

# Annual Bulk Entitlement Report

**Anglesea groundwater  
2020-2021**

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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. 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 is used to extract 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.

When in use, 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 was moved into a standby maintenance mode from 1 July 2020. Therefore, for the 2020-2021 reporting period the borefield was only operated for maintenance purposes to ensure the borefield remained operational if needed. This resulted in a total of 13.5 ML being extracted from the Anglesea Borefield for the 2020-2021 reporting period.

Barwon Water operates the Anglesea Borefield under the Bulk Entitlement (Anglesea Groundwater) Order 2009 (the Order), which requires Barwon Water 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, while 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. Barwon Water has since implemented the revised MAP 2014 and has been operating in accordance with the MAP 2014.

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 2020 to 30 June 2021.

## 2. Groundwater extraction (Clauses 16.1 A, 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. As of the end of June 2020 the borefield was moved into standby mode. The extracted volume of 13.5 ML during 2020-2021 is a result of ensuring the borefield remained operational by running the production bores for short periods of time as part of the maintenance schedule. Table 1 shows the daily extraction rates and Table 2 shows the total extraction per bore of the Anglesea Borefield during 2020-2021.

**Table 1: Total daily/monthly groundwater extraction 2020-2021**

Date	Groundwater extraction rates (ML)											
	Jul 2020	Aug 2020	Sept 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	May 2021	Jun 2021
1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
19	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
23	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
31	0.0	0.0		0.0		0.0	0.0		0.0		0.0	
Total	1.9	0.1	0.1	0.5	0.0	10.4	0.1	0.1	0.1	0.1	0.0	0.0
Prog. Total	1.9	2.0	2.1	2.6	2.6	13.0	13.1	13.3	13.4	13.5	13.5	13.5
Max. Flow	1.9	0.1	0.1	0.3	0.0	2.4	0.1	0.1	0.1	0.1	0.0	0.0
Min. Flow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ave. Flow	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0

**Table 2: Annual groundwater extraction by bore 2020-2021**

Production bores		Groundwater Extraction (ML)
MAP. ID	BE. ID	
GW1	(SPB1)	0.2
GW2		0.1
GW3	(SPB3)	0.2
GW4	(SPB4)	12.5
GW5		0.5
GW6	(NPB6)	0.0
GW7	(NPB7)	0.0
<b>Annual total</b>		<b>13.5</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 11 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.

There are two bore identified in the MAP that monitoring for saline intrusion, P14 and Coastal Bore. DELWP has advised that Coastal Bore 119349 is in poor condition and are scheduled for decommissioning and replacement. No water quality results are therefore available for 2020-2021 from the Coastal Bore.

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

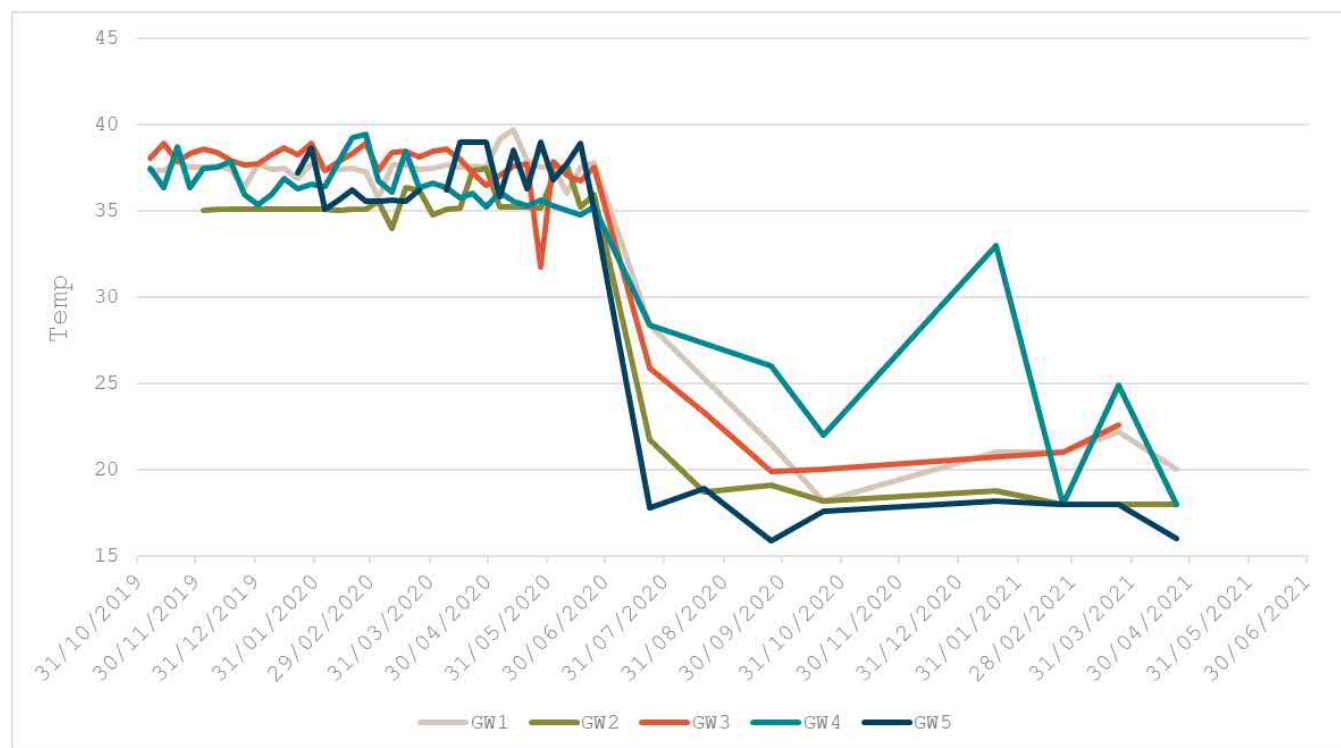
The MAP requires weekly monitoring of field salinity and temperature in each production bore (GW1-GW7) that is in operation when taking groundwater. The Anglesea borefield was moved into a standby maintenance mode from 1 July 2020. Given this, manual readings were taken when each of the production bores were briefly turned on for maintenance.

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. Production bores GW6 and GW7 are not featured as they were not in operation during the reporting period.

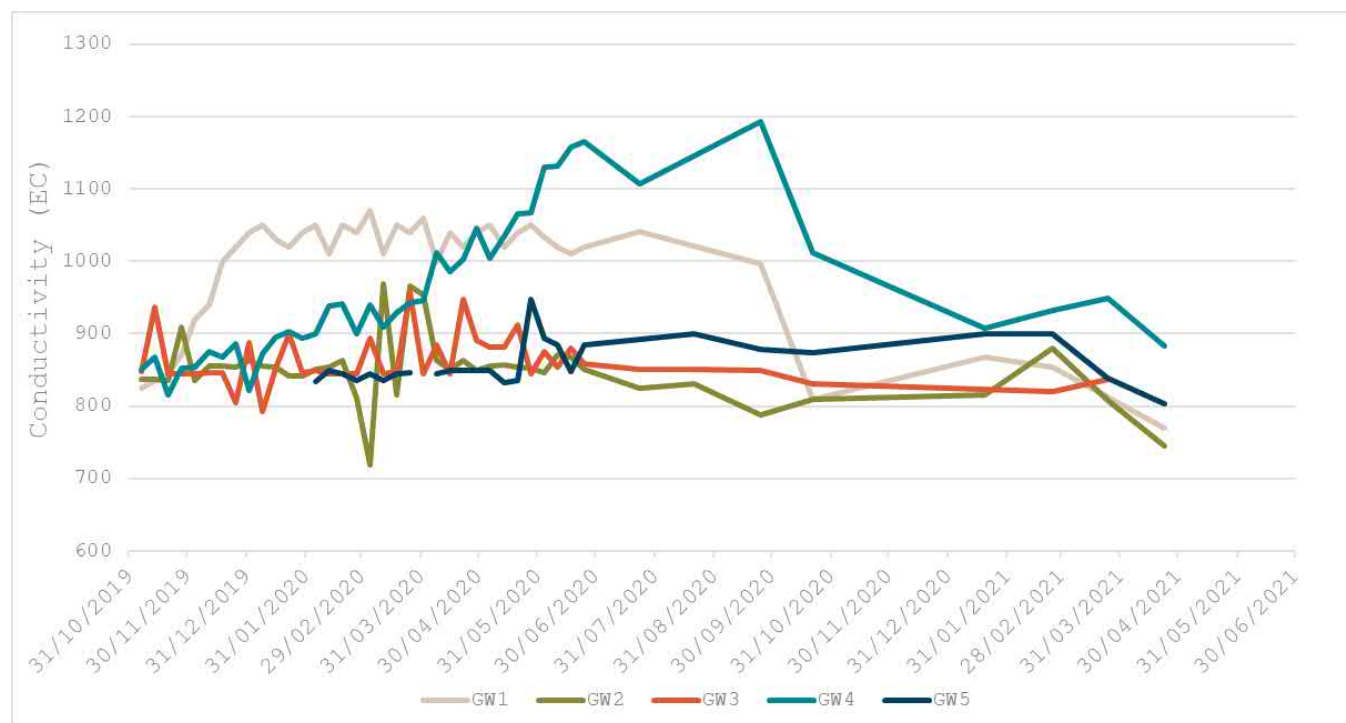
Due to the short operation time required for maintenance (<10mins) the temperature readings are not representative of the actual temperature in the LEVF due to cooling of the water as a result of the distance the water travels to the surface while in contact with the stainless steel casing of the production bore. Figure 1 shows the drop in the temperature measured for GW1-GW5 as result of the short operation time since operation of the borefield moved to standby mode in July 2020.

It is understood through previous monitoring that the salinity levels in the LEVF are lower than what is expected in the UEVF. The data shows that EC remains relatively stable for all production bores except GW4 and GW1, which displayed an upwards trend. This was believed to be due to increased

interconnection between the LEVF and UEVF in proximity to GW4 resulting from observation bore WB9 screening both aquifers. Alcoa have since decommissioned observation bore WB9 in August 2020 as part of their mine rehabilitation works. As shown in Figure 2 the trend has returned to historic values since this decommissioning took place.



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



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

### Deep observation bores

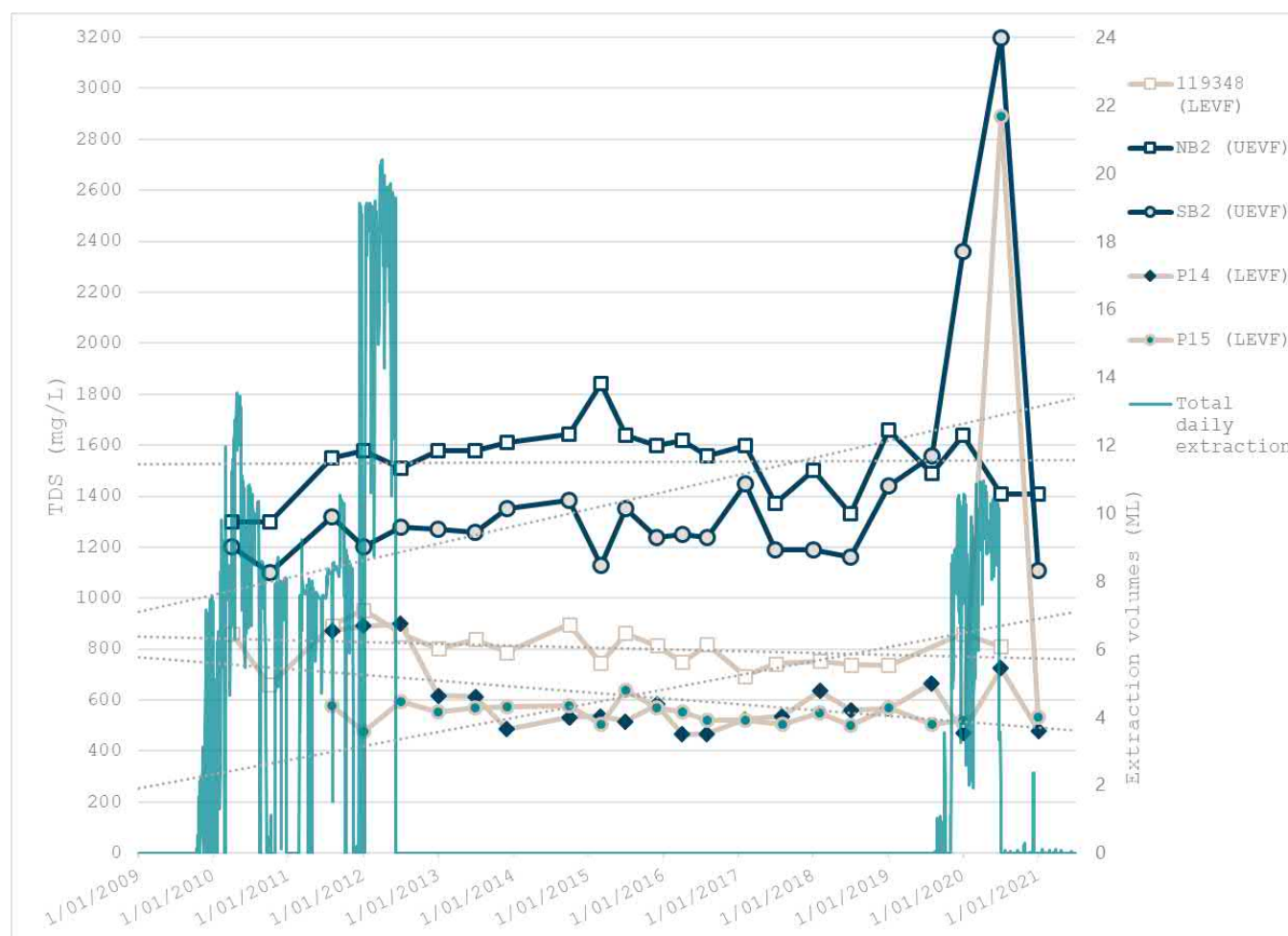
The 2020-2021 groundwater salinity results from the deep observation bores are provided in Table 3, while the results over the whole monitoring period (from April 2010 onwards) have been provided

graphically in **Error! Reference source not found.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 of major cations and anions, salinity (TDS and EC), pH, and bromide (for bores P14 and UEVF coastal only) was also completed 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	Jul -20	15.2	8.95	1391	1480	810
			-	Sample not take due to issue with observation bore (Pump stuck)				
SB2	UEVF	229	Jul – 20	15	5.63	5560	5680	3200
			Jan - 21	22.7	5.53	2160	2100	1110
NB2	UEVF	165	Jul – 20	16.3	5.71	2482	2530	1410
			Jan - 21	25.7	5.69	2457	2440	1410
P14	LEVF	504	Jul – 20	16	5.81	841	806	724
			Jan - 21	19.3	6.15	950	990	480
P15	LEVF	466	Jul – 20	15	5.11	938	890	2890
			Jan - 21	17.6	5.02	920	938	533



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

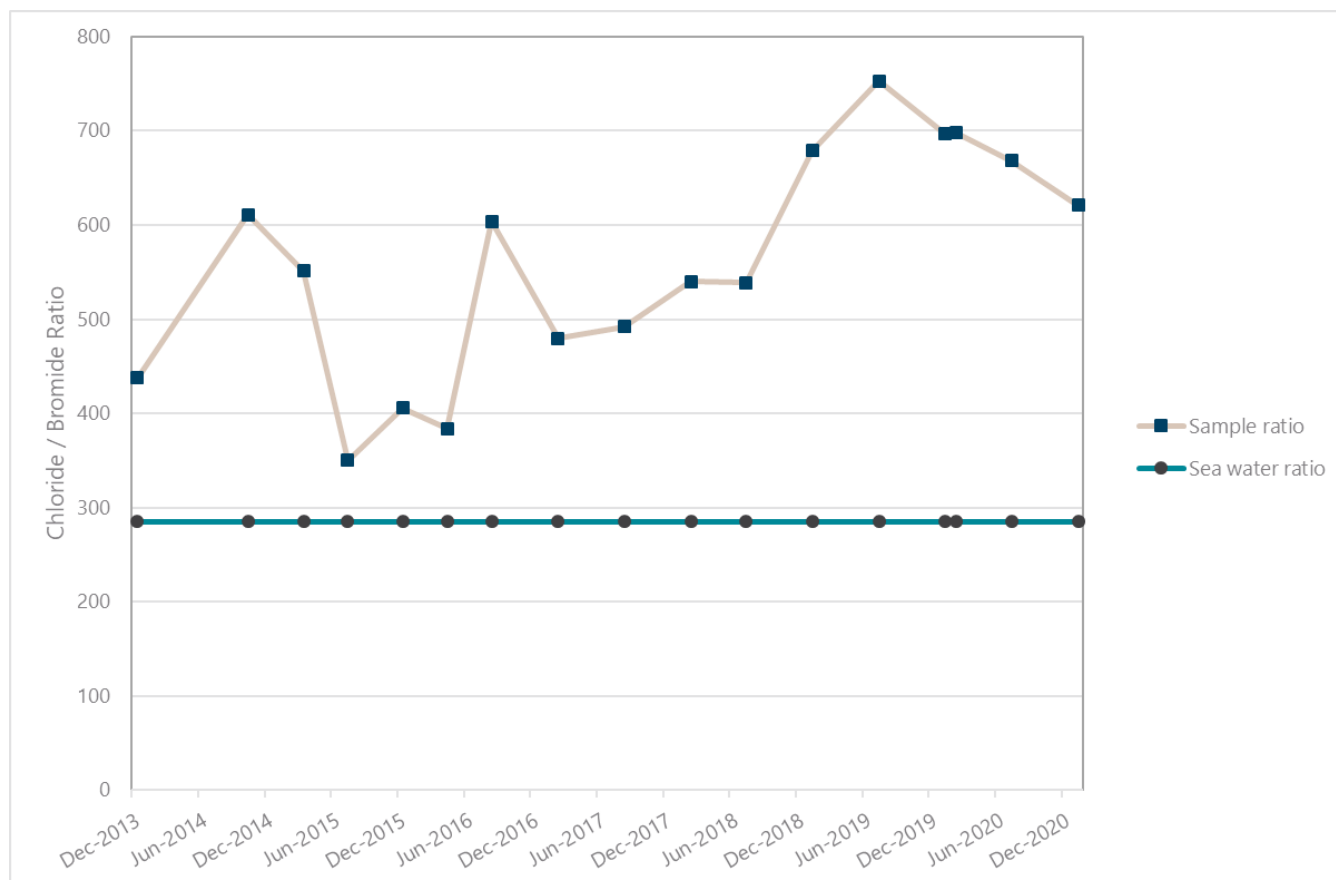


The field readings taken for the Electrical Conductivity (EC) are conducted during the bore purging process. Both the Total Dissolved Solids (TDS) and EC are taken to measure the salinity in groundwater samples. The TDS readings are taken in controlled laboratory conditions by weighing the residual solids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

As highlighted in the 2019-2020 annual report, the salinity results from the sampling undertaken in January 2020 at SB2 were higher than what we had observed through previous monitoring.

A further investigation was conducted which included conducting airlift of the bore to flush out any stagnant water that may have been sitting in the bore. In addition to this, monthly water quality testing was completed including groundwater quality monitoring at nearby bore 116459. A briefing note was provided to DELWP in March 2021 concluding that the airlifting appeared to have cleared the bore screen in SB2 and subsequently EC sample results have stabilised and returned to historical levels in recent water quality monitoring.

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.



Error! Reference source not found.illustrates the chloride/bromide ratios overtime. 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.



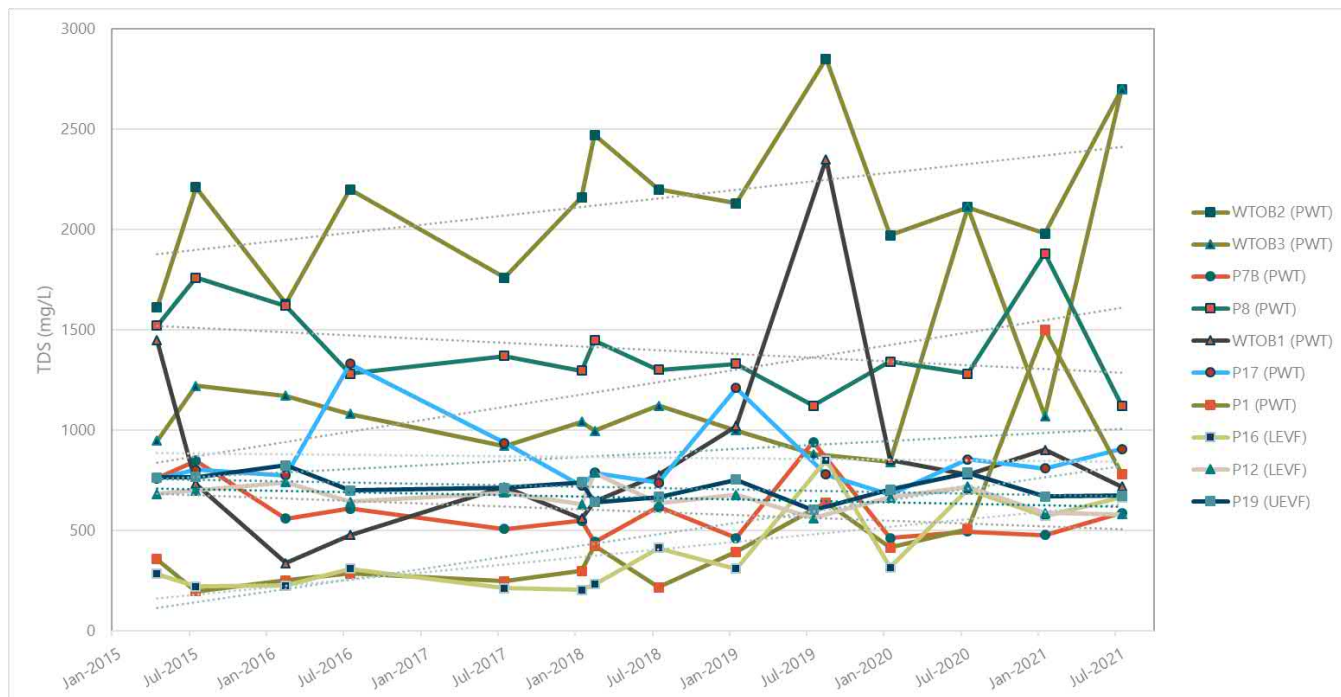
### **Shallow observation bores**

The 2020-2021 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 below 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. Salinity levels in the perched water table generally fluctuate more in the upper or lower eastern view formations. This is potentially due to the variable nature of the water level in the perched water table as a result of climatic variation. When considering the impact of the climate verses pumping it is important to consider P17 which is outside the area of influence from pumping. Results for shallow observation bore water level versus salinity level is provided in Appendix G.

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

		Field Parameters			Lab Result	
Bore ID	Date	Temp °C	pH	EC (µS/cm)	EC (µS/cm)	TDS (mg/L)
<b>Anglesea River Catchment</b>						
<b>WTOB3</b>	Jan-20	15.6	5.33	1606	1670	840
	Jul-21	14.4	5.49	1540	1670	2700
<b>P7B</b>	Jan-20	15.0	3.66	839	884	460
	Jul-21	12.6	3.89	858	919	586
<b>P8</b>	Jan-20	15.4	5.09	2117	2200	1340
	Jul-21	11	4.93	2344	2360	1120
<b>P19</b>	Jan-20	16.3	5.60	1198	1230	703
	Jul-21	14.95	5.85	1155	1230	673
<b>P12</b>	Jan-20	19.6	5.75	1149	1170	663
	Jul-21	18.6	5.91	1144	1200	580
<b>WTOB2</b>	Jan-20	14.9	3.99	3128	3320	1970
	Jul-21	14.2	4.02	3178	3700	2700
<b>Salt Creek Catchment</b>						
<b>P16</b>	Jan-20	14.7	4.24	472	499	314
	Jul-21	12	4.45	543	536	664
<b>P17</b>	Jan-20	15.8	6.35	1291	1270	676
	Jul-21	13.6	6.85	1530	1370	906
<b>P1</b>	Jan-20	15.3	5.88	565	510	413
	Jul-21	12.7	6.15	480	339	780
<b>WTOB1</b>	Jan-20	17.3	5.13	982	1010	852
	Jul-21	15.1	5.16	680	822	718



**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 is provided in Appendix C.

**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
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 generally increase. 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 (2020-21), indicating increasing salinity (EC) from upstream to downstream through the Salt Creek and Anglesea River catchments**

Date	Salt Creek				Anglesea River		
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
13/07/2020	435	Dry	232	615	Dry	Dry	5160
12/08/2020	442	555	245	613	Dry	Dry	5210
8/09/2020	368	411	199	212	964	Dry	4660
14/10/2020	367	458	281	248	555	837	4400
10/11/2020	527	385	271	1759	722	Dry	4180
9/12/2020	352	391	255	1395	282	Dry	4240
11/01/2021	314	343	308	1576	636	916	4360
9/02/2021	341	416	251	1001	764	Dry	4350
10/03/2021	Dry	Dry	373	1543	Dry	Dry	4630
14/04/2021	Dry	Dry	261	Dry	Dry	Dry	4700
11/05/2021	372	Dry	222	151	Dry	Dry	4030
3/06/2021	344	513	239	287	943	Dry	4930

- Table 8 shows the continuing trend of pH values decreasing as water flows downstream through the swamps, with the lowest pH value generally being recorded at the downstream end of the Salt Creek and Anglesea catchments. 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 catchments are subjected to wetting and drying cycles the pyritic sediments are oxidised, which causes acid generation in the swamps. The acid is released from the swamps when a large rainfall event flushes the stored acid from the downstream end of the swamps 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 (2019-20 & 2020-21), indicating decreasing pH from upstream to downstream in the Anglesea catchment**

Date	Salt Creek				Anglesea River		
	SV3	SV1	SV4	SV2	AV1	AV3	AV2
30/07/2019	4.5	5.8	5.2	4.6	5.4	4.1	2.9
00/08/2019	<i>Transition to Regional Water Monitoring Partnership (RWMP)</i>						
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
13/07/2020	5.0	Dry	6.5	4.2	7.5	Dry	2.8
12/08/2020	5.4	5.1	5.7	4.5	6.2	Dry	2.8
8/09/2020	4.9	5.2	7.6	4.7	6.3	Dry	2.8
14/10/2020	7.2	7.3	6.9	6.1	6.9	5.4	2.9
10/11/2020	6.2	5.6	6.9	4.1	6.2	Dry	3.0
9/12/2020	6.0	6.1	6.2	4.4	Dry	Dry	3.8
11/01/2021	6.3	6.8	6.6	3.3	Dry	5.3	3.2
9/02/2021	6.3	5.9	6.0	5.1	Dry	Dry	3.0
10/03/2021	Dry	Dry	6.1	4.1	5.7	Dry	2.9
14/04/2021	Dry	Dry	6.1	Dry	7.5	Dry	3.2
11/05/2021	6.2	Dry	6.2	4.9	6.2	Dry	3.7
3/06/2021	6.2	5.9	6.5	4.4	6.3	Dry	2.8

To further understand the distribution of acid sulfate soils across the Salt Creek and Anglesea River catchment, Monash University were contracted by Barwon Water to undertake soil sampling for potential acid sulfate soils. This report was completed in December 2020. A copy of the full report and summary report can be found on the Barwon Water website.

- 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 Swamp land:

- 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:

$$P8 = 0.3131 * P17 + 9.4666 - 2 \text{ Standard Deviations of Error}$$
$$P19 = 0.2391 * P1 + 16.82 - 2 \text{ Standard Deviations of Error}$$

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

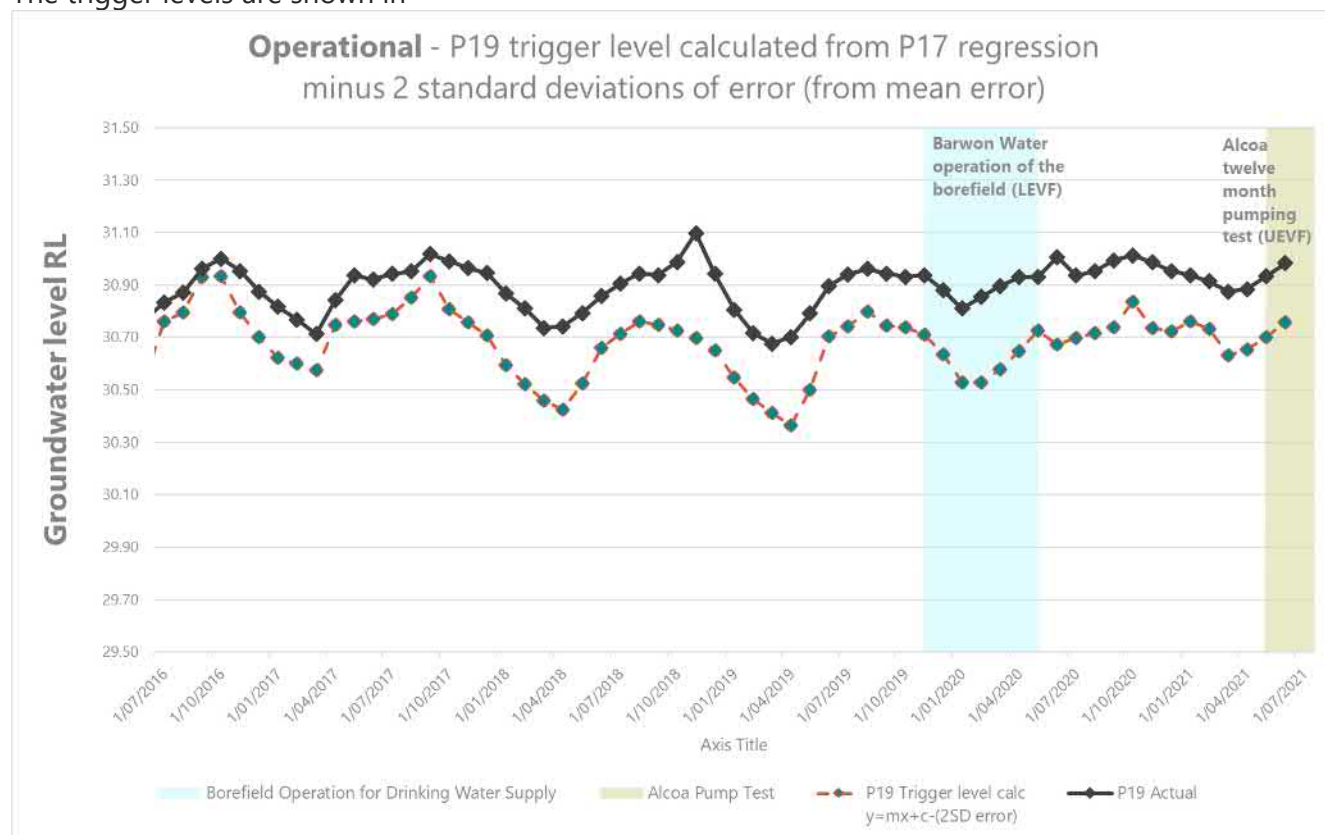
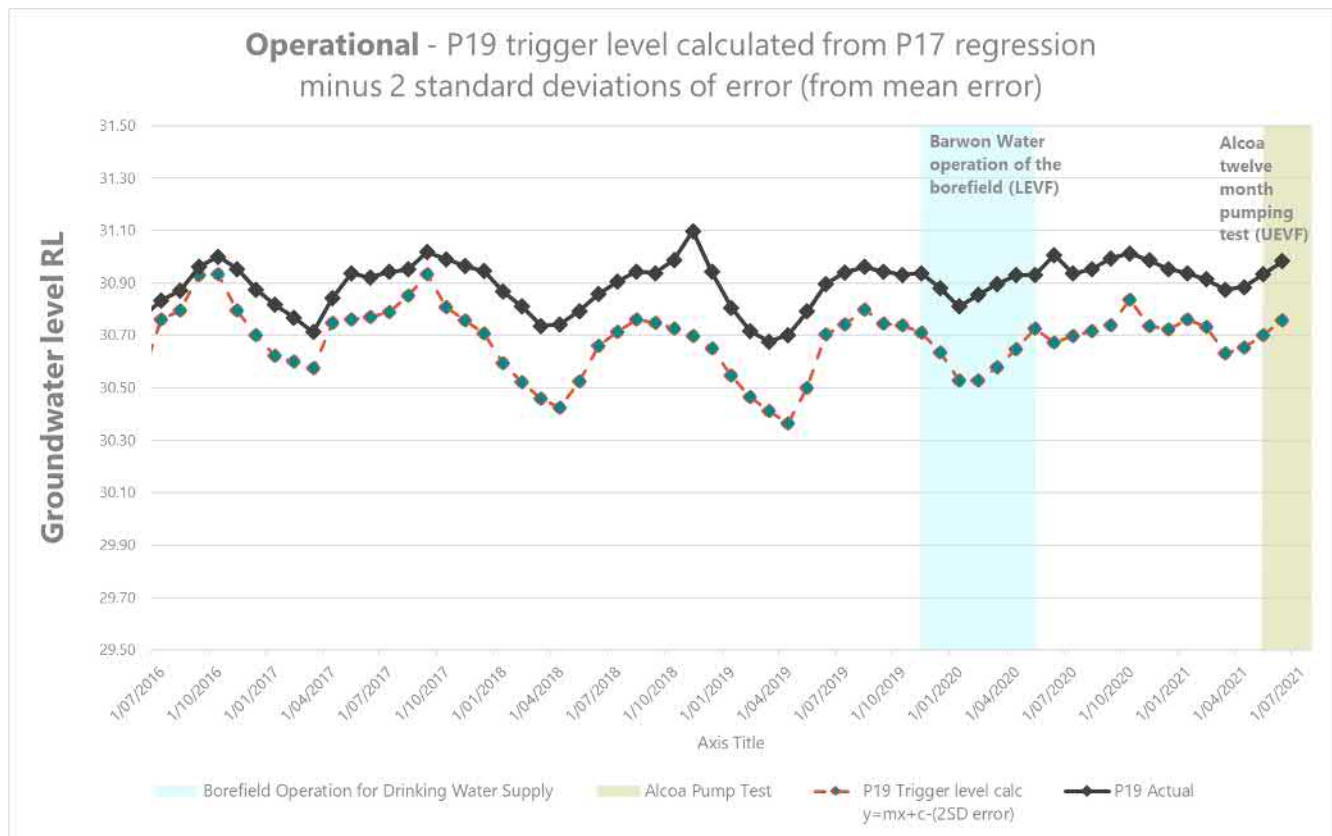
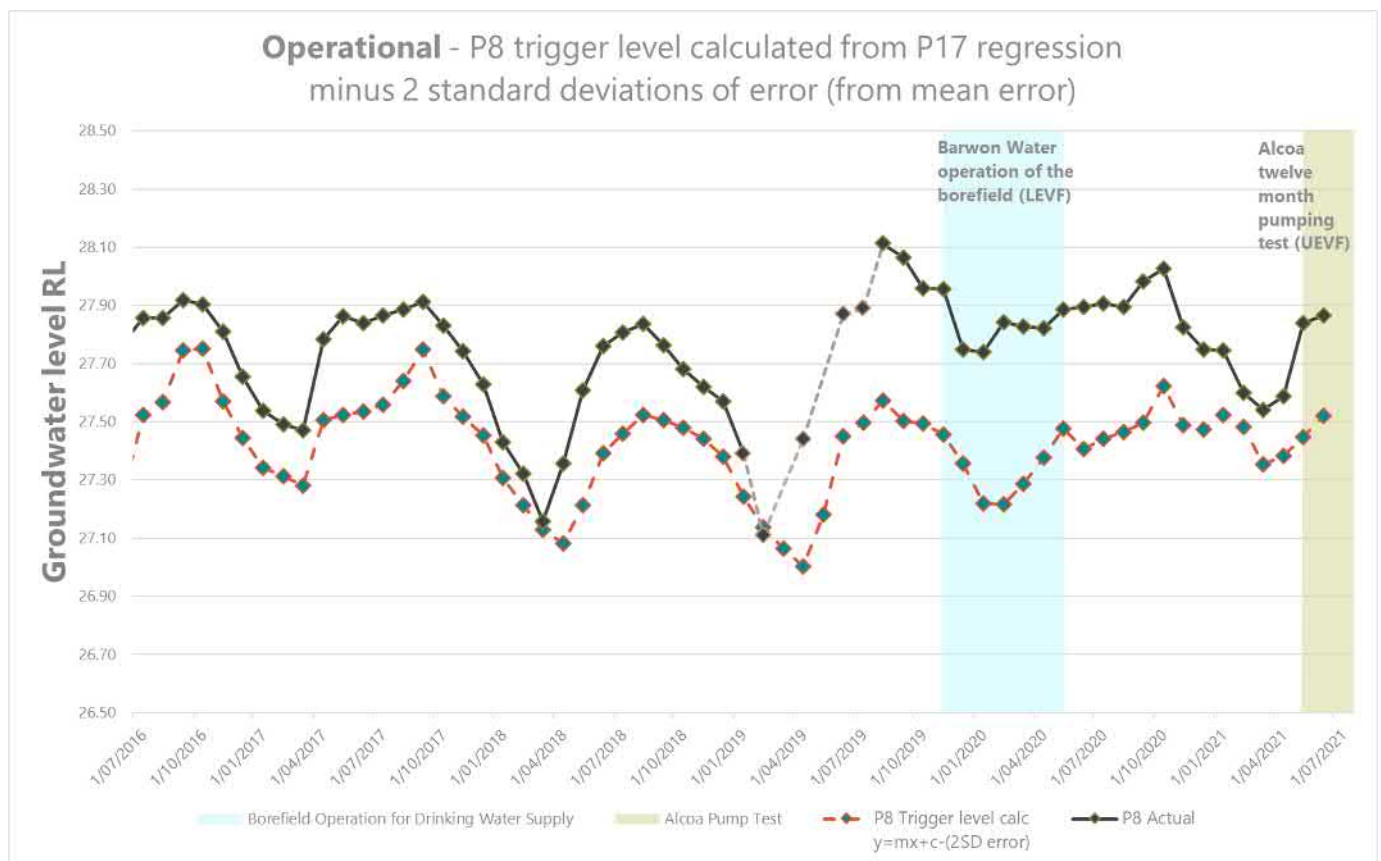


Figure and Figure . At all times during 2020-2021 the groundwater levels were above the required trigger levels.



**Figure 7: Groundwater level and the trigger level for P19 in the upper eastern view formation.**



**Figure 8: Groundwater level and the trigger level for P8 in the perched water table.**

During February 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 D, 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.

### 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.

This request for a minor amendment to the Bulk Entitlement (Anglesea Groundwater) Order 2009 has been provided to DELWP for consideration.

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

There have been no amendments to the MAP in 2020-2021 however; future amendments will be required as a result of the mine rehabilitation works being undertaken by Alcoa.

There are currently a number of observation bores that Alcoa own that are included in Barwon Water's monitoring and assessment program.

Alcoa have a bore assessment program as part of the general site decommissioning and rehabilitation. This also compliments the groundwater pumping test work Alcoa is undertaking. Bores that are no longer required for a specific purpose for Alcoa, are being decommissioned as a result. Decommissioned bores list below are not all listed in the MAP but are provided for context in what has changed over the reporting period in the Anglesea catchment.

Decommissioned:

- WB9            Sept 2020
- WB10        Aug 2020
- WB13        Jun 2021
- WB17        May 2021
- Old MB1     June 2021

Timing is to be confirmed and no license application has been made, but bores that are planned to be decommissioned by Alcoa at this stage include:

- WB5
- WB12

Other bores are still being assessed as part of Alcoa's program. Depending on what Alcoa finds, and whether the bores are required to support the groundwater pumping test, they may also be added to the list to be decommissioned.

## **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 coastal bore 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 observation bore applications are currently being assessed by relevant authorities.

# Appendix A

## Observation bore locations

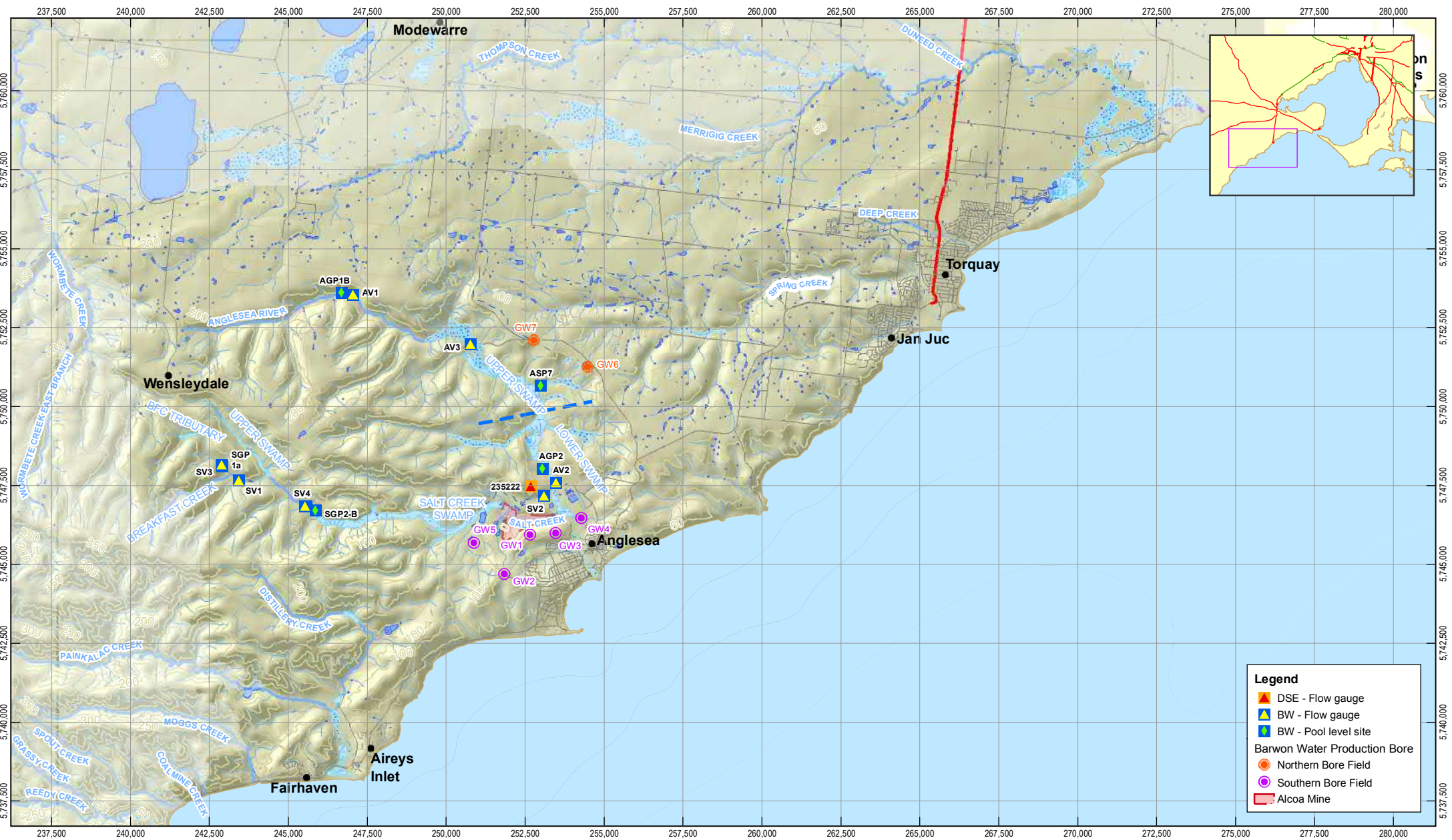






# Appendix B

## 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:\3132669\GIS\Maps\Deliverables\0002\_Anglesea\_Monitoring\_2014\_SW\_Locations.mxd

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

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

# Appendix C

## Surface water quality results - field testing

**Name** Breakfast Creek Tributary @ V notch  
**GHD/BW ID** SV3  
**SINo.** 235274A  
**BE Map ID** 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
13/07/2020	13:55	0.082	435	269.7	9.54	9.54	5.0	11.5	0.04	Cloudy	Air temp 11.5, Water Clear, Sample and photo taken
12/08/2020	13:15	0.088	442	274.0	8.92	8.92	5.4	8.5	0.04	Cloudy	Air temp 12.2 Water clear
8/09/2020	13:05	0.080	368	228.2	10.09	10.09	4.9	12.8	0.04	Cloudy	Air temp 14.5 Water clear
14/10/2020	11:00	0.141	367	227.5	9.86	9.86	7.2	13.6	0.90	Sunny	Air temp 15.8 Water clear
10/11/2020	10:10	0.082	527	326.7	9.63	9.63	6.2	11.4	0.04	Sunny	Air temp 23.9 Water clear
9/12/2020	9:30	0.111	352	218.2	7.27	7.27	6.0	12.1	0.04	Sunny	Air temp 15.2 Water clear
11/01/2021	10:35	0.100	314	194.7	8.15	8.15	6.3	13.5	0.03	Cloudy	Air temp 26.5 Water clear
9/02/2021	11:15	0.068	341	211.4	4.69	4.69	6.3	15.7	0.01	Cloudy	Air temp 26.5 Water clear, Photo and Sample.
10/03/2021	12:30	DRY	X	X	X	X	X	X	X	Cloudy	Air temp 16.5 , Dry
14/04/2021	11:50	DRY	X	X	X	X	X	X	X	Cloudy	Air temp 13.5 , Dry
11/05/2021	11:45	0.080	372	230.6	8.96	8.96	6.2	11.9	0.04	Cloudy	Air temp 11.8
3/06/2021	11:40	0.097	344	213.3	9.47	9.47	6.2	12.7	0.05	Cloudy	Air temp 14.1

**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
13/07/2020	14:20	Dry	n/a	n/a	n/a	n/a	n/a	n/a	11.4	dry	Cloudy	No WQ, Photos
12/08/2020	10:50	0.130	555	344.1	5.39	5.39	5.1	9.7	12.1	Flowing	Cloudy	Water clear
8/09/2020	11:50	0.116	411	254.8	8.92	8.92	5.2	11.2	14.8	Flowing	Cloudy	Water clear
14/10/2020	9:55	0.198	458	284.0	9.95	9.95	7.3	11.8	15.1	Flowing	Sunny	Water clear
10/11/2020	10:45	0.110	385	238.7	5.89	5.89	5.6	15.4	24.5	Trickle flow	Sunny	Water clear
9/12/2020	8:15	0.080	391	242.4	9.87	9.87	6.1	12.2	11.2	Trickle flow	Sunny	Water clear
11/01/2021	11:15	0.137	343	212.7	7.17	7.17	6.8	16.7	27.3	Flowing	Cloudy	Water clear
9/02/2021	10:15	0.101	416	257.9	5.70	5.70	5.9	15.5	18.5	Flowing	Cloudy	Water clear, Photo, Sample
10/03/2021	12:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	16.2	dry	Cloudy	No WQ
14/04/2021	10:10	Dry	n/a	n/a	n/a	n/a	n/a	n/a	14.2	dry	Cloudy	No WQ
11/05/2021	10:45	Dry	n/a	n/a	n/a	n/a	n/a	n/a	11.6	dry	Cloudy	No WQ
3/06/2021	10:45	0.110	513	318.1	7.12	7.12	5.9	9.7	12.0	Trickle flow	Cloudy	Water clear

**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
14/07/2020	12:45	0.122	232	144	9.85	9.85	5.6	8.3	12.2	Flowing	Cloudy	Flowing
13/08/2020	12:30	0.144	245	152	8.21	8.21	6.5	7.9	12.1	Flowing	Cloudy	Flowing
8/09/2020	14:15	0.106	199	123	10.02	10.02	5.7	12.4	15.7	Flowing	Cloudy	Flowing
14/10/2020	12:30	0.240	281	174	9.97	9.97	7.6	11.0	18.0	Flowing	Sunny	Flowing
10/11/2020	8:45	0.092	271	168	8.65	8.65	6.9	11.2	23.0	Flowing	Sunny	Flowing
9/12/2020	10:00	0.101	255	158	7.37	7.37	6.9	12.2	17.8	Flowing	Cloudy	Flowing
11/01/2021	8:15	0.176	308	191	8.46	8.46	6.2	14.1	23.8	Flowing	Cloudy	Flowing
9/02/2021	10:30	0.080	251	156	7.23	7.23	6.6	14.1	21.1	Flowing	Cloudy	Flowing
10/03/2021	10:30	BELOW	373	231	5.51	5.51	6.0	13.2	15.8	Flowing	Cloudy	Flowing
14/04/2021	12:45	0.075	261	162	7.80	7.80	6.1	12.1	16.9	Flowing	Cloudy	Flowing
11/05/2021	13:15	0.192	222	138	9.25	9.25	6.1	11.9	11.4	Flowing	Cloudy	Flowing
3/06/2021	13:00	0.122	239	148	8.21	8.21	6.2	11.8	15.5	Flowing	Cloudy	Flowing

**Name** Salt Creek (Encoder) @ Alcoa  
**GHD/BW ID** SV2  
**SINo.** 235222A  
**BE Map ID** 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
13/07/2020	11:00	Below	615	381.3	11.26	11.26	4.2	11.1	11.5	No Flow	Sunny	Water clear, Sample and photo taken.
11/08/2020	10:30	Below	613	380.1	11.34	11.34	4.5	8.6	9.4	No Flow	Cloudy	Water clear
7/09/2020	12:45	Below	212	131.4	9.83	9.83	4.7	16.0	24.1	No Flow	Cloudy	Water clear
15/10/2020	9:45	Below	248	153.8	8.96	8.96	6.1	15.5	17.1	No Flow	Cloudy	Water clear
11/11/2020	11:00	0.018	1759	1090.6	8.35	8.35	4.1	21.6	22.5	Trickle flow	Cloudy	Water clear
10/12/2020	12:15	Below	1395	864.9	8.78	8.78	4.4	22.0	18.1	No Flow	Cloudy	Water clear
12/01/2021	12:00	Below	1576	977.1	8.53	8.53	3.3	26.1	22.1	No Flow	Cloudy	Water clear
8/02/2021	12:05	Below	1001	620.6	8.94	8.94	5.1	20.5	20.5	No Flow	Cloudy	Water clear, Sample and photo taken.
9/03/2021	12:15	Below	1543	956.7	10.25	10.25	4.1	19.2	15.6	No Flow	Cloudy	Water clear
15/04/2021	12:45	DRY	x	x	x	x	x	x	17.8	No Flow	Cloudy	DRY
10/05/2021	12:00	BELOW	151	93.6	9.31	9.31	4.9	14.7	15.0	No Flow	Cloudy	Water clear
4/06/2021	12:00	BELOW	287	177.9	10.80	10.80	4.4	14.8	10.2	No Flow	Cloudy	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
14/07/2020	12:30	1.959	214	132.7	10.25	2.97	5.9	11.7	Flowing	Cloudy	Air temp 12.1 Dark tanin stain.
13/08/2020	12:25	1.995	222	137.6	10.31	3.30	6.0	8.4	Flowing	Cloudy	Air temp 12.1 Dark tanin stain.
8/09/2020	13:45	1.956	260	161.2	9.80	3.11	6.0	12.7	Flowing	Cloudy	Air temp 14.5 Dark tanin stain.
14/10/2020	12:10	2.072	361	223.8	9.78	3.25	7.6	10.8	Flowing	Sunny	Air temp 17.9 Dark tanin stain.
10/11/2020	8:25	1.919	292	181.0	9.04	2.93	7.5	11.8	Flowing	Sunny	Air temp 23.3 Dark tanin stain.
9/12/2020	10:35	1.930	265	164.3	8.78	3.22	7.4	12.0	Flowing	Sunny	Air temp 17.9 Dark tanin stain.
11/01/2021	8:05	2.004	279	173.0	8.42	3.21	6.1	13.6	Flowing	Sunny	Air temp 23.9 Dark tanin stain.
9/02/2021	12:15	1.905	268	166.2	7.11	2.31	6.7	13.5	Flowing	Cloudy	Air temp 20.2 Dark tanin stain.
10/03/2021	10:20	1.542	321	199.0	6.32	2.21	6.6	13.2	Flowing	Cloudy	Air temp 15.6 Dark tanin stain.
14/04/2021	12:25	1.887	272	168.6	6.87	3.11	6.5	12.6	Flowing	Cloudy	Air temp 16.7 Dark tanin stain.
11/05/2021	12:45	2.012	246	152.5	7.86	2.71	6.3	11.5	Flowing	Cloudy	Air temp 11.6 Dark tanin stain.
3/06/2021	12:50	1.966	284	176.1	7.66	3.22	6.2	9.5	Flowing	Cloudy	Air temp 15.6 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
14/07/2020	14:15	GH 0.889	909	563.6	8.92	2.21	6.0	8.2	Stagnant	CLOUDY	Air temp 12.3 Water tanin stained. Photo taken.
12/08/2020	10:10	GH 0.842	869	538.8	9.35	2.86	5.7	9.5	Stagnant	CLOUDY	Air temp 11.0 Water tanin stained.
8/09/2020	11:10	GH 1.181	853	528.9	8.94	2.75	6.2	12.7	Stagnant	CLOUDY	Air temp 14.5 Water tanin stained.
13/10/2020	13:00	GH 2.522	350	217.0	9.50	7.62	7.6	10.7	Stagnant	Sunny	Air temp 17.5 Water Muddy stain
10/11/2020	11:50	GH 2.270	474	293.9	8.04	3.21	6.7	11.1	Stagnant	Sunny	Air temp 28.3 Water Muddy stain
10/12/2020	8:15	GH 2.212	282	174.8	7.83	3.27	6.4	11.2	Stagnant	CLOUDY	Air temp 13.0 Water tanin stained.
11/01/2021	11:55	GH 2.390	786	487.3	7.31	2.71	6.2	12.3	Stagnant	Cloudy	Air temp 31.8 Water tanin stained.
9/02/2021	9:25	GH 2.274	981	608.2	6.39	2.83	6.3	16.6	Stagnant	CLOUDY	Air temp 16.5 Water tanin stained. Photo taken.
10/03/2021	8:50	GH 2.102	1181	732.2	6.85	3.22	5.8	13.1	Stagnant	CLOUDY	Air temp 15.5 Water tanin stained.
14/04/2021	9:05	GH 1.954	1207	748.3	6.91	3.10	6.8	13.8	Stagnant	CLOUDY	Air temp 14.9 Water tanin stained.
11/05/2021	9:50	GH 1.940	1009	625.6	10.09	3.21	5.4	10.0	Stagnant	CLOUDY	Air temp 9.8 Water tanin stained.
3/06/2021	10:10	GH 2.190	1237	766.9	7.47	2.31	6.9	9.0	Stagnant	CLOUDY	Air temp 10.1 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
14/07/2020	14:00	Dry	n/a	n/a	n/a	n/a	n/a	n/a	12.1	Dry	Cloudy	Dry. No Sample. Photo
12/08/2020	9:50	Dry	n/a	n/a	n/a	n/a	n/a	n/a	11.1	Dry	Cloudy	Dry
8/09/2020	10:40	0.070	964	598	5.9	5.93	5.2	11.0	15.9	Stagnant	Sunny	Water Milky clear.
13/10/2020	11:55	0.190	555	344	8.6	8.61	7.5	15.1	17.3	Flowing	Sunny	Water Milky clear.
10/11/2020	11:40	0.052	722	448	7.2	7.20	6.2	13.5	27.6	Flowing	Sunny	Water Milky clear.
10/12/2020	8:15	BELOW	282	175	6.6	6.61	6.3	12.2	13.2	Stagnant	Cloudy	Water Milky clear. Small pool around sensor
11/01/2021	11:35	0.117	636	394	7.2	7.20	6.9	16.7	30.4	Flowing	Sunny	Water Milky clear.
9/02/2021	8:45	0.092	764	473.68	7.3	7.37	6.2	15.3	16.5	Flowing	Cloudy	Water Milky clear. Sample. Photo
10/03/2021	8:30	DRY	n/a	n/a	n/a	n/a	n/a	n/a	13.8	Dry	Cloudy	Dry
14/04/2021	9:05	DRY	n/a	n/a	n/a	n/a	n/a	n/a	14.9	Dry	Cloudy	Dry
11/05/2021	9:25	DRY	n/a	n/a	n/a	n/a	n/a	n/a	11.0	Dry	Cloudy	Dry
3/06/2021	9:50	0.094	943	584.66	6.1	6.10	5.7	9.6	10.0	Flowing	Cloudy	Water Milky clear.

**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
13/07/2020	12:25	DRY	X	X	X	X	X	X	11.3	dry	Cloudy	No Sampling as pool dry. No flow. Photos
11/08/2020	13:15	DRY	X	X	X	X	X	X	12.6	dry	Cloudy	No Sampling as pool dry. No flow.
7/09/2020	14:10	DRY	X	X	X	X	X	X	24.0	dry	Cloudy	No Sampling as pool dry. No flow.
13/10/2020	10:40	0.138	837	519	8.76	8.76	5.4	14.2	15.0	Flowing	Sunny	Water clear
10/11/2020	12:35	DRY	X	X	X	X	X	X	28.0	dry	Cloudy	No Sampling as pool dry. No flow.
9/12/2020	12:20	DRY	X	X	X	X	X	X	18.9	dry	Cloudy	No Sampling as pool dry. No flow.
11/01/2021	12:45	0.107	916	568	6.88	6.88	5.3	19.8	32.5	Trickle	Cloudy	Water clear
9/02/2021	7:40	DRY	X	X	X	X	X	X	18.9	dry	Cloudy	No Sampling as pool dry. No flow. Photo
9/03/2021	8:20	DRY	X	X	X	X	X	X	14.8	dry	Cloudy	No Sampling as pool dry. No flow.
14/04/2021	13:55	DRY	X	X	X	X	X	X	18.0	dry	Cloudy	No Sampling as pool dry. No flow.
10/05/2021	10:00	DRY	X	X	X	X	X	X	12.5	dry	Cloudy	No Sampling as pool dry. No flow.
3/06/2021	8:55	DRY	X	X	X	X	X	X	8.0	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
14/07/2020	9:15	BELOW	2270	1407	9.91	9.91	3.0	9.9	9.1	STAGNANT	CLOUDY	Water clear.
13/08/2020	9:10	0.010	2320	1438	9.93	9.93	3.1	8.9	9.5	STAGNANT	CLOUDY	Water clear.
8/09/2020	9:00	0.016	2270	1407	8.42	8.42	2.8	13.2	19.3	STAGNANT	CLOUDY	Water clear.
13/10/2020	10:00	0.107	2050	1271	8.77	8.77	3.1	15.4	14.7	STAGNANT	SUNNY	Water clear
11/10/2020	8:20	0.018	2260	1401	7.74	7.74	3.2	19.9	22.5	STAGNANT	SUNNY	Water clear
9/12/2020	12:50	BELOW	2750	1705	6.45	6.45	3.1	23.7	18.6	STAGNANT	SUNNY	Water clear
21/01/2021	8:00	BELOW	2760	1711	7.70	7.70	3.2	16.2	17.9	STAGNANT	CLOUDY	Water clear.
11/02/2021	9:50	Dry	n/a	n/a	n/a	n/a	n/a	n/a	22.5	Dry	Cloudy	NO SAMPLING- SWAMP DRY
9/03/2021	9:15	Dry	n/a	n/a	n/a	n/a	n/a	n/a	15.5	Dry	Cloudy	NO SAMPLING- SWAMP DRY
15/04/2021	9:10	Dry	n/a	n/a	n/a	n/a	n/a	n/a	14.2	Dry	Cloudy	NO SAMPLING- SWAMP DRY
10/05/2021	9:00	BELOW	2720	1686	8.71	8.71	3.7	11.8	12.7	STAGNANT	CLOUDY	Water clear.
4/06/2021	9:10	BELOW	2540	1575	9.10	9.10	2.9	8.9	9.9	STAGNANT	CLOUDY	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
13/07/2020	11:50	0.310	3740	2318.8	10.10	10.10	2.9	11.8	11.5	Flowing	Cloudy	Water clear, Photo taken
13/08/2020	10:50	0.303	3790	2349.8	7.84	7.84	3.0	8.8	9.5	Flowing	Cloudy	Water clear,
8/09/2020	15:50	0.305	3590	2225.8	9.73	9.73	2.8	14.7	18.9	Flowing	Cloudy	Water clear,
15/10/2020	8:10	0.356	3190	1977.8	8.70	8.70	3.0	14.6	17.2	Flowing	Cloudy	Water clear,
11/11/2020	10:00	0.291	3180	1971.6	8.00	8.00	3.1	18.5	22.0	Flowing	Cloudy	Water clear,
10/12/2020	12:30	0.208	3190	1977.8	8.86	8.86	3.8	18.6	18.3	Flowing	Cloudy	Water clear,
12/01/2021	10:55	0.084	3500	2170.0	7.70	7.70	3.3	23.0	20.9	Flowing	Cloudy	Water clear,
8/02/2021	12:50	0.052	3300	2046.0	5.80	5.80	3.0	22.7	22.9	Flowing	Cloudy	Water clear, Photo taken
9/03/2021	8:20	DRY	n/a	n/a	n/a	n/a	n/a	n/a	25.1	Dry	Cloudy	Dry
15/04/2021	10:40	DRY	n/a	n/a	n/a	n/a	n/a	n/a	15.2	Dry	Cloudy	Dry
10/05/2021	11:00	0.140	3340	2070.8	6.63	6.63	3.4	13.4	14.0	Flowing	Cloudy	Water clear
4/06/2021	10:30	0.288	3390	2101.8	8.95	8.95	2.9	11.1	10.2	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
13/07/2020	10:00	0.088	5160	3199.2	5.45	5.45	2.8	9.4	9.3	Flowing	Sunny	Water very clear
11/08/2020	10:00	0.092	5210	3230.2	6.49	6.49	2.8	7.9	9.1	Flowing	Cloudy	Water very clear
7/09/2020	12:15	0.119	4660	2889.2	7.87	7.87	2.8	12.4	22.0	Flowing	Cloudy	Water very clear
15/10/2020	8:45	0.176	4400	2728.0	7.14	7.14	2.9	14.6	17.7	Flowing	Cloudy	Water very clear
11/11/2020	10:30	0.127	4180	2591.6	6.79	6.79	3.0	13.9	20.3	Flowing	Cloudy	Water very clear
10/12/2020	11:30	0.050	4240	2628.8	7.17	7.17	3.8	22.9	18.3	Flowing	Cloudy	Water very clear
12/01/2021	11:30	0.052	4360	2703.2	6.44	6.44	3.2	23.0	20.6	Flowing	Cloudy	Water very clear
8/02/2021	11:30	0.027	4350	2697.0	6.49	6.49	3.0	20.0	20.9	Flowing	Cloudy	Water very clear
9/03/2021	10:30	BELOW	4630	2870.6	5.18	5.18	2.9	18.2	15.4	Flowing	Cloudy	Water very clear
15/04/2021	11:15	BELOW	4700	2914.0	8.25	8.25	3.2	17.8	18.1	No Flow	Cloudy	Water clear small pools in swamp
10/05/2021	11:45	BELOW	4030	2498.6	9.49	9.49	3.7	12.4	14.0	No Flow	Cloudy	Water clear
4/06/2021	11:00	BELOW	4930	3056.6	8.12	8.12	2.8	11.5	10.1	Flowing	Cloudy	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)	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	9/02/2021	1115	270	330	<2	<2	<2	77	<5		0.5	10	0.5	57	5.1
		14/07/2021	1220	260	300	2	2	<2	72	27		0.5	9.5	0.5	22	4.9
	SV1	9/02/2021	1015	360	390	32	32	<2	92	<10		6.6	14	2.3	48	6.3
		14/07/2021	1125	380	540	16	16	<2	140	<20		6.9	14	1.8	73	6.5
	SV4	9/02/2021	1245	210	250	10	10	<2	68	<20		1.8	5.6	1.3	38	5.9
		12/07/2021	1150	220	330	4	4	<2	91	<20		2.1	6.7	1.1	42	5.5
	SV2	8/02/2021	1205	580	990	<2	<2	<2	87	380		21	33	6	57	3.7
		13/07/2021	1325	160	250	<2	<2	<2	38	68		5.3	6.7	2	22	4.4
Anglesea River	AV1	9/02/2021	845	470	740	5	5	<2	200	44		2.5	15	2.8	100	5.5
		12/07/2021	900	400	720	4	4	<2	200	32		2.2	14	2.2	100	5.7
	AV3	9/02/2021	740	Dry												
		12/07/2021	750	560		<2	<2	<2	250	78		6.4	23	5	130	4.1
	AV2	13/07/2020	1000	2700	5100	<2<2	<2	<2	950	1500		83	110	9.8	470	2.7
		8/02/2021	1130	2700	4400	<2<2	<2	<2	870	960		59	83	9	420	2.8
	AGP1-B	Not required														

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				Major Ions					Ionic Balance		
Bore	Date	pH	TDS (mg/L)	EC (µS/cm)	Sulphate as SO4 (mg/L)	Bromide	Carbonate as CaCO3	Bicarbonate as CaCO3 (mg/ L)	Hydroxide as CaCO3	Alkalinity (total) as CaCO3	Calcium (mg/L)	Chloride (mg/L)	Magnesium m (mg/L)	Potassium m (mg/L)	Sodium (mg/L)	Total Cations (meq/l)	Total Anions (meq/L)	Ionic Balance
Inter-aquifer Flow Monitoring																		
119348	21/07/2020	8.14	810	1480	<1000		28	137	<1	164	8	397	7	27	223	11.4	14.5	12
NB2	16/07/2020	6.02	1410	2530	129,000		<1	91	<1	91	70	742	53	22	280	20.6	25.4	10.5
	11/01/2021	6.38	1410	2440	127,000		<1	85	<1	85	72	696	52	22	283	20.7	24	7.22
SB2	21/07/2020	6.11	3200	5680	357,000		<1	59	<1	59	56	1640	118	61	827	50	54.9	4.61
	11/01/2021	6.19	1110	2100	137,000		<1	58	<1	58	18	598	50	38	238	16.3	20.9	12.2
P15	22/07/2020	5.16	2890	890	62,000		<1	4	<1	4	5	267	18	14	114	7.05	8.9	11.6
	14/01/2021	5.41	533	938	60,000		<1	12	<1	12	4	267	18	15	116	7.11	9.02	11.8
Saline Intrusion Monitoring																		
P14	20/07/2020	5.98	724	806	22,000	0.347	<1	65	<1	65	7	232	12	44	93	6.51	8.3	12.1
	13/01/2021	6.5	480	990	6000	0.385	<1	125	<1	125	9	239	10	42	122	7.65	9.36	10
Swamp GDE																		
WTOB3	14/07/2020	5.92	975	1670	74,000		<1	24	<1	24	5	498	28	3	237	12.9	16.1	10.8
	12/01/2021	5.9	1070	1630	74,000		<1	25	<1	25	5	484	27	3	241	13	15.7	9.27
P7B	14/07/2020	4.35	494	919	47,000		<1	<1	<1	<1	6	249	14	3	115	6.53	8	10.1
	12/01/2021	4.11	475	867	52,000		<1	<1	<1	<1	6	272	15	3	120	6.83	8.76	12.4
P8	14/07/2020	5.12	1280	2360	126,000		<1	4	<1	4	44	689	53	14	273	18.8	22.1	8.18
	12/01/2021	4.98	1880	2410	126,000		<1	3	<1	3	46	704	54	17	295	20	22.5	5.96
WTOB2	15/07/2020	4.08	2110	3700	638,000		<1	<1	<1	<1	66	890	76	28	422	28.6	38.4	14.6
	13/01/2021	4.08	1980	3260	516,000		<1	<1	<1	<1	54	877	64	29	378	25.1	35.5	17
P17	15/07/2020	6.77	853	1370	2000		<1	171	<1	171	33	352	24	5	164	10.9	13.4	10.3
	19/01/2021	6.53	808	1150	35,000		<1	134	<1	134	24	313	20	4	149	9.43	12.2	13
P1	15/07/2020	5.13	505	339	8000		<1	4	<1	4	1	69	3	2	43	2.22	2.19	0.58
	19/01/2021	5.32	1500	384	23,000		<1	8	<1	8	3	103	4	2	59	3.1	3.54	6.74
WTOB1	15/07/2020	5.37	778	822	59,000		<1	22	<1	22	3	202	11	2	116	6.15	7.37	8.98
	13/01/2021	5.41	900	987	63,000		<1	25	<1	25	5	277	14	2	143	7.67	9.62	11.3
Upper Anglesea Swamp and Trigger Level Site																		
P8	14/07/2020	5.12	1280	2360	126,000		<1	4	<1	4	44	689	53	14	273	18.8	22.1	8.18
	12/01/2021	4.98	1880	2410	126,000		<1	3	<1	3	46	704	54	17	295	20	22.5	5.96
P19	14/07/2020	6.28	787	1230	16,000		<1	64	<1	64	10	372	15	22	158	9.17	12.1	13.8
	12/01/2021	6.28	667	1190	54,000		<1	73	<1	73	10	347	15	25	162	9.42	12.4	13.5
P12	14/07/2020	6.45	718	1200	10,000		<1	80	<1	80	10	346	13	23	154	8.86	11.6	13.3
	12/01/2021	6.53	585	1160	10,000		<1	79	<1	79	10	356	13	26	157	9.06	11.8	13.2
Breakfast Creek Tributary																		
P16	15/07/2020	4.64	703	536	82,000		<1	<1	<1	<1	3	102	13	3	69	4.3	4.58	3.23
	19/01/2021	4.31	570	630	67,000		<1	<1	<1	<1	3	205	21	4	89	5.85	7.18	10.2

# Appendix F

## Monitoring and Assessment Program Update

## 1. Purpose

Under the bulk entitlement for the Anglesea borefield, Barwon Water has established a comprehensive Monitoring and Assessment Program (MAP) that has been independently reviewed by independent experts and approved by the Minister for Water.

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 our understanding of the long-term sustainability of groundwater resources in the Anglesea area.

The following section provides an update on the MAP for reporting period of the annual report.

## 2. Groundwater level monitoring

The Anglesea borefield was moved into a standby maintenance mode from 1 July 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.

## 3. 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 2020–2021.

## 4. 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.

## 5. 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 bore field and has all been completed throughout 2020 -2021.

## 6. 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 will next be completed in Spring 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 2020 – 2021.

#### 7. 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 2020.

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 2020.

#### 8. Acid sulfate soil investigations

To further understand the distribution of acid sulfate soils across the Salt Creek and Anglesea River catchment, Monash University were been contracted by Barwon Water to undertake soil sampling for potential acid sulfate soils. This report was completed in December 2020. A copy of the full report and summary report can be found on the Barwon Water website.

#### 9. Land level surveying

Barwon Water has 30 survey monitoring points covering the area of likely drawdown of groundwater levels in the Lower Eastern View Formation (LEVF). This regional subsidence network is surveyed annually. If land subsidence levels are recorded outside the permitted range of 20mm for two consecutive surveys at three survey locations or more, we must investigate further and change borefield operations as required.

#### 10. Rainfall gauging

Rainfall is recorded via rain gauges at three sites across the catchment. This data is downloaded on a monthly basis and maintained in accordance with approved Bureau of Meteorology standards.

#### 11. Failure of monitoring infrastructure

During the 2020-2021 period, any data loggers in observation bores nearing end of life (10 years) were replaced. This resulting in the purchase of 20 new loggers that have now been installed in observation bores.

# Appendix G

Shallow observation bore water  
level versus salinity level



