Water Quality Assessment of Emergency Discharges from Morwell River Diversion to Latrobe River

IA262900-2 | 1

29 September 2021

EnergyAustralia Yallourn

PO 4700002450

Water Quality Assessment of Emergency Discharges from Morwell River Diversion to Latrobe River

Project No:	IA262900
Document Title:	Water Quality Assessment of Emergency Discharges from Morwell River Diversion to Latrobe River
Document No.:	IA262900-2
Revision:	1
Document Status:	Final
Date:	29 September 2021
Client Name:	EnergyAustralia Yallourn
Client No:	PO 4700002450
Project Manager:	Hugo Bolton
Author:	Bonneville Consulting and Dr Simon Treadwell
File Name:	EnergyAustralia Water Quality Assessment Report FINAL

Jacobs Australia Pty Ltd.

Floor 11, 452 Flinders Street
Melbourne, VIC 3000
PO Box 312, Flinders Lane
Melbourne, VIC 8009
Australia
T +61 3 8668 3000
F +61 3 8668 3001
www.jacobs.com

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
A	15/09/2021	Preliminary Draft for EA	BB	HB	J-MB	ST
B	20/9/2021	Final Draft addressing EA feedback	BB	HB	J-MB	ST
C	23/9/2021	Draft Final addressing EA feedback	BB	HB	J-MB	ST
0	29/9/2021	Final	BB	HB	J-MB	ST
1	29/9/2021	Final – add more explanation in Section 3.4	BB	HB	J-MB	ST

Contents

Executive Summary

EnergyAustralia Yallourn has received an emergency discharge licence under Section 30A (Environment Protection Act 1970) from the Victorian EPA to discharge water from the Township Field Fire Services Pond (FSP) to the Latrobe River up to the end of August 2021. This is required in preparation for necessary repairs to a section of the Morwell River Diversion (MRD) because of flood damage during June 2021.

A water quality monitoring program commenced in the Latrobe River on 15th June 2021 to monitor any potential water quality related impacts from the FSP discharge. This data report provides analysis of the water quality results from 15th June 2021 to 13th August 2021.

The FSP emergency discharge commenced intermittently on 29th June 2021 following EPA approval. The average discharge volume was 63 ML/d, with a maximum of 90 ML/d, which was significantly lower than the maximum discharge volume of 232 ML/d allowed in the Section 30 A emergency discharge licence. Passing flows in the Latrobe River ranged from 1000 ML/d to 3500 ML/d, providing an average dilution rate (X:1) for the FSP discharge volume of 27:1 (3.7% of Latrobe River flows).

Water quality data analysis for the FSP emergency discharges to the Latrobe River show the following:

- Elevations in Sulfate and Electrical Conductivity immediately downstream
- No change in TSS, VSS and turbidity downstream
- Variability in Zinc, Aluminium, Copper, and Iron, but catchment influences have a greater effect than the discharge

Statistical t-tests show concentrations of most indicators were significantly higher in the Latrobe River at Thoms Bridge (Y94) than upstream (Y97) *regardless* of whether discharge was occurring or not. The only water quality indicators where the discharge made a significant difference was for sulfate and electrical conductivity. For all others, the difference at Thoms Bridge could not be confidently attributed to the discharge alone and was more likely from the influence of the Morwell River.

Sulfate was the only indicator for which the FSP discharge caused water quality conditions to exceed the ambient range in the Latrobe River. The observed sulfate concentrations were not expected to impact on any of the downstream environmental values of the Latrobe River.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to undertake Water Quality Assessment of Emergency Discharges from Morwell River Diversion to Latrobe River in accordance with the scope of services set out in the contract between Jacobs and the EnergyAustralia Yallourn ('the Client'). That scope of services, as described in this report in Section 1.2, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, the Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

EnergyAustralia Yallourn has received an emergency discharge licence under Section 30A (Environment Protection Act 1970) from the Victorian EPA to discharge water from the Township Field Fire Services Pond (FSP) to the Latrobe River up to the end of August 2021. This is to prepare the FSP to be part of the Morwell River Diversion (MRD) bypass system while necessary repairs are made to a section of the MRD because of flood damage during June 2021.

The FSP emergency discharge commenced on 29th June 2021 following EPA approval. Temporary emergency discharge infrastructure pumps the FSP water directly to Latrobe River, with the outfall located approximately 500 m upstream of the Morwell River confluence.

A water quality monitoring program commenced in the Latrobe River on 15th June 2021, upstream and downstream of the FSP discharge, to monitor any potential water quality related impacts from the FSP discharge. This data report provides analysis of the water quality results from 15th June 2021 to 13th August 2021 to identify any impacts that can be confidently attributed to the discharge.

2. Environmental Monitoring

This section outlines the water quality monitoring program.

2.1 Sampling dates

Water quality sampling has occurred three times a week in the Latrobe River since 15th June 2021. Results are available up until 13th August 2021. These sampling events have captured a range of flow conditions in the Latrobe River. They have also captured times where the FSP discharge was occurring (29th June to 15th July, 26th July to 1 August, 3rd to 9th August), and periods when the discharge ceased (Figure 2-1).

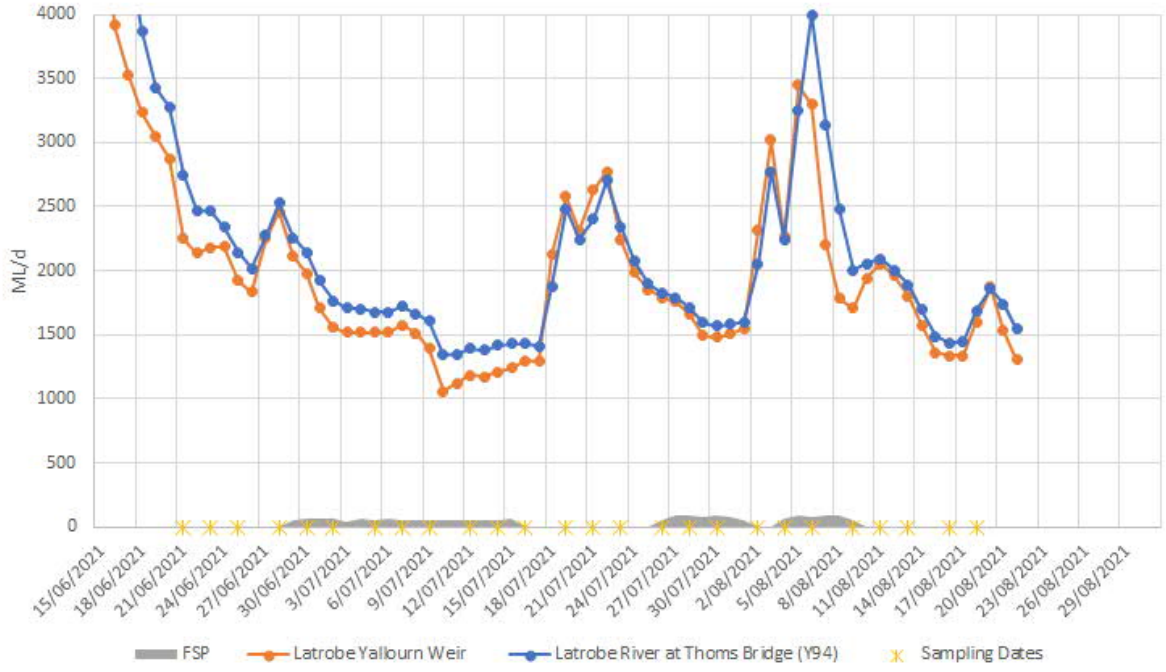

Figure 2-1 FSP emergency discharge volume (grey) in comparison to Latrobe River flows upstream (blue) and downstream (orange). Sampling dates are shown.

2.2 Sampling sites

The sampling locations of interest for this report are summarised in Table 2-1 and Figure 2-2. This included the emergency discharge quality from the FSP (YFSR) and sites upstream (Y97) and downstream (Y210 and Y94) in the Latrobe River. The downstream monitoring site (Y210) is upstream of the Morwell River confluence. This site location was moved on 4th August 2021 from 50 m downstream of the FSP discharge location to 30 m upstream of the Morwell River confluence (approximately 420 m downstream of the FSP discharge location) to ensure complete mixing of the FSP discharge with the Latrobe River passing flows. The earlier data (29th June – 3rd August) may be influenced by incomplete mixing. Water quality monitoring was also conducted at sites on the Morwell River, but these data were not included in this analysis.

Table 2-1 Sampling locations

Code	Location	Reason
YFSR	Township Field Fire Services Pond	Emergency Discharge Quality
Y97	Latrobe River at Yallourn Upstream of Emergency Discharge	Near-field upstream site
Y210	Latrobe River Downstream of Emergency Discharge, relocated from 50 m downstream of the discharge to 30 m upstream of the Morwell Confluence on 4th August 2021	Near-field downstream site
Y94	Latrobe River at Thoms Bridge Downstream of Emergency Discharge and Morwell River Confluence	Far-field downstream site

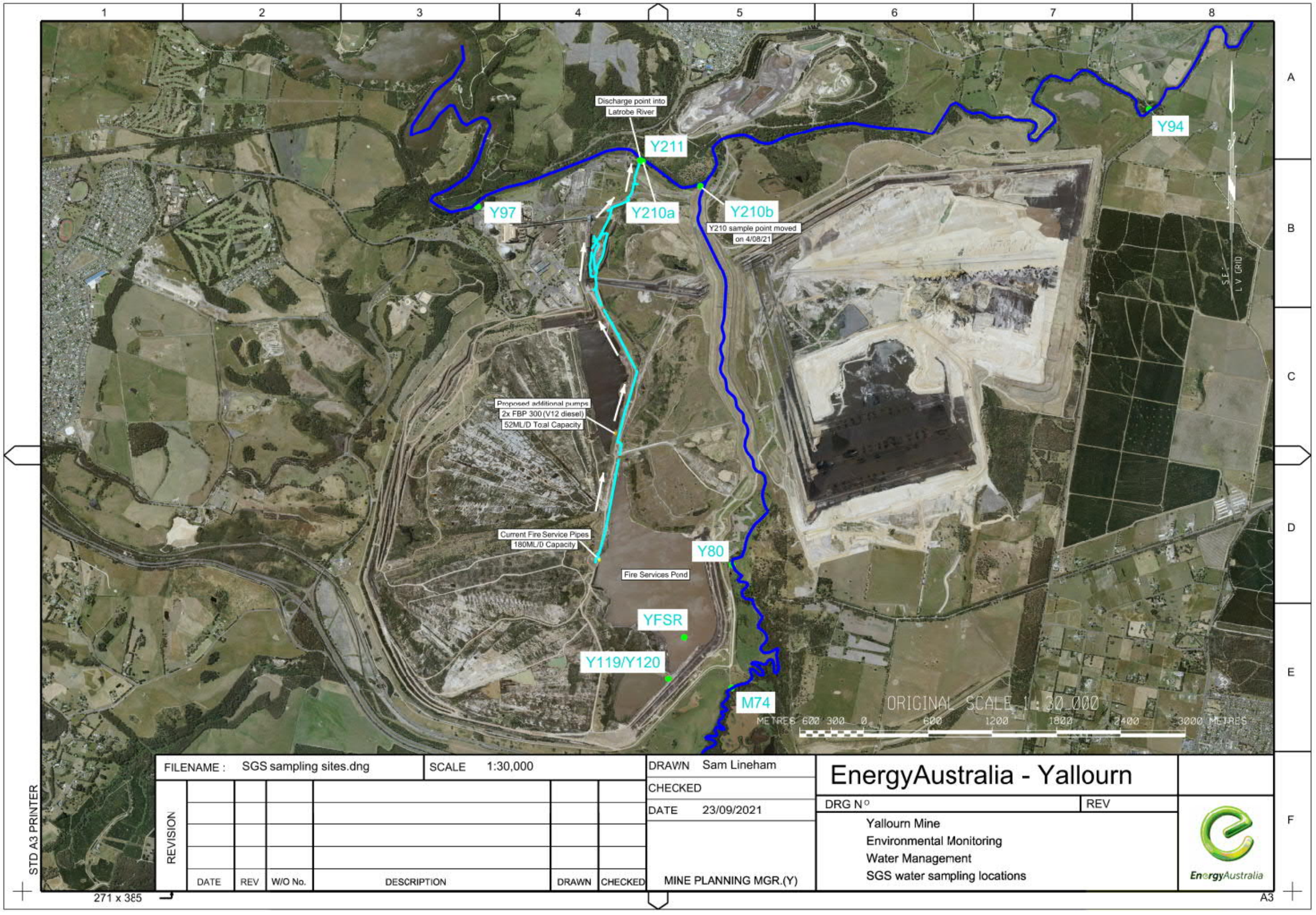

Figure 2-2 Location of sampling sites in the study location, showing location of Y97, Y210, YFSR and Y94

2.3 Indicators

The full-suite of water quality indicators that were routinely monitored are summarised in Table 2-2.

Table 2-2 Water quality indicators

Indicators	Reason	Analysis	Comment
Basic phys-chem	Basic water quality	pH, EC, TDS, DO, Turb, TDS, VSS, TSS, TFSS, Turbidity, Colour, temperature, Si02	
Anions and cations	Basic water quality	Alkalinity, F, Ca, Mg, Na, K, SO4, Cl	
Nutrients	Basic water quality	TN, TP, NO2, NO3, FRP, Ammonia, TKN	
Heavy metals	Runoff from industrial processes and disturbed geology	Total and dissolved - Hg, Al, Cd, Cr, Cu, Fe, Pb, Mn, Mo, Ni, Se, Zn, Sb, Ag, V Total – As, Be, B,	
Organic sulfur	Industrial solvent	Carbon disulfide	All concentrations were below the detection limits
Chlorinated hydrocarbons	Industrial solvents and raw materials	Chlorinated alkenes, chloroethanes, chloromethanes, chloropropanes, chlorobenzenes, chloronaphthalenes	All concentrations were below the detection limits
Polycyclic Aromatic Hydrocarbons	Occur in coal, crude oil and petroleum	Naphthalene	All concentrations were below the detection limits
BTEX	Found in crude oil, gas and petroleum	Benzene, Toluene, ethylbenzene, xylene (and sub-species)	All concentrations were below the detection limits
Total VOCs	Volatile organic carbons	VOCs	All concentrations were below the detection limits
Total Recoverable Hydrocarbons	Quantity of organic compounds including petroleum hydrocarbons	TRH C6-C9, C6-C10, C6-C10 minus BTEX, C10-C14, C15-28, C29-36, C37-40, >C10-C16, >C10-C16 minus Napthalene, C16-C34, C34-C40 and C10-C40	All concentrations were below the detection limits

Indicators	Reason	Analysis	Comment
Polychlorinated biphenyls (PCBs) also known as Arochlors. Arochlors have 4 digit numbers that indicate type and % of chlorine	Widely used in electric fluids in transformers, capacitors and coolants	Arochlor 1016, 1221, 1232, 1248, 1254, 1260, 1262, 1268, (DL < 1 µg/L) Total Aroclors (DL < 5 µg/L) Total PCBs (DL < 0.5 µg/L	All concentrations were below the detection limits

2.4 Water quality objectives

Water Quality Objectives (WQOs) are levels of indicators which must be met to achieve the environmental quality needed to protect environmental values of waters (Table 2-3). The following WQOs apply to the Latrobe River:

- WQOs for ecosystem stressors (physicochemical parameters and nutrients) are provided in the Environmental Reference Standard 2021 for the lowlands of the Latrobe River basin.
- WQOs for ecosystem toxicants (heavy metals and organics) are those provided in the Australian and New Zealand guidelines (ANZG) for fresh and marine water quality (2018 update of the ANZECC, ARMCANZ 2000 guidelines, Department of Agriculture and Water Resources) for the protection of 95% species in slightly to moderately modified ecosystems.
- WQOs for human consumption of aquatic food, agriculture, irrigation, and aquaculture are those provided in the Australian and New Zealand guidelines for fresh and marine water quality published in 2000 (ANZECC, ARMCANZ 2000).
- WQOs for water-based recreation are based upon ADWG as per recommendations in the Guidelines for Managing Risk in Recreational Waters (NHMRC, 2008).
- No WQOs are provided for Traditional Owner cultural values or Cultural and spiritual values. The SEPP (Waters) indicates that WQOs for water dependent ecosystems go some way to protect these beneficial uses.
- No WQOs are provided for Industrial and Commercial.

Table 2-3 Default water quality objectives for a range of environmental values

Indicator	Units	Aquatic Ecosystems[1]	Human consumption aquatic food, Aquaculture[17]	Irrigation[5]	Stock Watering[6]	Water-based recreation	
						Health[8]	Aesthetics[8]
Electrical conductivity (EC)	µS/cm	250[2]	-	1,000[12]	-	-	-
pH (acidity)	pH units	6.7 – 7.7[2]	44444	6 – 9[11]	6 – 9[11]	-	6.5 – 8.5
Dissolved oxygen (DO)	% sat	75 - 130[2]	>5 mg/L	-	-	>85	-
Turbidity	NTU	25	-	-	-	-	-
Suspended solids (SS)	mg/L	-	40				
Total dissolved salts (TDS)	mg/L	-	3000	-	2,000[14]	-	-
Colour, true	Pt Co	-	30-40	-	-	-	15
Aluminium	mg/L	0.055	0.03	5	5	ID	0.2
Antimony	mg/L	0.009[7]	-	-	-	0.03	-
Arsenic	mg/L	0.013	0.05	0.1	0.5	0.1	-
Beryllium	mg/L	0.00013[7]	-	0.1	ID	0.6	-
Boron	mg/L	0.37	-	0.5	5	40	-
Cadmium	mg/L	0.0002	0.0002 – 0.0018	0.01	0.01	0.2	-
Chromium	mg/L	0.0033[7]	0.02	0.1	1	-	-
Copper	mg/L	0.0014	0.005	0.2	0.4	20	1
Iron	mg/L	0.3[7]	0.01	0.2	NG	ID	0.3
Lead	mg/L	0.0034	0.001 – 0.007	2	0.1	0.1	-
Manganese	mg/L	1.9	0.01	0.2	NG	5	0.1
Mercury	mg/L	0.0006	0.001	0.002	0.002	0.01	-
Molybdenum	mg/L	0.034[7]	-	0.01	0.15	0.5	-
Nickel	mg/L	0.011	0.1	0.2	1	0.2	-
Silver	mg/L	0.05	0.003	-	-	0.1	-
Selenium	mg/L	0.011	0.01	0.02	0.02	1	-
Zinc	mg/L	0.008	0.005	2	20	ID	3
Total Nitrogen	mg/L	1.1[2]	-	5[9]	-	-	-
Ammonia (total)	mg N/L	0.9	-	-	-	ID	0.4[16]
Ammonium	mg N/L	0.02[3]	0.02	-	-	-	-
Nitrate	mg N/L	2.4[4]	11.3[16]	-	90[16]	110 [16]	-
Nitrite	mg N/L	-	0.03[16]	-	9.1[16]	90 [16]	-
NOx	mg N/L	0.04[3]	-	-	-	-	-
Total Phosphorus	mg/L	0.055[2]	-	0.05[10]	-	-	-
Phosphate (as P)	mg/L	0.02[3]	0.1	-	-	-	-

Indicator	Units	Aquatic Ecosystems[1]	Human consumption aquatic food, Aquaculture[17]	Irrigation[5]	Stock Watering[6]	Water-based recreation	
						Health[8]	Aesthetics[8]
Alkalinity	mg/L	-	>20	-	-	-	-
Chloride	mg/L	-	-	350[13]	-	-	-
Fluoride	mg/L	-	0.02	1	-	-	-
Sulfate	mg/L	-	-	-	1000	-	-
Calcium	mg/L	-	-	-	1000	-	-
Magnesium	mg/L	-	15	-	ID	-	-
Sodium	mg/L	-	-	230[13]	-	-	180

Notes: ID denotes insufficient data to derive an objective. NG denotes no guideline required, e.g. parameter is not toxic.
EC – Electrical Conductivity, DO – Dissolved Oxygen, SS – Suspended solids, TDS – Total Dissolved Solids.

[1] Quality objectives from ANZG except otherwise noted. Indicator values from ANZG were obtained via the Water Quality Australia website on 26 August 2019.
[2] SEPP (Waters).
[3] Default trigger values for physical/ chemical stressors for lowland rivers in south-east Australia, slightly disturbed ecosystems. For nitrogen species, this objective applies to ammonium, i.e. NH_4^+ and the sum of nitrate plus nitrite, i.e. NOx.
[4] The technical brief for nitrate available via the Water Quality Australia website states that the default guideline value for nitrate in the ANZECC, ARMCANZ (2000) guidelines was erroneous and that the "grading" guideline values from NIWA (2013) should be adopted. In the absence of nitrate in ambient monitoring data this grading value was adopted for NOx.
[5] Irrigation objectives taken from Section 4.2 of the ANZECC, ARMCANZ 2000 guidelines. Long-term trigger values (LTVs) were adopted as the quality objectives as a conservative measure unless otherwise noted. These are the maximum concentration of contaminant in the irrigation water which can be tolerated assuming 100 years of irrigation, based upon irrigation loading assumptions described in Section 9.2.5 of the ANZECC, ARMCANZ 2000 guidelines.
[6] Quality objectives were adopted from Section 4.3 of the ANZECC, ARMCANZ 2000 guidelines.
[7] Low reliability guideline value
[8] Quality objectives from the ADWG, values marked * have been multiplied by a factor of 10 to account for reduced consumption of water during recreational water use.
[9] Objective is protective of crop yield and quality. As it is lower than the short-term trigger value, which was set to minimise the risk of contaminating groundwater and surface water, the LTV is also considered to be protective of these endpoints. However it is noted that ANZECC, ARMCANZ 2000 recommends site-specific information pertaining to the type of crop being grown, what constitutes an environmentally significant concentration and gaseous losses be considered when applying STVs.
[10] Objective is protective for minimisation of bioclogging of irrigation equipment only (prevent algal growth in irrigation water).
[11] Objective is to limit corrosion and fouling of pumping, irrigation and stock watering systems.
[12] Objective is that of the most sensitive crop listed as important within the Latrobe region (Beans, *Phaseolus vulgaris*)
[13] Objective is that of moderately sensitive crops (most sensitive crop of the Latrobe region in the list provided – Potato)
[14] Objective is the most conservative value provided and is considered to be protective of poultry (and by default all other categories of stock including beef cattle, dairy cattle, sheep, horses, pigs and poultry).
[15] Units for colour in ADWG are Hazen Units (HU) however these are considered to be equivalent to Pt Co units.
[16] Converted from mg/L to mg N/L.
[17] Aquaculture objectives taken from Section 4.4 of the ANZECC, ARMCANZ 2000 guidelines. Where ranges are provided, the objective depends upon other factors such as hardness (this does not apply to pH). Some objectives are minimum values, e.g. DO concentrations should be greater than 5 mg/L.

3. FSP Emergency Discharge

This section summarises the FSP emergency discharge volume and quality.

3.1 Discharge volume

Over the monitoring period, the FSP emergency discharge to the Latrobe River occurred from 29th June to 15th July, 26th July to 1 August, 3rd to 9th August 2021. The average discharge volume was 63 ML/d, with a maximum of 90 ML/d on 28th July (Figure 3-1). This was significantly lower than the maximum discharge volume of 232 ML/d allowed in the Section 30 A emergency discharge licence.

Passing flows in the Latrobe River ranged from 1000 ML/d to 3500 ML/d (see Figure 2-1). Average dilution rates (X:1) for the FSP discharge volume provided by the Latrobe River were 27:1 (3.7% of Latrobe River flows), with a minimum of 18:1 (5%) and maximum of 45:1 (2.2%).

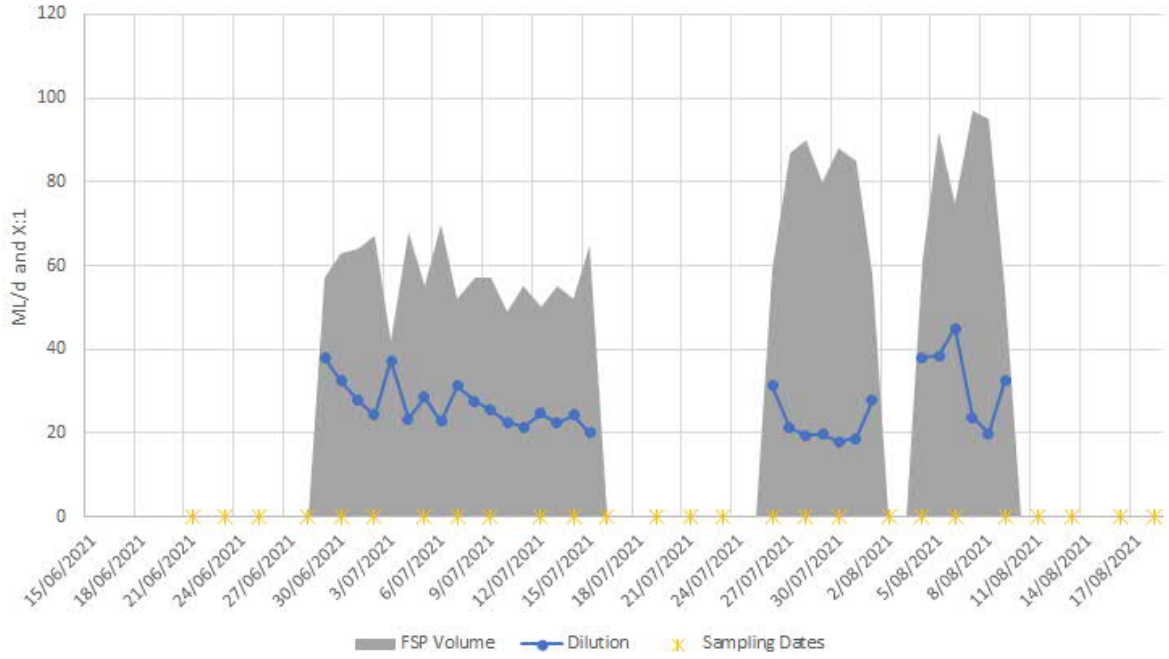

Figure 3-1 Emergency Discharge volume (ML/d, grey), dilution with Latrobe River flows (X:1, blue) and sampling dates (yellow)

3.2 Emergency discharge quality

The FSP emergency discharge quality over the period of discharge is summarised in Table 3-1. All concentrations of organics were below the detection limit and were not included (see Table 2-2).

Table 3-1 FSP Emergency discharge quality (June 2021 – August 2021) compared to Section 30A licence limits

Indicator	Units	Count	Min	10th	50th	90th	Max	Licence limits
Basic physio-chemistry								
Temperature	℃	22	9	10	10	11.9	13	
pH	pH Units	22	6.6	6.7	6.9	7.0	7.0	6.0-8.5
Electrical Conductivity	uS/cm	22	690	721	740	760	760	790 (median)
Total Dissolved Solids	mg/L	22	430	461	480	509	550	
Total Suspended Solids	mg/L	22	12	18	30	40	40	
Volatile Suspended Solids	mg/L	18	6	8	12	14	16	
Non-Volatile Suspended Solids	mg/L	18	2.5	2.5	19	25	27	
Turbidity	NTU	22	67	67.1	70	75	77	100 (max)
Colour	Hazen	22	50	50	50	59.5	60	
Total Alkalinity as CaCO3	mg/L	22	15	15	16	17	19	
Dissolved Oxygen	mg/l	10	9.4	9.6	10.8	12.1	12.5	
Anions and Cations								
Fluoride by ISE	mg/L	19	0.05	0.05	0.1	0.2	0.2	
Total Calcium	mg/L	22	13	14	15	16	18	
Total Magnesium	mg/L	22	17	18	19	20	22	
Total Sodium	mg/L	22	91	92	99	109	120	
Total Potassium	mg/L	22	6.3	6.43	6.9	7.39	8.2	
Total Mercury Hg	mg/L	22	<0.0001					
Mercury Hg (Soluble)	mg/L	22	<0.0001					
Reactive Silica, SiO_2	mg/L	19	2	8	29	45	46	
Chloride, Cl	mg/L	22	93	99	110	120	140	
Sulfate, SO4	mg/L	22	130	140	150	160	170	
Nutrients								
Nitrite, NO2 as N	mg/L	22	0.0025	0.0025	0.0295	0.784	0.83	
Nitrate, NO_3 as N	mg/L	22	0.0025	0.08	0.605	0.777	0.81	
Ammonia, NH3 as N	mg/L	22	0.005	0.005	0.005	0.059	0.11	
Total Nitrogen	mg/L	22	0.445	0.475	0.588	1.376	1.499	
Filterable Reactive P as P	mg/L	22	0.0025	0.0082	0.0185	0.054	0.074	
Total Phosphorus as P	mg/L	21	0.02	0.03	0.04	0.07	0.07	
Heavy metals								
Aluminium, Al (Soluble)	mg/L	22	0.34	0.34	0.38	0.46	0.47	
Cadmium, Cd (Soluble)	mg/L	22	<0.0001					
Chromium, Cr (Soluble)	mg/L	22	<0.001					
Copper, Cu (Soluble)	mg/L	22	<0.002					
Iron, Fe (Soluble)	mg/L	22	0.36	0.36	0.39	0.43	0.44	
Lead, Pb (Soluble)	mg/L	22	<0.001					
Manganese, Mn (Soluble)	mg/L	22	0.054	0.055	0.06	0.063	0.064	

Indicator	Units	Count	Min	10th	50th	90th	Max	Licence limits
Molybdenum, Mo (Soluble)	mg/L	22	<0.001					
Nickel, Ni (Soluble)	mg/L	22	<0.004					
Selenium, Se (Soluble)	mg/L	22	0.001	0.002	0.002	0.002	0.002	
Zinc, Zn (Soluble)	mg/L	22	0.011	0.011	0.013	0.014	0.019	
Antimony, Sb (Soluble)	µg/L	19	<1					
Silver, Ag (Soluble)	µg/L	19	<1					
Vanadium, V (Soluble)	µg/L	19	<1					
Total Aluminium	mg/L	22	1.5	1.6	1.7	1.9	2	
Total Arsenic	mg/L	22	<0.001					
Total Beryllium	mg/L	22	<0.001					
Total Boron	mg/L	22	0.053	0.059	0.067	0.076	0.076	
Total Cadmium	mg/L	22	<0.0001					
Total Copper	mg/L	22	0.003	0.003	0.004	0.004	0.004	
Total Chromium	mg/L	22	0.002	0.002	0.002	0.003	0.003	
Total Iron	mg/L	22	1.6	1.7	1.8	1.9	2.1	
Total Manganese	mg/L	22	0.073	0.075	0.079	0.0943	0.12	
Total Molybdenum	mg/L	22	<0.001					
Total Nickel	mg/L	22	0.005	0.005	0.005	0.006	0.006	
Total Selenium	mg/L	22	0.002	0.002	0.002	0.0029	0.003	
Total Zinc	mg/L	22	0.023	0.024	0.025	0.028	0.032	
Total Lead	mg/L	22	<0.001					
Total Antimony	µg/L	19	<1					
Total Silver	µg/L	19	<1					
Total Vanadium	µg/L	19	3	3	3	4	4	

Dilution requirements to meet WQOs were calculated for water quality indicators (90th percentiles) that were significantly higher in the FSP emergency discharge compared to ambient Latrobe River concentrations and/or exceeded the ANZG (2018) default guideline values for the protection of 95% of species (Table 3-2). Those indicators with the highest dilution requirements to meet water quality objectives (WQO) were total aluminium (34:1), total zinc (21:1) and sulfate (14:1). Aluminium levels are naturally high in the Latrobe River, so compared to the ambient median, the FSP discharge had a 3:1 dilution requirement. Other indicators with high dilution requirements to meet the ambient Latrobe River concentrations during the monitoring period were sulfate (27:1), total boron (6:1) and sodium (5:1).

Given the average dilution of the FSP discharge provided by passing flows was 27:1, with a minimum of 18:1 and maximum of 45:1, the dilution requirements for most indicators were met during the monitoring period. The exception was sulfate and total aluminium.

Table 3-2 Dilution requirements for FSP discharge in the Latrobe River to meet WQOs. Dilution to meet WQO was calculated as $(C_{fsp} – C_{wqo})/(C_{wqo}-C_{amb})$, except where $C_{wqo}<C_{amb}$, then C_{fsp}/C_{wqo}; Dilution to meet ambient was C_{fsp}/C_{wqo}

Indicator (mg/L)	FSP Discharge 90th percentile	WQO ANZG* or 80th percentile of ambient	Ambient Latrobe River 50th Percentile	Dilution factor to meet WQO (X:1)	Dilution factor to meet ambient (X:1)
Sulfate	160	17	6	14:1	27:1
Total Selenium	0.003	0.011*	<0.001	-	3:1
Soluble Selenium	0.002	0.011*	<0.001	-	2:1
Total Boron	0.076	0.940	0.012	-	6:1
Fluoride	0.2	<0.1	<0.1	2:1	2:1
Sodium	109	29	21	11:1	5:1
Electrical Conductivity (µS/cm)	760	322	180	4:1	4:1
Total Dissolved Solids	509	192	120	4:1	4:1
Total Zinc	0.028	0.008*	0.007	21:1	4:1
Soluble Zinc	0.014	0.008*	<0.005	3:1	3:1
Total Suspended Solids	40	30	17	2:1	2:1
Turbidity (NTU)	75	35	20	4:1	4:1
Total Aluminium	1.9	0.055*	0.66^	34:1	3:1
Soluble Aluminium	0.46	0.055	0.25	8:1	2:1
Total Iron	1.9	0.3*	1.1^	6:1	2:1
Soluble Iron	0.43	0.3	0.46	1:1	1:1
Total Copper	0.004	0.0014*	<0.002	1.5:1	2:1
Soluble Copper	<0.002	0.0014	<0.002	1.5:1	1:1

*DGV for protection of 95% of species, $^C_{amb}>C_{wqo}$

3.3 Ambient water quality

Time-series plots of selected indicators are provided below (Figure 3-2 to Figure 3-10). The downstream site Y210 was moved on 4th August 2021 from 50 m downstream of the FSP discharge location to 30 m upstream of the Morwell River confluence (approximately 420 m downstream of the FSP discharge location) to ensure complete mixing of the FSP discharge with the Latrobe River passing flows. The earlier data (29th June – 3rd August) may be influenced by incomplete mixing.

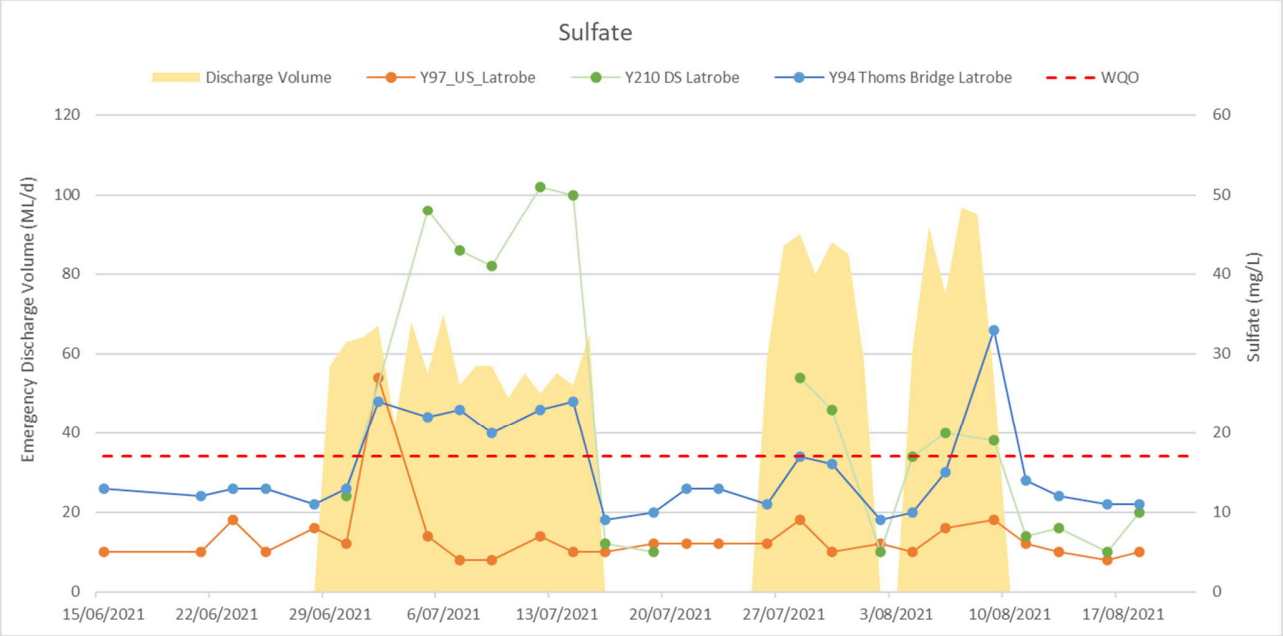

Figure 3-2 Ambient sulfate levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Sulfate levels are elevated downstream during periods of discharge.

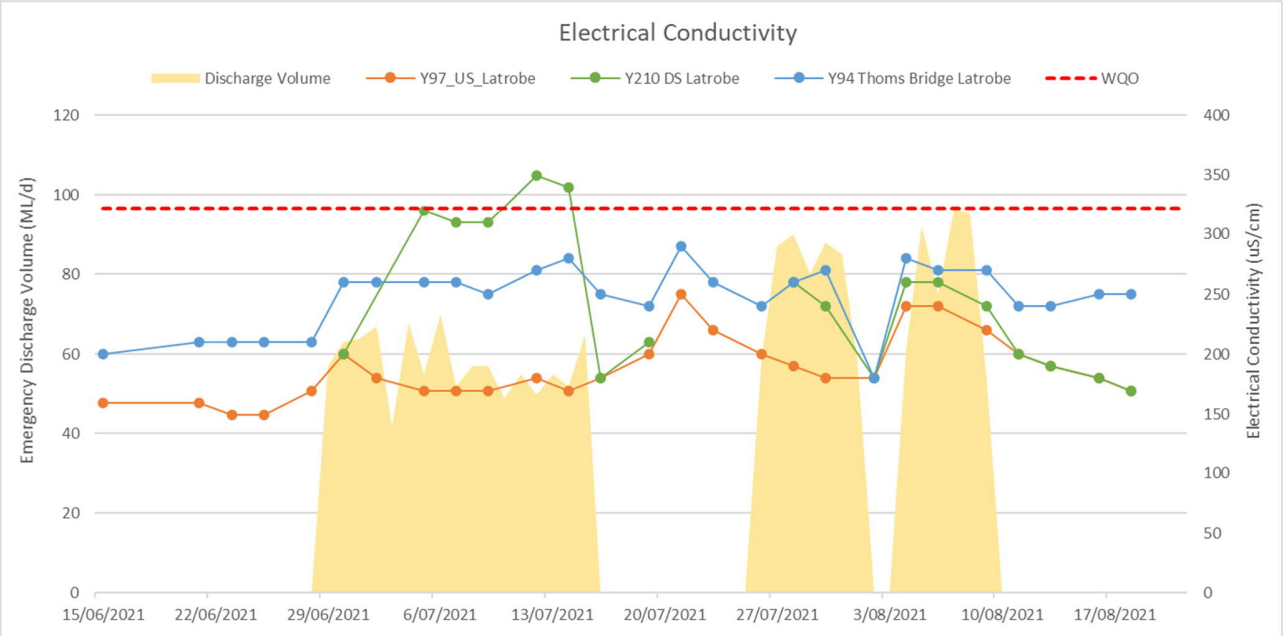

Figure 3-3 Ambient EC levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Electrical conductivity levels are elevated downstream during periods of FSP discharge, which may be due to incomplete mixing before 4th August

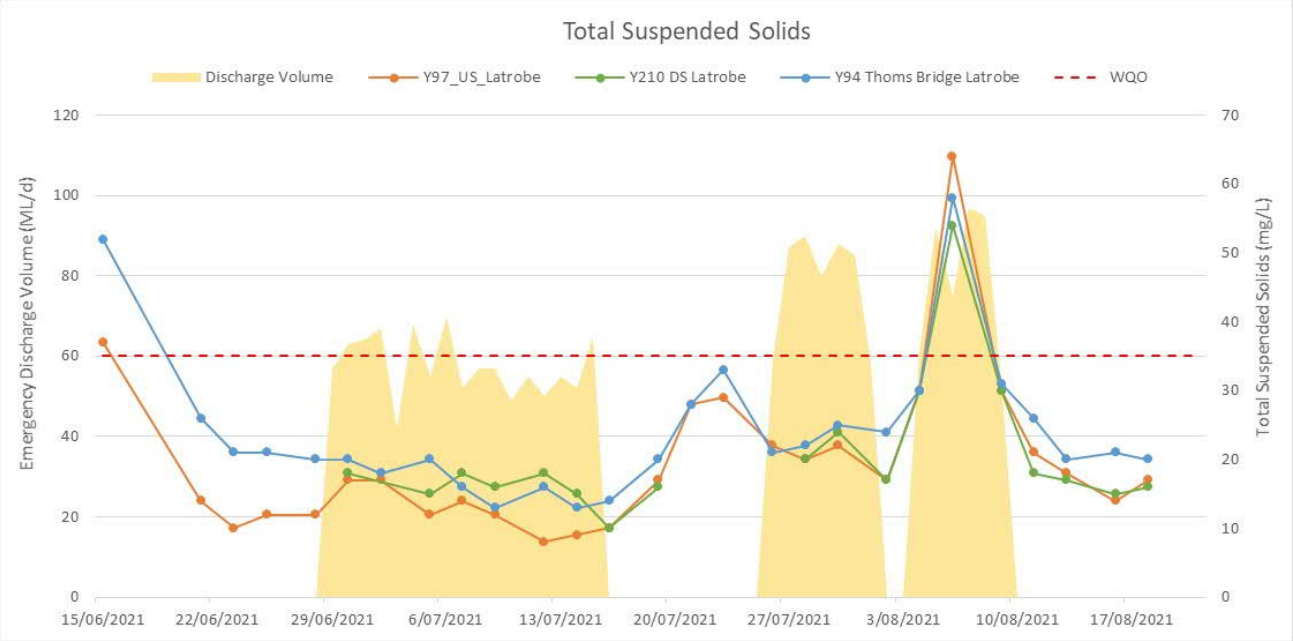

Figure 3-4 Ambient TSS levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- There is no change in TSS due to the FSP discharge

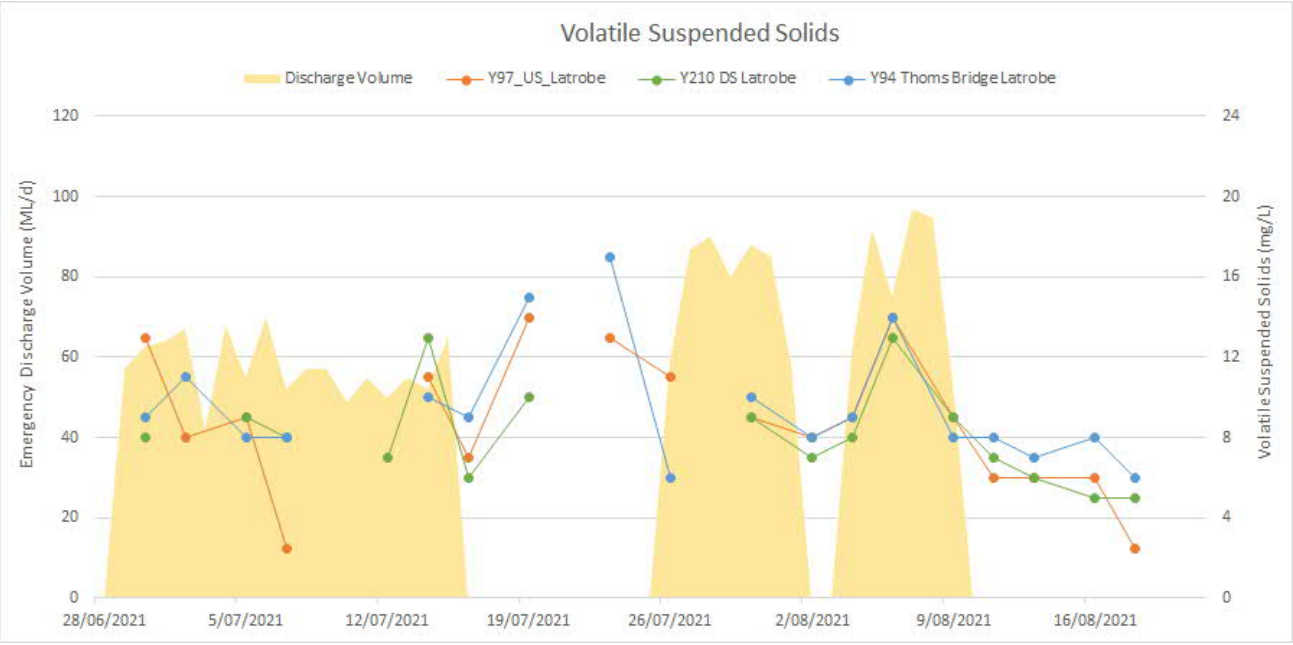

Figure 3-5 Ambient VSS levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- There is no change in VSS due to the FSP discharge

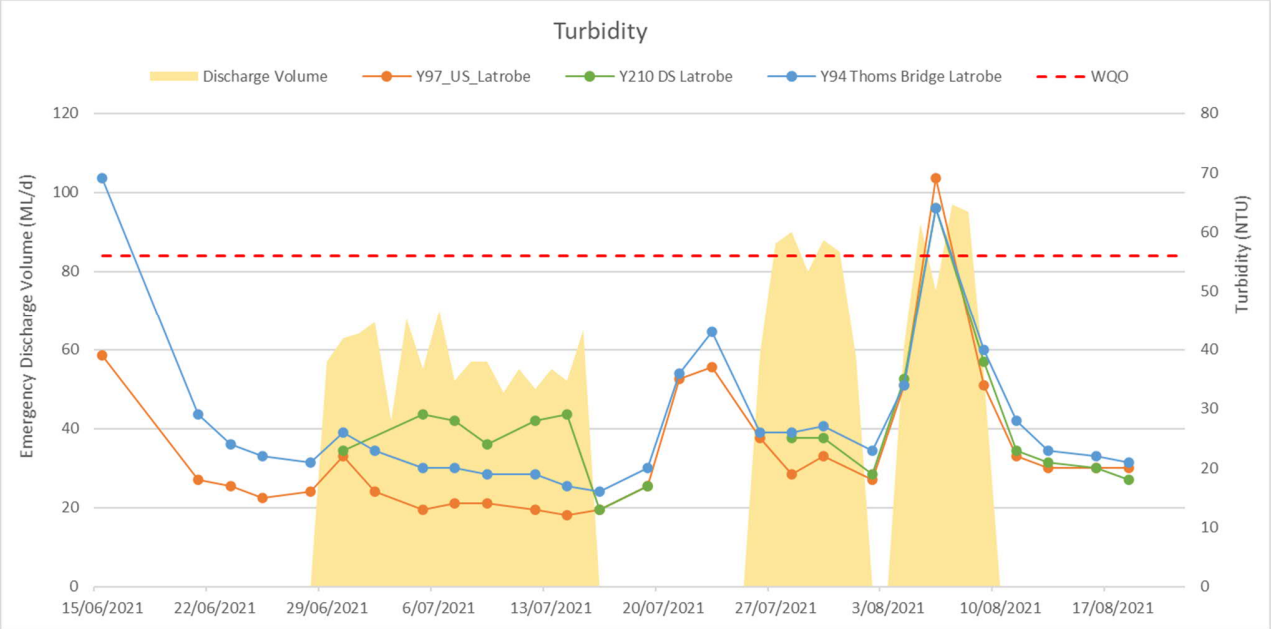

Figure 3-6 Ambient Turbidity levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Turbidity levels are elevated downstream but within the natural range of the river
- Flow was the primary driver of turbidity, irrespective of the discharge

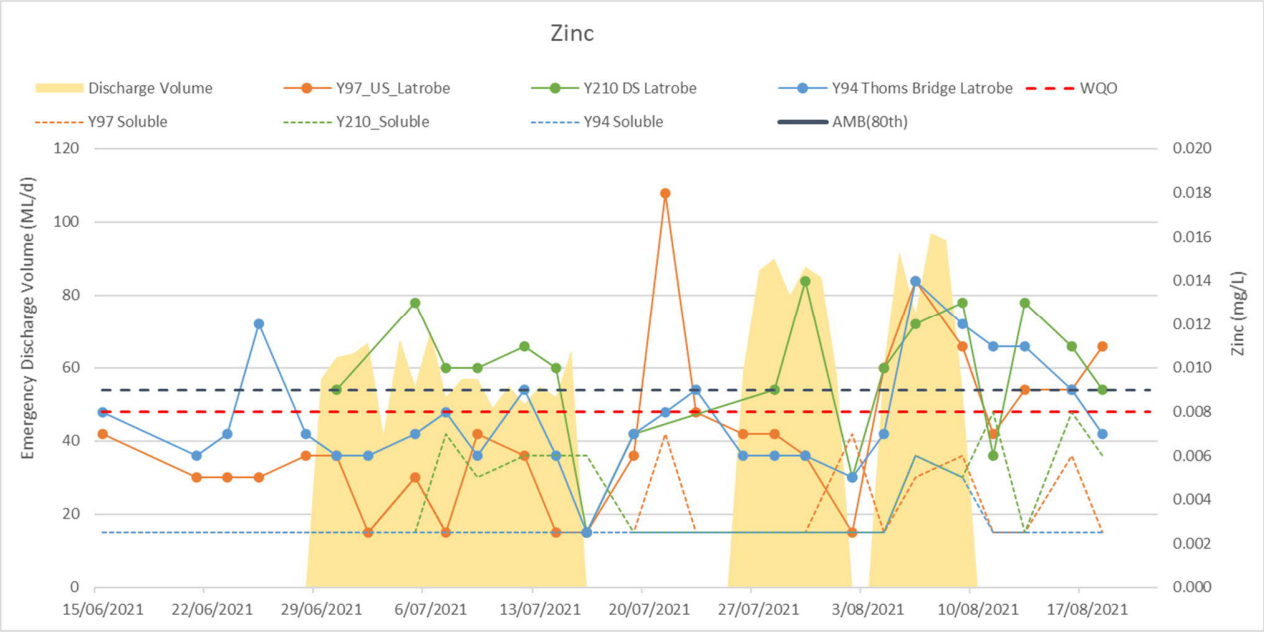

Figure 3-7 Ambient Total and Dissolved Zinc levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Total Zinc levels are elevated immediately downstream during periods of FSP discharge, but attenuates downstream at Thoms Bridge

- Soluble zinc is below the WQO on all occasions

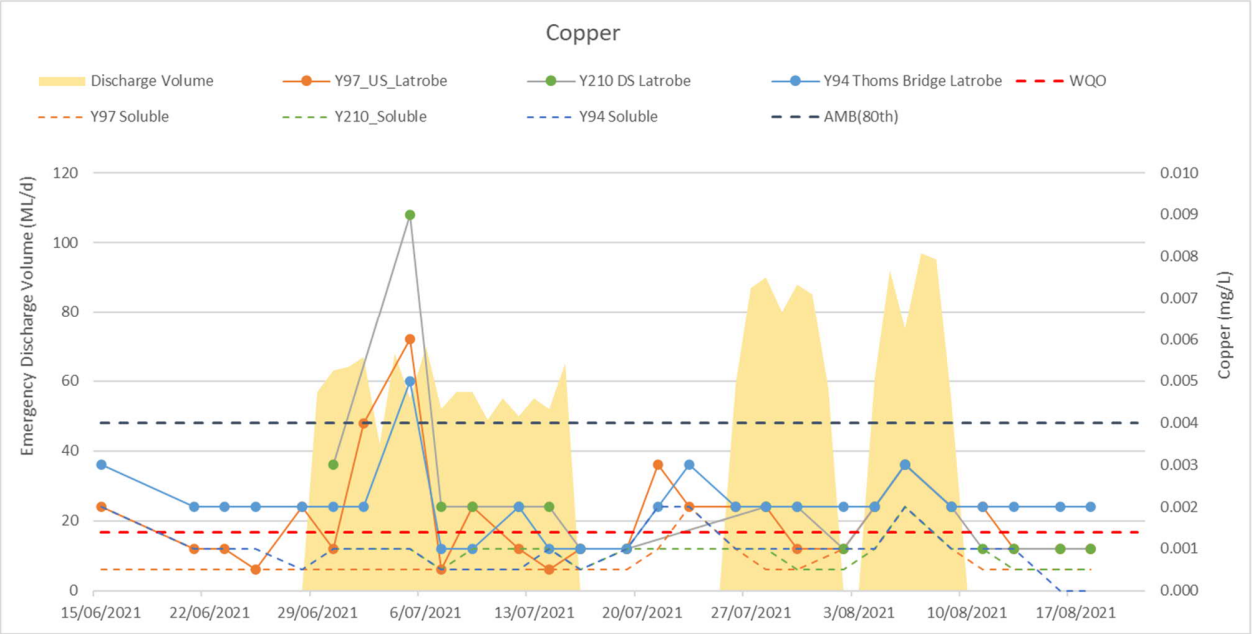

Figure 3-8 Ambient Copper levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Copper levels are generally at the detection limit, apart from a spike in early July which is unrelated to the discharge.
- Soluble copper is below the WQO on all occasions

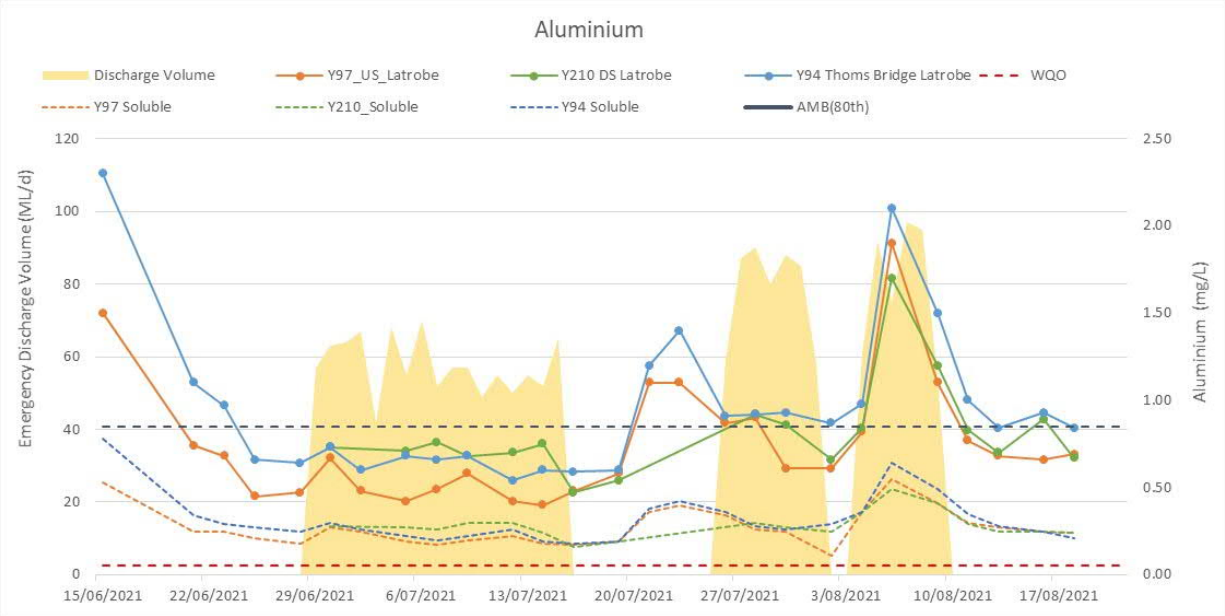

Figure 3-9 Ambient Total and Soluble Al levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Aluminium levels are increased slightly downstream during periods of FSP discharge
- Catchment influences have a larger impact on Aluminium

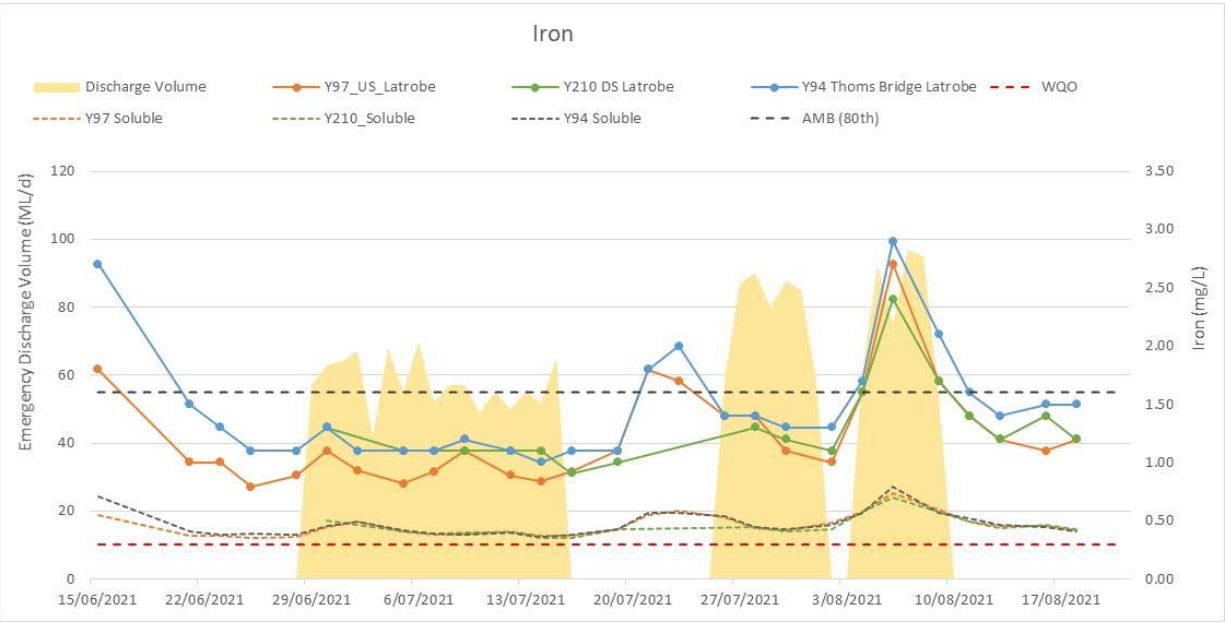

Figure 3-10 Ambient Total and Soluble Fe levels in the Latrobe River immediately US, DS and at Thoms Bridge DS during the monitoring period. The shaded area shows the volume of discharge.

- Total Iron levels are increased slightly downstream during periods of FSP discharge
- Catchment influences have a larger impact on Iron

3.4 Statistical analysis

Paired t-tests were performed on the water quality indicators for the Latrobe upstream of the discharge (Y97) and at Thoms Bridge (Y94) and separated for periods when discharge was and wasn't occurring.

Four tests were conducted to test any significant difference between Y97 and Y94 that could confidently be attributed to the discharge or whether there was just a general difference (for example, because of the confluence with the Morwell River). The test for significance was based on an analysis of p-values. If the p-value is <0.05 then there is a >95% probability that any difference in concentration between sites is significant – the lower the p-value the greater the probability that any differences are significant. If the p-value is >0.05 then any difference between sites is not significant.

The t-tests show concentrations were significantly higher at Thoms Bridge (Y94) than upstream (Y97) ***regardless*** of whether discharge was occurring or not (Bold in Table 3-3). The only water quality indicators where the discharge made a significant difference was for sulfate and EC (red in Table 3-3). For all others, the difference at Thoms Bridge could not be confidently attributed to the discharge alone and was more likely a result of the Morwell River (or at least a combination of the discharge and Morwell River).

One limitation is that the influence of river flow was not considered in the analysis. It might be that difference become significant under low flows compared to high flows.

Table 3-3 Paired t-tests for Latrobe River upstream and downstream, with and without the FSP emergency discharge. P-values in **bold** represent a significant difference ($p<0.05$) between sites. Concentrations in red indicate a significant difference ($p<0.05$) as a result of the FSP discharge.

Variable	Latrobe River Upstream of Discharge (Y97)	Thoms Bridge Downstream of Discharge (& Morwell River) (Y94)	P-value between upstream and downstream with and without discharge	Comment
Sulfate				Sulfate is significant higher at Thoms Bridge than upstream with and without discharge, but is also significantly higher at Thoms Bridge when discharge was occurring compared to when it was not – Discharge has a significant impact on Sulfate at Thoms Bridge
no discharge	5.77 mg/L	11.7 mg/L	0.000	
with discharge	7.85 mg/L	19.3 mg/L	0.000	
p-value at same site with & without discharge	0.22	0.000		
Electrical conductivity				EC is significant higher at Thoms Bridge than upstream with and without discharge, but is also significantly higher at Thoms bridge when discharge was occurring compared to when it was not – Discharge has a significant impact on EC at Thoms Bridge
no discharge	183	231	0.000	
with discharge	193	264	0.000	
p-value at same site with & without discharge	0.33	0.001		
Turbidity				Turbidity is significantly higher at Thoms Bridge than upstream with and without discharge. There is no significant difference within sites without and without discharge. – Discharge does not have a significant impact on turbidity at Thoms Bridge. Difference is most likely due to Morwell River
no discharge	22	28	0.006	
with discharge	24	28	0.001	
p-value at same site with & without discharge	0.73	0.91		
Suspended solids				Suspended Solids is significantly higher at Thoms Bridge than upstream with and without discharge. There is no significant difference within sites without and without discharge. – Discharge does not have a significant impact on Suspended solids at Thoms Bridge. Difference is most likely due to Morwell River.
no discharge	18	25	0.000	
with discharge	21	23	0.070	
p-value at same site with & without discharge	0.51	0.73		
Total Aluminium				Total Al is significantly higher at Thoms Bridge than upstream with and without discharge. There is no significant difference within sites without and without discharge. – Discharge does not have a significant impact on Total Al at Thoms Bridge. Difference is most likely due to Morwell River.
no discharge	0.751	0.996	0.000	
with discharge	0.743	0.910	0.000	
p-value at same site with & without discharge	0.96	0.62		

Variable	Latrobe River Upstream of Discharge (Y97)	Thoms Bridge Downstream of Discharge (& Morwell River) (Y94)	P-value between upstream and downstream with and without discharge	Comment
Soluble Aluminium				As for total Al, but mean difference and level of significance is less.
no discharge	0.27	0.320	0.018	
with discharge	0.281	0.311	0.002	
p-value at same site with & without discharge	0.71	0.87		
Total Copper				Total Cu is significantly higher at Thoms Bridge than upstream without discharge, but not significantly different with discharge. There is no significant difference within sites without and without discharge. – Discharge does not have a significant impact on Total Cu.
no discharge	0.001	0.002	0.006	
with discharge	0.002	0.002	1.00	
p-value at same site with & without discharge	0.14	0.81		
Soluble Copper				Soluble Cu is significantly higher at Thoms Bridge than upstream with and without discharge. There is no significant difference within sites without and without discharge. – Discharge does not have a significant impact on Soluble Cu at Thoms Bridge. Difference is most likely due to Morwell River.
no discharge	0.0007	0.0011	0.006	
with discharge	0.0007	0.0010	0.008	
p-value at same site with & without discharge	0.76	0.55		
Total Zinc				Total Zinc is not significantly different between upstream and downstream with or without discharge. Discharge does not have a significant impact on Total Zn at Thoms Bridge.
no discharge	0.007	0.008	0.57	
with discharge	0.007	0.008	0.17	
p-value at same site with & without discharge	0.70	0.84		
Soluble Zinc				Soluble Zinc is not significantly different between upstream and downstream with or without discharge. Discharge does not have a significant impact on Total Zn at Thoms Bridge.
no discharge	0.003	0.003	0.51	
with discharge	0.004	0.003	0.07	
p-value at same site with & without discharge	0.23	0.86		
Total Iron				Total Iron is significantly higher at Thoms Bridge than upstream with and without discharge. There is no significant difference within sites without and without discharge. – Discharge does not have a significant impact
no discharge	1.207	1.500	0.000	
with discharge	1.269	1.438	0.000	
p-value at same site with & without discharge	0.71	0.75		

Variable	Latrobe River Upstream of Discharge (Y97)	Thoms Bridge Downstream of Discharge (& Morwell River) (Y94)	P-value between upstream and downstream with and without discharge	Comment
				on Total Iron at Thoms Bridge. Difference is most likely due to Morwell River.
Soluble Iron				Soluble Iron is not significantly different between upstream and downstream with or without discharge. Discharge does not have a significant impact on Soluble Iron at Thoms Bridge.
no discharge	0.446	0.467	0.10	
with discharge	0.478	0.481	0.57	
p-value at same site with & without discharge	0.40	0.74		

4. Conclusion

4.1 Conclusions

Over the monitoring period, the FSP emergency discharge to the Latrobe River occurred from 29th June to 15th July, 26th July to 1 August, 3rd to 9th August 2021. The average discharge volume was 63 ML/d, with a maximum of 90 ML/d on 28th July, which was significantly lower than the maximum discharge volume of 232 ML/d allowed in the Section 30 A emergency discharge licence. Passing flows in the Latrobe River ranged from 1000 ML/d to 3500 ML/d, providing an average dilution rate (X:1) for the FSP discharge volume of 27:1 (3.7% of Latrobe River flows).

Water quality data analysis for the FSP emergency discharges to the Latrobe River show the following:

- Elevations in Sulfate and Electrical Conductivity immediately downstream
- No change in TSS, VSS and turbidity downstream
- Variability in Zinc, Aluminium, Copper, and Iron, but catchment influences have a greater effect than the discharge

Statistical t-tests show concentrations of most indicators were significantly higher at Thoms Bridge (Y94) than upstream (Y97) *regardless* of whether discharge was occurring or not. The only water quality indicators where the discharge made a significant difference was for sulfate and Electrical conductivity. For all others, the difference at Thoms Bridge could not be confidently attributed to the discharge alone and was more likely from the influence of the Morwell River.

Sulfate was the only indicator for which the FSP discharge caused water quality conditions to exceed the ambient range in the Latrobe River. The observed sulfate concentrations were not expected to impact on any of the downstream environmental values of the Latrobe River.

4.2 Recommendations

The following recommendations are given:

- Reduce monitoring frequency to weekly for basic water quality, nutrients, and heavy metals
- Reduce monitoring frequency of organics to fortnightly

The frequency of monitoring may be adjusted depending on dilution rates and discharge volumes.

5. References

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Online Resource. Accessed 15/2/21, https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/toxicants/zinc-2000.