

Upper Barwon River Investigation Spring 2020

- Data Report
- February 2021

Upper Barwon River Investigation Spring 2020

Austral Research and Consulting
ABN 73 007 840 779
15 Buntings Rd
Kirkstall Vic 3283 Australia
Web: www.austral.net.au

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1. Introduction

Austral Research and Consulting (Austral) were contracted by Barwon Water to undertake an investigation into the sediment and water quality and macroinvertebrate condition of the upper Barwon River with regard to the extent of impact of low pH inflows from Boundary Creek.

The survey determined a baseline for ongoing monitoring of the Barwon River as part of a remediation plan required by a section 78 Ministerial Notice by:

- Assessing the spatial extent of surface water effects resulting for acidic discharge from Boundary Creek in the Barwon River,
- Determining if acidic discharge from Boundary Creek has affected sediment in the Barwon River and if so, the spatial extent and depth of accumulation, and;
- Assess the potential impact of acidic discharge from Big Swamp at Yeodene on the macroinvertebrate community structure in Boundary Creek and the Barwon River.

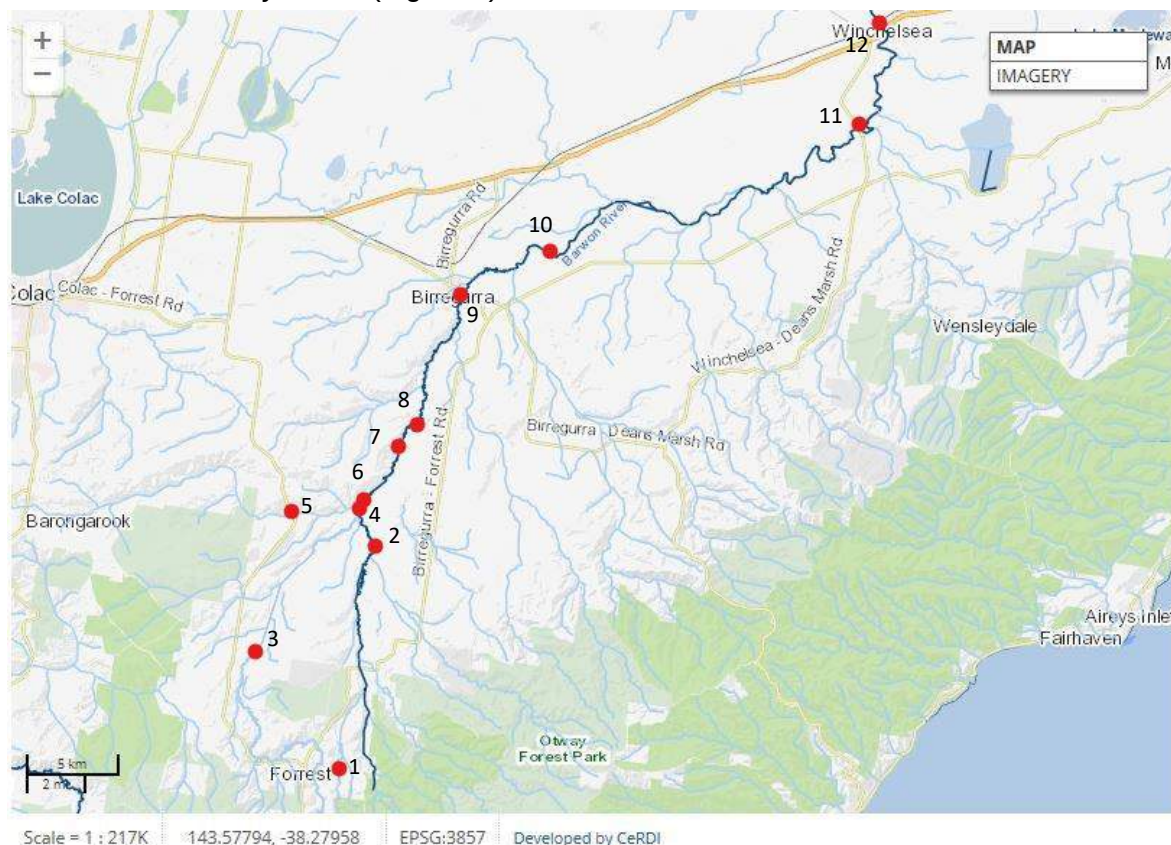
This is a data report only and the information will be incorporated with data to be collected in Autumn 2021 and compared to data collected by Austral Research and Consulting in 2019/20. This report will provide an overall assessment of all the macroinvertebrate sampling undertaken to date as part of the remediation plan.

1.1. Background

Studies have confirmed that past water extractions from the Barwon Downs borefield by Barwon Water to boost Geelong's water supply in conjunction with a dry climate led to reductions in flows in lower Boundary Creek (Jacobs, 2017). This in turn caused Big Swamp to dry out activating naturally occurring acid sulfate soils that when rewetted have released acidic water into the lower reaches of Boundary Creek. Boundary Creek joins the Barwon River 3.7km downstream of Big Swamp.

2. Methods

A total of twelve sites were surveyed along East Barwon, West Barwon, and Barwon Rivers in addition to Boundary Creek (Figure 1).



■ **Figure 1: Barwon River and Boundary Creek (base map from Waterwatch Victoria)**

2.1. Site Selection

Sites were selected in consultation with Barwon Water to best give an indication of the impact of water coming from Big Swamp on Boundary Creek and particularly the Barwon River. Two sites are on the East Barwon River, one site is on the West Barwon River, one site is on Boundary Creek and eight sites are on the mainstem Barwon River. They incorporate existing Waterwatch sites, upstream sites that are unimpacted by Boundary Creek (sites 1-4) and sites focused on any impacts from Boundary Creek (Table 1).

Site no.	Existing number	Site description	Lat	Long
1	CO_BAR004 (inact.)	East Barwon River @ Kents Road, Yaughar	-38.512196	143.732530
2	New	East Barwon River @ Dewings Bridge Road	-38.434878	143.747933
3	CO_WES010	West Barwon River @ 7 bridges Road	-38.474669	143.689396
4	New	Barwon River immediately u/s of Boundary Ck conf.	-38.418236	143.742025
5	CO_BOU009	Boundary Creek, Colac-Forrest Road	-38.421122	143.710475
6	New	Barwon River immediately d/s of Boundary conf.	-38.416717	143.742383
7	New	Barwon River u/s CO_BAR016	-38.402291	143.757554
8	CO_BAR016	Barwon River @ Colac-Lorne Road	-38.388771	143.768956
9	CO_BAR020	Barwon River @ Birregurra	-38.339105	143.790971

10	CO_BAR030	Barwon River @ Conns Lane	-38.325134	143.832385
11	CO_BAR040	Barwon River @ Winchelsea Deans Marsh Road	-38.278018	143.978382
12	CO_BAR060	Barwon River @ Princes Hwy bridge, Winchelsea	-38.240445	143.989326

■ **Table 1: Site locations and descriptions**

2.2. Sampling methodology

Macroinvertebrates and *in situ* water quality, vegetation, site descriptions and photos were collected with specific sampling methods detailed below.

2.2.1. In-situ water quality

In-situ water quality parameters were measured at each site including dissolved oxygen (mg/L), temperature (°C), specific conductivity (µS/cm) and pH using a YSI ProPlus water quality meter. Turbidity (NTU) and alkalinity (mg/L) were measured using HACH meters and test kits respectively.

2.2.2. Metals in water

Water samples were collected for metals analysis and kept refrigerated prior to delivery to the NATA accredited Eurofins Laboratory. Unfortunately the December samples were not filtered by the laboratory as requested, therefore values were Total Metals, not filtered metals as previous samples were. Retesting occurred on January 20, 2021 and the results reported against the December results in Appendix 2. The metals reported in the body of this report are all filtered concentrations to enable comparisons with previous samples and ANZECC guidelines.

2.2.3. Macroinvertebrates

The benefit of monitoring the biological community is that it is affected by numerous types of toxicants and disturbances and the impacts can be evident over months or years (if two seasons are sampled) unlike chemical testing which may not capture an event.

Macroinvertebrates were collected at each site and photos and site assessment sheets were completed as per Victorian EPA guidelines (EPA, 2003). In the absence of riffle habitats, two edge samples were collected (L. Metzling 2019 pers. comm. August 12) using a 250µm mesh dip net to sample ten meters of representative habitat at two locations at each site on the 7th and 8th December, 2020. A significant rain event prevented samples being collected in late November as planned. The contents of the net are placed into a white tray to be picked through for 30 minutes with the aim of picking over 100 animals into 70% ethanol for later identification to family level following the Rapid Bioassessment Methodology for Rivers and Streams (EPA, 2003). Macroinvertebrates were identified in the laboratory in accordance with the guidelines; to class for Oligochaeta and Mites, chironomids to sub-family and all other taxa to family except those that are not included in EPA Victoria biotic calculations (EPA, 2003).

2.2.4. Site descriptions

EPA Victoria field sampling and habitat assessment sheets were filled out at each site and site photos taken (EPA, 2003). This information has been summarised in Appendix 1. The reported habitat parameter score is not expected to change over the short term unless works have been undertaken at the site such as riparian revegetation or fencing or large woody debris introduction or the site is experiencing changes in flow such as drought conditions.

3. Results

3.1. Water quality

Water samples were collected and *in situ* readings taken at all 12 sites at the same time as macroinvertebrates were collected giving an indication of conditions at the time of sampling.

■ **Table 2: In-situ water quality data- Spring 2019, Autumn 2020, Spring 2020**

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (mg/L)	DO %	Alkalinity	Turbidity
Site 1 East Barwon Rv	Spring 19	13.2	6.2	186.7	240	13.07	123	5	9.09
	Autumn 20	14	8.67	161.8	210.16	4.42	47.5	5	2.6
	Spring 20	16.0	7.2	123.7	149.5	7.79	80.1	35	2.88
Site 2 East Barwon Rv	Spring 19	15.5	6.3	544	664	6.8	66.8	10	9.97
	Autumn 20	16	7.71	180.7	218.2	5.85	59.9	10	9.49
	Spring 20	16.2	7.6	272.0	327.3	10.86	110.4	55	9.35
Site 3 West Barwon Rv	Spring 19	14.7	5.26	473.4	590.6	7.3	73.5	10	16.3
	Autumn 20	14.4	8.23	179.6	224.0	4.45	42.9	10	3.28
	Spring 2020	12.7	7.1	195.2	255.0	6.12	56.3	50	5.58
Site 4 Barwon Rv	Spring 19	17.9	7.4	575	664	9.15	96.4	10	8.01
	Autumn 20	17	6.60	211.2	248.4	6.08	64.3	10	41.5
	Spring 2020	14.1	7.4	248.1	326.1	8.25	80.5	55	17.7
Site 5 Boundary Ck	Spring 19	12.1	3.94	777	1030	7.43	67.6	0	2.92
	Autumn 20	10.4	4.05	680	944	2.05	18.5	0	260
	Spring 2020	12.9	3.1	614	798	5.31	50.6	0	6.82
Site 6 Barwon Rv	Spring 19	14.4	7.34	608	756	7.3	71.3	10	9.43
	Autumn 20	15.8	6.88	207.7	250.6	6.58	66.1	10	31.7
	Spring 2020	13.9	7.0	298.5	378.8	6.88	67.1	50	12.2
Site 7 Barwon Rv	Spring 19	13.4	7.9	599	770	7.2	71.7	5	10
	Autumn 20	15.4	6.46	207.9	256.2	7.46	75.6	5	21.8
	Spring 2020	14.2	7.1	276.6	348.2	7.15	69.7	45	13.6
Site 8 Barwon Rv	Spring 19	16.2	7.8	660	795	8.8	87.9	10	13.5
	Autumn 20	15.9	6.79	234.8	284.8	3.22	32	10	5.13
	Spring 2020	16.3	7.3	286.3	344.2	6.55	67.7	50	5.61
Site 9 Barwon Rv	Spring 19	15.4	7.8	1049	1288	9.7	98	15	16.6
	Autumn 20	16.2	6.79	494.4	600.6	6.65	69.8	15	11.1
	Spring 2020	16.7	7.5	477.8	568.1	8.28	86.6	25	16.2
Site 10 Barwon Rv	Spring 19	14.6	7.9	1252	1561	8.1	86.1	15	18
	Autumn 20	16.2	5.56	511	613	3.96	40.2	15	19.2
	Spring 2020	15.6	7.5	756	920	7.45	76.2	75	22.2
Site 11 Barwon Rv	Spring 19	13	7.9	1707	2227	9.23	87	15	26.1
	Autumn 20	15.6	6.26	762	929	3.62	35.2	15	13.3
	Spring 2020	15.5	7.6	863	1054	6.28	64.7	75	13.7
Site 12 Barwon Rv	Spring 19	12.4	8	1788	2364	8.4	82.1	15	19.9
	Autumn 20	15.9	6.69	924	1117	52.5	54.5	15	20.7
	Spring 2020	15.0	7.6	1048	847	6.25	62.8	85	17.1

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- Table 3: Metal results for water samples (mg/L) and ANZECC water quality guidelines (2000, Table 3.4.1) for trigger values applying to typical *slightly-moderately disturbed* systems. Spring 2020 results were taken in January 2021, see Appendix 2 for Spring 2020 and January 2021 information.

mg/L	Season	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Site 1	Spring 19	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	< 0.001	0.04	< 0.0001	< 0.001	< 0.005	0.032
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.21	< 0.001	0.007	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	0.06	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.68	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005	< 0.005
Site 2	Spring 19	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.4	< 0.001	0.15	< 0.0001	< 0.001	< 0.005	0.008
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.08	< 0.001	0.037	< 0.0001	0.001	< 0.005	< 0.005
	Spring 20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.006	< 0.0001	< 0.001	< 0.005	< 0.005
Site 3	Spring 19	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.31	< 0.001	0.31	< 0.0001	< 0.001	< 0.005	0.051
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	0.004	0.015	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.09	< 0.001	0.12	< 0.0001	< 0.001	< 0.005	< 0.005
Site 4	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	< 0.001	0.15	< 0.0001	< 0.001	< 0.005	0.017
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.14	< 0.001	0.35	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	< 0.001	0.019	< 0.0001	< 0.001	< 0.005	< 0.005
Site 5	Spring 19	10*	< 0.005	< 0.001	0.0002	< 0.001	< 0.001	5.4	< 0.001	0.06	< 0.0001	< 0.001	< 0.005	0.34
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	17	< 0.001	0.18	< 0.0001	< 0.001	< 0.005	0.015
	Spring 20	7.2*	< 0.005	0.001	< 0.0002	0.001	< 0.001	40	< 0.001	0.061	< 0.0001	0.001	< 0.005	0.23
Site 6	Spring 19	0.09	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.13	< 0.001	0.17	< 0.0001	< 0.001	< 0.005	0.057
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.17	< 0.001	0.16	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.69	< 0.001	0.29	< 0.0001	< 0.001	< 0.005	< 0.005
Site 7	Spring 19	0.07	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.15	< 0.001	0.08	< 0.0001	< 0.001	< 0.005	0.013
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	0.001	0.09	< 0.001	0.01	< 0.0001	< 0.001	< 0.005	0.006
	Spring 20	0.06	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.37	< 0.001	0.023	< 0.0001	< 0.001	< 0.005	< 0.005
Site 8	Spring 19	0.1	< 0.005	< 0.001	< 0.0002	< 0.001	0.001	0.23	< 0.001	0.066	< 0.0001	< 0.001	< 0.005	0.015
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.24	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005	< 0.005
Site 9	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.098	< 0.0001	< 0.001	< 0.005	0.01
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.016	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.37	< 0.001	0.037	< 0.0001	< 0.001	< 0.005	< 0.005
Site 10	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.09	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.027	< 0.0001	< 0.001	< 0.005	0.008
	Spring 20	0.09	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.6	< 0.001	0.045	< 0.0001	< 0.001	< 0.005	< 0.005
Site 11	Spring 19	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.42	< 0.001	0.1	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn20	< 0.05*	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.082	< 0.0001	< 0.001	< 0.005	< 0.005
	Spring 20	0.16	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	1.4	< 0.001	0.028	< 0.0001	< 0.001	< 0.005	< 0.005
Site 12	Spring 19	0.07	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.56	< 0.001	0.1	< 0.0001	< 0.001	< 0.005	< 0.005
	Autumn20	< 0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	< 0.05	< 0.001	0.044	< 0.0001	< 0.001	< 0.005	0.015
	Spring 20	0.27	< 0.005	0.001	< 0.0002	< 0.001	0.001	1.7	< 0.001	0.049	< 0.0001	< 0.001	< 0.005	< 0.005
ANZECC		0.05 (>6.5pH) *ID (<6.5pH)	ID	0.013	0.0002	0.001	0.0014	ID	0.0034	1.2	0.00006	0.005	0.00005	0.008

ID= insufficient data

Shaded exceeds trigger values

*aluminium results where pH is <6.5

Aluminium concentrations in Spring 2020 are above ANZECC guideline levels at Site 1, Site 7, and Sites 10, 11, and 12. Iron concentrations in Spring 2020 are greater than in Spring 2019 at Site 1, Site 5 (Boundary Creek), and Sites 6-12 although within the Barwon River (sites 1 and 6-12) neither element is likely to be bioavailable at the near neutral pH values recorded. Manganese is elevated in Spring 2020 compared to Spring 2019 only at Site 6 but remains well below ANZECC guidelines. Zinc levels are lower in Spring 2020 than Spring 2019 but still exceed ANZECC guidelines at Site 5 (Boundary Creek). Turbidity values are scattered but do show a trend for higher values to occur downstream, consistent with a catchment wide runoff contribution. At the pH values measured, elements may be adsorbed on the colloidal material or be insoluble oxyhydroxides and should not be bioavailable. There is no evidence for other point sources of these metals other than site 5.

3.2. Macroinvertebrates

Full analysis and reporting on macroinvertebrate community compositions will occur following the Autumn survey which will incorporate temporal trends and allow comparisons with environmental objectives. EPA (2004) advises, 'It is essential for the application of these indicators and objectives that this (Spring and Autumn) sampling protocol is followed' and that the 'Use of invertebrate data collected by other methods may lead to misleading interpretations.' Two full years of data will be available following the Autumn 2021 survey enabling any trends in waterway health to be identified and analysed.

■ **Table 4: Macroinvertebrate families collected and number of individuals in two samples (A and B) at each site in Spring 2020.**

Macroinvertebrate Family	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	9A	9B	10A	10B	11A	11B	12A	12B
Aeshnidae			2																					
Atyidae	4	10		4			2				1		2	2	1	2	2	1	11	9	8	5	2	1
Baetidae						1	26	4			3	2			1	1	2	4			33	8		
Belostomatidae			15	1								1												
Calamoceratidae						1									1			1			1			
Ceinidae	27	13	6	18		1	1	11			1		16	17	7	3	5	22	8	18	2	5	5	8
Ceratopogonidae			2				2	1		1		1	6		3		5	5		1				1
Chironominae	9	4	4	1	35	22	30	15	4		1	6	27	8	3	5	35	31	1		12	15	6	10
Coenagrionidae			20	14			3	3			11	11	11	6	11	14	15	5	4	2	4		8	5
Corduliidae												1												
Corixidae			31	14	1	2	2	1		1	18	10	2	4	7	14		3		3	15	26	27	19
Crambidae			23	2			1	1					3	1			6							
Culicidae					2				4	14		1	1			5	2				10	9	4	12
Dixidae		8																	1					
Dugesiidae		2	2		1	1	1	1			1	2	7	2	2	1	8	2	12		8	10	2	3
Dytiscidae	1	3	6	6	2	2		1	5	1	2	3		3									1	1
Dytiscidae (Larva)	1	2	4	2	1	7	1	1	1	1			1	6			1	1						
Ecnomidae											1		1		1									

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Macroinvertebrate Family	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	9A	9B	10A	10B	11A	11B	12A	12B
Elmidae																								1
Glossiphoniidae			1	19	2						1													1
Gripopterygidae	1	3				1											1							
Gyrinidae																					2	1		
Gyrinidae (Larva)			2	2				1					2	1			1	1	1	2	1			1
Hydraenidae				1	1		2														2			
Hydrobiidae	4				1																	1		8
Hydrobiosidae		23					3	2										1						
Hydrochidae												1									1			
Hydrophilidae			1								1						1							
Hydroptilidae	12	11	1		6	10	1	3				1	1	2		3	3	1		2				
Janiridae									11	4											6	7		1
Koonungidae										1														
Leptoceridae	7	14	16	10	21	7	26	7			18	26	23	7	13	25	23	11	5	7	5	6	4	6
Leptophlebiidae	1	14	3	1	1	5	2					1		2	1		6	14	1		1	1		1
Lymnaeidae			2	2	1							1		3										
Mites	2	1	3	2	9	13	2	2				4	1	3		1	2	4	6	2	19	20	12	5
Naucoridae			6									1				1			1					
Notonectidae			7	7							4	2	8	12	5	7	1		1	3	1		1	1
Notonemouridae							1	3					1											
Oligochaeta	1		4		19	3	3	4				1	5	3	3		2		1		1		1	
Orthocladiinae			6	3	3	2	9	12		1		3	4	5	2	4	32	14	11	21	1	2	1	4
Paramelitidae					3	2	7	5					2		1			4			3	4		
Perthiidae				2		2	3	1						1										
Physidae	14	20	26	10	28	1		1			7	10	13	14	10	8	19	4	5	6	28	20	6	17
Planorbidae	2	3		1	7	13		13			11	9			6	1				1			1	
Pleidae																	1						2	

Macroinvertebrate Family	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7A	7B	8A	8B	9A	9B	10A	10B	11A	11B	12A	12B
Podonominae		1																						
Scirtidae									4	5														1
Simuliidae		4					11	3																
Tanypodinae	4	17			1		4	5			1	2	2	2						2	9	3		3
Telephlebiidae							1							1								1		
Veliidae		1	2		13	11	1	1	4			1	4		6	2		2	9	1		1	2	7

3.3. Recommendations

Sampling of metals in the water along the Barwon River during the Boundary Creek remediation works should give an indication of whether they are still being mobilised by the low pH water coming into the system. Sampling at the same time as macroinvertebrates will give an indication of any impacts during higher flow (Spring) and lower flow (Autumn) conditions. Continuation of annual macroinvertebrate sampling in Autumn and Spring on the Barwon River during the remediation works on Boundary Creek should give an accurate picture of the health of the Barwon River.

4. References

ANZECC (2000) *Australian and New Zealand guidelines for fresh and marine water quality*. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

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Appendix 1:

4.1. Site 1- East Barwon River@ Kents Road



Site 1: upstream Spring 2019



Site 1: downstream Spring 2019



Site 1: upstream Autumn 2020



Site 1: downstream Autumn 2020



Site 1: upstream Spring 2020



Site 1: upstream Spring 2020

The East Barwon at Kents Road has diverse habitat with large deep pools and some riffle/run areas although in Autumn these runs had dried to trickles. The average stream width at was eight meters and bank full in Spring but had contracted to five meters in Autumn. Willows dominate the riparian zone and are growing within the stream channel. The

substrate is a mix of clay and silt with a number of aquatic macrophytes growing in the margins and shallow pool areas. The majority of the riparian zone is exotic vegetation, dominated by blackberries, willows and pasture grass. One larval fish was collected as bycatch during macroinvertebrate sampling. A concurrent snapshot study by EnviroDNA (2019) found evidence of platypus at this site. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 74 out of 140.

4.2. Site 2- East Barwon River@ Dewings Bridge Road



Site 2: upstream Spring 2019



Site 2: downstream Spring 2019



Site 2: upstream Autumn 2020



Site 2: downstream Autumn 2020



Site 2: upstream Spring 2020



Site 2: downstream Spring 2020

The East Barwon at Dewings Bridge Road consists of a slow flowing channel with extensive backwaters. There is very little riparian zone present but a number of submerged and emergent macrophytes provide good habitat for macroinvertebrates and fish. One larval fish was found in the sample net in Autumn 2020 and three pygmy perch in Spring 2020. The substrate is a mix of clay and silt with some sand. The average stream width at this site was seven meters and was bank full during both Spring and Autumn sampling. The majority of the riparian zone is pasture grass with stock access on both sides. Overall analysis of the

health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 59 out of 140.

4.3. Site 3- West Barwon River@ Seven Bridges Road



Site 3: upstream Spring 2019



Site 3: downstream Spring 2019



Site 3: upstream Autumn 2020



Site 3: downstream Autumn 2020



Site 3: upstream Spring 2020



Site 3: downstream Spring 2020

The West Barwon River at Seven Bridges Road has large deep pools with a number of large deep backwaters. The average stream width at this site is seven meters, narrow at the top of the surveyed reach and widening into a large pool near the bridge. The substrate is clay and silt mixed with 20% sand. There are some macrophytes present along with trailing bank vegetation, roots and instream large woody debris (primarily willow branches). Willows dominate the riparian zone a mix of shrubs and native and pasture grasses in the understory. Four larval fish were collected as bycatch during macroinvertebrate sampling in

Spring 2019. One mountain galaxias, one common galaxias, one pygmy perch and a laval galaxias were collected in Spring 2020. A concurrent snapshot study by EnviroDNA (2019) found evidence of platypus at this site in Spring 2019. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 85 out of 140.

4.4. Site 4- Barwon River upstream of Boundary Creek confluence



Site 4: upstream Spring 2019



Site 4: downstream Spring 2019



Site 4: upstream Autumn 2020



Site 4: downstream Autumn 2020



Site 4: upstream Spring 2020



Site 4: downstream Spring 2020

The Barwon River immediately upstream of the Boundary Creek confluence is a large slow flowing channel with shallow side sections that support a number of macrophyte beds. The average stream width at this site is nine meters. The substrate is clay and black silt with some large woody debris and filamentous algae present in addition to the macrophytes. *Juncus*, *Typha*, *Triglochin* and *Polygonum* are all present instream though riparian vegetation is limited to some isolated trees, a narrow native plantation and pasture grass with stock access. The introduced *Gambusia* (mosquito fish) were collected as bycatch

during macroinvertebrate sampling in Spring 2019. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 79 out of 140.

4.5. Site 5- Boundary Creek @ Colac- Forrest Road



Site 5: upstream Spring 2019



Site 5: downstream Spring 2019



Site 5: upstream Autumn 2020



Site 5: downstream Autumn 2020



Site 5: upstream Spring 2020



Site 5: downstream Spring 2020

Boundary Creek at Colac- Forrest Road has a mix of large deep pools, a large shallow pool at the bridge and shallow runs. It was bankfull at the time of Spring sampling in 2019 and 2020 with an average stream width of four meters, narrow at the top of the surveyed reach and widening into a large pool upstream of the bridge. During Autumn 2020 sampling, Boundary Creek at this site had contracted to a pool approximately 4 meters long by 2.5 meters wide. The pooled water was stagnant, with low oxygen concentrations and very high turbidity. The substrate is a mix of cobble, pebble, gravel, sand, clay and silt. There are no

macrophytes but there was some filamentous algae in Spring 2019, (absent in Spring 2020) and trailing bank vegetation present. The riparian zone is wide and a mix of native and exotic vegetation except the ground cover which is dominated by *Convolvulus* sp. and pasture grasses. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 81 out of 140.

4.6. Site 6- Barwon River downstream of Boundary Creek confluence



Site 6: upstream Spring 2019



Site 6 : downstream Spring 2019



Site 6: upstream Autumn 2020



Site 6: downstream Autumn 2020



Site 6: upstream Spring 2020



Site 6 : downstream Spring 2020

The Barwon River immediately downstream of the Boundary Creek confluence is a narrow deep channel with wide shallow edges dominated by grasses and aquatic macrophytes. The average stream width at this site is five meters and was bank full in Spring 2019 and 2020. There is a narrow channel at the top of the surveyed reach, narrowing to a confined channel downstream. The river had contracted to the main channel but remained flowing, leaving the fringes to dry out in Autumn 2020. The substrate consists of clay and silt with filamentous algae tangled through the macrophyte beds. Macrophyte species are varied

with Triglochin, Polygonum, Phragmites, and Juncus all present in addition to trailing grasses. Three different fish species were collected at this site as bycatch; southern pygmy perch, smelt and a galaxid in Autumn 2020 and gambusia and southern pygmy perch in Spring 2020. The riparian zone is limited to grasses and scattered native trees and shrubs with stock access to the site. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 70 out of 140.

4.7. Site 7- Barwon River upstream of CO_BAR16



Site 7: upstream Spring 2019



Site 7: downstream Spring 2019



Site 7: upstream Autumn 2020



Site 7: downstream Autumn 2020



Site 7: upstream Spring 2020



Site 7: downstream Spring 2020

The Barwon River upstream of CO_BAR16 adjacent to the northern boundary of the pine plantation has a large deep channel with any shallow areas dominated by beds of *Phragmites*. The average stream width at this site is seven meters. The substrate is clay and silt. In addition to the *Phragmites* beds there are beds of *Triglochin*, and scattered *Polygonum*, *Juncus* and other grasses. The riparian zone has a good mix of trees, shrubs and understory with a majority of native trees and shrubs. Overall analysis of the health of

the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 90 out of 140.

4.8. Site 8- Barwon River @ Colac- Lorne Road



Site 8: upstream Spring 2019



Site 8: downstream Spring 2019



Site 8: upstream Autumn 2020



Site 8: downstream Autumn 2020



Site 8: upstream Spring 2020



Site 8: downstream Spring 2020

The Barwon River at Colac- Lorne Road has large deep pools with a shallow areas at the sides and willow trees growing in the channel and some substrate exposed. The average stream width at this site is eight meters with a predominantly clay and silt substrate mixed with some sand. There are beds of Triglochin and Phragmites in addition to trailing grasses and large willows. The riparian zone consists of willow trees, pasture grasses and blackberries and allows stock access. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 69 out of 140.

4.9. Site 9- Barwon River @ Birregurra



Site 9: upstream Spring 2019



Site 9: downstream Spring 2019



Site 9: upstream Autumn 2020



Site 9: downstream Autumn 2020



Site 9: upstream Spring 2020



Site 9: downstream Spring 2020

The Barwon River at Birregurra consists of a large deep slow flowing pool. The average stream width at this site is five meters with steep clay banks. The substrate is clay and silt with willow roots, some snags and Triglochin beds scattered along the edges of the channel. There were recent willow removal works and replanting of the riparian zone in Spring 2019 amongst the pasture grass and blackberry groundcover. Rakali footprints were evident in

the soft sediment edge in Spring 2019. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 67 out of 140.

4.10. Site 10- Barwon River @ Conns Lane



Site 10: upstream Spring 2019



Site 10: downstream Spring 2019



Site 10: upstream Autumn 2020



Site 10: downstream Autumn 2020



Site 10: upstream Spring 2020



Site 10: downstream Spring 2020

The Barwon River at Conns Lane has large deep pools with some small deep backwaters and a narrow deep run at the top of the reach. The average stream width at this site is six meters. The substrate is clay and silt mixed with some sand and gravel. Phragmites beds line the channel and there are isolated patches of Triglochin in addition to Polygonum and trailing grasses along the waters edge. Larval fish and gambusia were collected in the macroinvertebrate net in Spring 2020. The riparian zone consists of relatively new and older native revegetation with pasture grass understory. Overall analysis of the health of the

waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 98 out of 140.

4.11. Site 11- Barwon River@ Winchelsea- Deans Marsh Road



Site 11: upstream Spring 2019



Site 11: downstream Spring 2019



Site 11: upstream Autumn 2020



Site 11: downstream Autumn 2020



Site 11: upstream Spring 2020



Site 11: downstream Spring 2020

The Barwon River at Winchelsea- Deans Marsh Road has large deep pools with a shallow run at the top of the reach. The average stream width at this site is five meters and the substrate is clay and silt mixed with some sand and gravel. Triglochin is growing in the shallow areas of the channel and there are roots, large woody debris and trailing grasses. The riparian zone is predominately native trees and understory with a mix of grasses as groundcover. Rakali footprints were spotted at the waters edge in Spring 2019. Overall

analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 90 out of 140.

4.12. Site 12- Barwon River @ Winchelsea



Site 12: upstream Spring 2019



Site 12: downstream Spring 2019



Site 12: upstream Autumn 2020



Site 12: downstream Autumn 2020



Site 12: upstream Spring 2020



Site 12: downstream Spring 2020

The Barwon River at Winchelsea has large deep pools with a large shallow pool at the top of the reach. The average stream width at this site is twelve meters. The substrate is clay and silt mixed with sand and some gravel. In addition to the *Phragmites* beds at the top of the reach and along some edges there are also patches of *Triglochin*. Large woody debris, trailing grasses and emergent vegetation such as *Polygonum* are also present. Riparian vegetation is predominantly native with many established eucalypts and groundcover is pasture grass. A concurrent snapshot study by EnviroDNA (2019) in Spring found evidence

of platypus at this site. Overall analysis of the health of the waterway using EPA habitat parameters for Low Gradient Streams gives this site a score of 88 out of 140.

Appendix 2: Water testing in Spring 2020

A laboratory error (total rather than filtered metals analysed) following the collection of Spring 2020 samples necessitated resampling once the error had been identified. Samples were collected on January 20th, 2021 and analysed for both total metals (to compare to the Spring 2020 sample) and filtered metals (to compare to previous samples and ANZECC guidelines). Table 5 also shows the variation in total metal concentrations, and most likely filtered metal concentrations, within a two month period.

- **Table 5: Metal results for water samples (mg/L) and ANZECC water quality guidelines (2000, Table 3.4.1) for trigger values applying to typical *slightly–moderately disturbed systems* for filtered metals.**

mg/L	Sample date (total or filtered metals)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
Site 1	Dec20 Total	0.06	< 0.005	0.001	0.0017	< 0.001	< 0.001	0.48	< 0.001	0.074	< 0.0001	0.003	< 0.005	< 0.005
	Jan21 Total	0.07	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.96	< 0.001	0.13	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	0.06	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.68	< 0.001	< 0.005	< 0.0001	< 0.001	< 0.005	< 0.005
Site 2	Dec20 Total	0.15	< 0.005	< 0.001	0.0014	< 0.001	< 0.001	0.7	< 0.001	0.068	< 0.0001	< 0.001	< 0.005	0.006
	Jan21 Total	0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.43	< 0.001	0.061	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	<0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.22	< 0.001	0.006	< 0.0001	< 0.001	< 0.005	< 0.005
Site 3	Dec20 Total	0.08	< 0.005	< 0.001	0.0016	< 0.001	0.001	0.73	< 0.001	0.23	< 0.0001	< 0.001	< 0.005	0.007
	Jan21 Total	<0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	0.003	0.21	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	<0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.09	< 0.001	0.12	< 0.0001	< 0.001	< 0.005	< 0.005
Site 4	Dec20 Total	0.15	< 0.005	< 0.001	0.0019	< 0.001	0.002	0.88	< 0.001	0.13	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Total	0.11	< 0.005	< 0.001	< 0.0002	< 0.001	0.001	0.75	< 0.001	0.13	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	<0.05	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	0.33	< 0.001	0.019	< 0.0001	< 0.001	< 0.005	< 0.005
Site 5	Dec20 Total	10*	< 0.005	0.003	0.0017	0.001	< 0.001	53	< 0.001	0.086	< 0.0001	< 0.001	< 0.005	0.46
	Jan21 Total	7.2*	< 0.005	0.003	0.0002	0.002	< 0.001	70	< 0.001	0.061	< 0.0001	0.001	< 0.005	0.25
	Jan21 Filtered	7.2*	< 0.005	0.001	< 0.0002	0.001	< 0.001	40	< 0.001	0.061	< 0.0001	0.001	< 0.005	0.23
Site 6	Dec20 Total	0.37	< 0.005	< 0.001	0.0016	< 0.001	< 0.001	1.1	< 0.001	0.12	< 0.0001	< 0.001	< 0.005	0.014
	Jan21 Total	0.15	< 0.005	< 0.001	< 0.0002	< 0.001	< 0.001	1.8	< 0.001	0.45	< 0.0001	< 0.001	< 0.005	0.008

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mg/L	Sample date (total or filtered metals)	Aluminium	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Selenium	Silver	Zinc
	Jan21 Filtered	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.69	< 0.001	0.29	< 0.0001	< 0.001	< 0.005	< 0.005
Site 7	Dec20 Total	0.31	< 0.005	< 0.001	0.0016	< 0.001	0.001	1.1	< 0.001	0.085	< 0.0001	< 0.001	< 0.005	0.008
	Jan21 Total	0.12	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.69	< 0.001	0.07	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	0.06	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.37	< 0.001	0.023	< 0.0001	< 0.001	< 0.005	< 0.005
Site 8	Dec20 Total	0.14	< 0.005	< 0.001	0.0015	< 0.001	0.002	0.72	< 0.001	0.095	< 0.0001	< 0.001	< 0.005	0.006
	Jan21 Total	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	<0.001	0.39	0.002	0.063	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	<0.001	0.24	< 0.001	<0.005	< 0.0001	< 0.001	< 0.005	< 0.005
Site 9	Dec20 Total	0.29	< 0.005	< 0.001	0.0015	< 0.001	0.002	1.1	< 0.001	0.098	< 0.0001	< 0.001	< 0.005	0.008
	Jan21 Total	0.13	< 0.005	< 0.001	<0.0002	< 0.001	0.001	0.75	< 0.001	0.082	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	<0.05	< 0.005	< 0.001	<0.0002	< 0.001	< 0.001	0.37	< 0.001	0.037	< 0.0001	< 0.001	< 0.005	< 0.005
Site 10	Dec20 Total	0.3	< 0.005	< 0.001	0.0014	< 0.001	0.001	1.3	< 0.001	0.12	< 0.0001	< 0.001	< 0.005	0.008
	Jan21 Total	0.31	< 0.005	< 0.001	<0.0002	< 0.001	0.001	1.3	< 0.001	0.078	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Filtered	0.09	< 0.005	< 0.001	<0.0002	< 0.001	<0.001	0.6	< 0.001	0.045	< 0.0001	< 0.001	< 0.005	< 0.005
Site 11	Dec20 Total	0.22	< 0.005	0.001	0.0018	< 0.001	0.003	1.2	< 0.001	0.091	< 0.0001	< 0.001	< 0.005	< 0.005
	Jan21 Total	0.52	< 0.005	0.001	<0.0002	< 0.001	0.001	2.2	0.001	0.088	< 0.0001	< 0.001	< 0.005	0.005
	Jan21 Filtered	0.16	< 0.005	<0.001	<0.0002	< 0.001	<0.001	1.4	< 0.001	0.028	< 0.0001	< 0.001	< 0.005	< 0.005
Site 12	Dec20 Total	0.43	< 0.005	0.002	0.0013	0.001	< 0.001	1.6	< 0.001	0.14	< 0.0001	< 0.001	< 0.005	0.009
	Jan21 Total	0.58	< 0.005	0.002	<0.0002	< 0.001	0.002	2.8	0.001	0.11	< 0.0001	< 0.001	< 0.005	0.005
	Jan21 Filtered	0.27	< 0.005	0.001	<0.0002	< 0.001	0.001	1.7	< 0.001	0.049	< 0.0001	< 0.001	< 0.005	< 0.005
ANZECC applies to filtered only Greater than:		0.05 (>6.5pH) *ID (<6.5pH)	ID	0.013	0.0002	0.001	0.0014	ID	0.0034	1.2	0.00006	0.005	0.00005	0.008

■ Table 6: Table 2: In-situ water quality data associated with Spring 2020 sampling

Site Waterway	Season	Temp. (°C)	pH	Conductivity (µS/cm)	Specific Conductivity (µS/cm@25°C)	Dissolved oxygen (mg/L)	DO %	Alkalinity	Turbidity
Site 1 East Barwon Rv	Dec 20	16.0	7.2	123.7	149.5	7.79	80.1	35	2.88
	Jan 21	15.6	6.3	122.1	148.7	6.23	63.2	35	6.02
Site 2 East Barwon Rv	Dec 20	16.2	7.6	272.0	327.3	10.86	110.4	55	9.35
	Jan 20	17.4	6.61	203.2	237.1	7.26	76.9	55	4.74
Site 3 West Barwon Rv	Dec 20	12.7	7.1	195.2	255.0	6.12	56.3	50	5.58
	Jan 20	15.1	6.01	215.3	265.3	5.23	51.7	50	2.50
Site 4 Barwon Rv	Dec 20	14.1	7.4	248.1	326.1	8.25	80.5	55	17.7
	Jan 20	18.5	7.34	209.7	239.5	6.39	67.9	55	9.58
Site 5 Boundary Ck	Dec 20	12.9	3.1	614	798	5.31	50.6	0	6.82
	Jan 20	16.8	3.4	633.0	772	6.25	62.2	0	27.4
Site 6 Barwon Rv	Dec 20	13.9	7.0	298.5	378.8	6.88	67.1	50	12.2
	Jan 20	17.3	7.44	221.6	258.4	5.95	62.7	50	13.1
Site 7 Barwon Rv	Dec 20	14.2	7.1	276.6	348.2	7.15	69.7	45	13.6
	Jan 20	17.4	7.53	230.3	269.2	5.97	61.9	45	14.2
Site 8 Barwon Rv	Dec 20	16.3	7.3	286.3	344.2	6.55	67.7	50	5.61
	Jan 20	18.7	6.91	235.9	268.1	5.9	54.5	50	3.73
Site 9 Barwon Rv	Dec 20	16.7	7.5	477.8	568.1	8.28	86.6	25	16.2
	Jan 20	19.6	7.09	338.2	376.3	7.24	78.6	25	12.0
Site 10 Barwon Rv	Dec 20	15.6	7.5	756	920	7.45	76.2	75	22.2
	Jan 20	20.7	7.15	337.8	367.6	6.13	68.4	75	22.0
Site 11 Barwon Rv	Dec 20	15.5	7.6	863	1054	6.28	64.7	75	13.7
	Jan 20	18.8	7.29	327.3	371.2	6.08	65.1	75	27.3
Site 12 Barwon Rv	Dec 20	15.0	7.6	1048	847	6.25	62.8	85	17.1
	Jan 20	20.0	7.27	356.0	393.8	6.19	68.9	85	22.1

Extra in-situ water quality measurements were taken whilst resampling metal concentrations and were fairly similar between the start of December, 2020 and mid January, 2021. Turbidity was increased at Site 5, Boundary Creek and Site 11 in January compared to December and Electrical Conductivity was similar along the Barwon River in January unlike the increase seen at all sites below Birregurra in December.