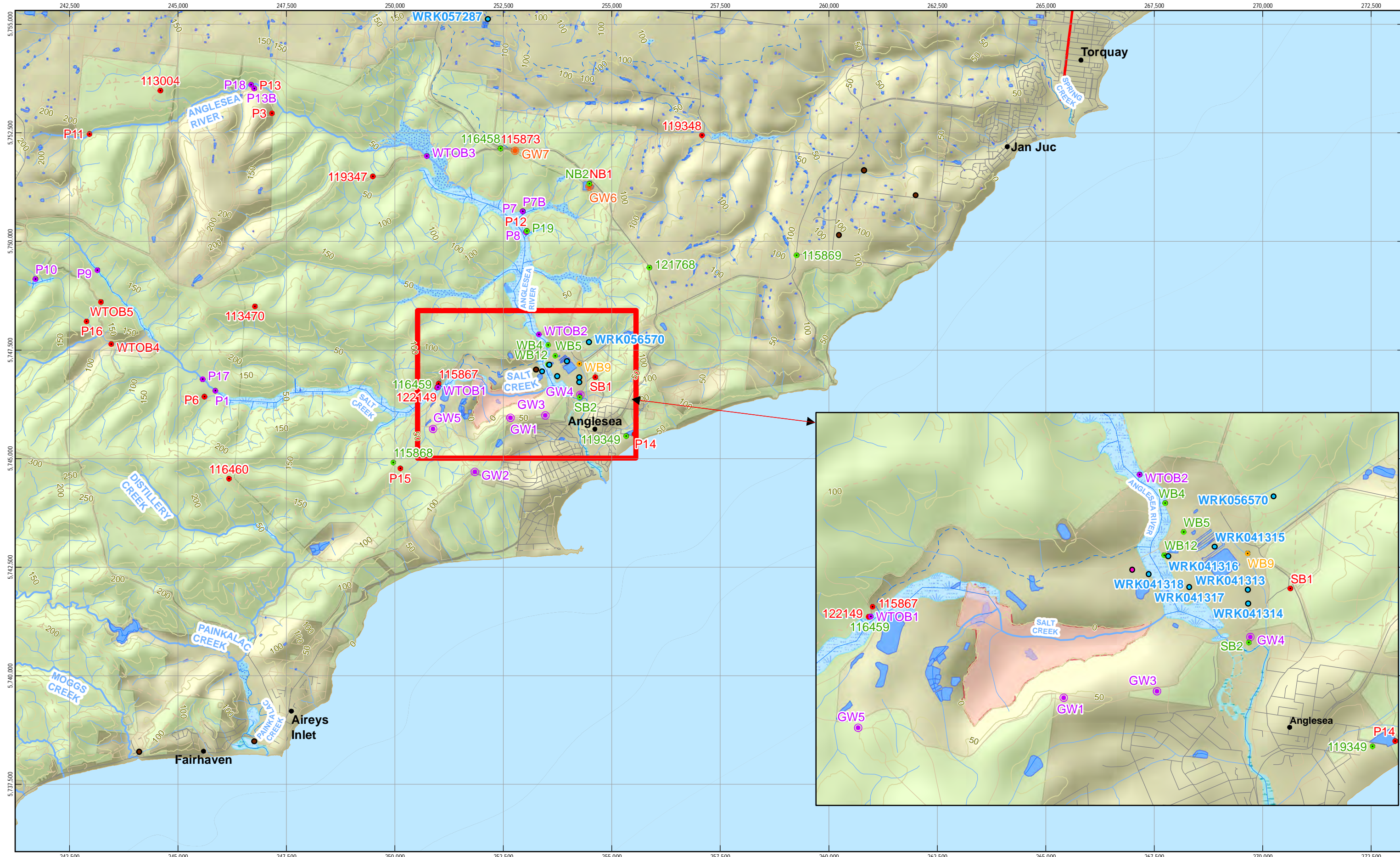
There were a number of groundwater level data loggers replaced during the 2019–2020 reporting period due to the loggers approaching end of life. Monthly dip readings continue to be taken when logger data has been downloaded to ensure a minimum monthly groundwater level reading has been obtained. As part of our data logger replacement program, Barwon Water has installed 16 new groundwater data loggers during 2019–2020. There were failures of five loggers during the period of extraction by Barwon Water. Condition, age and status of all loggers are tracked and loggers are replaced as required with the aim to ensure there is minimal time where daily logging not taking place.



# Appendix A

## Observation bore locations





1:80,000

Paper Size A3

0 0.3750.75 1.5 2.25 3

Kilometers

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55

N

Towns

Highway (38)

Sealed Road (Arterial & Local) (1,359)

Unsealed Road (1,062)

Unsealed Track (271)

River

Stream

Channel / Drain

Connector

Estuary

Lake

Flat

Swamp

pondage

Alco.

DSE

Cont

Licensed Groundwater Bores (SRW)

GMS Bores

Stock & Domestic Bores

Northern Bore Field

Southern Bore Field

**Bulk Entitlement Monitoring Bores**

**Aquifer Monitored**

PWT

UEVF

LEVF

UEVF\_LEVF

Barwon Water  
Anglesea Borefield  
Numerical Modelling and Recalibration

Groundwater Monitoring  
Bore Locations

Job Number  
Revision  
Date

31-32669  
A  
12 Jun 2015

G:\31\32669\GIS\Maps\Deliverables\0001\_Anglesea\_Monitoring\_2014\_MonitoringBores.mxd

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Data source: VicMap 2011 (rivers, roads, contours), GHD 2011 (monitoring locations), GMS 2011 (GMS Bore Locations) Created by:jeamonth

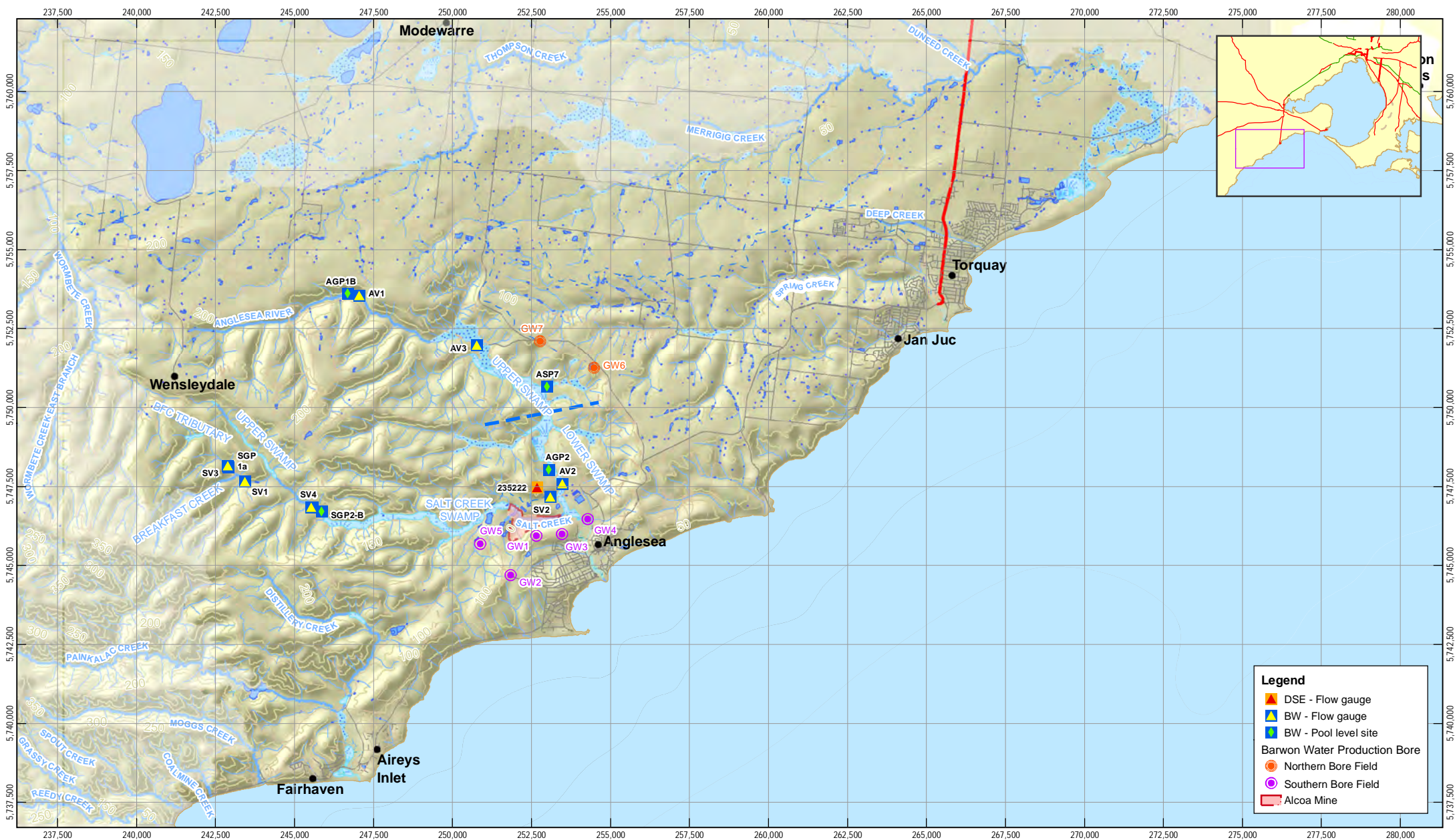
180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

Figure 1



# Appendix B

## Surface water monitoring locations



1:160,000 Paper Size A4

0 0.5 1 2 3 4 5  
Kilometers

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



#### LEGEND

- Towns
- Highway
- Sealed Road (Arterial & Local)
- Unsealed Road
- Unsealed Track
- Estuary
- Lake
- Flat
- Swamp
- pondage
- River
- Stream
- Channel / Drain
- Connector
- Contours (50m)



Barwon Water  
Anglesea Borefield  
Numerical Modelling and Recalibration  
Surface Water  
Monitoring Locations

Job Number 31-32669  
Revision A  
Date 12 Jun 2015

Figure 2

G:\31\32669\GIS\Maps\Deliverables\0002\_Anglesea\_Monitoring\_2014\_SW\_Locations.mxd

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Data source: VicMap, DSE, ABARES, Corangamite CMA, DPI, Barwon Water, BOM and SILO Created by:jeamonth

# Appendix C

Surface water quality results  
– field testing

Name

GHD/BW ID

SINo.

BE Map ID

Breakfast Creek Tributary @ V notch

SV3

235274A

GS7

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Flow at V notch	General weather conditions	Comments
30/07/2019	10:30	0.121	362	224.44	7.5	7.5	4.5	9.4	<0.1	Overcast / Drizzle	Air temp 10,
00/08/2019											Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	12:35	0.120	334	335	10.6	10.6	5.1	12	<0.1	Clear	First sampling by ALS under the RWMP
15/10/2019	10:45	0.090	333	206.46	6.9	6.9	4.8	10.3	<0.1	Cloudy	Air temp 15.5 Water clear.
14/11/2019	10:15	0.096	343	212.66	8.4	8.4	6	11.8	<0.1	Cloudy	Air temp 15.6 Water clear.
12/12/2019	9:55	0.078	348	215.76	8.31	8.31	6.68	11.8	<0.1	Cloudy	Air temp 12.2 Water clear.
13/01/2020	12:00	DRY	X	X	X	X	X	X	X	Cloudy	Air temp 18.2, Dry
10/02/2020	10:55	DRY	X	X	X	X	X	X	X	Cloudy	Air temp 18.2, Dry
17/03/2020	12:30	DRY	X	X	X	X	X	X	X	Cloudy	Air temp 14.5, Dry
15/04/2020	11:55	BELOW	505	313.1	8.4	8.4	5.4	13.3	X	Sunny	Air temp 18.2, Stagnant
13/05/2020	13:25	0.081	466	288.92	9.8	9.8	5.6	12.1	<0.1	Cloudy	Air temp 11.3 Water clear.
12/06/2020	10:20	0.076	231	143.22	8.71	8.71	6.2	7.5	<0.1	Cloudy	Air temp 5.6 Water clear

**Name** Breakfast Creek @ Road bridge  
**GHD/BW ID** SV1 - Bridge  
**SINo.** 235273A  
**BE Map ID** GS1

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
30/07/2019	9:30	0.177	437	271	7.2	7.2	5.8	8.1	9	Flowing	Overcast	Water clear.
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	11:45	0.186	547	542	11	11	5.7	10.1	12	Flowing	Slightly Overcast	First sampling by ALS under the RWMP
15/10/2019	10:15	0.121	381	236	6	6	5.7	11.6	14.4	Flowing	Cloudy	Water clear , Rustic coloured algae in water
14/11/2019	10:45	0.12	390	242	9.1	9.1	7	12.8	15.4	Flowing	Cloudy	Water clear , Rustic coloured algae in water
12/12/2019	10:15	BELOW	454	281	3.65	3.65	6.9	14.2	14.8	Stagnant	Cloudy	WQ, Sensor in Pool Only
13/01/2020	12:30	Dry	n/a	n/a	n/a	n/a	n/a	n/a	24.3	dry	Sunny	No WQ
10/02/2020	10:15	Dry	n/a	n/a	n/a	n/a	n/a	n/a	18	dry	Sunny	No WQ
17/03/2020	11:00	Dry	n/a	n/a	n/a	n/a	n/a	n/a	18.2	dry	Sunny	No WQ
15/04/2020	11:15	Dry	n/a	n/a	n/a	n/a	n/a	n/a	15.3	dry	Sunny	No WQ
13/05/2020	13:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	15	dry	Sunny	No WQ
12/06/2020	13:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	5.5	dry	Cloudy	No WQ

**Name** Salt Creek @ Denhams Track  
**GHD/BW ID** SV4  
**SINo.** 235276A  
**BE Map ID** GS2

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
30/07/2019	12:15	0.187	323	200	6.8	6.8	5.2	7.8	11	Flowing	Overcast	Water Clear
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	13:30	0.186	312	314	10.1	10.1	5.4	8.5	14.2	Flowing	Clear	First sampling by ALS under the RWMP
16/10/2019	10:30	0.121	298	185	4.8	4.8	5.4	10.9	14.5	Flowing	Cloudy	Changed Battery .
14/11/2019	9:00	0.122	261	162	8.7	8.7	6.1	11.6	15.8	Flowing	Overcast	Water Clear
13/12/2019	7:55	BELOW	368	228	8.07	8	6.6	12.8	11.2	Flowing	Overcast	Water Clear
13/01/2020	11:00	Dry	n/a	n/a	n/a	n/a	n/a	n/a	10	Dry	Sunny	No WQ
10/02/2020	11:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	10	Dry	Sunny	No WQ
17/03/2020	12:20	BELOW	337	209	6.34	6.34	6.2	13.9	20.1	Stagnant	Sunny	Water Clear
15/04/2020	13:00	0.09	222	138	8.62	8.62	5.2	13.1	19.9	Stagnant	Sunny	Stagnant
13/05/2020	12:15	0.12	236	146	9.2	9.2	6.9	13.1	11.2	Stagnant	Sunny	Stagnant
12/06/2020	9:00	0.11	228	141	8.75	8.75	6.45	7.6	3.4	Stagnant	Sunny	Stagnant



Name

GHD/BW ID

SINo.

BE Map ID

Salt Creek (Encoder) @ Alcoa

SV2

235222A

GS3

Date	Time (EST)	Gauge Height	EC (μS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	10:15	-0.030	1653	1025	8.8	8.8	4.6	8.5	13	No Flow	Sunny	Muddy light brown water
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
16/09/2019	10:45	0.024	1424	1435	10.7	10.7	3.65	12.8	12	Flowing	Light Showers	First sampling by ALS under the RWMP
15/10/2019	12:50	Below	1657	1027	9.5	9.5	3.6	19.3	15.3	Flowing	Cloudy	Water clear
13/11/2019	10:45	Below	1773	1099	10.3	10.3	3.5	13.3	15.7	No Flow	Cloudy	Water clear
13/12/2019	9:30	Below	2950	1829	10.1	10.1	3.6	16.4	16.3	No Flow	Cloudy	Water clear
14/01/2020	8:15	DRY	n/a	n/a	n/a	n/a	n/a	n/a	22	Dry	Cloudy	Dry
10/02/2020	13:15	Below	1540	955	8.2	8.2	3.6	23.7	22	No Flow	Cloudy	Water clear
18/03/2020	8:45	Below	1868	1158.16	9.02	9.02	1.98	23.4	19.2	No Flow	Sunny	Water clear
14/04/2020	11:00	Below	560	347.2	9.77	9.77	4.3	15.3	15.4	No Flow	Sunny	Water clear
14/05/2020	10:30	Below	697	432.14	10.9	10.9	4.2	11.4	9.2	No Flow	Sunny	Water clear
10/06/2020	13:15	Below	628	389.36	11.09	11.09	4	10.7	11.4	No Flow	Sunny	Water clear

**Name** Salt Creek (Pool)above swamp @ Denham Track (new downstream site)  
**GHD/BW ID** SGP2-B  
**SINo.** 235275A  
**BE Map ID**

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Pool conditions	General weather conditions	Comments
30/07/2019	12:30	2.020	323	200.26	7.1	6.8	5.2	7.9	Flowing	Overcast, Drizzle	Air temp 10.5, Water is clear with slight tanin. Turbidity = 2.5. "Bottom readings EC=323.T=7.8, pH=5.2, TB=2.3"
00/08/2019											Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	1325	2.011	325	201.5	10.2	3.1	5.3	10.8	Stagnant	Overcast	Air temp 14.2 Dark tanin stain, First sampling by ALS under the RWMP
16/10/2019	11:15	1.971	297	184.14	4.8	2.1	5.4	11	Stagnant	Cloudy	Air temp 14.5 Dark tanin stain.
14/11/2019	9:00	1.98	331	205.22	9.5	3.6	6.1	13.7	Stagnant	Cloudy	Air temp 15.9 Dark tanin stain.
13/12/2019	7:40	1.75	371	230.02	8.35	1.61	7	11.8	Stagnant	Cloudy	Air temp 11.0 Dark tanin stain.
13/01/2020	10:50	1.07	401	248.62	4.77	4.77	5.54	23.5	Stagnant	Sunny	Air temp 23.4 Dark tanin stain.
10/02/2020	11:40	0.86	330	204.6	4.08	4.08	5.49	18	Stagnant	Cloudy	Air temp 18.5 Dark tanin stain.
17/03/2020	12:20	1.02	684	424.08	6.83	3.21	6.66	13.8	Stagnant	Sunny	Air temp 20.2 Dark tanin stain.
15/04/2020	12:50	1.92	241	149.42	8.73	8.73	5.84	13.3	Stagnant	Sunny	Air temp 18.2 Dark tanin stain.
13/05/2020	12:05	1.94	238	147.56	9.5	3.25	6.3	11.3	Stagnant	Sunny	Air temp 11.2 Dark tanin stain.
12/06/2020	9:00	1.93	285	176.7	11.35	3.21	6.2	7.1	Stagnant	Sunny	Air temp 3.5 Dark tanin stain.

**Name** Upper Anglesea River (Pool) @ Australian Automotive Research Centre - (New downstream pool site)  
**GHD/BW ID** AGP1-B  
**SINo.** 235271A  
**BE Map ID**

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	14:55	2.450	754	467.48	4	0.4	5.6	7.4	Flowing	Overcast	Air temp 13.0. Water almost grey colour. (Bottom readings EC 1710, Temp 8.0, Ph 5.6) Turbidity 12.3
00/08/2019											Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	11:05	GH 2.340	957	593.34	6.24	0.2	5.5	11.8	Stagnant	Slightly Overcast	First sampling by ALS under the RWMP
15/10/2019	9:35	GH 2.280	1002	621.24	5.97	0.3	6.2	12	Stagnant	Overcast	Air temp 15.0 Water tanin stained.
14/11/2019	11:45	GH 2.262	1007	624.34	9.54	2.67	6.6	15.2	Stagnant	Overcast	Air temp 15.9 Water tanin stained.
12/12/2019	11:35	GH 2.153	1111	688.82	7.31	1.67	7.1	15.4	Stagnant	Overcast	Air temp 16.2 Water tanin stained.
13/01/2020	10:00	GH 1.970	1191	738.42	6.62	2.11	6.2	20.7	Stagnant	Overcast	Air temp 22.4 Water tanin stained.
10/02/2020	9:45	GH 1.671	1121	695.02	4.87	4.87	6.0	18.2	Stagnant	Cloudy	Air temp 19.3 Water tanin stained. Photo taken. WQ sample taken
17/03/2020	10:15	GH 1.382	1105	685.1	7.55	7.55	7.4	15.7	Stagnant	Sunny	Air temp 17.6 Water tanin stained.
15/04/2020	9:20	GH 1.200	1017	630.54	7.69	2.38	5.9	15.1	Stagnant	Sunny	Air temp 15.1 Water tanin stained.
13/05/2020	11:15	GH 1.080	1022	633.64	8.76	8.76	5.4	11	Stagnant	Sunny	Air temp 10.1 Water tanin stained.
12/06/2020	11:55	GH 0.955	1112	689.44	7.61	2.31	6.0	7.2	Stagnant	Sunny	Air temp 5.6 Water tanin stained.

**Name** Upper Anglesea River @ AARC ( V notch site)  
**GHD/BW ID** AV1  
**SINo.** 235270A  
**BE Map ID** GS4

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	14:30	0.182	482	299	6	6	5.4	8.6	13	Flowing	Overcast, Drizzle	Water Milky clear.
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	10:45	0.152	634	633	6.5	3.2	5.1	10.6	10.8	Flowing	Slightly overcast	First sampling by ALS under the RWMP
15/10/2019	9:15	0.099	697	432	1.4	1.4	5.3	10.5	14.4	Flowing	Cloudy	Water Milky clear.
14/11/2019	11:30	0.04	789	489	8.2	8.2	6.5	13.2	15.4	Flowing	Cloudy	Water Milky clear.
12/12/2019	11:15	Dry	n/a	n/a	n/a	n/a	n/a	n/a	16.2	Dry	Overcast	Dry
13/01/2020	9:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	24.2	Dry	Sunny	Dry
10/02/2020	9:20	Dry	n/a	n/a	n/a	n/a	n/a	n/a	24.2	Dry	Sunny	Dry
17/03/2020	9:55	Dry	n/a	n/a	n/a	n/a	n/a	n/a	16.9	Dry	Sunny	Dry
15/04/2020	9:20	Dry	n/a	n/a	n/a	n/a	n/a	n/a	15.3	Dry	Sunny	Dry
13/05/2020	11:00	Dry	n/a	n/a	n/a	n/a	n/a	n/a	10.1	Dry	Sunny	Dry
12/06/2020	11:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	5.4	Dry	Cloudy	Dry

**Name** Anglesea River @ Gumflats Road  
**GHD/BW ID** AV3  
**SINo.** 235277A  
**BE Map ID** GS6

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	13:30	0.137	804	498	9.6	9.6	4.1	9.2	15	Flowing	Cloudy	Water clear
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
16/09/2019	14:00	0.11	812	809	9.51	9.51	4.1	12.5	11	Low flow	Slightly overcast	First sampling by ALS under the RWMP
15/10/2019	8:15	DRY	X	X	X	X	X	X	11	dry	CLOUDY	No Sampling as pool dry. No flow.
13/11/2019	12:30	DRY	X	X	X	X	X	X	15.4	dry	Overcast	No Sampling as pool dry. No flow.
12/12/2019	12:40	DRY	X	X	X	X	X	X	16.5	dry	Overcast	No Sampling as pool dry. No flow.
13/01/2020	9:00	DRY	X	X	X	X	X	X	23.4	dry	Overcast	No Sampling as pool dry. No flow.
10/02/2020	8:30	DRY	X	X	X	X	X	X	18.2	dry	Overcast	No Sampling as pool dry. No flow. Photos
17/03/2020	9:00	DRY	X	X	X	X	X	X	18.2	dry	Sunny	No Sampling as pool dry. No flow.
14/04/2020	13:20	DRY	X	X	X	X	X	X	16.1	dry	Cloudy	No Sampling as pool dry. No flow.
13/05/2020	10:10	DRY	X	X	X	X	X	X	8.8	dry	Cloudy	No Sampling as pool dry. No flow.
12/06/2020	12:20	DRY	X	X	X	X	X	X	5.6	dry	Cloudy	No Sampling as pool dry. No flow.

**Name** Anglesea Swamp @ Vegetation Site P7  
**GHD/BW ID** ASP7  
**SINo.** 235280A  
**BE Map ID**

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	12:450:00 PM	Below	2324	1441	7.1	7.1	3.2	12.6	14	STAGNANT	Overcast, Drizzle	Water clear. Sensor out of water
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
17/09/2019	9:45	0.06	2690	1668	9.8	9.8	2.7	10.2	10.7	Stagnant	Slightly Overcast	First sampling by ALS under the RWMP
15/10/2019	8:30	BELOW	3060	1897	4.2	4.2	2.8	13.9	14.2	STAGNANT	CLOUDY	Water clear.
13/11/2019	12:00	BELOW	3350	2077	8.6	8.6	3.1	16.4	15.4	STAGNANT	CLOUDY	Water clear.
13/12/2019	10:40	Dry	n/a	n/a	n/a	n/a	n/a	n/a	23	Dry	Overcast	NO SAMPLING- SWAMP DRY
13/01/2020	8:15	Dry	n/a	n/a	n/a	n/a	n/a	n/a	23	Dry	Sunny	NO SAMPLING- SWAMP DRY
10/02/2020	8:00	Dry	n/a	n/a	n/a	n/a	n/a	n/a	18.5	Dry	Sunny	NO SAMPLING- SWAMP DRY
17/03/2020	8:15	Dry	n/a	n/a	n/a	n/a	n/a	n/a	15.2	Dry	Sunny	NO SAMPLING- SWAMP DRY
14/04/2020	12:40	BELOW	2700	1674	8.61	8.61	3.42	15.7	16.1	STAGNANT	CLOUDY	Water clear.
15/05/2020	9:10	BELOW	2590	1606	7.44	7.44	3.49	10.9	8.6	STAGNANT	CLOUDY	Water clear.
12/06/2020	8:55	BELOW	2660	1649	12.39	12.39	4.58	5.5	5	STAGNANT	SUNNY	Water clear

**Name** Anglesea Wetlands @ Allardyne Track  
**GHD/BW ID** AGP2  
**SINo.** 235272A  
**BE Map ID**

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	11:00	0.32	4250	2635	7.9	7.9	2.7	8.5	14	Flowing	Sunny	Pool is filling, Water clear.
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
16/09/2019	11:45	0.346	3860	3870	9.9	9.9	2.6	12.3	11	Flowing	Overcast	First sampling by ALS under the RWMP
16/10/2019	9:20	0.258	3730	2313	6	6	2.8	14.3	12.8	Flowing	Cloudy	Water clear,
13/11/2019	11:15	0.216	3660	3870	8.6	8.6	2.8	15.5	18.7	Flowing	Cloudy	Water clear,
13/12/2019	10:10	DRY	n/a	n/a	n/a	n/a	n/a	n/a	16.8	Dry	Cloudy	Dry
14/01/2020	7:35	DRY	n/a	n/a	n/a	n/a	n/a	n/a	19.3	Dry	Cloudy	Dry
10/02/2020	12:45	DRY	n/a	n/a	n/a	n/a	n/a	n/a	19.3	Dry	Cloudy	Dry
18/03/2020	8:00	DRY	n/a	n/a	n/a	n/a	n/a	n/a	22.5	Dry	Cloudy	Dry
14/04/2020	11:30	0.08	3930	2437	9.58	9.58	3.18	16	16.2	Flowing	Cloudy	Water clear,
14/05/2020	9:30	BELOW	4260	2641	10.6	10.6	3.03	11.4	7.6	Flowing	Cloudy	Water clear,
10/06/2020	12:30	0.266	4070	2523	10.1	10.1	2.98	10.6	11.3	Flowing	Cloudy	Water clear,

**Name** Anglesea River (Marshy Creek) @ Alcoa  
**GHD/BW ID** AV2  
**SINo.** 235260A  
**BE Map ID** GS5

Date	Time (EST)	Gauge Height	EC (µS/cm)	TDS (mg/L)	DO (mg/L) (Top)	DO (mg/L) (Bottom)	pH	Water Temperature (°C)	Air Temperature (°C)	Pool conditions	General weather conditions	Comments
29/07/2019	9:45	0.117	6266	3885	6	6	2.9	12.1	12.5	Flowing	Sunny	Black Tanin water. (Turbidity 1.9)
00/08/2019												Transition to Regional Water Monitoring Partnership (RWMP)
16/09/2019	10:00	0.142	4960	4970	7.2	7.2	2.6	10.1	11	Flowing	Slightly Overcast	First sampling by ALS under the RWMP
15/10/2019	12:00	0.089	4880	3026	5.5	5.5	2.7	14	19.6	Flowing	Cloudy	Water very clear
13/11/2019	10:30	0.078	4910	3044	7.5	7.5	2.6	11.7	13.8	Flowing	Cloudy	Water very clear
13/12/2019	9:15	0.028	5210	3230	8.8	8.8	2.9	15.5	16.2	Flowing	Cloudy	Water very clear
14/01/2019	7:45	BELOW	5730	3553	7.7	7.7	3	20.9	20.3	Stagnant	Sunny	Water very clear
10/02/2020	13:00	BELOW	5430	3366.6	7.22	7.22	2.69	25.3	23.1	Stagnant	Sunny	Water very clear
18/03/2020	8:30	BELOW	5400	3348	5.78	5.78	2.84	18.9	19.1	Stagnant	Sunny	Water very clear
14/04/2020	10:30	0.038	5310	3292.2	8.09	8.09	2.81	14.8	14.7	Stagnant	Sunny	Water very clear
14/05/2020	10:00	0.04	5420	3360.4	7	7	2.7	11.4	8	Stagnant	Sunny	Water very clear
10/06/2020	12:45	0.061	5440	3372.8	8.7	8.7	2.7	8.2	11.4	Stagnant	Sunny	Water very clear



# Appendix D

Surface water quality results  
– laboratory testing

							Alkalinity			Anions by IC		Nutrients	Total Metals by ICP				pH
Catchment	Site	Date	Time (EST)	Sample No.	TDS (mg/L)	EC (µS/cm)	Total Alkalinity (mg CaCO <sub>3</sub> /L)	Bicarbonate Alkalinity (mg CaCO <sub>3</sub> /L)	Carbonate Alkalinity (mg CaCO <sub>3</sub> /L)	Chloride (mg/L)	Sulphate (mg/L)	Nitrate as N (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	pH (Lab)
Salt Creek	SV3	30/07/2019		EM1912326	220	380	1	1	<1	74	56		<1	13	<1	45	5.39
		10/02/2020	10:30:00 AM	6436940	Site Dry												
	SV1	30/07/2019		EM1912326	305	448	10	10	<1	113	46		5	13	2	62	6.52
		10/02/2020	9:15:00 AM	6436939	Site Dry												
	SV4	30/07/2019		EM1912326	204	324	<1	<1	<1	87	27		2	7	1	47	4.19
		10/02/2020	11:00:00 AM	6436941	Site Dry												
	SV2	29/07/2019		EM1912233	469	173	3	3	<1	29	26		2	4	2	21	6.21
		10/02/2020	1:15:00 PM	6436936	1200	1600	<2	<2	<2	160	630		24	43	8.7	97	3.6
Anglesea River	AV1	29/07/2019		EM1912233	300	500	<1	<1	<1	134	33		2	9	2	76	4.12
		10/02/2020	12:00:00 PM	6436938	Site Dry												
	AV3	29/07/2019		EM1912233	440	852	<1	<1	<1	209	103		9	22	8	108	4.16
		10/02/2020	8:30:00 AM	6436942	Site Dry												
	AV2	29/07/2019		EM1912233	3770	5900	<1	<1	<1	939	1930		84	109	13	429	2.64
		10/02/2020	1:00:00 AM	6436937	4200	5600	<2	<2	<2	1100	1700		80	110	10	510	2.7
	AGP1-B	Not required															
		Transition to Regional Water Monitoring Partnership															

Notes:

AGP1-B is to be sampled whenever AV1 is dry. AGP1-B is a pool located in close proximity to the AV1 Gauge.

# Appendix E

Groundwater quality results  
– laboratory testing

						Alkalinity						Dissolved Major Cations				Ionic Balance		
Bore	Date	pH	EC (µS/cm)	TDS (mg/L)	Bromide	Hydroxid e Alkalinity as CaCO3 (mg/L)	Carbonat e Alkalinity as CaCO3 (mg/L)	Bicarbon ate Alkalinity as CaCO3 (mg/ L)	Total Alkalinity as CaCO3 (mg/L)	Sulphate as SO4 (mg/L)	Chloride (mg/L)	Calcium (mg/L)	Magnesi um (mg/L)	Sodium (mg/L)	Potassiu m (mg/L)	Total Anions (meq/L)	Total Cations (meq/l)	Ionic Balance
Inter-aquifer Flow Monitoring																		
119348	No sampling conducted while DELWP conducted refurbishment works																	
	Jan-2020	9	1440	860		<1	26	122	148	2	412	8	6	241	26	14.6	12	9.68
NB2	Aug-2019	6.02	2440	1490		<1	<1	57	57	129	737	72	51	274	21	24.6	20.2	9.74
	Jan-2020	6.27	2520	1640		<1	<1	68	68	124	762	73	52	283	22	25.4	20.8	10
SB2	Aug-2019	6.18	2810	1560		<1	<1	52	52	174	871	25	62	342	41	29.2	22.3	13.5
	Jan-2020	6.07	4300	2360		<1	<1	50	50	279	1250	42	90	581	49	42.1	36	7.73
P15	Aug-2019	5.58	886	504		<1	<1	12	12	58	248	4	16	107	16	8.44	6.58	12.4
	Jan-2020	5.33	943	520		<1	<1	12	12	60	271	4	18	116	18	9.13	7.19	11.9
Saline Intrusion Monitoring																		
P14	Aug-2019	6.75	1050	666	0.368	<1	<1	152	152	2	277	14	10	143	36	10.9	8.66	11.4
	Jan-2020	6.35	800	472	0.317	<1	<1	68	68	13	221	6	9	104	41	7.86	6.61	8.64
Swamp GDE																		
WTOB3	Jul-2019	5.71	1640	880		<1	<1	16	16	74	508	5	27	237	3	16.2	12.8	11.5
	Jan-2020	5.8	1670	840		<1	<1	14	14	72	515	3	18	269	2	16.3	13.4	9.85
P7B	Jul-2019	4.22	850	940		<1	<1	<1	<1	54	249	6	14	115	3	8.15	6.53	11
	Jan-2020	4.06	884	460		<1	<1	<1	<1	52	254	5	14	136	3	8.25	7.39	5.46
P8	Jul-2019	4.76	2130	1120		<1	<1	<1	<1	134	672	42	48	261	15	21.7	17.8	10
	Jan-2020	5.06	2200	1340		<1	<1	2	2	129	675	34	42	311	16	21.8	19.1	6.55
WTOB2	Aug-2019	3.87	3850	2850		<1	<1	<1	<1	680	940	79	79	424	31	40.7	29.7	15.6
	Jan-2020	3.91	3320	1970		<1	<1	<1	<1	564	824	68	72	426	30	35	28.6	10
P17	Aug-2019	6.49	1080	777		<1	<1	116	116	25	312	21	18	154	3	11.6	9.3	11.1
	Jan-2020	6.92	1270	676		<1	<1	160	160	2	295	27	21	167	5	11.6	10.5	4.96
P1	Aug-2019	5.37	371	637		<1	<1	4	4	30	98	2	4	54	<1	3.47	2.78	n/a
	Jan-2020	5.76	510	413		<1	<1	28	28	25	132	3	5	87	3	4.8	4.42	4.13
WTOB1	Aug-2019	5.25	1180	2350		<1	<1	12	12	78	352	6	16	176	3	11.2	9.35	9.14
	Jan-2020	5.4	1010	852		<1	<1	16	16	66	296	5	16	153	3	10	8.3	9.52
Upper Anglesea Swamp and Trigger Level Site																		
P8	Jul-2019	4.76	2130	1120		<1	<1	<1	<1	134	672	42	48	261	15	21.7	17.8	10
	Jan-2020	5.06	2200	1340		<1	<1	2	2	129	675	34	42	311	16	21.8	19.1	6.55
P19	Jul-2019	6.01	1200	600		<1	<1	47	47	19	378	11	16	162	24	12	9.53	11.5
	Jan-2020	6.31	1230	703		<1	<1	56	56	15	381	9	14	180	24	12.2	10	9.6
P12	Jul-2019	6.28	1150	650		<1	<1	75	75	8	354	11	13	154	25	1.6	8.96	13.1
	Jan-2020	6.41	1170	663		<1	<1	68	68	8	355	9	12	174	26	11.5	9.67	8.81
Breakfast Creek Tributary																		
P16	Aug-2019	4.38	481	850		<1	<1	<1	<1	71	101	6	12	62	2	4.33	4.04	3.5
	Jan-2020	4.01	499	314		<1	<1	<1	<1	54	113	3	12	64	3	4.31	4	3.78

# Appendix F

## Monitoring and Assessment Program Update

### **1. Groundwater level monitoring**

The Anglesea Borefield was operated during 2019–2020. Groundwater level monitoring has, therefore, been conducted at a daily frequency at 42 observation bores. For the three trigger bores P8, P17 and P19 Barwon Water have maintained daily monitoring and installed telemetry for constant oversight.

As stated in the report, there were a number of groundwater level data logger failures during the 2019–2020 reporting period due to the loggers approaching end of life. Monthly dip readings continue to be taken when logger data has been downloaded to ensure a minimum monthly groundwater level reading has been obtained. As part of our data logger replacement program, Barwon Water has installed 16 new groundwater data loggers during 2019–2020. Five failure of loggers happened during the period of extraction by Barwon Water.

Condition, age and status of all loggers are tracked and loggers are replaced as required with the aim to ensure there is minimal time where daily logging not taking place.

### **2. Groundwater quality monitoring**

During operation of the Anglesea Borefield, the MAP requires a minimum of weekly field salinity and temperature monitoring in each production bore (GW1–GW7) that is being pumped.

Field and laboratory water quality parameters required for both deep and shallow observation bores under the MAP were recorded during this sampling in 2019 – 2020.

### **3. Surface water flow & level monitoring**

The monitoring and assessment program has seven surface water flow monitoring sites with four located in the Salt Creek catchment and three located in the Anglesea River catchment. All sites have permanent data loggers recording on a minimum daily frequency.

Surface water level is also monitored with a data logger located in a pool in Salt Creek and three sites in the Anglesea River, two of which have data loggers and one that is measured monthly during field sampling.

### **4. Surface water quality monitoring**

The MAP has identified 11 water quality monitoring sites across the Salt Creek and Anglesea River catchments. Monitoring consists of laboratory testing twice-yearly along with monthly field sampling. The frequency of this sampling does not change in relation to activation of the borefield and has all been completed throughout 2019 –2020.

## **5. Aquatic ecology monitoring**

The aquatic ecology monitoring consists of two components and includes macroinvertebrate and Southern Pygmy Perch sampling.

Macroinvertebrate sampling is required in Spring every third year at 11 sites across the catchment. This was last conducted in 2018 so is not due again until 2021.

A combination of Southern Pygmy Perch and macroinvertebrate sampling is also required to be conducted on an annual basis at a select number of sites across the catchment.

This component of the MAP does not change during operation of the borefield and all required monitoring was completed during 2019 – 2020.

## **6. Terrestrial ecology monitoring**

Terrestrial ecology monitoring also comprises of two components, including monitoring of both frog assemblages and vegetation.

When taking groundwater, the MAP requires monitoring of frogs annually. Frog surveys were conducted in Spring 2019.

For vegetation monitoring, when taking groundwater, Barwon Water is required to undertake vegetation assessments annually in Spring at six sites in the Anglesea Swamp and four sites in the Anglesea Estuary. This was last conducted in Spring 2019.

## **7. Acid sulfate soil investigations**

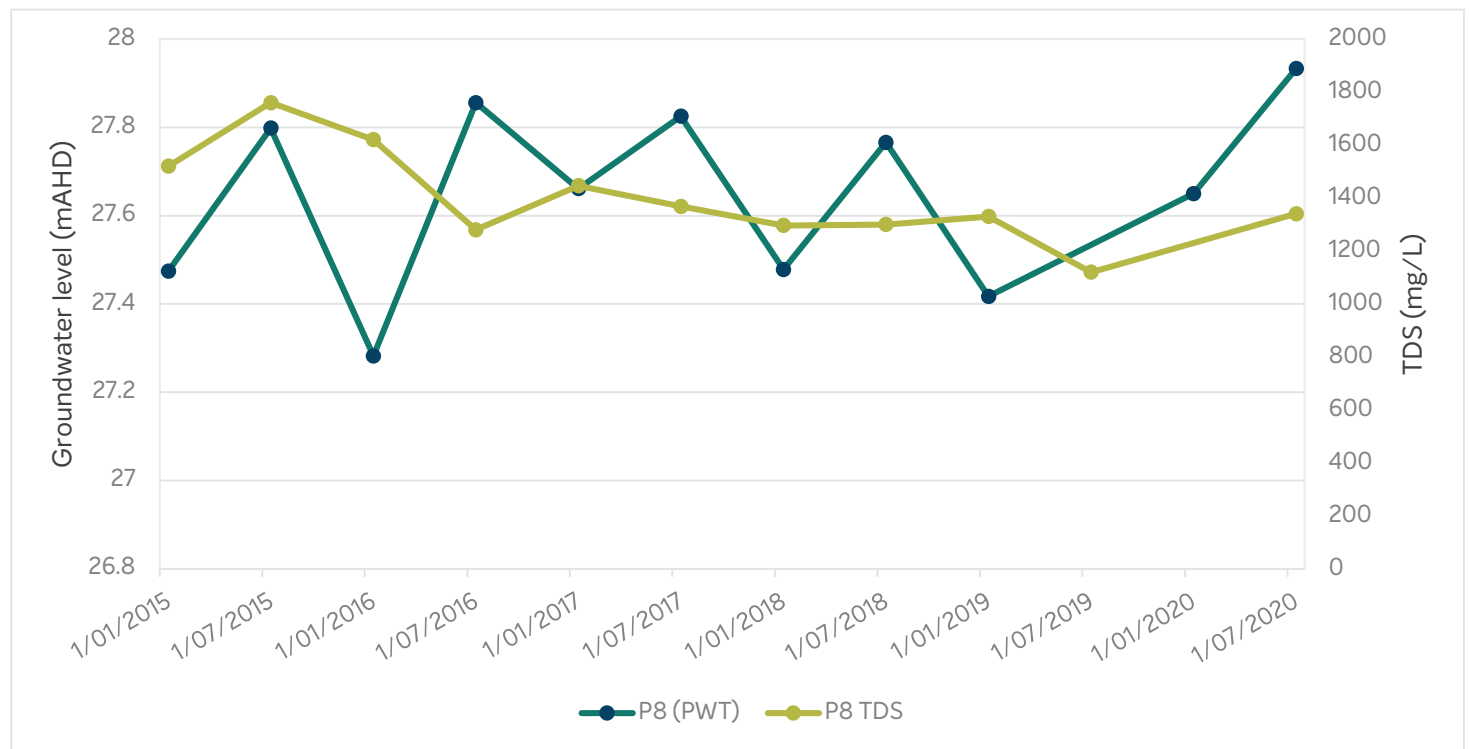
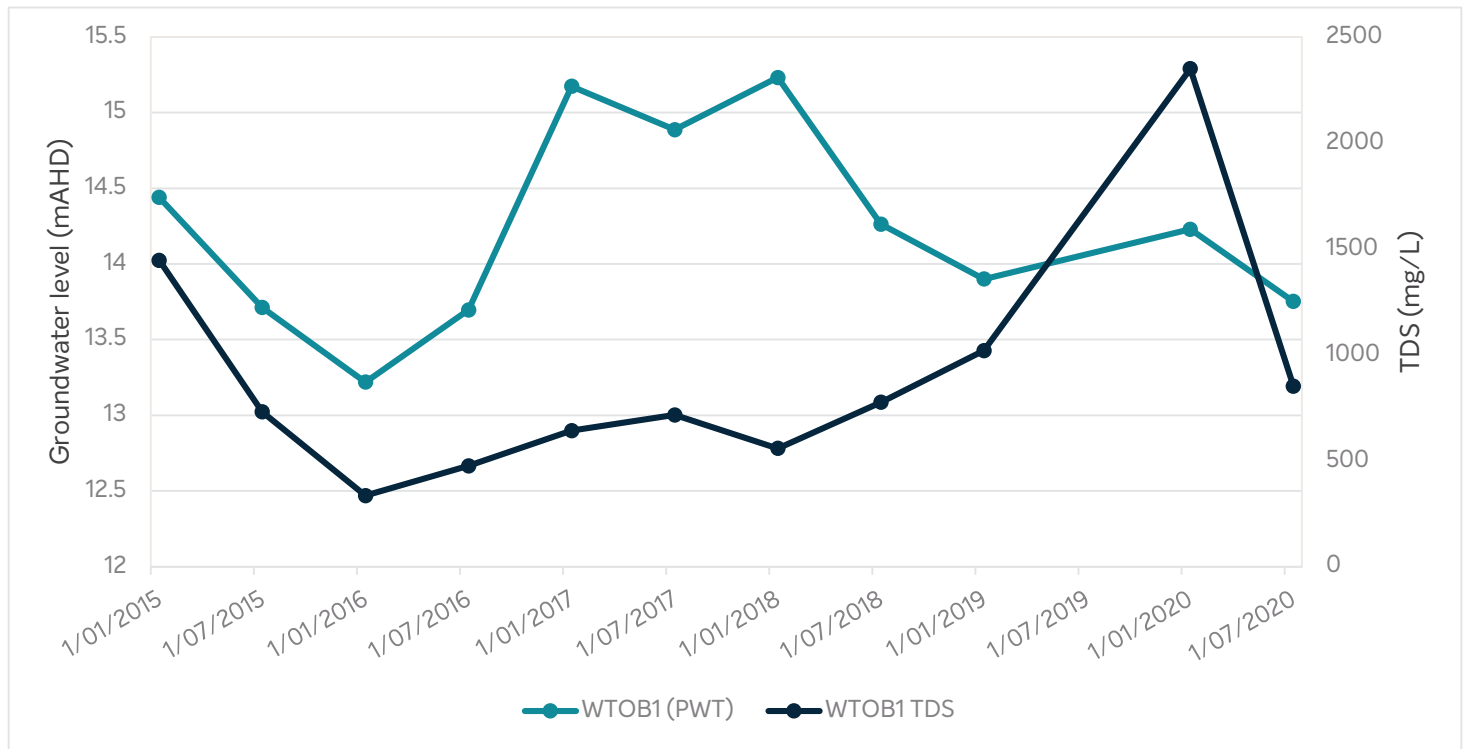
Monash University have been contracted by Barwon Water to undertake soil sampling for potential acid sulfate soils in the Anglesea catchment. This report is currently being finalised.

# Appendix G

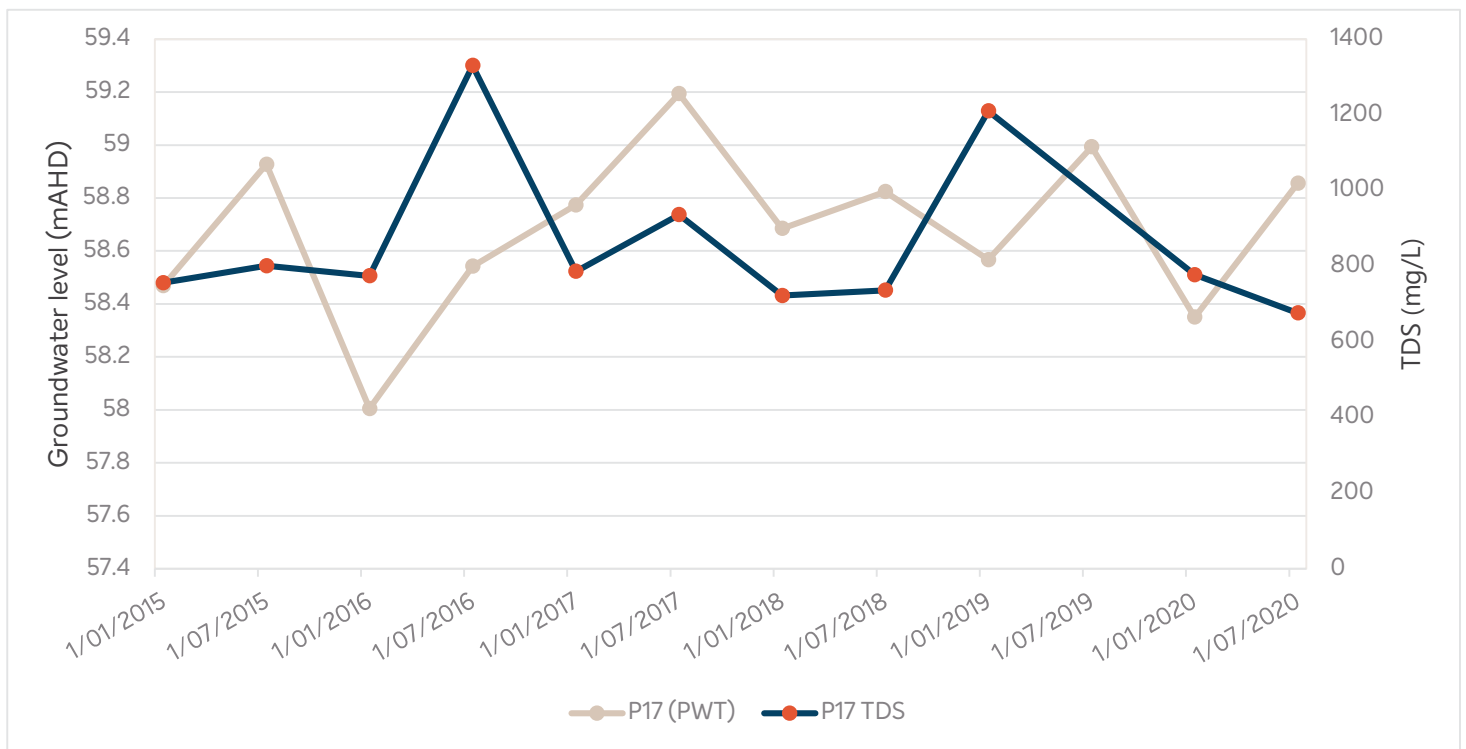
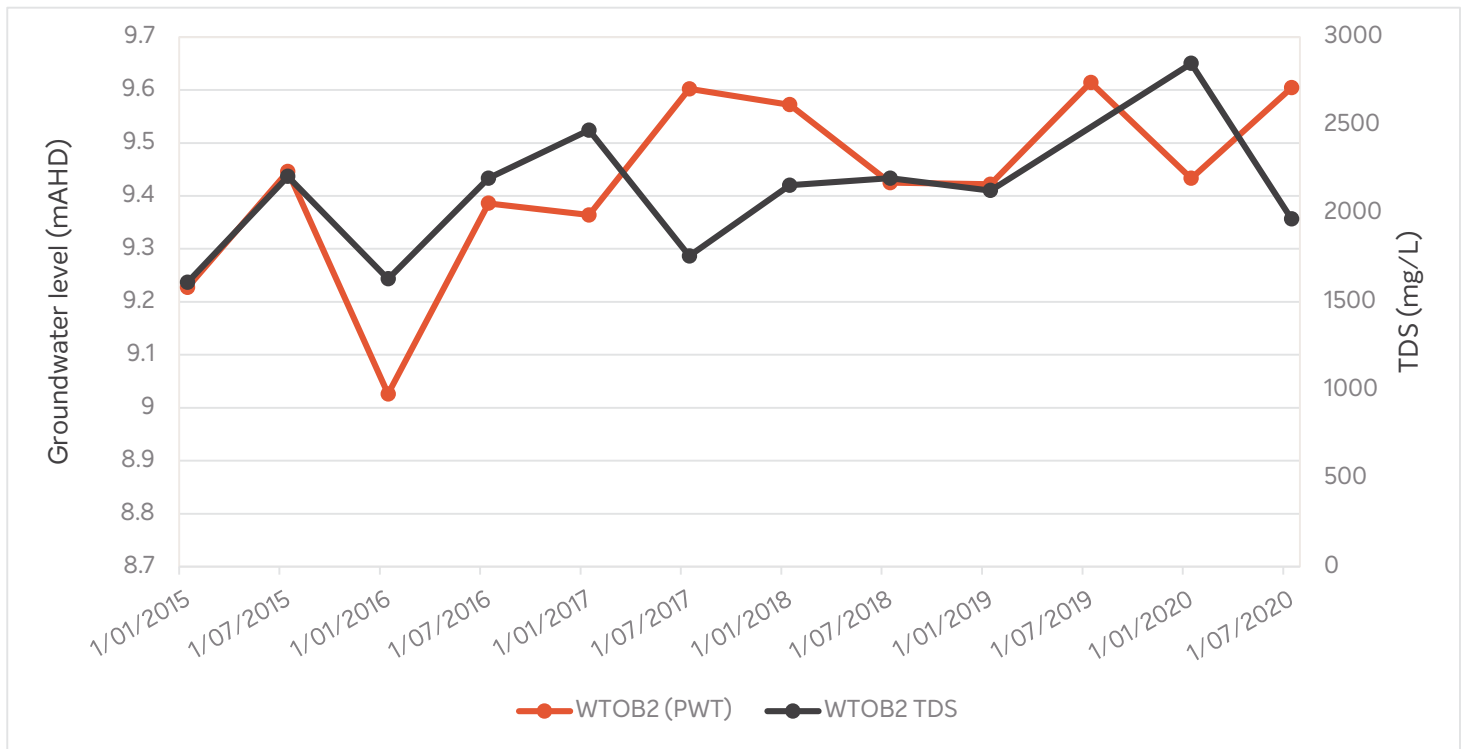
Shallow observation bore  
water level versus salinity  
(TDS)



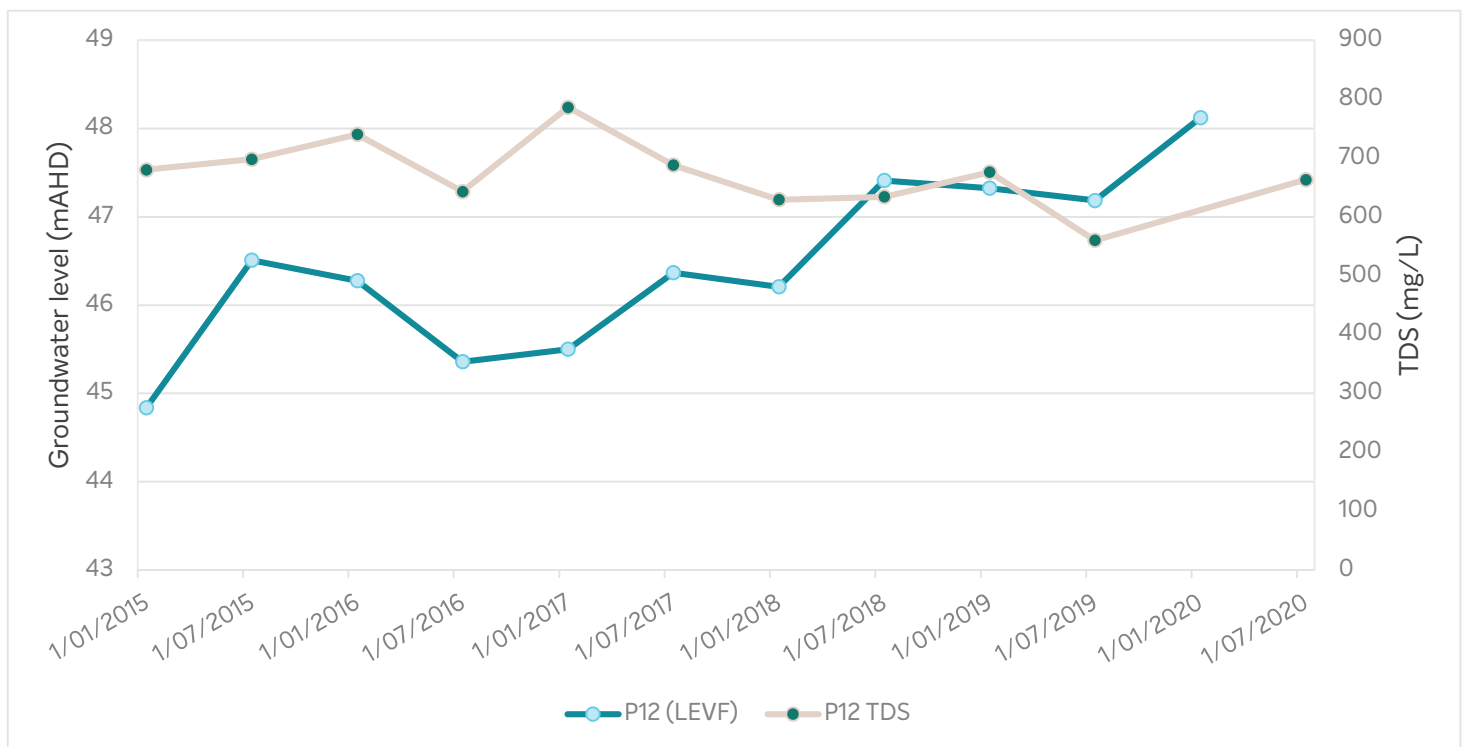
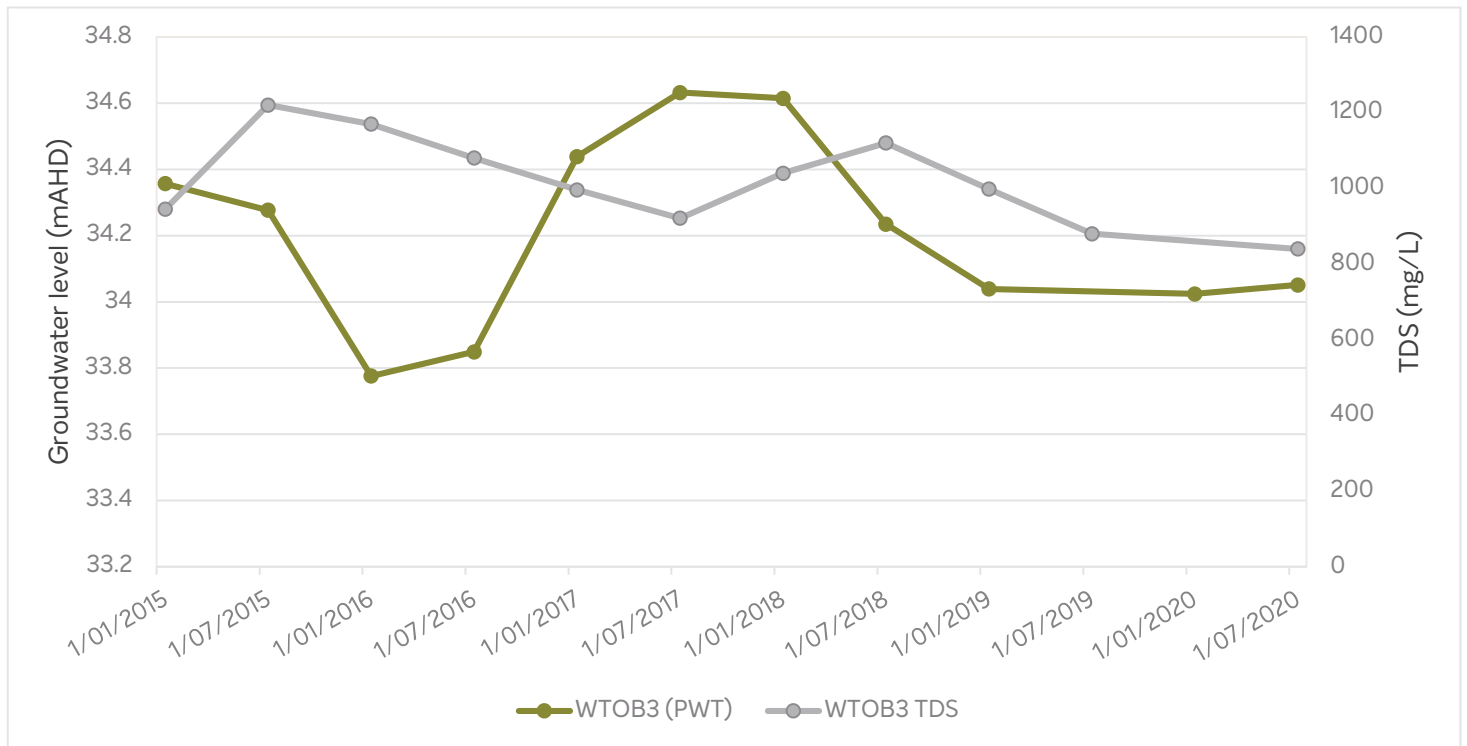
## Appendix G – Groundwater level and salinity level in shallow bores



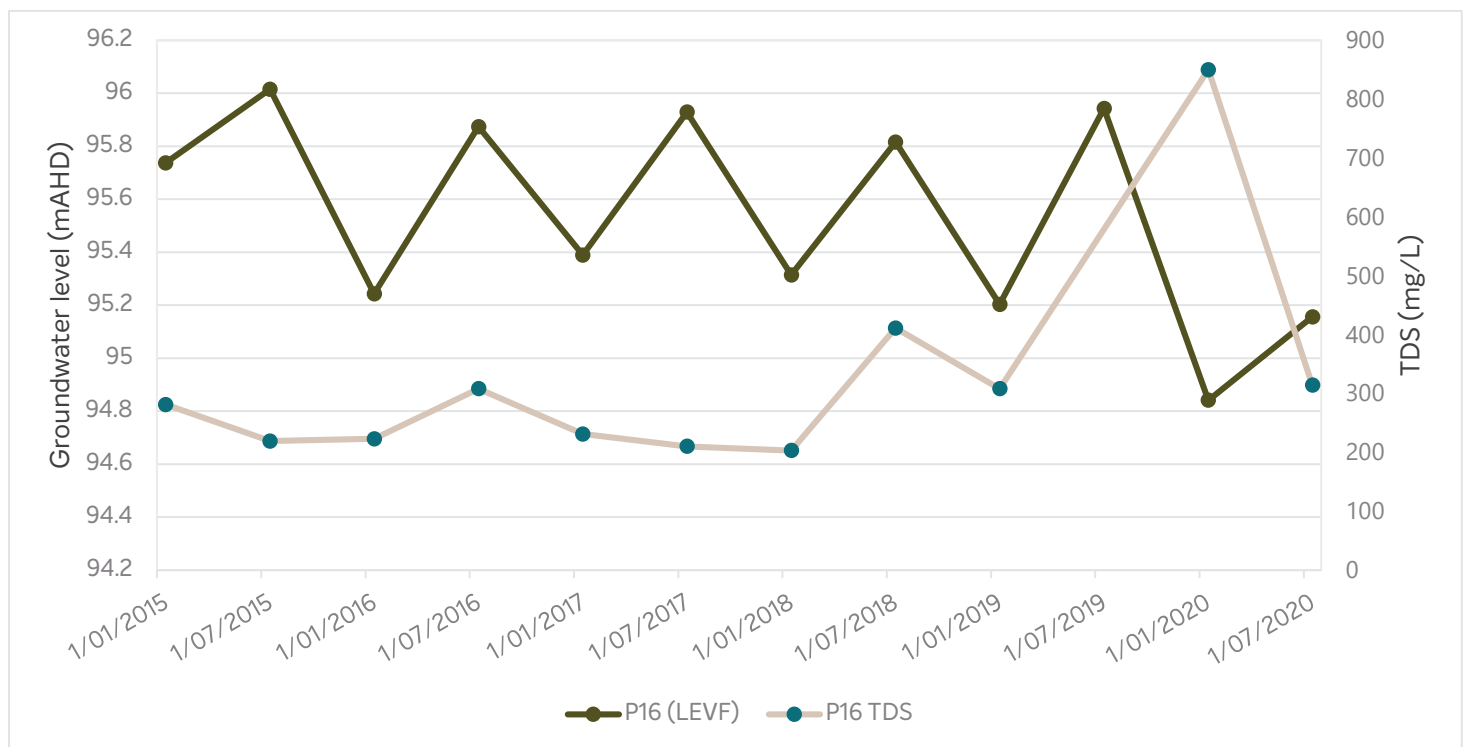
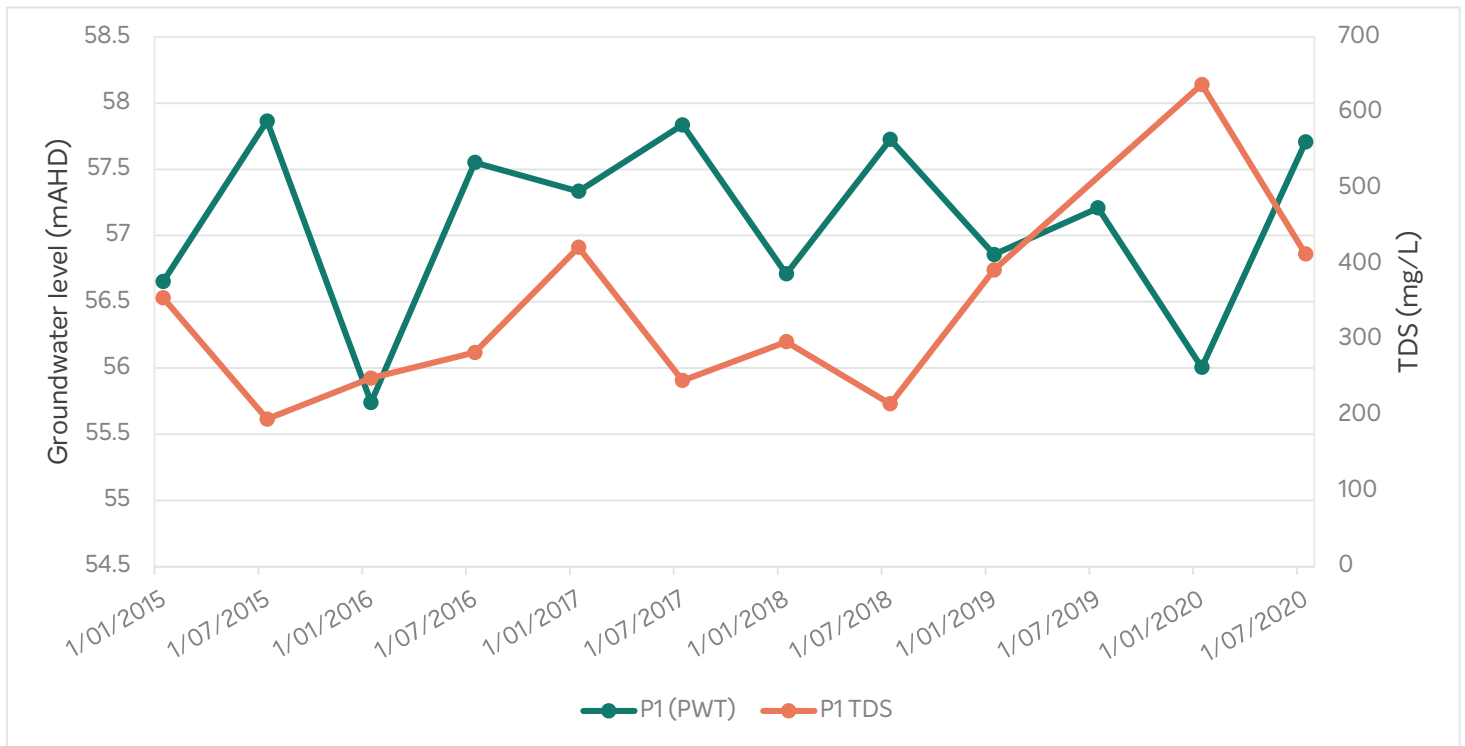
## Appendix G – Groundwater level and salinity level in shallow bores



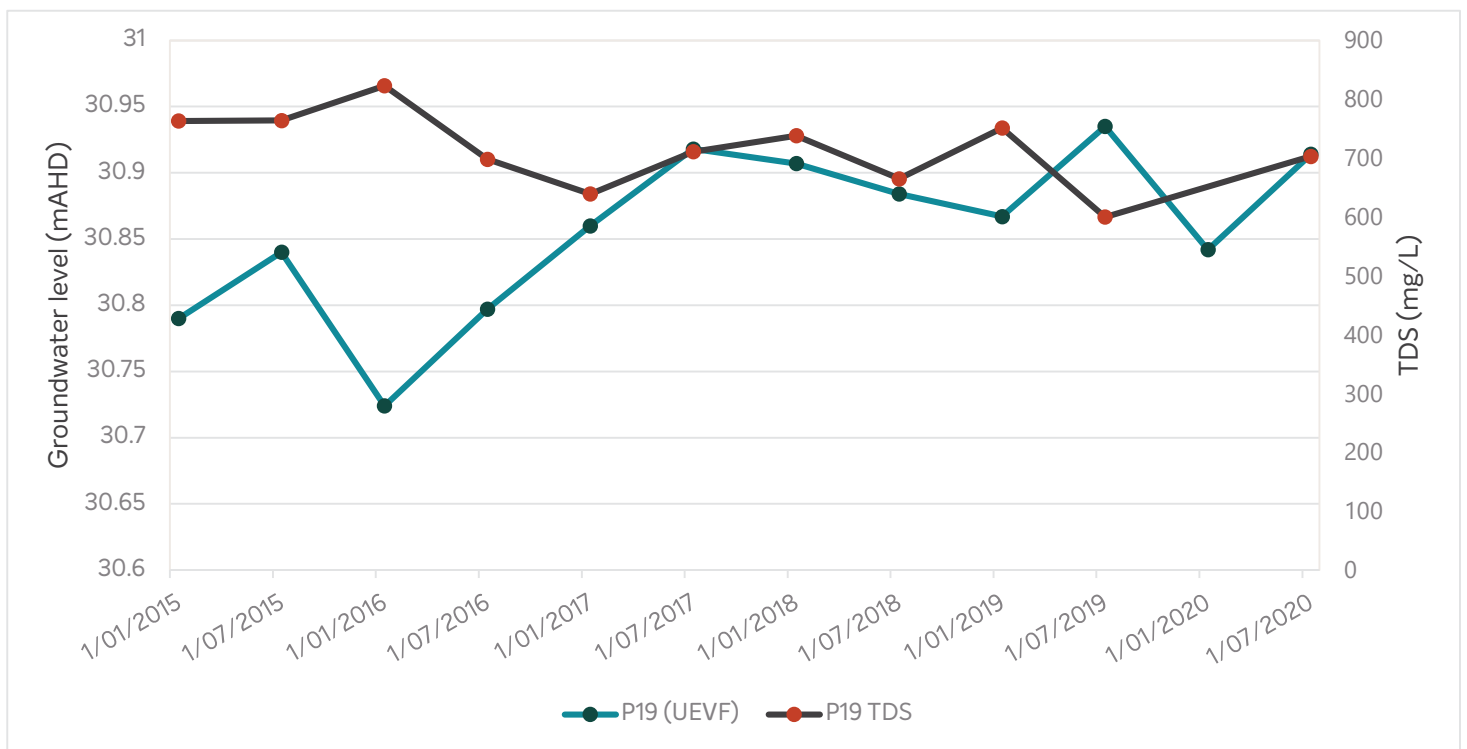
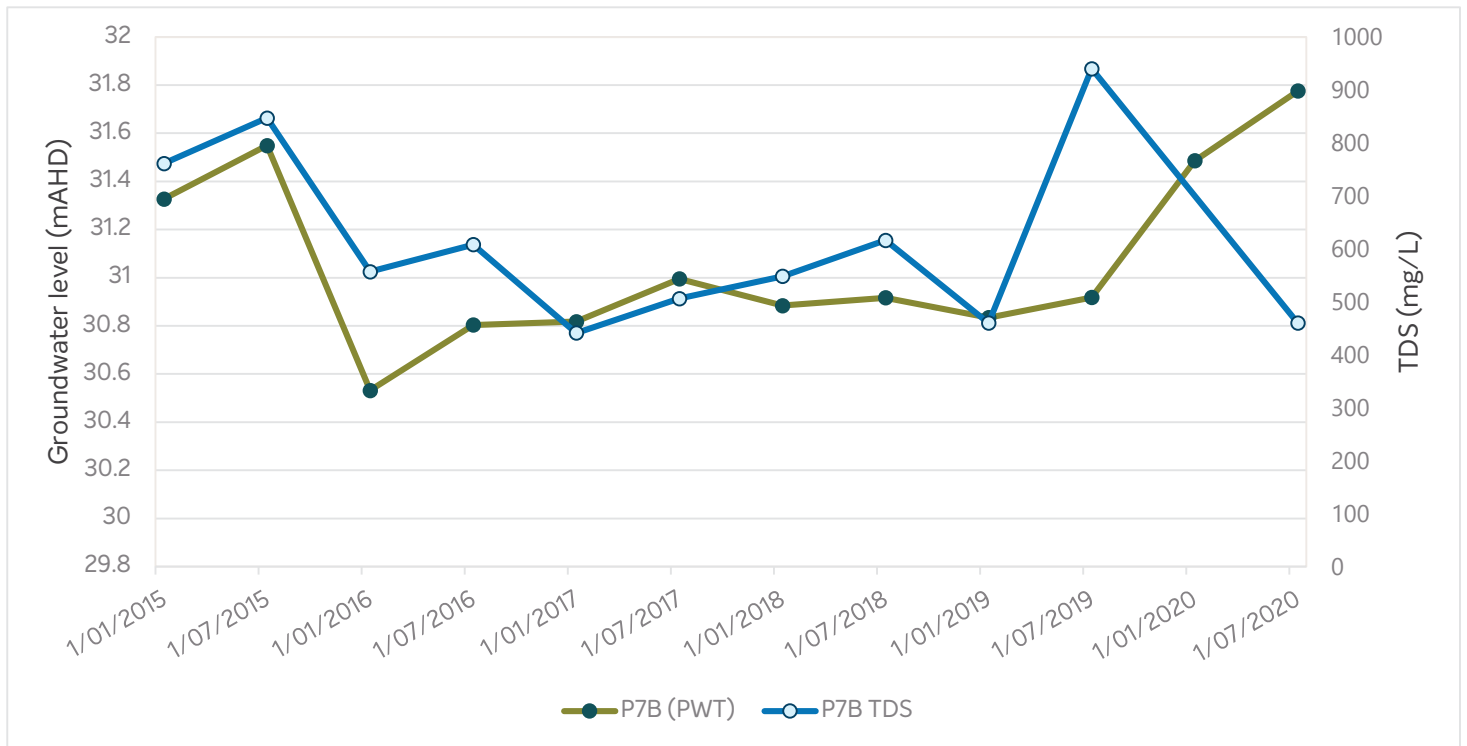
## Appendix G – Groundwater level and salinity level in shallow bores



## Appendix G – Groundwater level and salinity level in shallow bores



## Appendix G - Groundwater level and salinity level in shallow bores







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f t y o i n

Picture shows environmental monitoring at Anglesea Borefield and was taken in November 2019, before coronavirus (COVID-19).